Comprehensive Facilities Assessment

Durham County Facilities

Durham County, North Carolina
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Appendices

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Appendix D – Retro-Commissioning Savings Potential Summary
Appendix E – Supplemental Electrification Analysis Calculations
Appendix F – Light Duty Fleet Charging Infrastructure Guidance Memo

Acronyms

ABA	Architectural Barriers Act
ADA	American with Disabilities Act
AIM Act	American Innovation and Manufacturing Act of 2020
APS	Advanced Power Strip
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BESS	Battery Energy Storage System
BEV	Battery Electric Vehicle
CH_4	Methane
CO_2	Carbon dioxide
County	County of Durham
DCFC	DC Fast Charger
DHW	Domestic Hot Water
DOE	U.S. Department of Energy
EBERP	Energy Burden & Emissions Reduction Program
EECBG	Energy Efficiency and Conservation Block Grant
EPA	Environmental Protection Agency
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contract
EUI	Energy use intensity
FEMP	Federal Energy Management Program
GCR	Ground Cover Ratio
GWP	Global Warming Potential
HD	Heavy Duty
HDR	HDR Engineering, Inc. of the Carolinas
HFC	Hydrofluorocarbons
HOMER	Hybrid Optimization of Multiple Energy Resources
HVAC	Heating, ventilation, and air conditioning
ICE	Internal Combustion Engine
IRR	Internal Rate of Return
JRC	Justice Resource Center
JSD	Justice Services Department
LCC	Life-Cycle Cost
LCCA	Life Cycle Cost Analysis
LED	Light-Emitting Diode
LGS	Large General Service
MD	Medium Duty
MEP	Mechanical, Electrical, and Plumbing
MILCON	Military Construction
MT CO2e	Metric Ton of Carbon Dioxide Equivalent
N_2O	Nitrous oxide

NCCEF	North Carolina Clean Energy Fund
NCSEA	North Carolina Sustainable Energy Association
NEMA	National Electrical Manufacturers Association
NIST	National Institute of Standards and Technology
NPV	Net Present Value
O&M	Operations and Maintenance
PV	Photovoltaic
RCx	Retro-Commissioning
ROI	Return on Investment
RTU	Rooftop Unit
SGS	Small General Service
SIR	Savings/Investment Ratio
SLD	Single-Line Diagram
TOU	Time-of-Use
TRM	Technical Reference Manual
UESC	Utility Energy Services Contract
UL	Underwriters Laboratories
Utility	Duke Energy Carolinas

Disclaimer

The intent of this Comprehensive Facilities Assessment Report is to provide a preliminary estimate of the potential energy, energy cost and carbon savings available at the project site. HDR Engineering, Inc. of the Carolinas ("HDR") has exercised all reasonable efforts consistent with the degree of skill and care exercised by similarly situated members of the profession performing similar services at the same time and in the same locale as the Project, to confirm the accuracy of the analysis inputs, including verifying that actual details correspond to the building as currently designed. While the preliminary findings in this report have been reviewed for technical accuracy and are believed to be reasonably accurate, the actual results may vary. As a result, HDR is not liable if estimated energy or financial savings are not realized. All savings and cost estimates in the report are for informational purposes and are not to be construed as a design document or as guarantees. There are a number of factors that may cause the actual energy use of the building to diverge from the projected energy use of the analysis model, including without limitation differences in building construction relative to the building modeled; differences in actual weather conditions relative to the weather modeled; variations in schedules for equipment, systems, and occupancy; inconsistencies in the application of controls and operations strategies compared to those used in the model; the level of direct loads; and changes in connected loads and electricity and gas rates.

The County of Durham ("County") shall independently evaluate any advice or suggestions provided in this report. In no event will HDR be liable for the failure of the customer to achieve a specified amount of energy savings, the operation of the customer's facilities, or any incidental or consequential damages of any kind in connection with this report or the installation of evaluated decarbonization and electrification measures. This document may contain information regarding third-party products and equipment; the inclusion of such information is not an endorsement by HDR.

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1 Executive Summary

1.1 Introduction

The County has contracted HDR to conduct a comprehensive facilities assessment to identify opportunities to increase energy efficiency and to potentially convert selected fossil fuel end-uses to renewable energy, including analysis for the incorporation of PV solar and energy storage systems in County facilities.

Increasingly, building owners and operators are making a focused assessment of their building's operational carbon performance and its effect on the operation's financial bottom line, building occupants, and the surrounding environment. Rising energy prices and uncertainty in the commodity markets have also been significant drivers for increasing the operational carbon performance of a building. Decarbonization via Energy Efficiency is a proven tool for reducing a building's energy usage and resulting operating costs. Most commercial and institutional buildings use 10 to 30 percent more energy than necessary and have abundant opportunities to save.

Most buildings have never gone through a formal systematic decarbonization assessment or quality assurance process and are likely performing below their potential. Decarbonization assessments are designed to help improve building performance and capture energy, demand, energy cost, and carbon emission savings opportunities. Decarbonization assessments not only identify problems due to design flaws or events that occurred during construction, but they also identify and recommend solutions to problems that have developed during the building's operating lifetime. Improving the efficiency of major building systems presents a significant opportunity for energy, demand, energy cost, and carbon emission savings, usually with financial evaluation metrics that prove the measure to be economically feasible. A key goal of the decarbonization assessment process is to achieve more efficient operation of these systems to reduce energy waste and improve building performance and occupant comfort.

1.2 Objectives / Goals

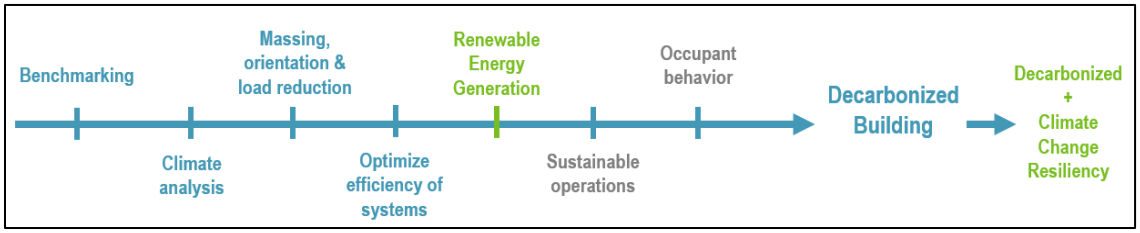
The purpose of this work is to estimate the financial impact, the potential impact of greenhouse gas emissions reduction, and the creation of a potential timeline for the conversion of end uses from fossil fuels to electricity and the addition of energy storage in County facilities. The Comprehensive Facilities Assessment Report includes the following:

- Evaluation of each identified County facility for fuel switching/electrification options.
- Identification of specific equipment to be replaced and options for replacement given available technologies and current equipment conditions and lifecycle.
- Assessment of equipment using R-410A, R-22, and other refrigerants and projected schedules and costs for replacing those systems.
- Identification of any ancillary fuel switching/electrification impacts, including but not limited to additional infrastructure needed to complete fuel switching and electrification projects and impacts on operations.

- Evaluation of identified facilities for inclusion of on-site solar generation and necessary infrastructure and structural improvements to enable such generation.
- Identification of specific opportunities for battery energy storage in county facilities including opportunities to reduce demand charges and/or serve as backup power generation where practical and compliant.
- Estimation of financial implications for recommendations.
- Estimation of Scope 1 and Scope 2 greenhouse gas impacts for all recommendations using available data from eGrid Region SRVC energy generation mix and EPA fossil fuel emission factors.
- Recommendations for electric vehicle charging stations for facilities with parking including number of stations, ideal locations, upgrades, for County fleet, staff and customers use etc.

1.3 Methodology

Reducing energy usage in a building and ultimately reducing carbon emissions needs to follow a strict pathway to truly optimize the capacity and sizing of building HVAC equipment in addition to building renewable energy systems.

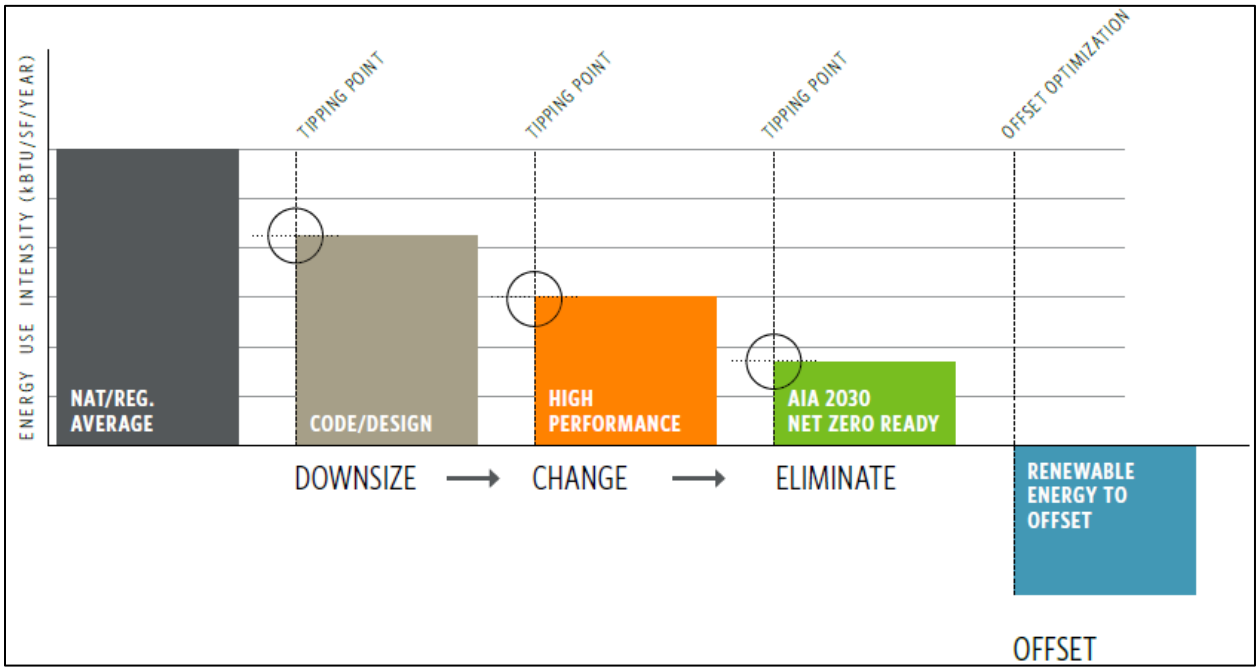


The more granular steps identified in the previous graphic are detailed as follows:

- **Be Climate Specific –** Understand project-specific climate conditions and opportunities and identify potential design measures appropriate for the project type and local climate.
- **Minimize Building Loads –** Improve the building envelope, reduce lighting power densities and usage, incorporate suitable daylighting techniques, reduce equipment power densities and usage, and reduce water consumption flow rates.
- **Improve System Efficiency –** Improve HVAC system design, increase motor efficiencies, utilize solar heating technologies, incorporate energy recovery technologies, utilize applicable controls strategies, increase plant efficiency, review utility rate options, and evaluate heating and cooling options.
- **Maximize Renewable Generation –** Provide suitable renewable energy generation and incorporate energy storage techniques.
- **Optimize Operations and Maintenance –** Establish continuous commissioning, measurement, and verification practices; incorporate robust training programs; and educate and inform occupant behavior.

By following this focused pathway to decarbonization, a phenomenon called “tipping points” presents itself, in that optimization to a building’s internal loads (envelope, lighting, plug/process, etc.) results in lower heat gains/losses and thus a “tipping point” is developed. When this occurs, the larger HVAC equipment previously needed to serve the building loads can be replaced with smaller and more appropriately sized equipment, resulting in annual operational savings from both energy usage and O&M expenditures. Continuing along that pathway, through more efficient MEP systems that consume less energy, the overall annual energy profile of the building would be lower, resulting in smaller and more cost-effective renewable energy systems to meet the on-site percentile offsets desired for the project’s carbon emission and resiliency goals.

Figure 1-1. Decarbonization & Energy Efficiency Tipping Points



1.3.1 Building Decarbonization Analysis Methodology

Calculations for Building Decarbonization measures are based on a combination of algorithms from various State-approved TRM, direct outputs of the full-year (8,760 hours) energy simulation analysis (as described in Section 1.3.2 below), and industry-trusted resources.

A TRM is a resource used to help plan and evaluate energy efficiency programs. TRMs outline how much energy can be expected to be saved for certain measures, either through deemed savings values or engineering algorithms. TRMs also contain source documentation, specified assumptions, and other metrics associated with energy efficiency measures. For Decarbonization Analysis reports for projects in a given state, it is common practice to utilize savings algorithms from other states and adjust for regional parameters to determine project-specific savings opportunities.

The individual Decarbonization measures are detailed below with information regarding the source origin, the calculation equation(s), and variable matrix:

HVAC | Air-Side Economizer

Most commercial buildings have some spaces that need cooling all year long. If it's colder outdoors than indoors, it often makes energy-sense to "economize" by bringing in more than minimum outdoor air to reduce the hours of mechanical cooling system operation.

The output results for air-side economizer opportunities are direct outputs of the full-year (8,760 hours) energy simulation analysis (as described in Section 1.3.2 below). The simulation analysis includes hourly cooling loads compared to hourly outside air conditions to determine when an air-side economizer can reduce or eliminate mechanical cooling. Mechanical cooling is eliminated when analysis shows a cooling load is present and outside air conditions are below the temperature balance point, as well as the maximum enthalpy value.

Variable	Variable Description	Variable Source
$T_{balance}$	The maximum Outdoor Air temperature for when a building can utilize 100% free cooling for when a building cooling load exists. This balance temperature varies depending on the building type. Buildings with higher interior loads such as plug loads, lighting loads or occupant loads will have lower balance temperature points while low-load buildings will have higher balance temperatures.	NA
Max Enthalpy	Enthalpy is a measure of the total energy of the air including both sensible heat (related to dry air temperature) and latent heat (related to the presence of water vapor). During air-side economizer sequences, the outside air enthalpy should be monitored, and the economizer sequence should be turned off if the conditions are at an enthalpy value of 28 BTU/lb or higher.	ASHRAE 90.1

HVAC | Smart Thermostat

Per the Mid-Atlantic TRM (version 10, 2020), the Smart Thermostat measure involves the replacement of a manually operated or conventional programmable thermostat with a "smart" thermostat. This measure only applies to thermostats that control central air conditioning, heat pumps, furnaces, or RTUs with a capacity of up to 300,000 BTU/h that serve normally conditioned spaces rather than semi-conditioned spaces or spaces with large frequently open doors (e.g., loading docks and car repair shops).

Equation 1 |Smart Thermostat Calculation Equations

$$Cooling\ Savings: \Delta kWh = \frac{CCAP}{SEER} * \ EFLHc * \ Cooling_Saving_\%$$

$$Electric\ Heat\ Savings: \Delta kWh = \frac{HCAPelec}{HSPF} * \ EFLHh * \ Elec_Heating_Saving_\%$$

$$Fossil\ heat\ Savings: \Delta MMBTU = \frac{HCAPfuel}{AFUE} * \ EFLHh * \ Fuel_Heating_Saving\%$$

Variable	Variable Description	Variable Source
CCAP	Cooling capacity of existing AC unit, in kBTU/hr.	Per Building parameters
HCAPelec	Heating capacity of existing electric heat unit, in kBTU/hr.	Per Building parameters
HCAPfuel	Heating capacity of existing fossil heat unit, in MMBTU/hr.	Per Building parameters
SEER	SEER of controlled unit. If unknown use current energy code requirements for mechanical cooling efficiency (14 SEER). For GSHPs use EER.	Per Building parameters
HSPF	HSPF of controlled unit. If unknown use current energy code requirements for mechanical heating efficiency (8.2). Electric strip heat HSPF = 3.412. For GSHPs use COP x 3.412.	Per Building parameters
AFUE	AFUE of controlled unit. If unknown use 82% for boiler, 80% for furnace.	Per Building parameters
EFLHcool	Full load hours for cooling equipment.	Per annual energy simulation analysis
EFLHheat	Full load hours for heating equipment.	Per annual energy simulation analysis
Cooling_Saving_%	5%	Per TRM
Elec_Heating_Saving_%	4%	Per TRM
Fuel_Heating_Saving%	5%	Per TRM

HVAC | Air Conditioner Tune-up

Per the TRM, an air conditioning system that is operating as designed saves energy and provides adequate cooling and comfort to the conditioned space.

For this characterization to apply, the efficient equipment is assumed to be a unitary or split system air conditioner of at least three (3) tons. The measure requires that a certified technician performs the following items:

- Check refrigerant charge
- Identify and repair leaks if refrigerant charge is low
- Measure and record refrigerant pressures
- Measure and record temperature drop at indoor coil
- Clean condensate drain line
- Clean outdoor coil and straighten fins
- Clean indoor and outdoor fan blades
- Clean indoor coil with spray-on cleaner and straighten fins
- Repair damaged insulation – suction line
- Change air filter
- Measure and record blower amp draw

Equation 2 | Air Conditioner Tune-up Calculation Equation

$$\Delta kWh = \frac{\left(\frac{kBtu}{hr}\right)}{EERbefore} * EFLH * \%Savings$$

Variable	Variable Description	Variable Source
kBTU/hr	Capacity of the cooling equipment actually installed in kBTU per hour (1 ton of cooling capacity equals 12 kBTU/hr).	Per Building parameters
EERbefore	Energy Efficiency Ratio of the baseline equipment prior to tune-up.	Per Building parameters
EFLH	Equivalent Full Load Hours for cooling	Per annual energy simulation analysis
%Savings	Deemed percent savings per Tune-Up component. These are additive if condenser cleaning, evaporator cleaning and refrigerant charge correction are performed.	Per TRM

HVAC | Space Heating Fossil Fuel Boiler Tune-up

Per the TRM, this measure is for a non-residential boiler that provides space heating. The tune-up will improve boiler efficiency by cleaning and inspecting burners, combustion chamber, and burner nozzles; adjusting air flow and reducing excessive stack temperatures; adjusting burner and gas input; and checking venting, safety controls, and adequacy of combustion air intake. Combustion efficiency should be measured before and after a tune-up using an electronic flue gas analyzer.

Equation 3 | Space Heating Fossil Fuel Boiler Tune-up Calculation Equation

$$\Delta Therms = \frac{\left(Capacity * EFLH * \left(\left(\frac{Effbefore + Ei}{Effbefore}\right) - 1\right)\right)}{100{,}000}$$

Variable	Variable Description	Variable Source
Capacity	Boiler gas input size	Per Building parameters
EFFbefore	Efficiency of the boiler before the tune-up	Per Building parameters
EFLH	Equivalent Full Load Hours for heating	Per annual energy simulation analysis
Ei	Efficiency improvement of the boiler tune-up measure. Assumed value is 2.3%.	Per TRM

DHW | Low Flow Faucet Aerators

Per the TRM, this measure pertains to the direct installation of a low-flow faucet aerator in a commercial building.

Equation 4 | Low Flow Faucet Aerator Calculation Equations

$$\Delta kWh = \%ElectricDHW * \left(\frac{GPM_{base} - GPM_{low}}{GPM_{base}}\right) * Usage * EPG_{electric} * ISR$$

$$\Delta Therms = \%FossilDHW * \left(\frac{GPM_{base} - GPM_{low}}{GPM_{base}}\right) * Usage * EPG_{gas} * ISR$$

Variable	Variable Description	Variable Source
%ElectricDHW	Proportion of water heating supplied by electric resistance heating	Per Building parameters
GPM_base	Average flow rate, in gallons per minute, of the baseline faucet "as-used". 1.39 gpm utilized.	Per TRM
GPM_low	Average flow rate, in gallons per minute, of the low-flow faucet aerator "as-used". 0.94 gpm utilized.	Per TRM
Usage	Estimated usage of mixed water (mixture of hot water from water heater line and cold water line) per faucet (gallons per year)	Per TRM
EPG_electric	Energy per gallon of mixed water used by faucet (electric water heater)	Per TRM
ISR	In service rate of faucet aerators dependent on install method. 0.95 for Direct Install.	Per TRM
%FossilDHW	Proportion of water heating supplied by fossil fuel heating.	Per Building parameters
EPG_gas	Energy per gallon of mixed water used by faucet (gas water heater).	Per TRM

DHW | Solar Thermal Domestic Hot Water

Solar water heating systems, or solar thermal systems, use energy from the sun to warm water for storage in a hot water cylinder or thermal store. Due to the fluctuating availability of solar energy, a solar water heating system will not provide 100% of the hot water demand throughout the year.

The calculation methodology for Solar Thermal Domestic Hot Water is based on a detailed calculation developed by HDR. It calculates the solar potential for all 8,760 hours of the year using the Typical Meteorological Year data from the Raleigh-Durham Airport weather file. Possible capacities for the Solar Thermal System vary by building and are offered as either a 5-, 10-, 15- or 20-panel system.

Lighting | LED Retrofit

Per the TRM, this measure pertains to the installation of an LED luminaire or retrofit kit for general area illumination in place of a fluorescent light source. These luminaires and retrofit kits are typically recessed, suspended, or surface-mounted and intended to provide ambient lighting in office spaces, schools, retail stores, and other commercial environments. Because of the improved optical control afforded by LED luminaires and retrofit kits, LED lighting systems can typically reduce total lumen output while maintaining required illuminance on work surfaces.

Equation 5 | LED Retrofit Calculation Equations

$$\Delta kWh = Applicable\ Area * \left(\frac{(LPDbase - LPDee)}{1000}\right) * HOURS * WHFe$$

$$\Delta MMBTU = \left(\frac{-\Delta kWh}{WHFe}\right) * 0.70 * 0.003413 * \frac{0.23}{0.75}$$

$$\Delta MMBTU = -\Delta kWh * 0.00073$$

Variable	Variable Description	Variable Source
LPDbase	Actual Connected Lighting Power Density of baseline fixture	Per ASHRAE 90.1 LPDs nearest construction year
LPDee	Actual Connected Lighting Power Density of LED fixture	Per ASHRAE 90.1-2022 LPDs
HOURS	Average hours of use per year	Per annual energy simulation analysis
WHFe	Waste Heat Factor for Energy to account for cooling and heating impacts from efficient lighting.	Per TRM

Lighting | Lighting Occupancy Sensor

Per the TRM, this measure defines the savings associated with installing a wall-, fixture-, or remote-mounted occupancy sensor that switches lights off after a brief delay when it does not detect occupancy.

Equation 6 | Lighting Occupancy Sensor Calculation Equations

$$\Delta kWh = kWconnected * HOURS * SVGe * WHFe$$

$$\Delta MMBTU = \left(\frac{-\Delta kWh}{WHFe}\right) * 0.70 * 0.003413 * \frac{0.23}{0.75}$$

$$\Delta MMBTU = -\Delta kWh * 0.00073$$

Variable	Variable Description	Variable Source
HOURS	Average hours of use per year	Per annual energy simulation analysis
SVGe	Percentage of annual lighting energy saved by lighting control; Assumed value = 0.28	Per TRM
WHFe	Waste Heat Factor for Energy to account for cooling and heating impacts from efficient lighting.	Per TRM

Lighting | LED Exit Signs

Per the TRM, this measure pertains to the installation of an exit sign illuminated with LEDs. This measure should be limited to early replacement applications.

Equation 7 | LED Exit Signs Calculation Equations

$$\Delta kWh = \left(\frac{(WattsBASE - WattsEE)}{1000}\right) * HOURS * WHFe$$

$$\Delta MMBTU = \left(\frac{-\Delta kWh}{WHFe}\right) * 0.70 * 0.003413 * \frac{0.23}{0.75}$$

$$\Delta MMBTU = -\Delta kWh * 0.00073$$

Variable	Variable Description	Variable Source
WattsBASE	Actual Connected load of existing exit sign. Assuming value of 16W.	Per TRM
WattsEE	Actual Connected load of LED exit sign	Per TRM
HOURS	Average hours of use per year = 8,760	Per TRM
WHFe	Waste Heat Factor for Energy to account for cooling and heating impacts from efficient lighting.	Per TRM

Lighting | Daylight Dimming Control

Per the TRM, this measure defines the savings associated with installing a daylighting dimming control system to reduce electric lighting levels during periods of high natural light. Systems typically include daylight sensors, control electronics, and dimmable ballasts as necessary.

Equation 8 | Daylight Dimming Control Calculation Equations

$$\Delta kWh = kWconnected\ x\ HOURS\ x\ SVG\ x\ WHFe$$

$$\Delta MMBTU = \left(\frac{-\Delta kWh}{WHFe}\right) * 0.70 * 0.003413 * \frac{0.23}{0.75}$$

$$\Delta MMBTU = -\Delta kWh * 0.00073$$

Variable	Variable Description	Variable Source
HOURS	Average hours of use per year	Per annual energy simulation analysis
SVG	Percentage of annual lighting energy saved by lighting control; Assumed value = 0.28	Per TRM
WHFe	Waste Heat Factor for Energy to account for cooling and heating impacts from efficient lighting.	Per TRM

Lighting | LED Outdoor Pole/Arm

Per the TRM, this measure pertains to the installation of an LED outdoor pole/arm- or wall-mounted luminaire or retrofit kit for parking lot, street, or general area illumination in place of a high-intensity discharge light source.

Equation 9 | LED Outdoor Pole/Arm Calculation Equation

$$\Delta kWh = \left(\frac{(WattsBASE - WattsEE)}{1000}\right) * HOURS$$

Variable	Variable Description	Variable Source
WattsBASE	Actual Connected load of baseline fixture	Per TRM
WattsEE	Actual Connected load of the LED fixture	Per TRM
HOURS	Average hours of use per year = 3,604	Per TRM

Power | Variable Speed Drive Screw Air Compressors

Per the TRM, this measure pertains to the installation of a new high-efficiency, oil-flooded, screw air compressor of 100 HP or less with a variable speed drive.

Equation 10 | Variable Speed Drive Screw Air Compressor Calculation Equation

$$\Delta kWh = 0.9874 * HP * HOURS * (COMPFbase - COMPFee)$$

Variable	Variable Description	Variable Source
HP	Compressor motor nominal HP	Per Building parameters
HOURS	Compressor total hours of operation	Per annual energy simulation analysis
COMPFbase	Baseline compressor factor. Assumed value = 0.890.	Per TRM
COMPFee	Installed compressor factor, actual. Assumed value = 0.705.	Per TRM

Power | NEMA Premium Low Voltage Dry-Type Distribution Transformers

Per the TRM, this measure applies to single or three phase low voltage dry-type distribution transformers meeting or exceeding the NEMA Premium efficiency requirements at 35% load. 'Low voltage dry-type distribution transformer' refers to a distribution transformer with an input voltage of 600 volts or less, is air-cooled, and does not use oil as a coolant.

Equation 11 | NEMA Premium Low Voltage Dry-Type Distribution Transformers Calculation Equation

$$kWh\ Savings = (TL_{FM-15.9\%} - TL_{NP-15.9\%}) * \frac{8{,}760}{1{,}000}$$

Variable	Variable Description	Variable Source
TL FM-15.9%	Total Losses for Federal Minimum (FM) transformers at 15.9% load	Per TRM
TL NP-15.9%	Total Losses for NEMA Premium (NP) transformers at 15.9% load	Per TRM

Power | Vending Machine Controller | Beverage

Per the TRM, vending machine controls use a custom passive infrared sensor to completely power down a vending machine when the area surrounding it is unoccupied for 15 minutes. Once powered down, the vending machine control will measure the ambient room temperature

of the vending machine's location. The vending machine control uses this information to automatically power up the machine in one to three intervals, independent of occupancy, to ensure that the vending products stay cold. When there is no activity in the area, the vending machine can go into "sleep" mode for a maximum of four (4) hours.

Equation 12 | Beverage Vending Machine Controller Calculation Equation

$$Beverage\ Vending\ Savings = 1{,}612\ kWh\ per\ year$$

Power | Vending Machine Controller | Snack

Per the TRM, vending machine controls use a custom passive infrared sensor to completely power down a vending machine when the area surrounding it is unoccupied for 15 minutes. Once powered down, the vending machine control will measure the ambient room temperature of the vending machine's location. The vending machine control uses this information to automatically power up the machine in one to three intervals, independent of occupancy, to ensure that the vending products stay cold. When there is no activity in the area, the vending machine can go into "sleep" mode for a maximum of four (4) hours.

Equation 13 | Snack Vending Machine Controller Calculation Equation

$$Snack\ Vending\ Savings = 287\ kWh\ per\ year$$

Power | EnergyStar Refrigerator Upgrade

Per the TRM, the upgrade of a non-EnergyStar-rated refrigerator to an EnergyStar-rated refrigerator offers the following savings opportunities:

Equation 14 | EnergyStar Refrigerator Upgrade Calculation Equation

$$Refrigerator\ Upgrade\ Savings = 105\ kWh\ per\ year$$

Power | Tier 1 Advanced Power Strip

Per the TRM, this measure pertains to the installation of a current-sensing master/controlled APS in place of a standard power strip, a device used to expand a single wall outlet into multiple outlets.

Equation 15 | Tier 1 APS Calculation Equation

$$Tier\ 1\ Power\ Strip\ Savings = 26.9\ kWh\ per\ year\ per\ power\ strip$$

Whole Building | Retro-Commissioning

Retro-Commissioning (RCx) is a systematic process that seeks to improve the performance of an existing building and how equipment and systems function together. RCx can often resolve problems that occurred during design or construction or address those that have developed throughout the building's life. RCx uses a whole-building systems approach to identify operational improvements in a building's O&M procedures that will save energy and increase occupant comfort.

RCx will take the Comprehensive Facilities Assessment an additional step further by utilizing the power of trend data to find operational anomalies in existing sequences of operation and identify new data-based opportunities. Data is acquired from a combination of trend-level Building Automation System data and/or setting up physical data logging devices for a specific period

during a heating or cooling season (or both) to acquire data that can be fed directly into a granular analysis. Numerous studies have provided estimated percent savings opportunities for implementing RCx on a given existing building. These percentages range anywhere from 5% to 15% across the board, varying for different building typologies and build dates.

While RCx looks at many measures, including automatic control measures, the following eighteen measures offer the highest opportunity for energy/carbon savings. Should a Retro-Commissioning program be initiated for the County facilities, these measures should be prioritized.

RCx Measure	Measure and Description
1	Scheduling equipment: AHUs, Fans, Pumps, Electrical Heat, VAV/FPBs, Lighting
2	Duct static pressure reduce/reset
3	Economizer and Outdoor Air Control
4	Supply Air temperature reset
5	Optimum Start for AHU
6	Reduce simultaneous heating and cooling
7	Reduce Supply Air and Ventilation Air
8	Condenser water temperature reset
9	Setback space temperature
10	Reduce ventilation
11	Chilled Water temperature reset
12	Demand Control Ventilation (DCV)
13	Optimize supply fan performance
14	Optimize chiller sequencing
15	Reduce VAV Minimum Position
16	Eliminate unnecessary fans
17	Install efficient filters
18	Balance airside

Retro-commissioning savings potential for each County Building was determined by looking at the potential of implementing the above eighteen RCx measures. When an individual measure was determined as applicable to a given building, an “X1” identifier was utilized. The Enpira platform was used to analyze the available high-level trend data for various measures and was assigned an "X2" identifier based on its significant potential. The total number of 1*X1 + 2*X2 identifiers was summed to find the total RCx measures for each building.

Equation 16 | Retro-Commissioning Savings Calculation Equation

$$RCx\ Savings\ =\ 5\%\ of\ Total\ Annual\ Energy\ for\ 6\ RCx\ identifiers$$
$$RCx\ Savings\ =\ 15\%\ of\ Total\ Annual\ Energy\ for\ 24\ RCx\ identifiers$$

1.3.2 Building Electrification Analysis Methodology

To accurately calculate the energy, energy cost, and carbon impacts of converting fossil fuel-powered heating and hot water systems to electric systems, a comprehensive 8,760-hour analysis is required to assess system performance under varying climate conditions and building operation part-load ratios. For County facilities, this granularity has to be generated from a variety of existing monthly data points and “expanded” via engineering analysis to represent hourly data for the entire year. The below steps describe the process utilized in generating the electrification calculations.

Step 1 | Department of Energy Commercial Reference Buildings

The DOE, in conjunction with three of its national laboratories, developed commercial reference buildings, formerly known as commercial building benchmark models. These reference buildings play a critical role in the program's energy modeling software research by providing complete descriptions for whole building energy analysis using EnergyPlus simulation software. Sixteen (16) building types represent approximately 70% of the commercial buildings in the U.S., according to the report published by the National Renewable Energy Laboratory titled U.S. Department of Energy Commercial Reference Building Models of the National Building Stock. These modules provide a consistent baseline of comparison and improve the value of computer energy simulations using software such as EnergyPlus.

Figure 1-2. Department of Energy Commercial Reference Buildings

Commercial Reference Buildings

Buildings

Buildings » Commercial Buildings » Past Projects » Commercial Reference Buildings

The U.S. Department of Energy (DOE), in conjunction with three of its national laboratories, developed commercial reference buildings, formerly known as commercial building benchmark models. These reference buildings play a critical role in the program's energy modeling software research by providing complete descriptions for whole building energy analysis using EnergyPlus simulation software.

There are 16 building types that represent approximately 70% of the commercial buildings in the U.S., according to the report published by the National Renewable Energy Laboratory titled *U.S. Department of Energy Commercial Reference Building Models of the National Building Stock* . These modules provide a consistent baseline of comparison and improve the value of computer energy simulations using software such as EnergyPlus .

Available Reference Buildings

Commercial reference building models are available for the following categories:

- New construction
- Existing buildings constructed in or after 1980 ("post-1980")
- Existing buildings constructed before 1980 ("pre-1980")

BUILDING TYPE AND CLIMATE ZONE

DOE developed 16 reference building types that represent most commercial buildings across 16 locations, which represent all U.S. climate zones.

BUILDING TYPE NAME	FLOOR AREA (FT^2)	NUMBER OF FLOORS
Large Office	498,588	12
Medium Office	53,628	3
Small Office	5,500	1
Warehouse	52,045	1
Stand-alone Retail	24,962	1
Strip Mall	22,500	1
Primary School	73,960	1
Secondary School	210,887	2
Supermarket	45,000	1
Quick Service Restaurant	2,500	1
Full Service Restaurant	5,500	1
Hospital	241,351	5
Outpatient Health Care	40,946	3
Small Hotel	43,200	4
Large Hotel	122,120	6
Midrise Apartment	33,740	4

Most of the County facilities align directly with the sixteen (16) building types available in the Commercial Reference Buildings file collection. After identifying the Commercial Reference Building model files needed for analyzing the entire portfolio of the County facilities, the energy model files were updated to reference the Raleigh-Durham Airport Typical Meteorological Year TMY3 weather file and simulated via EnergyPlus to develop annual energy consumption and disaggregated end-use load data for 8,760 hours of the year. The end-uses for space heating loads, space cooling loads, and domestic hot water loads are of the highest priority for use. These raw datasets are preset with fuel sources for the various end-uses and thus need to be adjusted to align with specific County facility end-use fuel sources.

Step 2 | End-Use Fuel Source Adjustments

The DOE Commercial Reference Building file for medium-sized offices, for example, utilizes natural gas for domestic water heating. However, certain buildings within the County facilities currently have electric domestic water heating; therefore, the next step in the electrification analysis is to adjust the outputs from the Step 1 energy simulations to align with the end-use fuel sources specific to the analyzed building by developing end-use adjustment factors that account for the baseline model efficiency and the existing building efficiency. For example, if the model file simulated domestic water heating with natural gas at an 80% efficiency level, and the County building being analyzed utilizes electric resistance heating at a 100% efficiency level (1.0 COP), the hourly consumption values for domestic hot water are individually adjusted using a 0.80 adjustment factor (baseline model nominal efficiency / existing building nominal efficiency = 0.80 / 1.00 = 0.80). This methodology is replicated for each end-use in the building with the potential to have varying fuel sources, specifically space heating and domestic hot water. These fuel source-adjusted datasets are relative to the gross areas outlined in the reference model parameters and thus need to be adjusted to align with County facility sizes.

Table 1-1. Example End-Use Fuel Source Adjustment Matrix

Prototype Building Sub-Meter	Actual Building Main-Meter	Prototype Adj	Actual Adj	Adj Factor
Heating:Electricity [J](Hourly)	Gas:Facility [J](Hourly)	1.00	0.82	1.22
Cooling:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
InteriorLights:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
ExteriorLights:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
InteriorEquipment:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
Fans:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
Pumps:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
Refrigeration:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
Humidifier:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
HeatRejection:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
ExteriorEquipment:Electricity [J](Hourly)	Electricity:Facility [J](Hourly)	1.00	1.00	1.00
Heating:NaturalGas [J](Hourly)	Gas:Facility [J](Hourly)	0.80	0.80	1.00
InteriorEquipment:NaturalGas [J](Hourly)	Gas:Facility [J](Hourly)	1.00	1.00	1.00
WaterSystems:NaturalGas [J](Hourly)	Electricity:Facility [J](Hourly)	0.80	1.00	0.80

Step 3 | Area Adjustments

Each building analysis utilizes area adjustment ratios to upscale or downscale the hourly consumption values to align with the gross area for the specific County building. This simple adjustment takes the existing building gross area divided by the prototype model gross area and applies this adjustment ratio to all hourly electric consumption, hourly natural gas consumption, hourly space heating loads, hourly space cooling loads, and hourly domestic hot water loads. The resultant dataset per building is 8,760 hours of data at the baseline model operational performance levels. The next step is to adjust the dataset to align with the monthly operational performance levels from existing data contained in the Enpira platform the County utilizes to manage building utility data.

Step 4 | Operational Performance Adjustments

The Enpira platform provides monthly consumption data for electricity and natural gas, enabling the calculation of the monthly EUI for the existing building's operational performance. On the prototype model side, the same monthly EUI values can be calculated and compared to the existing monthly metrics for operational performance adjustments. For example, if the prototype model electric consumption EUI for January is 3.157 kBTU/ft2 and the existing building under analysis electric consumption EUI for January is 4.424 kBTU/ft2, the hourly electric consumption values for January are adjusted by a factor of 1.40 (4.424 / 3.157). This process is continued for each month and for both electric consumption and natural gas consumption. The resultant dataset per building is 8,760 hours of data that is fuel-source adjusted, area adjusted, and operational performance adjusted. This dataset is now ready for electrification pathway analysis.

Figure 1-3. Enpira Sample Database Management and Operational Performance Metric Calculations

					1	2	3	4	5	6
H:MM	HH	D	M	Y	Administrative Building	JRC	Durham County Stadium	Durham County Warehouse	Eastern Sheriff's Station	EMS #2 - Old Fayetteville Road
Gross Area (ft2)					109,036	40,623	14,773	53,520	3,038	6,990
Monthly Electric Usage | Total (kWh)				2022	1,769,128.57	609,286.32	386,484.60	312,535.04	27,853.47	69,335.58
Monthly Electric Cost | Total ($US)				2022	$ 123,200.82	$ 47,827.18	$ 47,736.08	$ 27,930.59	$ 3,967.58	$ 6,037.08
Average Electric Rate ($/kWh)				2022	$ 0.0696	$ 0.0785	$ 0.1235	$ 0.0894	$ 0.1424	$ 0.0871
Monthly Electric Usage | Total (kWh)				2023	1,787,921.36	633,429.04	379,278.20	300,333.60	26,422.08	63,278.44
Monthly Electric Cost | Total ($US)				2023	$ 142,175.47	$ 56,687.57	$ 51,348.33	$ 33,717.13	$ 4,206.77	$ 6,448.35
Average Electric Rate ($/kWh)				2023	$ 0.0795	$ 0.0895	$ 0.1354	$ 0.1123	$ 0.1592	$ 0.1019
Monthly Natural Gas Usage | Total (therms)				2022	46,061.00	2,692.00	9,357.00	12,041.00	1,050.00	2,384.00
Monthly Natural Gas Cost | Total ($US)				2022	$ 48,427.92	$ 3,408.04	$ 11,021.77	$ 13,850.46	$ 1,461.39	$ 3,077.41
Average Natural Gas Rate ($/therm)				2022	$ 1.0514	$ 1.2660	$ 1.1779	$ 1.1503	$ 1.3918	$ 1.2909
Monthly Natural Gas Usage | Total (therms)				2023	48,839.00	1,215.00	6,899.00	14,537.00	741.00	1,654.00
Monthly Natural Gas Cost | Total ($US)				2023	$ 40,573.02	$ 1,579.33	$ 7,428.81	$ 16,047.14	$ 1,031.09	$ 2,033.18
Average Natural Gas Rate ($/therm)				2023	$ 0.8308	$ 1.2999	$ 1.0768	$ 1.1039	$ 1.3915	$ 1.2293
Elec | Energy Use Intensity (kBTU/ft2.year)				2022	55.38	51.19	89.29	19.93	31.29	33.85
Elec | Energy Use Intensity (kBTU/ft2.year)				2023	55.96	53.22	87.62	19.15	29.68	30.90
NG | Energy Use Intensity (kBTU/ft2.year)				2022	42.24	6.63	63.34	22.50	34.56	34.11
NG | Energy Use Intensity (kBTU/ft2.year)				2023	44.79	2.99	46.70	27.16	24.39	23.66
Energy Use Intensity (kBTU/ft2.year)				2022	97.62	57.82	152.63	42.43	65.85	67.96
Energy Use Intensity (kBTU/ft2.year)				2023	100.76	56.21	134.32	46.31	54.07	54.56
Elec | Max Electric Monthly Demand (kW)				2023	332.16	156.32	-	118.56	12.29	15.68
Elec | Max Electric Monthly Usage (kWh)				2023	191,953.73	70,549.84	39,288.00	45,370.80	4,140.75	7,327.72
Monthly Electric Usage [via 30 min data] (kWh)							uses monthly data	excludes PL Lighting		excludes PL Lighting
			1	2022	110,116.61	42,726.32	34,811.72	18,301.44	1,538.40	5,809.64
			2	2022	109,043.49	39,734.96	28,691.24	18,065.84	1,644.95	4,983.96
			3	2022	138,149.19	38,339.20	29,334.92	18,519.92	1,788.02	5,259.56
			4	2022	139,182.64	34,473.84	27,521.80	18,729.60	1,871.11	5,750.48
			5	2022	163,928.71	36,287.20	26,367.16	26,774.64	2,332.79	6,134.40
			6	2022	172,659.23	63,932.48	36,094.36	33,547.04	3,161.00	6,695.36
			7	2022	192,477.55	74,829.92	38,446.48	37,641.92	3,910.68	7,126.08
			8	2022	189,600.61	71,254.08	36,434.88	32,190.08	3,762.46	7,029.00
			9	2022	169,185.43	63,169.28	30,471.28	31,777.84	2,814.73	5,376.42
			10	2022	148,383.29	49,204.64	29,719.52	21,067.84	1,877.15	3,733.32
			11	2022	131,229.57	46,900.72	27,321.32	20,519.04	1,665.81	3,868.60
			12	2022	110,872.56	45,405.12	41,269.92	19,020.56	1,514.08	5,189.56
				Total	1,774,828.88	606,257.76	386,484.60	296,155.76	27,881.18	66,956.38
				%D from Monthly	-0.32%	0.50%	0.00%	5.24%	-0.10%	3.43%
			1	2023	121,862.02	46,502.08	37,524.96	20,282.56	1,864.07	5,177.64
			2	2023	126,838.33	43,768.56	35,538.60	16,379.52	1,536.15	3,993.08
			3	2023	144,008.04	45,112.24	38,290.80	18,539.44	1,445.87	4,132.84
			4	2023	144,764.69	47,456.32	27,171.84	20,321.84	1,376.47	3,869.56
			5	2023	154,740.93	52,391.28	29,598.00	20,707.04	1,841.01	4,123.24
			6	2023	161,697.42	61,715.44	36,380.00	30,820.88	2,646.53	5,503.48
			7	2023	182,993.77	72,860.40	38,725.00	43,035.84	4,196.31	7,269.28
			8	2023	182,287.62	69,537.04	39,288.00	39,577.60	3,768.52	7,536.24
			9	2023	161,410.62	48,453.68	34,361.00	28,683.04	2,835.73	5,856.08
			10	2023	151,915.46	52,611.60	32,062.00	17,948.72	1,809.34	4,407.36
			11	2023	131,055.90	47,527.36	30,338.00	11,323.12	1,426.20	4,012.12
			12	2023	127,239.08	46,976.56	-	11,098.16	1,699.68	4,527.04
				Total	1,790,813.88	634,912.56	379,278.20	278,717.76	26,445.88	60,407.96
				%D from Monthly	-0.16%	-0.23%	0.00%	7.20%	-0.09%	4.54%

Step 5 | Existing Building Load to Consumption Calculations

The resultant dataset per building of 8,760 hours of data is now analyzed on an hour-by-hour basis using the part-load ratios of the various end-use loads. The hourly part-load ratio for a given end-use is the end-use hourly load divided by the maximum load over the entire year. Heating systems have higher part-load ratios during the cold weather season, and lower part load ratios during the warm weather season, such as at night when heating is still required in the warm-weather season but at a greatly reduced part load ratio. The part-load ratios impact the efficiency of the systems, both natural gas-fueled and electric-powered systems. Performance curves provided by the DOE2 energy modeling engine are utilized to determine the impact of the part load ratios. These performance curves are of various quadratic and bi-quadratic formats and include A-B-C-D-E-F coefficients to use per equipment type to be combined with set hourly parameters, such as the part load ratio for a given hour or the outside air temperature for a given hour. The DOE2 performance curves for heating equipment are provided in Figure 1-4 for comparison.

Figure 1-4. DOE2 Example Performance Curve Coefficients for Space Heating Equipment

Heating Equipment	Function Format	X	Y	a	b	c	d	e	f
Packaged_Gas Furnace	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.01861	1.09420896	-0.11281899	0	0	0
Packaged_Electric Heat	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0	1	0	0	0	0
Packaged_Heat Pump	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.08565216	0.93881381	-0.18343613	0.15897022	0	0
HeatPumpChiller	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.03366649	0.53152555	0.43480805	0	0	0
Boiler_GasAtmospheric	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.02699999	1.10549998	-0.13249962	0	0	0
Boiler_ForcedDraft	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.01599992	0.94495332	0.03904687	0	0	0
Boiler_Electric	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.02	0.98000002	0	0	0	0
Boiler_ElectricSteam	Z1 = a + bX + cX^2 + dX^3	PLR	NA	0.03	0.97000003	0	0	0	0
Boiler_Condensing	Z1 = a + bX + cX^2 + dX^3	PLR	NA	1	0	0	0	0	0
Boiler_CondensingHiEff	Z1 = a + bX + cX^2 + dX^3	PLR	NA	1	0	0	0	0	0

Heating Equipment	Function Format	X	Y	a	b	c	d	e	f
Packaged_Gas Furnace	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	NA	NA	1	0	0	0	0	0
Packaged_Electric Heat	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	NA	NA	1	0	0	0	0	0
Packaged_Heat Pump	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	EDB	OAT	2.31432104	0	0	-0.04374285	0.00033571	0
HeatPumpChiller	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	HWS Temp	OAT	1.03992367	0.01459975	0.00000599	-0.05052603	0.00063477	-0.00015386
Boiler_GasAtmospheric	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	NA	NA	1	0	0	0	0	0
Boiler_ForcedDraft	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	NA	NA	1	0	0	0	0	0
Boiler_Electric	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	NA	NA	1	0	0	0	0	0
Boiler_ElectricSteam	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	NA	NA	1	0	0	0	0	0
Boiler_Condensing	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	PLR	HWR Temp	-0.09438953	0.90322417	0.01546033	0.00159778	-0.00000645	0.00111432
Boiler_CondensingHiEff	Z2 = a + bX + cX^2 + dY + eY^2 + fXY	PLR	HWR Temp	-0.08990421	0.81924802	0.0429914	0.00157122	-0.00000704	0.00183745

By calculating the Z1 and Z2 efficiency modifiers, the 100% full load efficiency for a given system can be modified (hourly efficiency = nominal efficiency * Z1 * Z2) to determine the hourly efficiency. This process can be repeated for all 8,760 hours of the year and all end-use types, including space heating, space cooling, and domestic hot water generation.

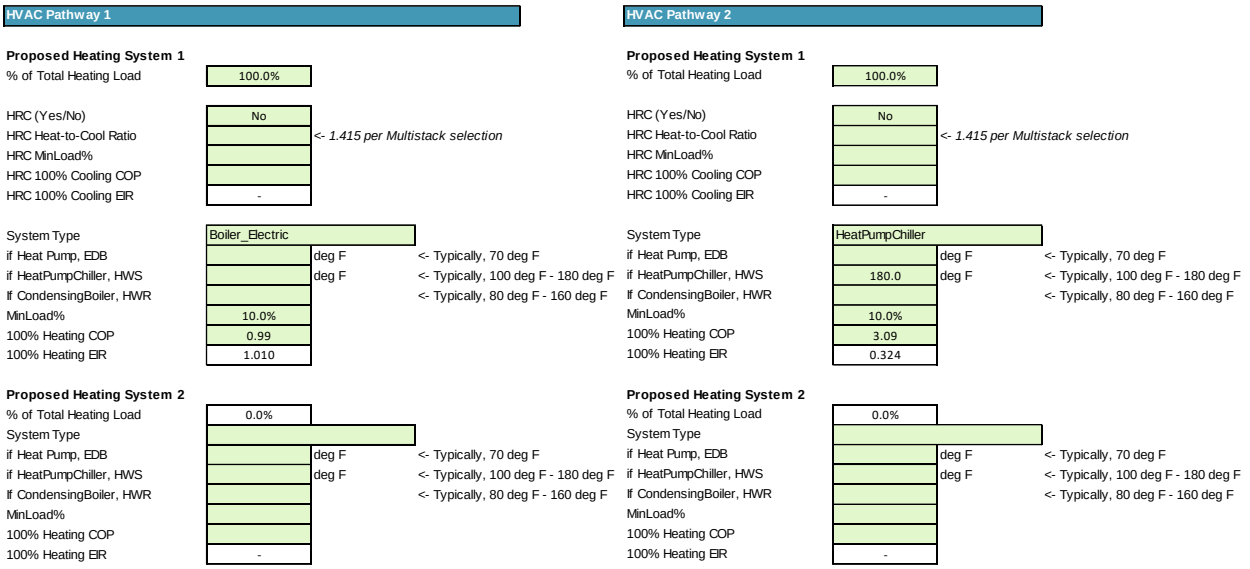
The hourly load can be converted to hourly energy consumption once an hourly efficiency is determined. The hourly consumptions for the space heating, space cooling, and domestic hot water generation are summed and represent the baseline condition, ready to be compared against the proposed electrification pathways. Space cooling consumption is calculated in this analysis to show the benefits of utilizing heat recovery chillers for certain County buildings, wherein when simultaneous heating and cooling is required, a heat recovery chiller will generate mechanical cooling. Instead of expelling the waste heat into the atmosphere, it will generate heating hot water to serve the simultaneous heating load present in the building.

All inputs for the baseline system parameters are built into the HDR-developed 'Electrification Tool' for this project and allow an optimized iteration-based analysis of the various baseline conditions and the proposed system electrification options.

Step 6 | Electrification Pathway Energy Consumption Calculations

Similar to the Baseline Energy Consumption calculations, the DOE2 Performance Curves were utilized to calculate the energy consumption metrics for the recommended electrification pathways for both space heating and domestic hot water systems, given the various inputs for system parameters of the electrified systems, as shown in Figure 1-5.

Figure 1-5. Sample Proposed HVAC Space Heating Electrification Pathway Inputs



HVAC Pathway 1			
Proposed Heating System 1			
% of Total Heating Load	100.0%		
HRC (Yes/No)	No		
HRC Heat-to-Cool Ratio		<- *1.415 per Multistack selection*	
HRC MinLoad%			
HRC 100% Cooling COP			
HRC 100% Cooling EIR	-		
System Type	Boiler_Electric		
if Heat Pump, EDB		deg F	<- Typically, 70 deg F
if HeatPumpChiller, HWS		deg F	<- Typically, 100 deg F - 180 deg F
If CondensingBoiler, HWR			<- Typically, 80 deg F - 160 deg F
MinLoad%	10.0%		
100% Heating COP	0.99		
100% Heating EIR	1.010		
Proposed Heating System 2			
% of Total Heating Load	0.0%		
System Type			
if Heat Pump, EDB		deg F	<- Typically, 70 deg F
if HeatPumpChiller, HWS		deg F	<- Typically, 100 deg F - 180 deg F
If CondensingBoiler, HWR			<- Typically, 80 deg F - 160 deg F
MinLoad%			
100% Heating COP			
100% Heating EIR	-		

HVAC Pathway 2			
Proposed Heating System 1			
% of Total Heating Load	100.0%		
HRC (Yes/No)	No		
HRC Heat-to-Cool Ratio		<- *1.415 per Multistack selection*	
HRC MinLoad%			
HRC 100% Cooling COP			
HRC 100% Cooling EIR	-		
System Type	HeatPumpChiller		
if Heat Pump, EDB		deg F	<- Typically, 70 deg F
if HeatPumpChiller, HWS	180.0	deg F	<- Typically, 100 deg F - 180 deg F
If CondensingBoiler, HWR			<- Typically, 80 deg F - 160 deg F
MinLoad%	10.0%		
100% Heating COP	3.09		
100% Heating EIR	0.324		
Proposed Heating System 2			
% of Total Heating Load	0.0%		
System Type			
if Heat Pump, EDB		deg F	<- Typically, 70 deg F
if HeatPumpChiller, HWS		deg F	<- Typically, 100 deg F - 180 deg F
If CondensingBoiler, HWR			<- Typically, 80 deg F - 160 deg F
MinLoad%			
100% Heating COP			
100% Heating EIR	-		

Two (2) pathways have been identified for space heating and domestic hot water systems, with the first pathway typically being a more “simplified” pathway to electrification. This pathway might include more drop-in electric resistance heating systems (Coefficient of Performance = 1.0) that can replace fossil-fuel equipment directly with faster installation and often lower capital costs. However, this simplified pathway comes at the expense of not necessarily “high efficiency” operation and can result in higher annual energy costs due to electricity consumption increase. The second pathway represents a high-performance electrification pathway relying on the incorporation of heat recovery chillers, heat pumps, and other electric-powered space heating and domestic hot water equipment with a Coefficient of Performances greater than 1.0.

Step 7 | Electrification Pathway Energy Cost Calculations

Electric energy costs were calculated based on the specific Duke Energy tariff assigned to the building. The two (2) primary tariff types that were analyzed were SGS and LGS. SGS is available to the individual customer with a kilowatt demand of 75 kW or less. If the customer’s measured demand exceeds 75 kW during any month, the customer will be served under Schedule LGS. LGS is available to the individual customer with a kilowatt demand of more than 75 kW. If the customer’s measured demand is 75 kW or less for twelve consecutive months, the customer will be served under Schedule SGS. Both SGS and LGS offer TOU tariff options. However, since the measures recommended in this report do not necessarily “shift” energy usage from the occupied portion of the day to the unoccupied portion of the day (e.g., thermal energy storage for cooling when TOU prices are typically reduced), these tariffs are not included in the analysis.

Table 1-2. Example Electric Consumption Rate Details for Duke LGS Tariff

Energy Consumption Charges

Season	TOU Period	kWh Block Size	kWh/kW Block Size	$ / kWh
All Seasons	All Periods	0	0	$0.132421
All Seasons	All Periods	3,000	0	-$0.054207
All Seasons	All Periods	0	125	$0.072962
All Seasons	All Periods	6,000	125	-$0.009679
All Seasons	All Periods	0	400	$0.059189
All Seasons	All Periods	0	0	$0.012442
All Seasons	All Periods	0	0	$0.004343
All Seasons	All Periods	0	0	-$0.000022
All Seasons	All Periods	0	0	-$0.000128
All Seasons	All Periods	0	0	$0.000071
All Seasons	All Periods	0	0	$0.000120
All Seasons	All Periods	0	0	-$0.003033
All Seasons	All Periods	0	0	-$0.000009
All Seasons	All Periods	0	0	$0.000000
All Seasons	All Periods	0	0	$0.000000
All Seasons	All Periods	0	125	$0.012442
All Seasons	All Periods	0	125	$0.004343
All Seasons	All Periods	0	125	-$0.000022
All Seasons	All Periods	0	125	-$0.000128
All Seasons	All Periods	0	125	$0.000071
All Seasons	All Periods	0	125	$0.000120
All Seasons	All Periods	0	125	-$0.003033
All Seasons	All Periods	0	125	-$0.000009
All Seasons	All Periods	0	125	$0.000000
All Seasons	All Periods	0	125	$0.000000
All Seasons	All Periods	0	400	$0.012442
All Seasons	All Periods	0	400	$0.004343
All Seasons	All Periods	0	400	-$0.000022
All Seasons	All Periods	0	400	-$0.000128
All Seasons	All Periods	0	400	$0.000071
All Seasons	All Periods	0	400	$0.000120
All Seasons	All Periods	0	400	-$0.003033
All Seasons	All Periods	0	400	-$0.000009
All Seasons	All Periods	0	400	$0.000000
All Seasons	All Periods	0	400	$0.000000

Natural gas energy costs were obtained by the Enpira platform and calculated as all-in rates wherein the total annual natural gas costs divided by the total annual natural gas consumption determined the virtual rate ($/therm) to utilize in natural gas cost savings calculations.

Step 8 | Electrification Pathway Carbon Emission Calculations

Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural Gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes emissions from CO_2, CH_4, and N_20 and are weighted per the individual components' GWP metrics.

Figure 1-6. eGrid FY2022 Grid Generation Mix Emission Factor Data

eGRID subregion acronym	eGRID subregion name	Total output emission rates lb/MWh						
		CO_2	CH_4	N_2O	CO_2e	Annual NO_x	Ozone Season NO_x	SO_2
AKGD	ASCC Alaska Grid	1,052.1	0.088	0.012	1,057.8	5.1	5.4	0.423
AKMS	ASCC Miscellaneous	495.8	0.023	0.004	497.6	7.9	7.3	0.680
AZNM	WECC Southwest	776.0	0.051	0.007	779.4	0.4	0.4	0.121
CAMX	WECC California	497.4	0.030	0.004	499.3	0.5	0.4	0.030
ERCT	ERCOT All	771.1	0.049	0.007	774.3	0.5	0.5	0.407
FRCC	FRCC All	813.8	0.048	0.006	816.9	0.3	0.3	0.142
HIMS	HICC Miscellaneous	1,155.5	0.124	0.019	1,163.1	7.2	7.3	3.069
HIOA	HICC Oahu	1,575.4	0.163	0.025	1,586.9	3.9	3.7	6.353
MROE	MRO East	1,479.6	0.133	0.019	1,488.7	1.0	1.0	0.306
MROW	MRO West	936.5	0.102	0.015	943.4	0.8	0.9	0.907
NEWE	NPCC New England	536.4	0.063	0.008	540.5	0.3	0.3	0.122
NWPP	WECC Northwest	602.1	0.056	0.008	605.9	0.5	0.5	0.318
NYCW	NPCC NYC/Westchester	885.2	0.023	0.003	886.6	0.2	0.2	0.028
NYLI	NPCC Long Island	1,200.7	0.135	0.018	1,209.3	0.9	0.9	0.474
NYUP	NPCC Upstate NY	274.6	0.015	0.002	275.4	0.1	0.1	0.043
PRMS	Puerto Rico Miscellaneou	1,593.5	0.087	0.014	1,599.9	3.1	3.1	4.262
RFCE	RFC East	657.4	0.045	0.006	660.3	0.3	0.2	0.302
RFCM	RFC Michigan	1,216.4	0.116	0.016	1,224.2	0.6	0.6	0.931
RFCW	RFC West	1,000.1	0.087	0.012	1,005.9	0.5	0.4	0.620
RMPA	WECC Rockies	1,124.9	0.101	0.014	1,131.7	0.6	0.6	0.348
SPNO	SPP North	952.6	0.100	0.014	959.4	0.5	0.6	0.160
SPSO	SPP South	970.4	0.072	0.010	975.3	0.8	0.8	0.862
SRMV	SERC Mississippi Valley	801.0	0.040	0.006	803.7	0.5	0.5	0.602
SRMW	SERC Midwest	1,369.9	0.151	0.022	1,380.2	1.0	0.7	2.410
SRSO	SERC South	893.3	0.064	0.009	897.7	0.4	0.4	0.151
SRTV	SERC Tennessee Valley	933.1	0.082	0.012	938.6	0.4	0.4	0.537
SRVC	SERC Virginia/Carolina	623.0	0.047	0.007	625.9	0.3	0.3	0.157
U.S.		**823.1**	**0.066**	**0.009**	**827.5**	**0.5**	**0.5**	**0.473**

1.3.2.1 Building Electrification Cost Estimation Methodology

Due to the preliminary nature of the information, HDR's estimation process involved gathering work descriptions from the engineering staff and obtaining equipment costs online. Electrical requirements were sized by kW for each piece of equipment, assuming 480V circuits would be the preferred voltage. The costs assume all necessary connections would be no further than fifty (50) feet from the equipment. Any physical upgrade to the building's electrical service and associated circuit breakers would be developed as the building improvements are refined and

addressed. The costs for each item are based on 2024 dollars, labor, and current markups seen in the labor force. The Opinion of Probable Costs does not include allowances, escalation, contingency, or design progression factors.

1.3.2.2 Building Electrification Financial Evaluation Methodology

Financial evaluation was completed on all recommended electrification pathways for space heating and domestic hot water systems. While the primary metric of NPV via an LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including Internal Rate of Return, Savings-to-Investment Ratio and Simple/Discounted Payback Periods are provided for additional consideration.

1.3.2.2.1 LCCA Methodology

The purpose of an LCCA is to estimate the overall costs of project alternatives and to select the design that ensures the facility will provide the lowest overall cost of ownership consistent with its quality and function. The LCCA should be performed early in the design process while there is still a chance to refine the design to ensure a reduction in LCC.

The first and most challenging task of an LCCA, or any economic evaluation method, is to determine the economic effects of alternative designs of buildings and building systems, quantify these effects, and express them in dollar amounts.

1.3.2.2.1.1 Costs

Numerous costs are associated with acquiring, operating, maintaining, and disposing of a building or building system. Building-related costs usually fall into the following categories:

- Initial Costs—Purchase, Acquisition, Construction Costs
- Fuel Costs
- Replacement Costs
- Residual Values—Resale or Salvage Values or Disposal Costs
- Finance Charges—Loan Interest Payments
- Non-Monetary Benefits or Costs

Only those costs within each category that are relevant to the decision and significant in amount are needed to make a valid investment decision. Costs are relevant when they are different for one alternative compared with another; costs are significant when they are large enough to make a credible difference in the LCC of a project alternative. All costs are entered as base-year amounts in today's dollars; the LCCA method escalates all amounts to their future year of occurrence and discounts them back to the base date to convert them to present values.

1.3.2.2.1.1.1 Initial costs

Initial costs may include capital investment costs for land acquisition, construction, or renovation and the equipment needed to operate a facility.

Land acquisition costs should be included in the initial cost estimate if they differ among design alternatives. For example, this would be the case when comparing the cost of renovating an existing facility with new construction on purchased land.

Construction costs: Detailed estimates of construction costs are not necessary for preliminary economic analyses of alternative building designs or systems. Such estimates are usually unavailable until the design is quite advanced and the opportunity for cost-reducing design changes has passed. LCCA can be repeated throughout the design process if more detailed cost information becomes available. Initially, construction costs are estimated by referencing historical data from similar facilities. Alternatively, they can be determined from government or private-sector cost-estimating guides and databases.

1.3.2.2.1.1.2 Energy Costs

Operational expenses for energy, water, and other utilities are based on consumption, current rates, and price projections. Energy and water costs are typically assessed for the entire building due to the interdependence of energy, water consumption, building configuration, and building envelope, rather than for individual building systems or components.

Energy usage: Energy costs are often difficult to predict accurately in the design phase of a project. Assumptions must be made about use profiles, occupancy rates, and schedules, all of which impact energy consumption. At the initial design stage, data on the amount of energy consumption for a building can come from engineering analysis or a computer program such as eQUEST.

When selecting a program, it is important to consider whether you need annual, monthly, or hourly energy consumption figures and whether the program adequately tracks savings in energy consumption when design changes or different efficiency levels are simulated.

Energy prices: Quotes of current energy prices from local suppliers should consider the rate type, the rate structure, summer and winter differentials, block rates, and demand charges to obtain an estimate as close as possible to the actual energy cost.

Energy price projections: Energy prices are assumed to increase or decrease at a rate different from general price inflation. This differential energy price escalation needs to be considered when estimating future energy costs. Energy price projections can be obtained either from the supplier or from energy price escalation rates published annually on April 1 by DOE in Discount Factors for LCCA, Annual Supplement to NIST Handbook 135.

1.3.2.2.1.1.3 Replacement Costs

The number and timing of capital replacements of building systems depend on the estimated life of the system and the length of the study period. The same sources that provide cost estimates for initial investments should be used to obtain estimates of replacement costs and expected useful lives. A good starting point for estimating future replacement costs is to use their cost as the base date. The LCCA method will escalate base-year amounts to their future time of occurrence.

1.3.2.2.1.1.4 Residual Values

The residual value of a system (or component) is its remaining value at the end of the study period or when it is replaced during the study period. Residual values can be based on the value in place, resale value, salvage value, or scrap value, net of any selling, conversion, or disposal costs. As a rule of thumb, the residual value of a system with remaining useful life in

place can be calculated by linearly prorating its initial costs. For example, for a system with an expected useful life of fifteen (15) years installed five (5) years before the end of the study period, the residual value would be approximately two-thirds (2/3) ([15-5]/15) of its initial cost.

1.3.2.2.1.1.5 Other Costs

Finance charges and taxes: Finance charges are usually not relevant for federal projects. However, finance charges and other payments apply if a project is financed through an ESPC or UESC. The finance charges are usually included in the contract payments negotiated with the ESCO or the utility.

Non-monetary benefits or costs: Non-monetary benefits or costs are project-related effects for which there is no objective way of assigning a dollar value. Examples of non-monetary effects may be the benefit derived from a particularly quiet HVAC system or an expected but hard-to-quantify productivity gain due to improved lighting. These effects are external to the LCCA by their nature, but if they are significant, they should be considered in the final investment decision and included in the project documentation.

1.3.2.2.1.2 Parameters for Present-Value Analysis

1.3.2.2.1.2.1 Discount Rate

To add and compare cash flows incurred at different times during the life cycle of a project, they must be made time-equivalent. To make cash flows time-equivalent, the LCC method converts them to present values by discounting them to a common point in time, usually the base date. The interest rate used for discounting is a rate that reflects an investor's opportunity cost of money over time, meaning that an investor wants to achieve a return at least as high as that of her next best investment. Hence, the discount rate represents the investor's minimum acceptable rate of return.

The discount rate for federal energy and water conservation projects is determined annually by FEMP; for other federal projects, those not primarily concerned with energy or water conservation, the discount rate is determined by OMB. These discount rates are real discount rates, not including the general inflation rate.

1.3.2.2.1.2.2 Cost Period(s)

Length of study period: The study period begins with the base date, to which all cash flows are discounted. The study period includes any planning/construction/implementation period and the service or occupancy period. The study period has to be the same for all alternatives considered.

Service period: The service period begins when the completed building is occupied or when a system is taken into service. This is the period over which operational costs and benefits are evaluated.

Contract period: The contract period in ESPC and UESC projects lies within the study period. It starts when the project is formally accepted, energy savings accrue, and contract payments come due. The contract period generally ends when the loan is paid off.

1.3.2.2.1.2.3 Discounting Convention

In Federal Energy Management Program, FEMP, studies, all annually recurring cash flows (e.g., operational costs) are discounted from the end of the year they are incurred; All single amounts (e.g., replacement costs, residual values) are discounted from their dates of occurrence.

1.3.2.2.1.2.4 Treatment of Inflation

An LCCA can be performed in constant dollars or current dollars. Constant-dollar analyses exclude the rate of general inflation, and current-dollar analyses include the rate of general inflation in all dollar amounts, discount rates, and price escalation rates. Both types of calculation result in identical present-value life-cycle costs.

Constant-dollar analysis is recommended for all federal projects, except for projects financed by the private sector (ESPC, UESC). The constant-dollar method has the advantage of not requiring an estimate of the inflation rate for the years in the study period. Alternative financing studies are usually performed in current dollars if the analyst wants to compare contract payments with actual operational or energy cost savings from year to year.

1.3.2.2.1.3 Simplified Life-Cycle Cost Calculation

After identifying all costs by year and amount and discounting them to present value, they are added to arrive at total simplified life-cycle costs for each alternative pathway:

Equation 17 | Life Cycle Cost Calculation

$$LCC = I + Repl — Res + E$$

Variable	Variable Description
LCC	Total LCC in present-value dollars of a given alternative
I	Present value investment costs (if incurred at base date, they need not be discounted)
Repl	Present value capital replacement costs
Res	Present value (resale value, salvage value) less disposal costs
E	Present value of energy costs

1.3.2.2.1.4 Evaluation Criteria

When analyzing the total LCC of a single design scenario, the lowest LCC signifies the most cost-effective option. When utilizing the LCC calculation process to perform a comparative analysis between a baseline scenario and an energy/water efficiency measure, the highest total LCC differential greater than $0 signifies the most cost-effective alternative. If a total LCC differential is less than $0, the baseline scenario offers a more cost-effective solution in comparison to the energy/water efficiency measure.

1.3.2.2.2 LCCA Required Inputs

Table 1-3. LCCA Parameters Utilized

LCCA Input Parameter	Input	Source
MARR [Minimum Attractive Rate of Return] (%):	3.000%	Federal Energy Management Program published discount rate for 2023
Dollar Analysis Convention:	Constant $	Default for Federal Energy Management Program LCCA
Real Discount Rate (%):	3.000%	Federal Energy Management Program published discount rate for 2023
Inflation Rate - Materials/O&M (%):	0.000%	Inflation NOT included when utilizing 'Constant $' Dollar Analysis Convention
NIST Energy Utility Cost Escalation Indices Region:	South	NIST Handbook 135, 2023 Supplement
Inflation Rate - Utility Costs (%):	0.000%	0% = Utilizing 'Real' Escalation Rate and Escalation Indices per NIST Handbook 135, 2023 Supplement
Discounting Convention:	End-of-Year	Default for Federal Energy Management Program LCCA
Study Period:	40 Years	Default for Federal Energy Management Program LCCA

1.3.2.2.3 Initial Investment Costs

Cost Estimations were provided by the HDR Cost Estimation team to develop Initial Investment Cost values for all energy efficiency measures.

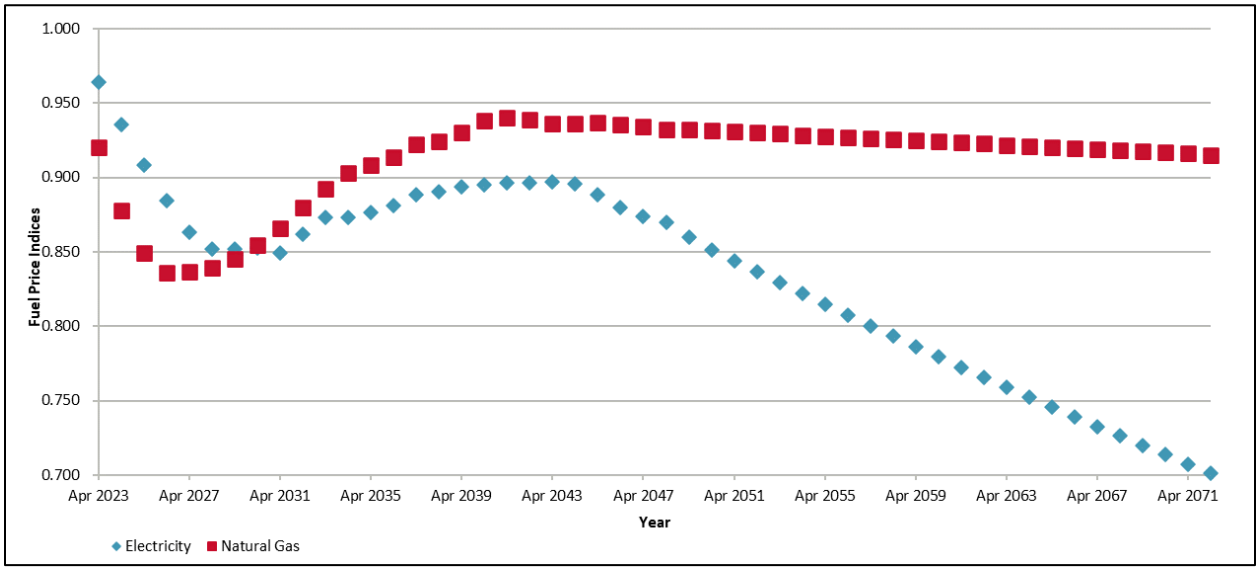
1.3.2.3 Fuel Escalation

As the annual operating costs, specific to energy, calculated in the section above are relative to the base year, these values need to be converted to individual Years 1–40 to be additive with the other present value converted cost inputs. Fuel escalation rates are utilized to convert these energy cost values.

NIST publishes Handbook 135, "Life-Cycle Costing Manual for the Federal Management Program", which contains estimated regional energy-specific escalation rates for the next 30 years. NIST's last published supplement to Handbook 135 utilizes 2023 energy prices as the baseline index and estimates that electric rates will escalate at a rate of -0.55% annually on average for the next 30 years and that natural gas rates will escalate at a rate of -0.60% annually on average for the next 30 years. As the study period for this LCCA is 40 years, the annual escalation factors for years 31–40 need to be extrapolated using data from years 1-30.

All LCCA calculations will utilize the NIST-provided energy escalation rates for years 1–30 in combination with the calculated energy escalation rates for years 31–40. Figure 1-7 graphically displays the estimated yearly escalation that NIST recommends using for financial calculations for both electricity and natural gas.

Figure 1-7. NIST Energy Price Indices | NIST South Region | 2023



1.3.2.3.1 Additional Financial Analysis Equations

Equation 18 | Internal Rate of Return

$$0 = NPV = \sum_{t=1}^{T} C_t \frac{C_t}{(1 + IRR)t} - C_O$$

The IRR is a discount rate that is used to identify potential/future investments that may be profitable. The IRR is used to make the NPV of cash flows from a project/investment equal to zero.

Variable	Variable Description
C_t	Net cash inflow during the period t
C_0	Total initial investment costs
IRR	The internal rate of return
t	The number of time periods

Equation 19 | Savings / Investment Ratio

$$SIR = \frac{Total\ Present\ Value\ Savings}{Total\ Present\ Value\ Investment}$$

The SIR tells all stakeholders whether a project will be cash-flow-positive. It is calculated by dividing the projected energy cost savings over the finance term by the total installed cost of the project, including the cost of equipment, installation, and financing.

Equation 20 | Simple Payback

$$SP = \frac{Total\ Investment}{Annual\ Cash\ Flow}$$

The simple payback period is the amount of time for a project to break even in cash collections using nominal dollars.

Equation 21 | Discounted Payback

$$DP = \frac{Total\ Present\ Value\ Investment}{Discounted\ Present\ Value\ Cash\ Flow}$$

The discounted payback period reflects the amount of time necessary to break even in a project, based not only on what cash flows occur but when they occur and the prevailing rate of return in the market.

1.3.3 Renewable Energy & Electric Vehicle Analysis Methodology

1.3.3.1 Data Collection and Constraints

In order to accurately prepare this plan, the Comprehensive Facilities Assessment Team gathered pertinent information for each facility through a combination of staff information requests, online resources, and field visit data acquisition. Prior to the on-site assessments, the team reviewed information for each facility and made additional information requests, with a specific focus on energy management data. In addition to the information identified for collection during the site visits, the following details are key assessment areas for the renewables and electric vehicle (EV) disciplines:

- Collection of data specific to the facility's annual energy consumption;
- Identification of the electric utility rate structure and the optimum rate plan for facility operation;
- General fleet vehicle make-up for each facility;
- EV charging location preferences for public and fleet vehicles;

Historical energy utility data was reviewed for the previous three years. This data was used to either confirm existing assumptions or make modifications to modeling and other estimation methods. Additional information, such as site operation logistics, space-function analysis, and opportunities for equipment adoption was obtained through field visits.

1.3.3.1.1 Site Visits

For each facility, a site visit was conducted with a focus on pertinent information for the renewables and EV disciplines. A general questionnaire was developed for use on the site visits to assist in prioritizing facility details. Some of these items include:

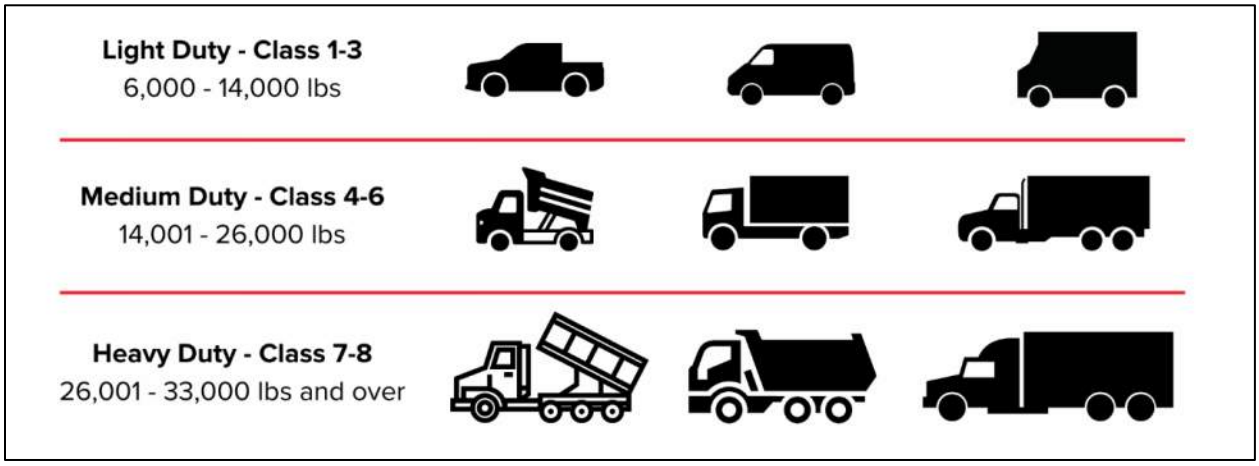
General Site Information	EV Specific Information
• Existing Utility transformer size (kVA) and location; • Considerations and obstacles to extending service;	• Existing fleet parking location; • Existing Public facing chargers on premises;

Solar Specific Information	BESS Specific Information
• Condition of roof, known year of roof replacement; • Parapet wall height (if present); • Roof slope(s) angle and azimuth; • Roof obstructions (trees, surrounding buildings, etc.); • Desire for canopy solar.	• Available (grass space or unused) footprint on property; • Proximity of available space to surrounding structures.

1.3.3.1.2 Fleet

The County staff have indicated the general duty size for the facilities interested in fleet electrification are light duty. This duty size type can be recognized based on the weight class of the vehicle, as illustrated in Figure 1-8. The staff have also provided insight that until future technologies are available, all MD and HD vehicles are to operate either as ICE or with a hydrocarbon fuel source. Under this approach, the light-duty fleet class was used for all further fleet electrification reviews for the facilities.

Figure 1-8. Vehicle Duty by Weight Class[1]



1.3.3.1.3 Public EV Charging

Operations and flow characteristics were considered when identifying possible public electric vehicle charger locations. Ten percent of available parking stalls for the total parking lots assumption was considered when identifying the quantity of potential public EV chargers for a given facility. Locations determined for review of EV were only considered for public EV charging.

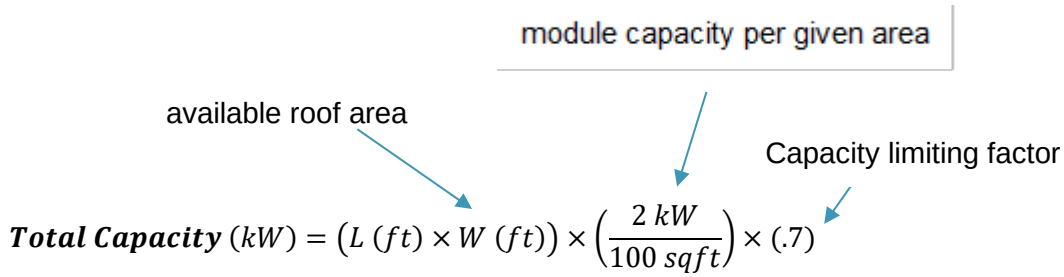
[1] Alternative Fuels Data Center Maps and Data - Vehicle Weight Classes & Categories (energy.gov)

1.3.3.1.4 Existing Electrical Infrastructure

Electrical utility infrastructure information was reviewed during the site visit within capabilities of safety or security measures. Considerations for utility specific construction requirements must also be considered in determining feasibility. [2]

1.3.3.2 Solar Analysis Methodology

Facility roof characteristics such as parapet height, roof replacement year, material, slope, and shading characteristics were reviewed for potential rooftop solar array configuration. The Heliene half-cut monocrystalline 520-540W bifacial module was utilized for design assumptions when considering potential rooftop solar capacity at each facility. The actual capacity for rooftop solar may vary based on the equipment chosen during system design and further analysis of the rooftop. Consideration should be given to roof age and roof material if a potential PV system is pursued at any building covered in this report. PV systems have a typical lifespan on approximately 25 years but may be impacted if the system is decommissioned or relocated due to roof repair or replacement. Height of the building being greater than 3 to 4 standard floor levels should be consider for feasibility of solar due to constructability with a crane. Theis solar module is assumed as 2 kW DC capacity for every 100 square feet of usable rooftop space and a DC:AC ratio of 1.25 was considered. To determine th module capacity per given area following equation was utilized:



When considering power module capacity restrictions such as local fire requirements for solar array pathway setbacks, Ground Coverage Ratio (GCR) of the buildable roof area, shading, and module damage, a 0.7 capacity limiting factor was applied to each capacity estimation. This total capacity and client-provided base building energy load data was processed through the HOMER modeling software. The HOMER analysis produces an optimized solar array size that can best serve the building. This array size takes the current load data and utility tariff into consideration and may be equal to or less than the total available solar capacity. This determined DC capacity will differ from the AC capacity seen by the interconnecting entity for the system due to conversion efficiency losses.

PV system models utilized estimations for the solar azimuth angle. In the case where PV layouts consisted of multiple orientations, the total system capacity was split and modeled with azimuth angles corresponding to the module orientation. The total recommended capacity is reflected as a sum of all the system orientations, although it is recommended to utilize azimuth

[2] Construction Toolbox - Partner with Us - Duke Energy (duke-energy.com)

angles ranging from +90° or -90° from due south. For most buildings, the optimal system size will lie within this range of azimuth angles as systems with angles outside this range tend to have lower annual production and thus a higher return on investment. Production of potential PV systems should be evaluated further during the design phase of the system.

All HOMER model runs utilized Duke Energy's Small General Service Time of Use (TOU) rate for annual utility cost estimation. Renewable fraction estimates for each system are calculated as the ratio of the total energy provided from renewable sources to the total load on an annual basis.

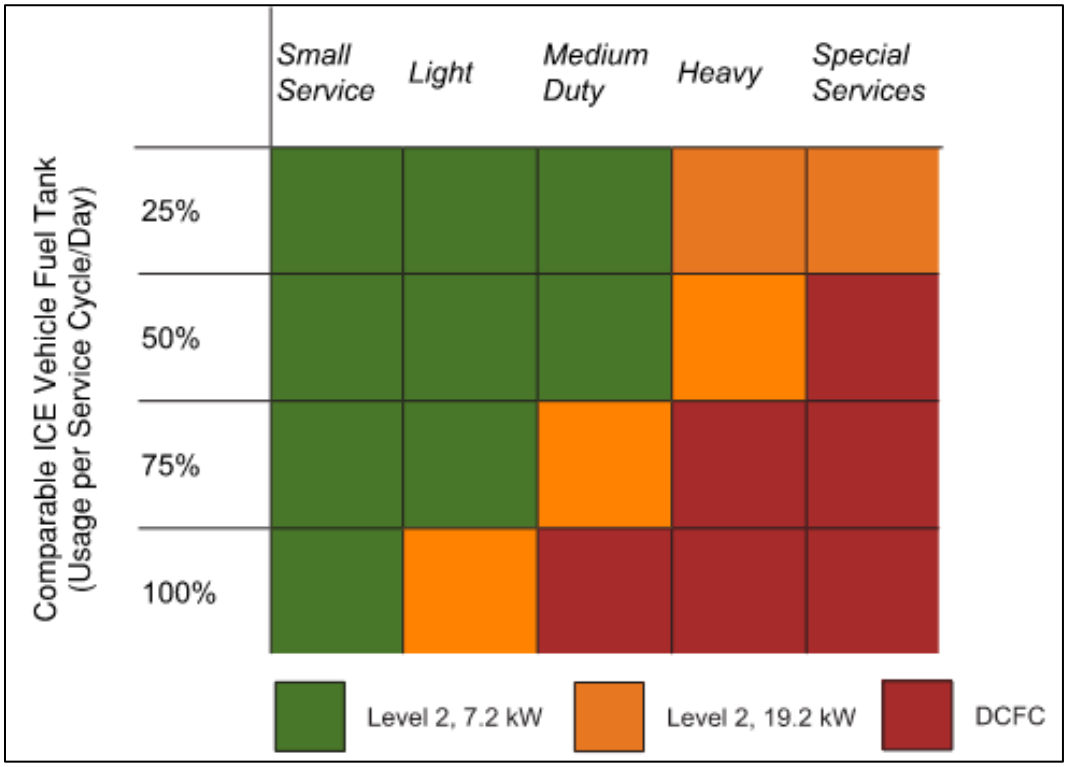
1.3.3.3 Battery Energy Storage Analysis Methodology

The acoustic and aesthetic pollutants associated with standalone BESS near commercial or residential zones may impact the equipment size and location. Due to the location of the reviewed facilities, small scale BESS was coupled with solar equipment or EV charging infrastructure. In order to provide further reliability and resiliency and because of the need for a compact size, a high energy density battery manufacturer is recommended. The BESS equipment coupled with the solar array was sized through the HOMER modeling software and is primarily dependent on the existing building load profile and potential solar capacity.

1.3.3.4 Fleet Electrification and Public Charging Analysis Methodology

All facilities considering fleet electrification are recommended to initially consult the self-assessment matrix detailed in Figure 19, considering the vehicle usage, daily service cycle, and vehicle duty size. Vehicle usage refers to the percent use of an ICE vehicle fuel tank that will later be replaced with the BEV. This vehicle usage should be considered for one service cycle, also known as the use period between vehicle charging events (or refueling). Based on the previously mentioned County preference for efficient or alternative fuel ICE vehicles for MD, HD, and special use vehicles, all scenarios resulting in an orange or red tile should be considered for hydrocarbon fuel at this time. The decision matrix detailed in Figure 19 provides a starting point to determine which fleet vehicles should be considered for electrification based on EV charging demand. Additional analysis can help determine optimized charger deployment and charging strategy to reduce capital and operational expenses.

Figure 1-9. Electric Vehicle Charger Demand based on Vehicle Duty Size and Usage



Public EV charger recommendations were provided for facilities that were recognized as ideal layover locations. Selection of these locations was influenced by facility operations.

1.3.3.5 Renewable Energy Analysis Cost Estimation Methodology

All assumptions, indirect cost, and direct cost methodologies detailed within this report are applicable for all renewables and EV cost summaries.

1.3.3.6 PV and BESS Cost and ROI

In order to provide greater insight into the cost performance of PV and PV + BESS hybrid systems, modeling was conducted to analyze the payback periods for reduced capital costs, primarily through grant funding. Analysis was conducted by modeling system performance with capital costs ranging from 100% to 50% in 10% increments. Three buildings with different sized PV systems were analyzed in this effort. Results for the Eastern Sheriff building, Animal Shelter, and South Regional Library are provided. The starting (100%) installed capital cost for PV is approximately $2,200/kW, and the starting capital cost for BESS is approximately $1,740/kWh. It should be noted that the capital costs for PV and BESS reflect current equipment cost, current construction cost and contingency cost that may change depending on the installation date and the final equipment selection. PV costs operate on a sliding scale where larger projects may experience a lower cost per kW due to economy of scale.

First, the impact of PV cost reduction was analyzed. The cost performance results for a PV only system with reducing PV costs is provided in Table 1-4. The table data is presented as payback period for each capital cost.

Table 1-4. PV System Payback Periods (Years)

	% of PV CAPEX					
System Size/BLDG	**100%**	**90%**	**80%**	**70%**	**60%**	**50%**
Small (Eastern Sheriff)	25	25	22	19	17	14
Medium (Animal Shelter)	23	20	18	16	14	11
Large (South Regional)	>25	25	22	19	16	14

The Animal Shelter system likely experiences a lower payback period due to higher utilization of PV production as compared to the other buildings.

Table 1-5 provides insight into the impact of reduced PV capital costs on PV + BESS hybrid systems.

Table 1-5. PV + BESS Hybrid System Payback Periods (Years)

System Size/BLDG	% of PV CAPEX					
	100%	**90%**	**80%**	**70%**	**60%**	**50%**
Small (Eastern Sheriff)	>25	>25	>25	>25	25	24
Medium (Animal Shelter)	24	22	20	18	16	15
Large (South Regional)	>25	>25	>25	>25	>25	>25

Reducing PV cost does not have as great of an effect on the payback periods of the hybrid systems. In some cases, where the BESS system is smaller and the PV system is highly utilized, the cost reduction greatly improves the baseline payback period. In general, it is recommended to install PV system if the total capital cost falls to approximately 80% (~$1800/kW) of the current modeled value. For certain buildings it is also recommended to install PV + BESS systems if the PV cost falls to approximately 70% ($1550/kW) of the current modeled value, although greater payback periods can likely be seen if the BESS cost is also reduced.

The impact of reducing PV and BESS capital costs was analyzed for each of the three sample buildings. Table 1-6, Table 1-7, and Table 1-8 provide matrices of payback periods for various combinations of reduced PV and BESS capital costs.

Table 1-6. Eastern Sheriff PV + BESS Payback Periods

Eastern Sheriff PV + BESS System Payback Periods							
		% of PV CAPEX					
		100	90	80	70	60	50
% of BESS Capex	100	>25	>25	>25	>25	>25	24
	90	>25	>25	>25	>25	25	23
	80	>25	>25	>25	>25	24	21
	70	>25	>25	>25	>25	23	20
	60	>25	>25	>25	24	22	19
	50	>25	>25	>25	23	21	18

Table 1-7. Animal Shelter PV + BESS Payback Periods

Animal Shelter PV + BESS System Payback Periods							
		% of PV CAPEX					
		100	90	80	70	60	50
% of BESS Capex	100	24	22	20	18	16	15
	90	24	22	20	18	16	14
	80	23	21	19	17	16	14
	70	23	21	19	17	15	13
	60	22	20	18	17	15	13
	50	22	20	18	16	14	12

Table 1-8. South Regional Library PV + BESS Payback Periods

South Regional Library PV + BESS System Payback Periods							
		% of PV CAPEX					
		100	90	80	70	60	50
% of BESS Capex	100	>25	>25	>25	>25	>25	>25
	90	>25	>25	>25	>25	>25	>25
	80	>25	>25	>25	>25	>25	>25
	70	>25	>25	>25	>25	>25	>25
	60	>25	>25	>25	>25	>25	25
	50	>25	>25	>25	>25	>25	25

As shown in the tables above, the impact of decreasing capex varies between buildings indicating that utilization of the system also plays a large role into the payback period. In general, for small buildings the payback periods are improved once PV costs drop to ~70% of the modeled value and BESS costs drop to 50% of the modeled value. For medium buildings, especially those with high system utilization, more favorable payback periods are seen when BESS capital costs are reduced to 80% of the original value or when PV costs are significantly reduced. For large buildings, where large battery storage systems are needed to see increases in renewable fraction, there are limited impacts on the payback periods with cost reduction due to the high capital costs and low excess PV generation.

In general, for systems with payback periods longer than 25 years it is recommended to monitor technology trends and re-evaluate system cost and performance if the PV capital cost reaches approximately $1500/kW and BESS capital cost reaches approximately $1000/kWh. These values may not provide improved system payback for every building but can serve as a starting point for reevaluating systems that may not have been economically viable previously. Durham County may also evaluate the technological improvements of PV and BESS systems within their respective markets every 3 to 5 years. Improvements in module power density, along with potential cost reductions, will likely lead to systems that have significantly improved electrical and cost performance.

1.4 Summary of Portfolio Recommendations

1.4.1 HVAC Refrigerants

Per the EPA[3], HFCs are potent greenhouse gases developed and manufactured as replacements for ozone-depleting substances. These fluorinated chemicals have no known natural sources. They can have impacts on the climate hundreds to thousands of times greater than the same amount of CO_2. The impact is measured by the GWP of a substance; one kilogram of a greenhouse gas with a GWP of 700 has an impact on the climate that is 700 times stronger than one kilogram of CO_2, which has a GWP of 1. Unlike ozone-depleting substances, HFCs do not deplete the stratospheric ozone layer.

Climate-damaging HFCs are used in many of the same sectors where ozone-depleting substances have been used: refrigeration and air conditioning, fire suppression, solvents, foam blowing, aerosols, and semiconductor manufacturing. As of 2018, about 75% of total HFC use in the United States occurred in refrigeration and air conditioning equipment in homes, commercial buildings, and industrial operations; approximately 8% in air conditioning in vehicles and refrigerated transport.

HFCs are extremely powerful greenhouse gases that accelerate climate change, which threatens society with costly health and environmental impacts such as floods, wildfires, drought, and increasingly severe weather events.

The AIM Act was enacted on December 27, 2020. The AIM Act mandates the phase-down of HFCs by 85 percent from historic baseline levels by 2036. The public is expected to reap health and climate benefits from transitioning away from climate-damaging HFCs to more energy-efficient cooling technologies. There are no requirements to stop using any specific equipment or appliance currently in use. Consumers will be able to continue using their equipment until the end of its useful life. As with the transition from ozone-depleting substances, which is largely concluded, the HFC phase-down may not be noticeable to most consumers.

For stationary air-conditioning, heat pumps, chillers, and refrigeration equipment the AIM Act begins the phase-down of HFC refrigerant use starting January 1, 2025. At that time, manufacturers will be prohibited from manufacturing or importing equipment using refrigerants with GWP of 700 or greater. Any equipment manufactured prior to the deadline will still be able to be purchased or installed. Manufacturers have begun updating their equipment designs to use new transition refrigerants; however, this process is not complete due to new standards that must be met.

Many of the transition refrigerants proposed to be used are mildly flammable, which has led ASHRAE to create a new refrigerant safety classification, A2L, for these non-toxic, mildly-flammable refrigerants and blends. Due to the flammability, the equipment and associated building spaces must be monitored to assure it remains below the Lower Flammability Limit.

[3] https://www.epa.gov/climate-hfcs-reduction/frequent-questions-phasedown-hydrofluorocarbons

New replacement safety and testing standards have been developed by UL to apply to equipment using A2L refrigerants. The new standard, UL 60335-2-40, replaces UL 1995 and was effective as of January 1, 2024.

Due to this need for sensing and monitoring to be factory installed in equipment, it will not be possible to replace existing A1 refrigerants with new A2L refrigerants. The only viable retrofit refrigerant with a similar capacity and a GWP less than 700 is R0513A to replace R-134A. This refrigerant would primarily be found in centrifugal and screw chillers.

At the time of this report, not all types of HVAC and refrigeration equipment are currently available using the transition refrigerants. Manufacturers are still in the process of redesigning and testing. The most widely available transition refrigerant-based equipment are hydronic chillers and hydronic heat pumps. Equipment with air handling components, including packaged roof top units and split systems, are limited to the legacy A1, non-toxic and non-flammable, refrigerants.

County owned facilities utilize a variety of HFCs specific to refrigeration and air conditioning systems. Should the County adopt a phase-out initiative of currently used HFCs, Table 1-9 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in County buildings in addition to direct-replacement refrigerant options that comply with EPA regulations and have GWP values less than 700.

Table 1-9. Durham County HFC Refrigerant Alternative Options

Legacy Refrigerant Type	GWP [Fifth Assessment Report (AR5)]	Retrofit Low-GWP Refrigerant (Similar Capacity)	Alternate Low-GWP Refrigerant (New Equipment)	GWP [Fifth Assessment Report (AR5)]	Alternate Refrigerant Safety Group [ASHRAE 34-2022]
R-134A	1,300.00	R-513A	R-513A	573.0	A1
			R-515B	299.0	A1
			R-1234yf	1.0	A1
			R-1234ze	1.0	A2L
R-410A	1,923.50		R-32	677.0	A2L
R-407C	1,624.21	N/A	R-452b	675.0	A2L
			R-454b	467.0	A2L
R-123	79.0	N/A	R-1233zd(E)	1.0	A1

Note: Alternate Replacement Options for existing HFC use should be validated by both the existing equipment manufacturer and the engineer of record for the refrigerant replacement project. Oil/Lubricant modifications may be required depending on the alternate replacement refrigerant parameters and the end-use application type.

After January 1, 2025, equipment using HFCs will not be manufactured or imported but the refrigerants themselves will still be allowed to be produced in reduced amounts through 2036 and beyond. In 2024 through 2028, production and importation of HFC refrigerants will be limited to 60% of the 2020 baseline. The next phasedowns will be to 30% in 2029, to 20% in 2034, and finally to 15% in 2036.

It is recommended that the County implement a refrigerant tracking system and policy to have all refrigerants from equipment being demolished recovered and turned over to the County. Recovery of existing refrigerants will allow the County to maintain a supply of refrigerants that may be re-used in County owned equipment and reduce the cost impacts of future refrigerant supply reductions.

Additionally, it is recommended to implement a policy to specify equipment for new projects or replacements using the low-GWP transition refrigerants as those equipment types are available. It is not recommended to replace equipment prior to their expected end-of-life only to change refrigerants. For existing chillers using R-134A, cost of replacing the refrigerant with R-513A should be evaluated case-by-case based on the current market rates if they experience leaks of 10% of their capacity or more.

1.4.2 Building Decarbonization

HDR's analysis included a thorough review of the greenhouse gas emission impacts of the County buildings.

Table 1-10. Durham County Building Decarbonization Summary

Building	Annual Electric Savings Identified (kWh)	Annual Natural Gas Savings Identified (Therms)	Annual Total Energy Savings Identified (MMBTU)	Annual Total Energy Cost Savings Identified ($US)	Annual Total GHG Emission Reduction Identified (MT CO2e)
Administrative Building	333,386.86	6,355.58	1,773.40	$31,790.82	128.41
Administrative Building II	354,952.78	7,549.72	1,966.41	$39,953.53	140.87
Agriculture Building	63,288.19	126.61	228.66	$6,748.09	18.64
Animal Control Office	12,195.34	0.00	41.62	$1,413.19	3.46
Animal Shelter	92,373.48	2,079.26	523.19	$11,569.53	37.27
Bethesda VFD	35,524.12	25.00	123.74	$3,154.68	10.22
Bragtown Library	1,898.27	0.00	6.48	$331.40	0.54
Center For Senior Life	64,035.61	659.94	284.55	$7,225.14	21.69
Community Shelter	74,512.74	1,058.65	360.17	$7,953.94	26.78
Detention Center	2,168,424.54	22,167.14	9,617.48	$178,743.22	733.36
Durham County Courthouse	1,236,914.82	22,022.33	6,423.79	$114,336.92	468.14
Durham County Stadium	57,953.67	2,303.03	428.10	$10,357.46	28.69
Durham County Warehouse	122,300.18	759.83	493.39	$14,568.87	38.76
East Regional Library	150,219.76	892.67	601.96	$13,809.42	47.39
Eastern Sheriff's Station	23,049.07	201.55	98.82	$3,950.20	7.61
EMS #2 - Old Fayetteville Road	32,582.02	11.07	112.31	$3,333.86	9.31
EMS #6 - Milton Road	30,278.27	464.75	149.81	$4,202.67	11.06
Fire Marshall	11,572.46	0.00	39.50	$1,858.53	3.29

Building	Annual Electric Savings Identified (kWh)	Annual Natural Gas Savings Identified (Therms)	Annual Total Energy Savings Identified (MMBTU)	Annual Total Energy Cost Savings Identified ($US)	Annual Total GHG Emission Reduction Identified (MT CO2e)
General Services	44,748.94	380.92	190.82	$4,977.42	14.73
Head Start	42,835.16	1,017.70	247.96	$5,681.22	17.57
Health and Human Services	1,131,126.06	18,214.67	5,681.97	$107,287.97	417.88
JRC	116,468.70	218.15	419.32	$10,706.72	34.22
JSD Living Facility	18,953.59	0.00	64.69	$1,969.28	5.38
Judicial Building Annex	181,024.36	1,523.10	770.14	$16,348.91	59.48
Leesville VFD	10,630.41	-48.79	31.40	$1,055.90	2.76
Main Library	237,836.41	4,321.99	1,243.93	$25,821.88	90.48
North Regional Library	140,827.66	624.21	543.06	$13,873.50	43.30
Parkwood VFD #1 (Station 18)	6,536.41	212.91	43.60	$891.21	2.99
Parkwood VFD #2	18,117.60	-91.28	52.71	$1,791.50	4.66
Rainbow Assisted Living	19,502.48	-108.52	55.71	$1,918.21	4.96
South Regional Library	138,525.53	358.61	508.64	$14,542.53	41.23
Southwest Regional Library	134,986.26	2,503.71	711.08	$14,834.08	51.62
TWWTP (Admin)	111,990.56	12.43	383.46	$9,365.39	31.86
TWWTP Bldg 2 (Sludge)	89,969.89	-66.21	300.44	$7,684.59	25.19

Note on Building Decarbonization Results: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylight Dimming Control measure will be less, as the baseline lighting power density will be lower as a result of the LED Retrofit.

1.4.3 Building Electrification

Table 1-11. Durham County Building Electrification Summary | HVAC Pathway 1

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Administrative Building	487,136.7	4.5%	$(65,896.21)	-32.8%	(82.55)	-11.0%
Administrative Building II	715.5	0.0%	$(149,952.17)	-69.8%	(120.54)	-15.6%
Agriculture Building	140,493.8	15.8%	$(8,354.94)	-45.2%	(2.36)	-3.9%
Animal Control Office	0.0	0.0%	$-	0.0%	0.00	0.0%
Bethesda VFD	9,886.8	1.1%	$(151.24)	-0.7%	0.21	0.3%

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Bragtown Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Center For Senior Life	0.0	0.0%	$-	0.0%	0.00	0.0%
Community Shelter	125,767.1	10.7%	$(8,697.04)	-35.5%	(1.72)	-2.1%
Detention Center	846,776.9	3.4%	$(64,673.04)	-16.5%	(34.05)	-1.9%
Durham County Courthouse	4,512,675.0	12.0%	$(400,620.54)	-71.0%	(121.13)	-4.7%
Durham County Stadium	183,487.8	8.2%	$(6,871.65)	-14.4%	(7.74)	-4.8%
Durham County Warehouse	444,489.2	17.5%	$(18,738.33)	-40.9%	(8.02)	-4.8%
East Regional Library	111,397.8	4.2%	$(18,736.66)	-32.9%	(20.93)	-10.8%
Eastern Sheriff's Station	15,568.4	8.2%	$(655.25)	-12.8%	(0.32)	-2.5%
EMS #2 - Old Fayetteville Road	43,694.8	10.1%	$(1,416.98)	-13.7%	(2.58)	-8.7%
EMS #6 - Milton Road	32,446.4	9.6%	$(392.00)	-4.4%	0.42	1.7%
Fire Marshall	0.0	0.0%	$-	0.0%	0.00	0.0%
General Services	135,918.2	14.7%	$(12,699.69)	-67.7%	(3.26)	-5.2%
Head Start	81,488.3	10.2%	$(3,623.26)	-21.1%	(3.69)	-6.8%
Health and Human Services	1,781,462.5	5.8%	$(330,635.72)	-69.9%	(309.62)	-14.6%
JRC	65,914.6	2.8%	$(2,326.73)	-3.8%	(1.02)	-0.5%
JSD Transitional Living Facility	0.0	0.0%	$-	0.0%	0.00	0.0%
Judicial Building Annex	198,435.8	5.0%	$(17,483.87)	-20.6%	(27.27)	-9.5%
Leesville VFD	551.3	0.6%	$(37.83)	-1.1%	(0.01)	-0.2%
Main Library	(31,413.9)	-0.5%	$(69,082.95)	-51.7%	(75.98)	-15.9%
North Regional Library	79,813.1	3.7%	$(16,406.15)	-34.0%	(15.71)	-10.0%
Parkwood VFD #1 (Station 18)	8,903.1	1.1%	$(124.19)	-0.6%	0.18	0.3%
Parkwood VFD #2	1,337.4	0.6%	$(35.73)	-0.5%	(0.03)	-0.2%
Rainbow Assisted Living	6,456.9	2.5%	$(174.87)	-2.1%	(0.15)	-0.7%
South Regional Library	93,157.0	4.0%	$(15,740.34)	-29.7%	(12.49)	-7.2%
Southwest Regional Library	314,482.7	8.2%	$(29,185.70)	-42.1%	(37.71)	-14.9%
TWWTP Bldg 2 (Sludge)	752,193.4	11.3%	$(56,764.32)	-42.1%	(19.56)	-4.2%

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
TWWTP(Admin)	(8,680.6)	-0.3%	$(294.05)	-0.3%	(0.72)	-0.3%

Table 1-12. Durham County Building Electrification Summary | HVAC Pathway 2

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Administrative Building	2,925,064.3	27.2%	$(2,533.05)	-1.3%	120.25	16.0%
Administrative Building II	2,679,460.9	24.4%	$(34,592.04)	-16.1%	102.28	13.2%
Agriculture Building	315,924.1	35.6%	$(133.15)	-0.7%	12.24	20.4%
Animal Control Office	0.0	0.0%	$-	0.0%	0.00	0.0%
Bethesda VFD	9,886.8	1.1%	$(151.24)	-0.7%	0.21	0.3%
Bragtown Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Center For Senior Life	143,362.2	7.5%	$5,326.53	9.2%	11.93	7.7%
Community Shelter	274,693.1	23.3%	$(358.89)	-1.5%	10.66	12.9%
Detention Center	969,887.1	3.8%	$(61,442.36)	-15.7%	(23.81)	-1.4%
Durham County Courthouse	4,512,675.0	12.0%	$(400,620.54)	-71.0%	(121.13)	-4.7%
Durham County Stadium	561,703.5	25.1%	$3,578.62	7.5%	23.72	14.8%
Durham County Warehouse	726,741.2	28.6%	$(8,954.91)	-19.6%	15.46	9.3%
East Regional Library	606,791.5	22.6%	$(3,636.22)	-6.4%	20.28	10.5%
Eastern Sheriff's Station	32,721.9	17.2%	$(43.15)	-0.8%	1.11	8.6%
EMS #2 - Old Fayetteville Road	88,806.9	20.5%	$(252.07)	-2.4%	1.17	3.9%
EMS #6 - Milton Road	33,444.7	9.9%	$(347.74)	-3.9%	0.50	2.1%
Fire Marshall	0.0	0.0%	$-	0.0%	0.00	0.0%
General Services	327,915.0	35.5%	$(2,170.81)	-11.6%	12.71	20.4%
Head Start	251,465.6	31.6%	$1,376.82	8.0%	10.45	19.3%
Health and Human Services	10,962,622.2	35.4%	$(77,339.97)	-16.3%	454.10	21.4%
JRC	144,539.5	6.2%	$681.26	1.1%	5.52	2.9%
JSD Transitional Living Facility	0.0	0.0%	$-	0.0%	0.00	0.0%

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Judicial Building Annex	860,488.0	21.6%	$482.02	0.6%	27.80	9.7%
Leesville VFD	551.3	0.6%	$(37.83)	-1.1%	(0.01)	-0.2%
Main Library	1,333,603.2	19.7%	$(23,866.68)	-17.9%	37.56	7.8%
North Regional Library	443,001.9	20.5%	$(4,256.90)	-8.8%	14.51	9.2%
Parkwood VFD #1 (Station 18)	8,903.1	1.1%	$(124.19)	-0.6%	0.18	0.3%
Parkwood VFD #2	1,337.4	0.6%	$(35.73)	-0.5%	(0.03)	-0.2%
Rainbow Assisted Living	15,577.9	6.0%	$43.37	0.5%	0.60	2.9%
South Regional Library	406,651.3	17.6%	$(4,518.66)	-8.5%	13.59	7.9%
Southwest Regional Library	1,267,385.0	33.2%	$(2,421.68)	-3.5%	41.55	16.4%
TWWTP (Admin)	(8,680.6)	-0.3%	$(294.05)	-0.3%	(0.72)	-0.3%
TWWTP Bldg 2 (Sludge)	752,193.4	11.3%	$(56,764.32)	-42.1%	(19.56)	-4.2%

Table 1-13. Durham County Building Electrification Summary | DHW Pathway 1

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Administrative Building	115,343.2	1.1%	$(6,111.73)	-3.0%	(7.61)	-1.0%
Administrative Building II	147,535.8	1.3%	$(8,086.69)	-3.8%	(6.74)	-0.9%
Agriculture Building	0.0	0.0%	$-	0.0%	0.00	0.0%
Animal Control Office	0.0	0.0%	$-	0.0%	0.00	0.0%
Bethesda VFD	0.0	0.0%	$-	0.0%	0.00	0.0%
Bragtown Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Center For Senior Life	19,202.1	1.0%	$(579.96)	-1.0%	(0.84)	-0.5%
Community Shelter	26,360.8	2.2%	$(853.19)	-3.5%	(0.96)	-1.2%
Detention Center	1,967,216.8	7.8%	$(144,528.26)	-36.8%	(75.17)	-4.3%
Durham County Courthouse	408,388.8	1.1%	$(34,144.86)	-6.1%	(22.05)	-0.9%
Durham County Stadium	23,518.2	1.0%	$(713.39)	-1.5%	(1.25)	-0.8%

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Durham County Warehouse	516.8	0.0%	$(23.38)	-0.1%	(0.03)	0.0%
East Regional Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Eastern Sheriff's Station	9,597.4	5.0%	$(713.46)	-14.0%	(0.52)	-4.1%
EMS #2 - Old Fayetteville Road	0.0	0.0%	$-	0.0%	0.00	0.0%
EMS #6 - Milton Road	12,901.5	3.8%	$(383.37)	-4.3%	(0.80)	-3.3%
Fire Marshall	0.0	0.0%	$-	0.0%	0.00	0.0%
General Services	0.0	0.0%	$-	0.0%	0.00	0.0%
Head Start	11,699.5	1.5%	$(405.42)	-2.4%	(0.68)	-1.2%
Health and Human Services	0.0	0.0%	$-	0.0%	0.00	0.0%
JRC	2,682.9	0.1%	$(94.35)	-0.2%	(0.10)	-0.1%
JSD Transitional Living Facility	0.0	0.0%	$-	0.0%	0.00	0.0%
Judicial Building Annex	0.0	0.0%	$-	0.0%	0.00	0.0%
Leesville VFD	0.0	0.0%	$-	0.0%	0.00	0.0%
Main Library	84,596.9	1.2%	$(4,301.60)	-3.2%	(4.50)	-0.9%
North Regional Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Parkwood VFD #1 (Station 18)	4,267.3	0.5%	$(186.11)	-0.9%	(0.31)	-0.5%
Parkwood VFD #2	1,071.0	0.5%	$(55.64)	-0.8%	(0.08)	-0.5%
Rainbow Assisted Living	0.0	0.0%	$-	0.0%	0.00	0.0%
South Regional Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Southwest Regional Library	0.0	0.0%	$-	0.0%	0.00	0.0%
TWWTP (Admin)	1,500.9	0.0%	$(76.49)	-0.1%	(0.07)	0.0%
TWWTP Bldg 2 (Sludge)	0.0	0.0%	$-	0.0%	0.00	0.0%

Table 1-14. Durham County Building Electrification Summary | DHW Pathway 2

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Administrative Building	493,825.6	4.6%	$3,395.79	1.7%	23.88	3.2%
Administrative Building II	535,355.7	4.9%	$3,253.63	1.5%	25.52	3.3%
Agriculture Building	3,421.6	0.4%	$92.71	0.5%	0.28	0.5%
Animal Control Office	5,696.9	2.8%	$140.30	2.0%	0.47	2.8%
Bethesda VFD	15,875.1	1.7%	$379.93	1.6%	1.32	1.8%
Bragtown Library	0.0	0.0%	$-	0.0%	0.00	0.0%
Center For Senior Life	68,536.8	3.6%	$679.26	1.2%	3.26	2.1%
Community Shelter	87,858.7	7.4%	$805.28	3.3%	4.15	5.0%
Detention Center	1,967,216.8	7.8%	$(144,528.26)	-36.8%	(75.17)	-4.3%
Durham County Courthouse	1,590,793.0	4.2%	$(2,118.21)	-0.4%	76.31	3.0%
Durham County Stadium	91,067.7	4.1%	$845.84	1.8%	4.37	2.7%
Durham County Warehouse	2,147.8	0.1%	$19.09	0.0%	0.10	0.1%
East Regional Library	13,630.0	0.5%	$376.88	0.7%	1.13	0.6%
Eastern Sheriff's Station	37,361.9	19.6%	$347.94	6.8%	1.79	13.9%
EMS #2 - Old Fayetteville Road	4,003.3	0.9%	$99.32	1.0%	0.33	1.1%
EMS #6 - Milton Road	52,290.0	15.4%	$594.91	6.6%	2.48	10.3%
Fire Marshall	2,439.0	2.6%	$91.48	2.4%	0.20	2.6%
General Services	12,477.0	1.4%	$292.02	1.6%	1.04	1.7%
Head Start	46,939.6	5.9%	$457.98	2.7%	2.26	4.2%
Health and Human Services	0.0	0.0%	$-	0.0%	0.00	0.0%
JRC	9,045.8	0.4%	$89.57	0.1%	0.43	0.2%
JSD Transitional Living Facility	10,987.6	8.9%	$405.34	7.9%	0.91	8.9%
Judicial Building Annex	21,728.1	0.5%	$578.60	0.7%	1.81	0.6%
Leesville VFD	1,494.9	1.7%	$62.64	1.8%	0.12	1.8%
Main Library	327,228.4	4.8%	$2,309.13	1.7%	15.69	3.3%
North Regional Library	11,558.7	0.5%	$324.46	0.7%	0.96	0.6%

Building	Total Energy Usage Savings (MMBTU)	Total Energy Usage Savings (%)	Total Energy Cost Savings ($US)	Total Energy Cost Savings (%)	Total Energy GHG Reduction (MT CO2e)	Total Energy GHG Reduction (%)
Parkwood VFD #1 (Station 18)	18,715.1	2.2%	$144.47	0.7%	0.89	1.3%
Parkwood VFD #2	4,697.3	2.2%	$34.64	0.5%	0.22	1.3%
Rainbow Assisted Living	6,788.7	2.6%	$167.03	2.0%	0.56	2.7%
South Regional Library	13,663.4	0.6%	$370.47	0.7%	1.14	0.7%
Southwest Regional Library	14,056.0	0.4%	$389.13	0.6%	1.17	0.5%
TWWTP (Admin)	5,436.4	0.2%	$35.17	0.0%	0.25	0.1%
TWWTP Bldg 2 (Sludge)	497,684.2	7.5%	$13,620.34	10.1%	41.40	8.8%

Table 1-15. Durham County Building Electrification Summary | HVAC Net Present Value Results

	HVAC Pathway 1		HVAC Pathway 2	
Building	**Incremental First Cost**	**40-Year NPV @ 3.00% DR**	**Incremental First Cost**	**40-Year NPV @ 3.00% DR**
Administrative Building	$469,101.00	$(1,932,878.99)	$5,790,132.00	$(7,786,218.31)
Administrative Building II	$744,102.84	$(4,079,845.16)	$2,942,910.84	$(4,616,951.58)
Agriculture Building	$(35,838.00)	$(114,602.17)	$29,319.00	$(29,165.55)
Animal Control Office	$26,617.00	$(35,967.66)	$26,617.00	$(35,967.66)
Bethesda VFD	$136,459.00	$(186,993.36)	$136,459.00	$(186,993.36)
Bragtown Library	$-	$-	$-	$-
Center For Senior Life	$644,452.00	$(870,850.66)	$3,764,558.00	$(4,974,670.67)
Community Shelter	$(76,192.17)	$(69,080.76)	$(45,939.17)	$65,977.09
Detention Center	$1,130,715.00	$(2,866,997.42)	$1,746,436.00	$(3,630,854.81)
Durham County Courthouse	$1,476,209.22	$(10,340,498.81)	$1,476,209.22	$(10,340,498.81)
Durham County Stadium	$(154,609.52)	$84,615.67	$(48,042.02)	$161,116.23
Durham County Warehouse	$371,471.30	$(857,250.77)	$560,236.30	$(905,895.07)
East Regional Library	$136,189.00	$(552,426.72)	$132,641.00	$(229,005.92)
Eastern Sheriff's Station	$6,035.25	$(20,204.98)	$17,980.00	$(23,430.36)

Building	HVAC Pathway 1 Incremental First Cost	HVAC Pathway 1 40-Year NPV @ 3.00% DR	HVAC Pathway 2 Incremental First Cost	HVAC Pathway 2 40-Year NPV @ 3.00% DR
EMS #2 - Old Fayetteville Road	$18,469.25	$(48,618.74)	$39,793.00	$(52,853.54)
EMS #6 - Milton Road	$64,827.67	$(93,429.31)	$347,409.67	$(474,349.69)
Fire Marshall	$2,187.78	$(2,956.35)	$2,187.78	$(2,956.35)
General Services	$77,777.25	$(359,203.25)	$114,659.00	$(186,877.54)
Head Start	$80,002.50	$(174,682.82)	$158,116.00	$(174,734.05)
Health and Human Services	$1,995,310.47	$(9,568,137.49)	$3,716,647.47	$(6,549,530.05)
JRC	$53,658.00	$(115,044.63)	$158,511.00	$(193,262.93)
JSD Transitional Living Facility	$-	$-	$-	$-
Judicial Building Annex	$188,135.89	$(584,777.93)	$1,844,360.89	$(2,443,753.15)
Leesville VFD	$252,266.00	$(341,640.31)	$252,266.00	$(341,640.31)
Main Library	$532,596.75	$(2,119,952.52)	$1,149,708.75	$(1,999,774.34)
North Regional Library	$135,130.00	$(509,137.57)	$657,269.00	$(958,351.46)
Parkwood VFD #1 (Station 18)	$106,372.00	$(145,917.46)	$106,372.00	$(145,917.46)
Parkwood VFD #2	$55,756.23	$(75,986.08)	$55,756.23	$(75,986.08)
Rainbow Assisted Living	$78,763.00	$(109,570.30)	$518,406.00	$(699,056.90)
South Regional Library	$698,398.00	$(1,256,642.65)	$692,270.00	$(1,011,579.31)
Southwest Regional Library	$657,684.00	$(1,450,310.74)	$657,243.00	$(884,981.61)
TWWTP (admin)	$89,031.00	$(126,512.56)	$89,031.00	$(126,512.56)
TWWTP Bldg 2 (Sludge)	$7,141.75	$(1,141,850.66)	$7,141.75	$(1,141,850.66)

Table 1-16. Durham County Building Electrification Summary | DHW Net Present Value Results

Building	DHW Pathway 1 Incremental First Cost	DHW Pathway 1 40-Year NPV @ 3.00% DR	DHW Pathway 2 Incremental First Cost	DHW Pathway 2 40-Year NPV @ 3.00% DR
Administrative Building	$(16,086.00)	$(94,440.23)	$650,728.00	$(794,895.62)
Administrative Building II	$113,945.00	$(310,459.76)	$300,121.00	$(322,754.18)
Agriculture Building	$-	$-	$10,127.00	$(11,728.44)
Animal Control Office	$-	$-	$2,772.00	$(785.39)

Building	DHW Pathway 1		DHW Pathway 2	
	Incremental First Cost	40-Year NPV @ 3.00% DR	Incremental First Cost	40-Year NPV @ 3.00% DR
Bethesda VFD	$32,603.00	$(44,056.57)	$265,117.00	$(350,237.05)
Bragtown Library	$-	$-	$-	$-
Center For Senior Life	$31,823.00	$(52,863.02)	$560,639.00	$(740,884.01)
Community Shelter	$86,338.00	$(131,700.06)	$1,147,479.00	$(1,530,629.86)
Detention Center	$-	$(2,991,167.86)	$-	$(2,991,167.86)
Durham County Courthouse	$22,350.00	$(738,534.62)	$939,038.00	$(1,301,481.86)
Durham County Stadium	$(6,825.00)	$(2,943.32)	$459,502.00	$(600,192.52)
Durham County Warehouse	$6,346.00	$(9,001.51)	$40,407.00	$(54,132.21)
East Regional Library	$-	$-	$(3,866.00)	$13,176.50
Eastern Sheriff's Station	$4,739.00	$(20,001.20)	$39,061.00	$(43,984.68)
EMS #2 - Old Fayetteville Road	$-	$-	$11,611.00	$(13,594.38)
EMS #6 - Milton Road	$5,220.00	$(13,136.46)	$14,619.00	$(5,195.27)
Fire Marshall	$-	$-	$17,688.00	$(21,971.51)
General Services	$-	$-	$1,020.00	$4,783.42
Head Start	$(2,111.00)	$(4,145.97)	$487,107.00	$(647,010.17)
Health and Human Services	$-	$-	$22,501.00	$(30,405.69)
JRC	$5,964.00	$(9,726.23)	$58,607.00	$(76,982.22)
JSD Transitional Living Facility	$-	$-	$14,617.00	$(11,199.15)
Judicial Building Annex	$-	$-	$-	$12,208.81
Leesville VFD	$-	$-	$8,852.00	$(10,639.95)
Main Library	$30,948.00	$(123,558.10)	$737,050.00	$(938,227.30)
North Regional Library	$-	$-	$8,278.00	$(4,339.75)
Parkwood VFD #1 (Station 18)	$(213.00)	$(3,109.17)	$9,901.00	$(9,800.80)
Parkwood VFD #2	$8,440.00	$(12,446.08)	$15,566.00	$(20,170.46)
Rainbow Assisted Living	$-	$-	$11,827.00	$(12,457.40)
South Regional Library	$-	$-	$366.00	$7,322.54
Southwest Regional Library	$-	$-	$6,210.00	$(180.68)

Building	DHW Pathway 1 Incremental First Cost	DHW Pathway 1 40-Year NPV @ 3.00% DR	DHW Pathway 2 Incremental First Cost	DHW Pathway 2 40-Year NPV @ 3.00% DR
TWWTP (admin)	$1,509.00	$(3,495.58)	$8,372.00	$(10,413.59)
TWWTP Bldg 2 (Sludge)	$-	$-	$(633.00)	$288,250.79

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems opportunities. The financial cost for implementing each Electrification Pathway for each building is in development. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

1.4.4 Renewable Energy & Energy Storage

For each facility identified for possible rooftop or canopy solar, as well as EV chargers, the following analysis was completed. This analysis identified the rooftop solar capacity and solar plus BESS capacity that provided the lowest payback period on Duke Energy TOU rates. The cost performance of each system was modeled with and without federal renewable energy incentives. The ideal EV charger locations and equipment sizing recommendations were also included for facilities. A summary of these findings for both renewables and EVs can be found in Table 1-17 with further details of each reviewed facility within the following sections.

Table 1-17. Renewables Analysis Summary

Building Name	Public EV Charging Recommended	EV Charging Recommended	PV Capacity kW DC/(kW AC)	PV Simple Payback Period (yrs)	BESS Capacity (kWh)	PV+ BESS Simple Payback Period (yrs)	PV Renewable Fraction (%)	PV + BESS Renewable Fraction (%)
Administrative Building II	YES	YES	62 (49.6 kW AC)	18	132	>25	4.4	4.4
Agriculture Building	YES	YES	113 (90.4 kW AC)	24	132	>25	73.8	86.1
Animal Control Office	NO	YES	30 (24 kW AC)	>25	53	>25	55	62.3
Animal Shelter	YES	NO	100 (80 kW AC)	23	26.4	>25	59.3	60.7
Bethesda VFD	NO	YES	32 (25.6 kW AC)	>25	66	>25	53.4	62.5
Bragtown Library	YES	NO	4 (3.2 kW AC)	>25	13.2	>25	41.1	43.7
Center for Senior Life	YES	NO	85 (68 kW AC)	>25	106	>25	48.6	52.7
Community Shelter	NO	NO	83.3 (66.64 kW AC)	>25	106	>25	47.9	51.9
Detention Center	YES	NO	200 (160 kW AC)	19	53	>25	6.7	6.7
Durham Center Access	NO	NO	130 (104 kW AC)	24	119	>25	38.4	39.4
Durham County Courthouse	YES	NO	145 (116 kW AC)	18	330	>25	3.4	3.4
Durham County Stadium	YES	YES	106 (84.8 kW AC)	22	106	>25	35.6	36.3
Durham County Warehouse	NO	YES	280 (224 kW AC)	>25	79	>25	72.4	75.9
East Regional Library	YES	NO	130 (104 kW AC)	>25	119	>25	38.8	40
Eastern Sheriff's Station	NO	YES	25 (20 kW AC)	>25	13.2	>25	69.3	74.8
EMS #1- Stadium Drive (HQ)	NO	NO	55 (44 kW AC)	>25	79.2	>25	51.2	57.2
EMS #2 - Old Fayetteville Road	NO	YES	47 (37.6 kW AC)	>25	13.2	>25	64	66.4
EMS #6 – Milton Road	NO	YES	25 (20 kW AC)	21	13.2	>25	52	54.6
General Services	NO	YES	9 (7.2 kW AC)	>25	39.6	>25	10.1	10.1
Head Start	NO	NO	75 (60 kW AC)	21	39.6	>25	66.3	70.5
Health & Human Services	YES	NO	300 (240 kW AC)	19	39.6	21	8.5	8.5
Judicial Building Annex	NO	YES	50 (40 kW AC)	22	92	>25	9.5	9.4
Justice Center Parking Garage	YES	YES	52 (41.6 kW AC)	>25	79	>25	39.5	40.1
Justice Resource Center (JRC)	YES	NO	40 (32 kW AC)	>25	172	>25	8	8
Leesville VFD	NO	YES	35 (28 kW AC)	23	13.2	>25	56	58.1

Building Name	Public EV Charging Recommended	EV Charging Recommended	PV Capacity kW DC/(kW AC)	PV Simple Payback Period (yrs)	BESS Capacity (kWh)	PV+ BESS Simple Payback Period (yrs)	PV Renewable Fraction (%)	PV + BESS Renewable Fraction (%)
Main Library	YES	NO	90 (72 kW AC)	21	132	>25	24	23.9
Main Library Annex	NO	NO	12 (9.6 kW AC)	18	13.2	>25	12.8	12.7
North Regional Library	YES	NO	120 (96 kW AC)	>25	119	>25	39.5	40.1
Parkwood VFD #1	NO	YES	N/A	N/A	N/A	N/A	N/A	N/A
Parkwood VFD #2	NO	YES	N/A	N/A	N/A	N/A	N/A	N/A
Queen Street Parking Garage	YES	YES	11 (8.8 kW AC)	>25	39.6	>25	61	78.6
South Regional Library	YES	NO	200 (160 kW AC)	>25	119	>25	50.6	53.4
Southwest Regional Library	YES	YES	210 (168 kW AC)	24	66	>25	30.2	30.3
Triangle Waste-Water Treatment Plant, Administrative Building	NO	YES	35 (28 kW AC)	18	66	>25	4.9	4.8
Triangle Waste-Water Treatment Plant, Filter Building	NO	NO	44 (35.2 kW AC)	22	132	>25	1.6	1.6
Triangle Waste-Water Treatment Plant, Sludge Building	NO	YES	75 (60 kW AC)	20	132	>25	8.6	8.5
Triangle Waste-Water Treatment Plant, Sludge Building Cover	NO	NO	2.5 (2 kW AC)	14	13.2	>25	2.4	2.4

1.4.4.1 Renewables Financial Review Analysis Summary

To assist with costs associated with the installation of renewable energy systems and EV chargers, various incentive and available grant programs were reviewed. The estimated renewable energy system facility costs can be found in Table 1-18.

1.4.5 Cost Estimation

A cost estimate was developed for each facility based on the solar and BESS capacity analysis. This cost is an estimate based on previously detailed assumptions and does not include grant program assistance. The estimated payback period is also provided for each facility. For EV charger infrastructure costs, it is recommended to install full build-out infrastructure at the beginning of the project to prevent repetitive costs.

Table 1-18. Renewables Cost Consideration Summary

Building Name	PV Estimated Cost ($)	PV Simple Payback Period (yrs)	PV+BESS Estimated Cost ($)	PV + BESS Simple Payback Period (yrs)
Administrative Building II	116,000	18	332,000	>25
Agriculture Building	209,000	24	425,000	>25
Animal Control Office	63,000	>25	150,000	>25
Animal Shelter	187,000	23	230,000	>25
Bethesda VFD	66,000	>25	174,000	>25
Bragtown Library	23,000	>25	45,000	>25
Center for Senior Life	159,000	>25	331,000	>25
Community Shelter	156,000	>25	328,000	>25
Detention Center	356,000	19	442,000	>25
Durham Center Access	238,000	24	432,000	>25
Durham County Courthouse	263,000	18	803,000	>25
Durham County Stadium	197,000	22	369,000	>25
Durham County Warehouse	509,000	>25	638,000	>25
East Regional Library	237,000	>25	431,000	>25
Eastern Sheriff's Station	56,000	>25	77,000	>25
EMS #1- Stadium Drive (HQ)	103,000	>25	232,000	>25
EMS #2 - Old Fayetteville Road	89,000	>25	110,000	>25
EMS #6 – Milton Road	55,000	21	77,000	>25
General Services	31,000	>25	96,000	>25
Head Start	140,000	21	205,000	>25
Health & Human Services	537,000	19	602,000	21
Judicial Building Annex	93,000	22	244,000	>25
Justice Center Parking Garage	1,320,000	>25	1,450,000	>25
Justice Resource Center (JRC)	95,500	17	139,000	>25
Leesville VFD	71,000	23	92,000	>25
Main Library	168,000	21	384,000	>25
Main Library Annex	36,000	18	57,000	>25
North Regional Library	237,000	>25	431,000	>25

Building Name	PV Estimated Cost ($)	PV Simple Payback Period (yrs)	PV+BESS Estimated Cost ($)	PV + BESS Simple Payback Period (yrs)
Parkwood VFD #1	N/A	N/A	N/A	N/A
Parkwood VFD #2	N/A	N/A	N/A	N/A
Queen Street Parking Garage	295,000	>25	360,000	>25
South Regional Library	356,000	>25	563,000	>25
Southwest Regional Library	374,000	20	482,000	>25
Triangle Waste-Water Treatment Plant, Administrative Building	71,000	18	178,000	>25
Triangle Waste-Water Treatment Plant, Filter Building	84,000	22	300,000	>25
Triangle Waste-Water Treatment Plant, Sludge Building	140,000	20	356,000	>25
Triangle Waste-Water Treatment Plant, Sludge Building Cover	21,000	14	42,000	>25

1.4.6 Incentives and Grant Programs

Durham County's local utility, Duke Energy, has developed rate structures to incentivize the use of EV chargers[4]. While they are not directly EV rate structures, these TOU rates reduce the peak demand costs and provide better rates during general EV charging times. Duke Energy is also working to expand its solar profile for its energy users and has programs established to connect solar sources to the grid[5].

Passed originally in 2010 and extended with the Inflation Reduction Act (Sec. 13403) (IRA), the Qualified Plug-In Electric Vehicle Tax Credit provides a tax credit rebate with the purchase of an electric vehicle. Through the Infrastructure Investment and Jobs Acts (IIJA) and IRA, grants and tax programs have been created or extended to make renewables and carbon reduction projects more economically feasible. The program provides a 15% credit, available through 2032, for each vehicle with a maximum rebate of $7,500 for any vehicle under 14,000 pounds. For reference, a pickup truck such as a GMC Sierra or Ford F-150 range from 4,000 to 6,000 pounds. If purchasing a vehicle over 14,000 pounds, the maximum tax credit increases to $40,000. Additionally, the IRA has extended the tax credit for installation of vehicle charging infrastructure. Capital investments in charging infrastructure would be eligible for 30% of the cost per charger installed with a maximum credit of $100,000. The IRA's Investment Tax Credit (ITC) or the Production Tax Credit (PTC) can also provide benefit for creating solar generation system(s). Beginning in 2023, tax-exempt entities became eligible to benefit from the ITC and PTC by being able to file for a direct pay option once the new generation facility is installed. The infrastructure program is valid through 2032.

Tax-exempt and government entities are permitted to receive payment equal to the full value of tax credits for building qualifying clean energy projects through twelve (12) credits of the IRA

[4] leaf-no-525-schedule-mgs-tou-ry1.pdf (duke-energy.com)

[5] Solar Power - North Carolina - Duke Energy (duke-energy.com)

direct pay program[6]. Political subdivisions, inclusive of counties such as Durham County, are eligible through the state, local, and territorial governments sector. To apply for direct pay, the applicable project must be constructed, placed into service, and have a pre-filing registration with the Internal Revenue Service (IRS).

The North Carolina Sustainable Energy Association (NCSEA) is a nonprofit organization that aims to drive the state toward clean energy solutions. NCSEA works with entities such as Durham County to achieve this through grant support in one of their ten clean energy sectors, inclusive of alternative fuel vehicles[7]. Similarly, the NCCEF is a nonprofit organization that supports clean energy in local communities not through policy promotion, but instead through financial and information support. The fund itself is built up of both public and private capital and is used to invest in clean energy projects and energy efficiency upgrades throughout the state.

The EECBG Competitive Program was recently offered through the Department of Energy and seeks to assist local governments in reducing their energy usage, improving their energy efficiency, and managing their carbon emissions. Durham County was one of 12 applicants approved through the program in 2023 (see Figure 1-11) and was selected to be awarded $1.5 million dollars in funding for their energy projects. A coalition between Durham, Granville, and Orange counties, known as the North Carolina EBERP, provides disadvantaged communities with access to neighborhood-level energy upgrades and energy efficiency workforce training[8]. This program is in partnership with both the NCSEA and the NCCEF, and utilizes funds received through the EECBG Competitive Program.

[6] Direct Pay | Clean Energy | The White House

[7] Home | North Carolina Sustainable Energy Association (NCSEA) (energync.org)

[8] Durham County, NC | NC Energy Burden & Emissions Reduction Program

Figure 1-10. Justice40 Map for Durham County



The Justice40 map shown in Figure 1-10 details the EV corridor and development of disadvantaged community profiles for the Durham County region for access to various grant programs. The NCSEA is a nonprofit organization that aims to drive the state toward clean energy solutions. NCSEA works with entities such as Durham County to achieve this through grant support in one of their ten clean energy sectors, inclusive of alternative fuel vehicles[9]. Similarly, the NCCEF is a nonprofit organization that supports clean energy in local communities not through policy promotion, but instead through financial and information support. The fund itself is built up of both public and private capital and is used to invest in clean energy projects and energy efficiency upgrades throughout the state.

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[9] Home | North Carolina Sustainable Energy Association (NCSEA) (energync.org)

[10] Durham County, NC | NC Energy Burden & Emissions Reduction Program

Figure 1-11. EECBG Competitive Program 2023 Winners



1.4.7 Electric Vehicles

EV charger capacity analysis, proposed equipment locations, and EV considerations for facilities interested in electrifying their fleet are detailed further within the individual facility reviews. Additionally, facilities identified as ideal layover EV charging locations were recommended as public charging facilities. ABA/ADA parking requirements for each facility parking lot must be considered when identifying EV charging parking spots within the lot. A summary of the fleet electrification and public charging analysis is detailed in the following section.

1.4.7.1 Fleet Electrification

Fleet electrification is considered as the transition of ICE fleet vehicles to EVs of a similar size and class. As fleet vehicles are estimated to account for the bulk of transportation-related greenhouse gas emissions, fleet electrification can be a valuable tool in reducing the environmental impact of normal operations. When understanding the EV charger size requirements for a fleet, it is important to consider the route length or service cycle of the vehicle, size of the vehicle, and available time to charge prior to the next service cycle.

The self-assessment matrix detailed in Figure 1-9 considers the ICE vehicle fuel tank usage, service cycle for a daily operation, and vehicle duty size. Based on the size of the vehicle and percent of fuel consumed in one service cycle, the estimated EV charger size was indicated within the matrix. This estimated EV charger size assumes an 8-hour charge period for the EV prior to its next service cycle. If it is not possible to charge the vehicle for that time period prior

to its next service, increasing the capacity of the EV charger can reduce the required charge time.

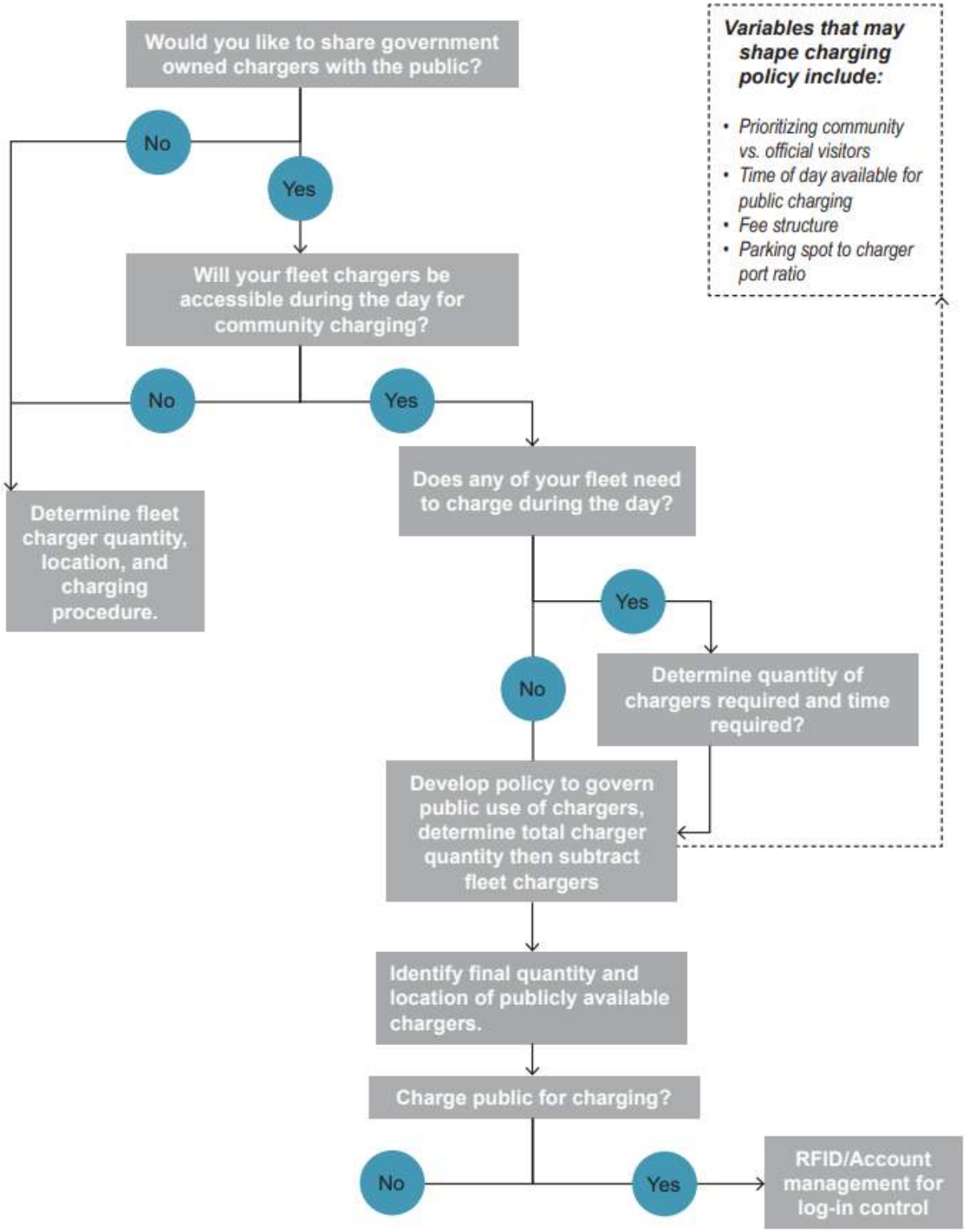
EVs have power level limitations that can be accepted for both level 2 and DCFC; this must be considered when determining the anticipated capacity of the EV charger to be used with the vehicle. DCFCs are more costly than level 2 EV chargers, and they can require additional utility infrastructure upgrades in many cases. The use of fuel efficient or alternative fuel (i.e., biodiesel) ICE vehicles for MD, HD, and special use vehicles can reduce the need for DCFC chargers and utility infrastructure upgrades in order to transition a fleet towards zero emissions or minimize ICE emissions until the vehicle can be electrified.

Vehicle specific considerations such as HVAC usage and route modeling allows for proper sizing of charging time needs, EV vehicle onboard battery, and required charger size. Once the size and quantity of EV chargers are determined for the fleet, consideration of an EV charge management system is crucial. An EV charge management system can assist in reducing peak demand as well as providing EV charger monitoring and security. Incorporation of BESS equipment with EV chargers also offers the ability to reduce peak demand.

1.4.7.2 Public Charging

EV chargers are typically compatible with a wide range of vehicles, including most commercially available consumer vehicles. When considering public charging, several factors need to be weighed (Figure 1-12), the most important being whether non-fleet charging will affect fleet logistics. Public-facing chargers can distinguish between government fleet users and public users with the help of a charge management system. Durham County has identified coordination with the City of Durham as key to ensure public charger policy preferences are consistent.

Figure 1-12. Public Electric Vehicle Charging Considerations Flow Chart



2 Administrative Building

Durham County | Administrative Building | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	200 E Main St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Forced Draft Boiler
Building Type	Office	**Cooling Generation**	Water-Cooled Chiller
Year Built	1926	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	109,036	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	7	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED (except 5th floor)	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 2-1. Administrative Building





2.1 Existing Building Performance & Condition

2.1.1 Past Conservation Projects and Successes

No historical data available.

2.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age. At the time of the site visit, compressor A1 of chiller CH-1 was noted as having a nitrogen holding charge and not functional. This condition indicates that only 3/4 of the chilled water plant capacity is available.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 2-1. Administrative Building Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	Complete repair of chiller CH-1.

2.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 2-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

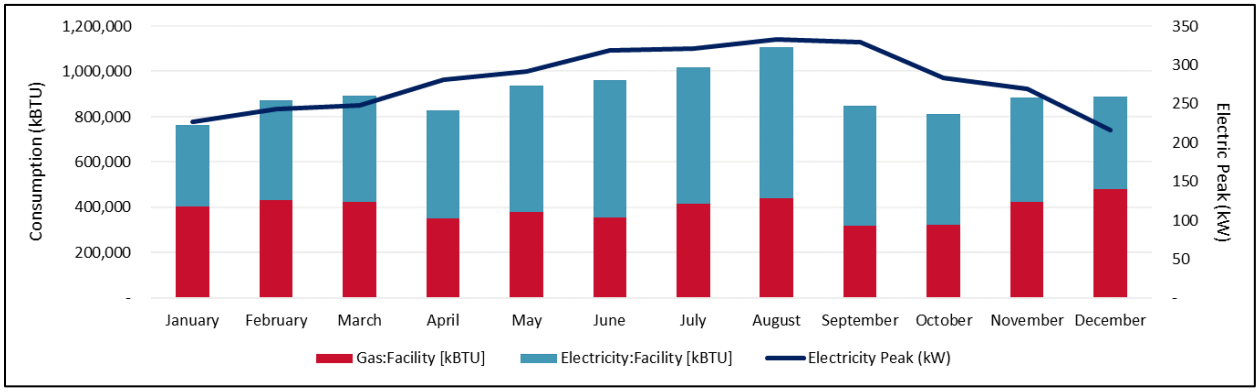
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 2-2. Administrative Building Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	105,816	4,025	764	227.3	$7,447	$4,144	$11,590	30,042	21,376	51,418
February	129,161	4,337	874	243.7	$8,507	$3,876	$12,383	36,669	23,033	59,703
March	138,507	4,219	895	248.3	$8,829	$3,623	$12,452	39,323	22,406	61,729
April	139,015	3,519	826	281.1	$9,095	$2,990	$12,085	39,467	18,691	58,158
May	163,863	3,781	937	291.4	$10,755	$3,249	$14,004	46,521	20,080	66,601
June	177,717	3,538	960	318.9	$13,973	$3,166	$17,139	50,454	18,789	69,244
July	177,076	4,153	1,020	321.5	$14,047	$3,693	$17,741	50,272	22,059	72,331
August	195,494	4,401	1,107	332.5	$15,300	$3,930	$19,230	55,501	23,373	78,875
September	155,657	3,176	849	329.1	$14,191	$2,945	$17,135	44,192	16,869	61,061
October	142,767	3,238	811	283.8	$10,962	$3,468	$14,430	40,532	17,199	57,731
November	134,507	4,253	884	269.6	$10,313	$4,452	$14,765	38,187	22,590	60,777
December	118,943	4,813	887	216.1	$9,268	$4,965	$14,233	33,768	25,564	59,332
ANNUAL	1,778,525	47,450	10,815	-	$132,688	$44,500	$177,189	504,929	252,030	756,959
PEAK	-	-	-	332.5	-	-	-	-	-	-

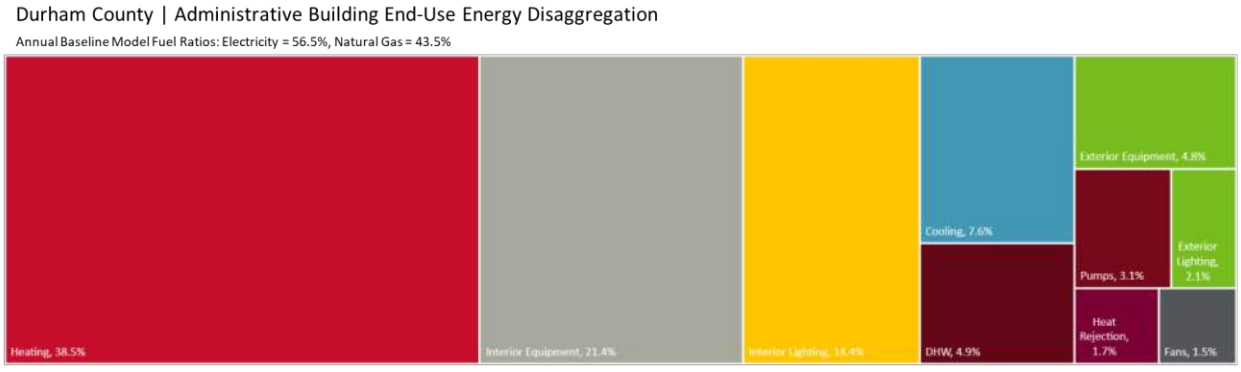
The data in Table 2-2 is represented in graphical format in Figure 2-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 2-2. Administrative Building Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



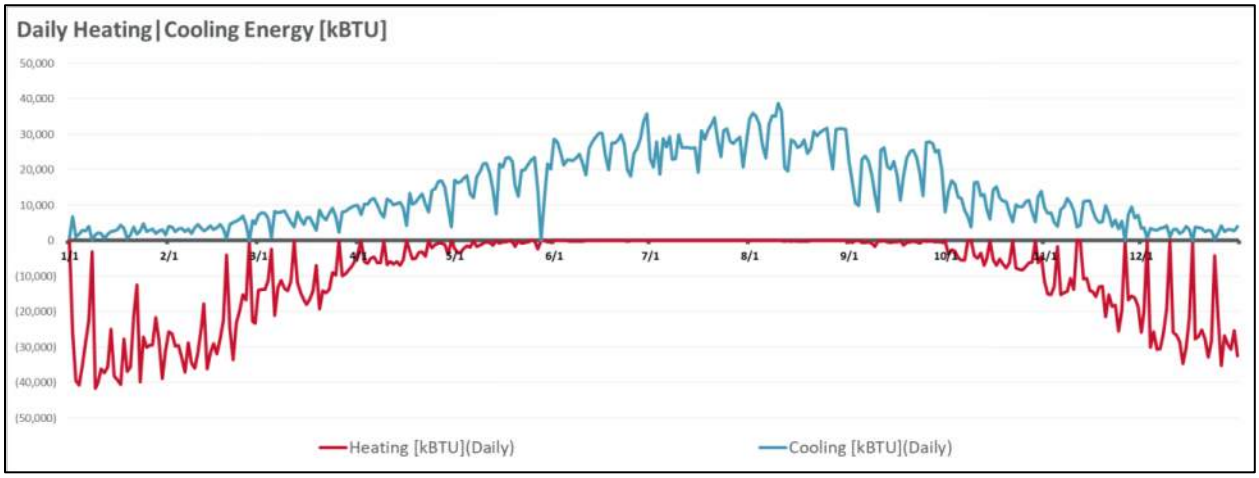
While Table 2-2 and Figure 2-2 encompasses “whole” building data, Figure 2-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 2-3. Administrative Building Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 2-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 2-4. Administrative Building Baseline Model Heating & Cooling Annual Load Profile



2.2 HVAC Refrigerants

The Durham County Administrative Building utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 2-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 2-3. Administrative Building HVAC Refrigerant Summary

	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Water-Cooled Chiller	Carrier 30HXC161	161 tons	R-134A	Circuit 1: 157 lbs, Circuit 2: 110 lbs	Interior
CH-2	Water-Cooled Chiller	Carrier 30HXC161	161 tons	R-134A	Circuit 1: 157 lbs, Circuit 2: 110 lbs	Interior
AC-1	Air-Cooled Condenser	Panasonic		R-410A	Unavailable	Exterior

2.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 2-4. Administrative Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Administrative Building	Baseline	1,787,921.36	48,839.00	10,986.02	$182,748.49	767.00

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	218,523.72	5,969.21	1,342.74	$22,335.93	93.74	Potential Annual Energy Savings (%)	12.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	20,604.31	0.00	70.32	$1,638.45	5.85	NA	NA	
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00	kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	867.15	86.72	$720.39	4.61	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	27.96	2.80	$23.23	0.15	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	44,531.17	-295.53	122.43	$3,295.61	11.07	Applicable Area %	20.0%	%
	Lighting Occupancy Sensor	11,918.64	-79.10	32.77	$882.06	2.96	Applicable Area %	10.0%	%
	LED Exit Signs	2,331.91	-15.48	6.41	$172.58	0.58	Quantity of Exit Signs	22	#
	Daylight Dimming Control	17,877.96	-118.64	49.15	$1,323.09	4.45	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	2,075.90	0.00	7.08	$165.08	0.59	Quantity of Outdoor Fixtures	8	#
Power	Variable Speed Drive Screw Air Compressors	995.67	0.00	3.40	$79.18	0.28	HP total of Air Compressors	2.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	6,519.28	0.00	22.25	$518.41	1.85	Transformer Size	2500.0	kVA
	Vending Machine Controller | Beverage	3,224.00	0.00	11.00	$256.37	0.92	Quantity of Beverage Vending Machines	2	#
	Vending Machine Controller | Snack	574.00	0.00	1.96	$45.64	0.16	Quantity of Snack Vending Machines	2	#
	EnergyStar Refrigerator Upgrade	525.00	0.00	1.79	$41.75	0.15	$0.00	5	#
	Tier 1 Advanced Power Strip	3,685.30	0.00	12.58	$293.05	1.05	Quantity of Power Strips	137	#
Decarbonization Measure Savings Totals (predicted)		**333,386.86**	**6,355.58**	**1,773.40**	**$31,790.82**	**128.41**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**18.6%**	**13.0%**	**16.1%**	**17.4%**	**16.7%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

2.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 2-5. Administrative Building Existing HVAC/DHW Systems

HVAC | Space Heating	Natural gas heating water non-condensing boiler (2019 vintage); CV primary VV secondary pumping; terminal reheat coils selected for 165F EWT; (2) Lochinvar Copper-Fin 2 model CHN1262, mfg. 2019, 1260 Mbh input, 1071 Mbh output
Domestic Hot Water	Natural gas storage water heaters w/ recirc; approx. 540 MBH / 500 gph recovery total; (2) State "Titan" model GPG81270NEA, power draft, 81 gallon, 270 Mbh input, mfg. 4/2016; approx. 80% eff.

Table 2-6. Administrative Building HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace boilers with (2) 320 kw electric boilers, 4-step control, Lochinvar BWX3-320C

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D %
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	0.0	(40,928.5)	1,056,473.6	NA	NA	2,834,998.5	5,720.5	94.0	4.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,734.9 MMBTU								10,247.8 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$261,495.90	$5,364.87	$2.45	-32.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$200,964.56 $US								$266,860.77 $US			
Carbon	504.9	247.8	6.90	0.0	(217.4)	299.9	NA	NA	804.9	30.4	7.66	-11.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	752.7 MT CO2e								835.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 2-7. Administrative Building HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Heat-recovery / heat-pump chiller system: *Replace chillers with Modular Water-Source Multipipe chillers - Trane "Thermafit" model MWS , (8) 40-ton modules, tandem scroll compressors; simultaneous heating/cooling, with dedicated condenser loop; *Replace cooling tower with hybrid fluid cooler - induced draft, closed circuit, (2) Marley DTW1212SAMB2L, 30 hp each, VFD fan; *Replace pumps with variable primary-only - two each for CHW, HW, CTW (total 6 pumps w/ VFDs) - (2) 10hp CTW pumps, (4) 15 hp CHW&HW pumps; *Add automatic glycol feed system for cooling tower loop *Add supplemental electric boilers (HVAC Pathway 1)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	6,717.4	(40,928.5)	335,443.3	NA	NA	2,120,685.7	5,720.5	71.6	27.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,734.9 MMBTU								7,809.9 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$198,132.74	$5,364.87	$1.87	-1.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$200,964.56 $US								$203,497.61 $US			
Carbon	504.9	247.8	6.90	1.9	(217.4)	95.2	NA	NA	602.1	30.4	5.80	16.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	752.7 MT CO2e								632.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 2-8. Administrative Building DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace WHs with (2) electric storage water heater, 119 gallon, 54 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	NA	NA	NA	(5,720.5)	133,813.8	1,912,338.7	40,928.5	97.4	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,734.9 MMBTU								10,619.6 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$168,691.95	$38,384.33	$1.90	-3.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$200,964.56 $US								$207,076.29 $US			
Carbon	504.9	247.8	6.90	NA	NA	NA	(30.4)	38.0	542.9	217.4	6.97	-1.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	752.7 MT CO2e								760.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 2-9. Administrative Building DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WHs with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ x 119 gallon storage tank each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**1,778,525.0**	**46,648.9**	**98.5**	**NA**	**NA**	**NA**	**(5,720.5)**	**22,918.4**	**1,801,443.4**	**40,928.5**	**93.9**	**4.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,734.9 MMBTU								10,241.1 MMBTU			
Energy Cost	**$157,215.35**	**$43,749.20**	**$1.84**						**$159,184.43**	**$38,384.33**	**$1.81**	**1.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$200,964.56 $US								$197,568.76 $US			
Carbon	**504.9**	**247.8**	**6.90**	**NA**	**NA**	**NA**	**(30.4)**	**6.5**	**511.4**	**217.4**	**6.68**	**3.2%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	752.7 MT CO2e								728.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 2-10. Administrative Building Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$469,101.00	($104,280.55)	$38,384.33	($65,896.21)	($1,932,878.99)	NA	NA	-2.0492	NA	NA	($4,209.82)
HVAC Pathway 2	$5,790,132.00	($40,917.39)	$38,384.33	($2,533.05)	($7,786,218.31)	-7.1416%	-9.8431%	0.0049	NA	NA	$6,132.76
DHW Pathway 1	-$16,086.00	($11,476.60)	$5,364.87	($6,111.73)	($94,440.23)	NA	NA	NA	NA	NA	($387.91)
DHW Pathway 2	$650,728.00	($1,969.07)	$5,364.87	$3,395.79	($794,895.62)	-6.2291%	-2.8603%	0.0960	NA	NA	$1,217.75

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$77,759.00
DHW Existing Replacement:	$51,008.00

Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

2.5 Renewable Energy, Energy Storage, and Electric Vehicles

2.5.1 Solar and BESS Analysis

Review of the Administrative Building was not completed due to the historic terra cotta roof.

2.5.2 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

2.6 Electrical Infrastructure Demand Feasibility Summary

Table 2-11. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	332.55 kW	332.55 kW
HVAC Electrification Pathway 1		1,005.83 kW
HVAC Electrification Pathway 2		925.77 kW
DHW Electrification Pathway 1		347.09 kW
DHW Electrification Pathway 2		335.04 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

2.6.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the size breaker required to supply power for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. Therefore, a new main service panelboard will be required.

2.6.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards can accommodate the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required.

2.6.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard cannot accommodate the PV or BESS systems as the main service panel has no available space to provide a connection and subsequent downstream panel don't have a large enough frame to house the required circuit breaker. Therefore, a new main service panelboard will be required.

3 Administrative Building II

Durham County | ADMINISTRATIVE BUILDING II | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	201 E Main St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Condensing Boilers
Building Type	Office	**Cooling Generation**	Water-Cooled Chiller
Year Built	1977 (2019 reno)	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	140,987	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	8	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Curtainwall	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 3-1. Administrative Building II



3.1 Existing Building Performance & Condition

3.1.1 Past Conservation Projects and Successes

- Total re-build in 2019.

3.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained. The domestic water boiler flue above the roof is off-vertical and the curb cap may have a crack or gap at a seam. No obvious signs of leaks were observed. There were no other noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 3-1. Administrative Building II Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	Repair domestic boiler flue.

3.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 3-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

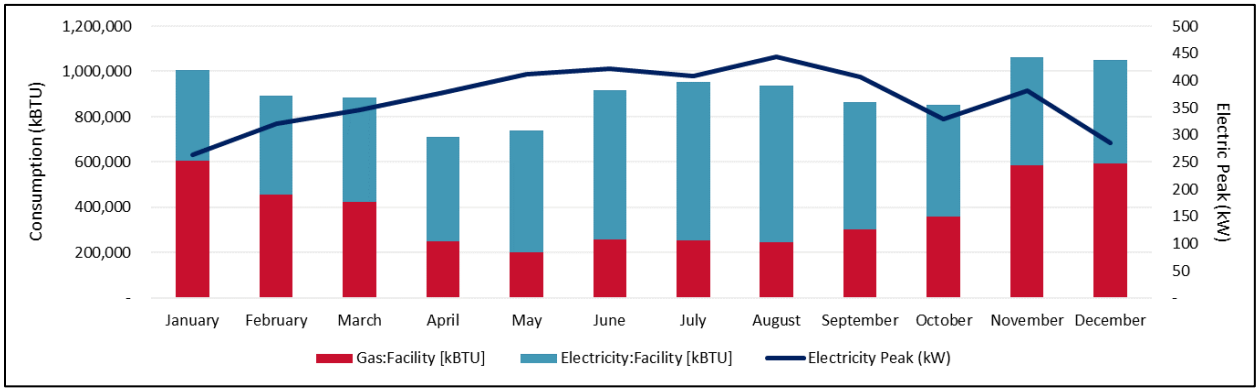
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 3-2. Administrative Building II Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	116,896	6,072	1,006	263.8	$10,934	$6,072	$17,006	33,187	32,249	65,436
February	127,935	4,572	894	321.4	$11,659	$4,067	$15,726	36,321	24,284	60,605
March	134,534	4,253	884	345.8	$12,015	$3,622	$15,637	38,195	22,590	60,784
April	135,024	2,482	709	378.6	$12,064	$2,139	$14,203	38,334	13,183	51,517
May	158,223	1,995	739	411.4	$13,593	$1,779	$15,372	44,920	10,594	55,514
June	193,304	2,561	916	421.4	$15,806	$2,409	$18,214	54,880	13,603	68,482
July	205,158	2,519	952	408.2	$16,625	$2,356	$18,980	58,245	13,377	71,622
August	203,787	2,438	939	444.0	$16,940	$2,273	$19,213	57,856	12,947	70,802
September	164,880	3,018	864	406.8	$15,812	$2,802	$18,615	46,810	16,027	62,837
October	143,824	3,603	851	329.6	$14,222	$3,538	$17,759	40,832	19,137	59,969
November	139,200	5,860	1,061	381.0	$13,801	$5,742	$19,544	39,519	31,123	70,642
December	134,343	5,924	1,051	284.8	$13,449	$5,725	$19,175	38,140	31,465	69,606
ANNUAL	1,857,106	45,294	10,868	-	$166,921	$42,524	$209,444	527,238	240,578	767,817
PEAK	-	-	-	444.0	-	-	-	-	-	-

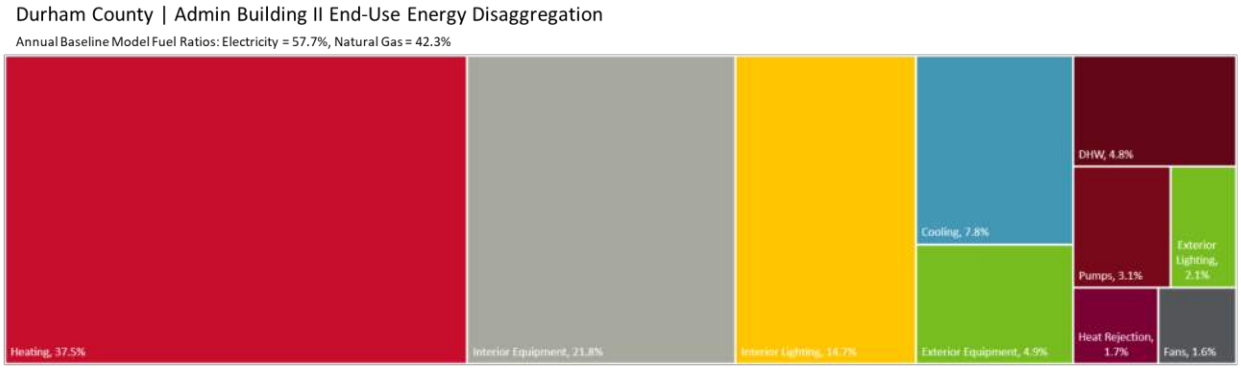
The data in Table 3-2 is represented in graphical format in Figure 3-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 3-2. Administrative Building II Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



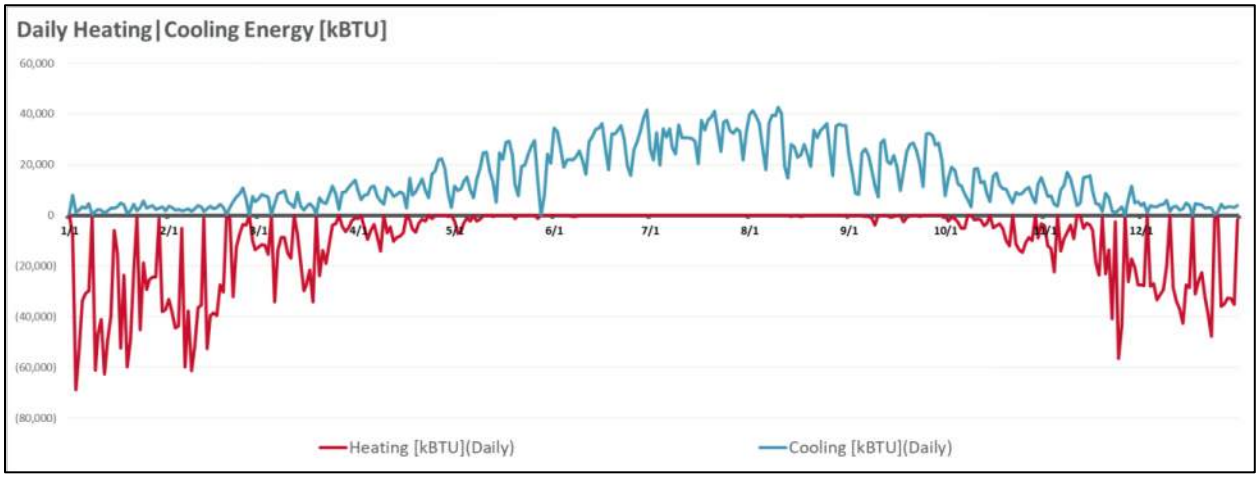
While Table 3-2 and Figure 3-2 encompasses “whole” building data, Figure 3-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 3-3. Administrative Building II Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 3-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 3-4. Administrative Building II Baseline Model Heating & Cooling Annual Load Profile



3.2 HVAC Refrigerants

The Durham County Administrative Building II utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 3-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 3-3. Administrative Building II HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Water-Cooled Chiller	Dunham-Bush WCFX 24TARJBR5CR	150 Tons	R-134A	376 lbs	Interior
CH-2	Water-Cooled Chiller	Dunham-Bush WCFX 24TARJBR5CR	150 Tons	R-134A	376 lbs	Interior
(1) DOASHP6-1	Air-Cooled Condenser	LG model ARUN096DTE4	8 Tons	R-410A	23.6 lbs (factory charge)	Exterior
(1) VRF-HP2	Air-Cooled Condenser	LG model ARUB121DTE4	10 Tons	R-410A	23.6 lbs (factory charge)	Exterior
(1) VRF-HP5	Air-Cooled Condenser	LG model ARUB168DTE4	14 Tons	R-410A	23.6 lbs (factory charge)	Exterior
CU8-1	Air-Cooled Condenser	LG model LSU363HLV	3 Tons	R-410A	77.6 oz	Exterior

3.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR

team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 3-4. Administrative Building II Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Admin Building II	Baseline	1,920,169.60	49,769.00	11,530.38	$223,653.66	809.49

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	245,355.00	6,359.37	1,473.33	$28,577.97	103.43	Potential Annual Energy Savings (%)	12.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	17,851.53	0.00	60.93	$1,689.58	5.07	NA	NA	
	Smart Thermostat	14,635.89	0.00	49.95	$1,385.23	4.16	Total Cooling Capacity Controled	1,608.00	kBTU/hr
	Air Conditioner Tune-up	14,620.02	0.00	49.90	$1,383.73	4.15	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	457.99	45.80	$385.73	2.43	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	27.96	2.80	$23.55	0.15	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$742.69	5.10	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	Lighting Occupancy Sensor	37,935.20	-251.75	104.30	$3,378.39	9.43	Applicable Area %	50.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	29	#
	Daylight Dimming Control	11,380.56	-75.53	31.29	$1,013.52	2.83	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	1,556.93	0.00	5.31	$147.36	0.44	Quantity of Outdoor Fixtures	6	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	3,761.89	0.00	12.84	$356.05	1.07	Transformer Size	232.5	kVA
	Vending Machine Controller | Beverage	3,224.00	0.00	11.00	$305.14	0.92	Quantity of Beverage Vending Machines	2	#
	Vending Machine Controller | Snack	574.00	0.00	1.96	$54.33	0.16	Quantity of Snack Vending Machines	2	#
	EnergyStar Refrigerator Upgrade	630.00	0.00	2.15	$59.63	0.18	$0.00	6	#
	Tier 1 Advanced Power Strip	4,761.30	0.00	16.25	$450.64	1.35	Quantity of Power Strips	177	#
Decarbonization Measure Savings Totals (predicted)		354,952.78	7,549.72	1,966.41	$39,953.53	140.87			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		18.5%	15.2%	17.1%	17.9%	17.4%			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

3.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 3-5. Administrative Building II Existing HVAC/DHW Systems

HVAC | Space Heating	(mult.) VRF heat pump systems, 1808 Mbh total capacity, no namplate data - per record dwgs; (2) Patterson-Kelley model C-2000H condensing boilers, 2000 mbh input, 1920 mbh output, 130F - 110F design water temps, CV primary - VV secondary pumps w/ VFD; (multi) single-duct and parallel FP terminal units, HW reheat; (4) HW unit heaters, 52.3 Mbh; (12) HW unit heaters, 26.1 Mbh;
Domestic Hot Water	Natural gas boiler and water storage tank w/ recirc; (1) AO Smith model HW-399, nat. draft, 399 Mbh input, 319 mbh output, mfg. 2017; approx. 80% eff.; (1) AO Smith TJVT 500 storage tank, 500 gallon

Table 3-6. Administrative Building II HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace HW unit heaters with (12) 7.5 kw + (4) 15 kw electric unit heaters *Replace (2) gas boilers with (2) electric boilers, 445kw each (890 kw total), 8-step control, Lochinvar BWX3-445C

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	0.0	(40,109.2)	1,174,989.6	NA	NA	3,032,095.6	6,324.3	77.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,981.6 MMBTU								10,980.9 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$358,713.64	$5,937.47	$2.59	-69.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$214,698.94 $US								$364,651.11 $US			
Carbon	527.2	246.6	5.49	0.0	(213.0)	333.6	NA	NA	860.8	33.6	6.34	-15.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	773.9 MT CO2e								894.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 3-7. Administrative Building II HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) gas boilers with (8) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 480 FLA @ 460V/3ph)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	0.0	(40,109.2)	390,117.1	NA	NA	2,247,223.1	6,324.3	58.9	24.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,981.6 MMBTU								8,302.1 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$243,353.51	$5,937.47	$1.77	-16.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$214,698.94 $US								$249,290.98 $US			
Carbon	527.2	246.6	5.49	0.0	(213.0)	110.8	NA	NA	638.0	33.6	4.76	13.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	773.9 MT CO2e								671.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 3-8. Administrative Building II DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas boiler WH-1 with (1) electric boiler, 120 kw input, Bradford White "Brute" model BEB-120

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	NA	NA	NA	(6,324.3)	142,073.7	1,999,179.7	40,109.2	76.8	1.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,981.6 MMBTU								10,834.1 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$185,129.69	$37,655.93	$1.58	-3.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$214,698.94 $US								$222,785.62 $US			
Carbon	527.2	246.6	5.49	NA	NA	NA	(33.6)	40.3	567.6	213.0	5.54	-0.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	773.9 MT CO2e								780.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 3-9. Administrative Building II DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas boiler WH-1 with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) back-up electric boiler, 120 kw input, Bradford White "Brute" model BEB-120

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	NA	NA	NA	(6,324.3)	28,442.4	1,885,548.4	40,109.2	74.1	4.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	10,981.6 MMBTU								10,446.2 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$173,789.37	$37,655.93	$1.50	1.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$214,698.94 $US								$211,445.31 $US			
Carbon	527.2	246.6	5.49	NA	NA	NA	(33.6)	8.1	535.3	213.0	5.31	3.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	773.9 MT CO2e								748.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 3-10. Administrative Building II Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$744,102.84	($187,608.10)	$37,655.93	($149,952.17)	($4,079,845.16)	NA	NA	-3.0575	NA	NA	($6,147.75)
HVAC Pathway 2	$2,942,910.84	($72,247.97)	$37,655.93	($34,592.04)	($4,616,951.58)	-8.6411%	NA	-0.1610	NA	NA	$5,216.46
DHW Pathway 1	$113,945.00	($14,024.15)	$5,937.47	($8,086.69)	($310,459.76)	NA	NA	-1.0163	NA	NA	($343.94)
DHW Pathway 2	$300,121.00	($2,683.83)	$5,937.47	$3,253.63	($322,754.18)	-5.0238%	-1.0110%	0.2042	NA	NA	$1,301.34

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$191,976.00
DHW Existing Replacement:	$56,858.00

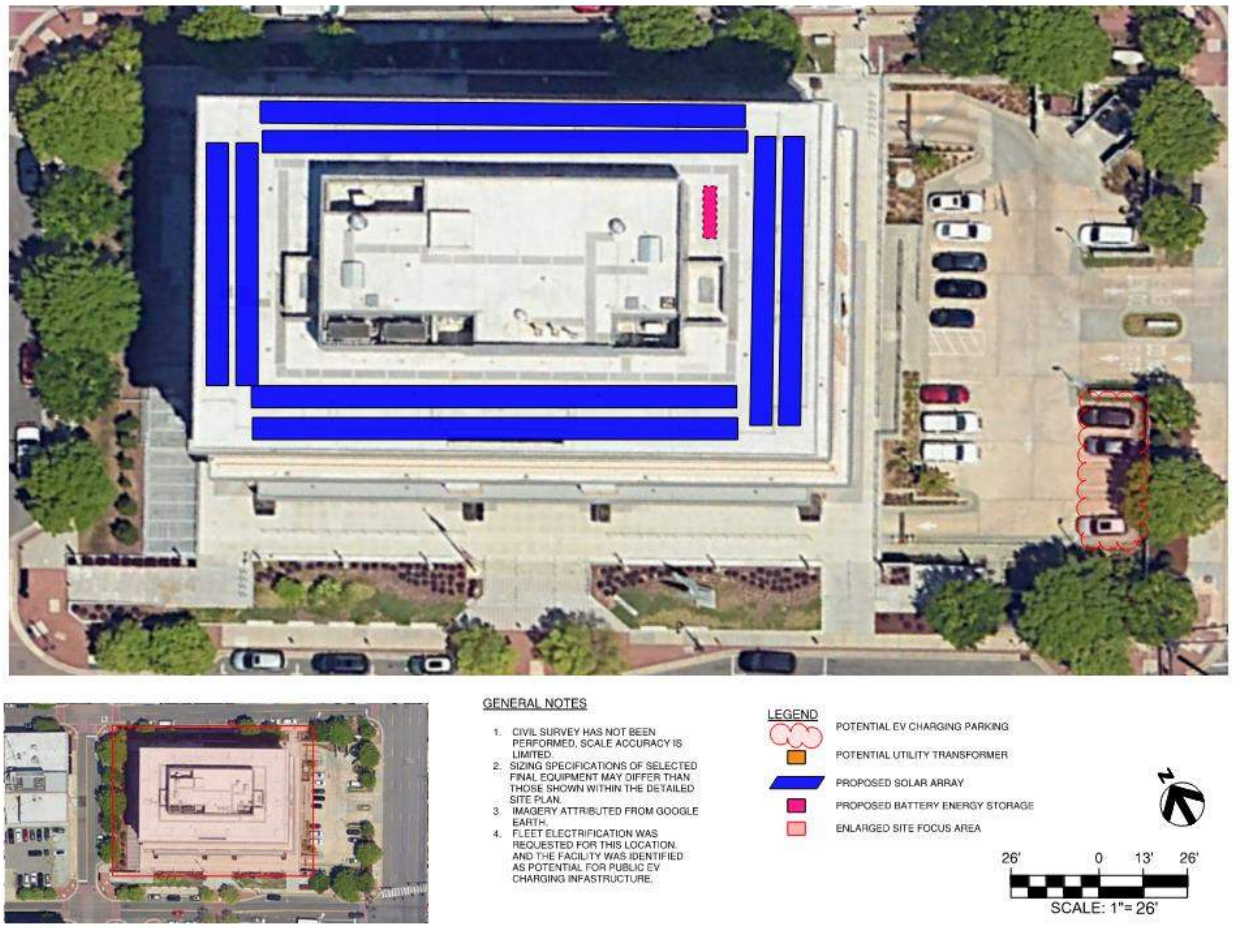
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

3.5 Renewable Energy, Energy Storage, and Electric Vehicles

3.5.1 Solar and BESS Analysis

The Administrative Building II building possesses a uniquely shaped roof due to a large obstruction with equipment in the center of the roof top. This large structure does result in minimal concern for shading of panels on the Northern edge of the roof (roof material unknown). The age of the roof was not confirmed, and the replacement cycle was not identified. The roof is scheduled for replacement in 2039. The single level of this roof is flat with a small parapet wall surrounding the perimeter. The estimated solar capacity for the structure is 62 kW DC and placement of BESS equipment is recommended in a secure interior location of the facility due to the large quantity of foot traffic surrounding the entirety of the building, Figure 3-5.

Figure 3-5. **Administrative Building II Conceptual Renewables and EV Visual Aid**



*BESS system to be located in a secure interior location. Durham County to determine installation location.

The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 1,912,944 kWh with a peak August load of 489 kW. The estimated roof solar capacity is 124 kW DC; however, initial HOMER analysis indicates that only a 62 kW DC nameplate PV system

would be optimal. HOMER model results indicate that multiple PV systems possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS and small amounts of excess PV generation. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 3-11. Due to the low renewable fraction and high payback periods for this site, it is recommended to wait until the energy density of PV and BESS technology improves.

Table 3-11. Administrative Building II Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	1,912,944	N/A	N/A	N/A
62 kW PV Only	1,828,631	84,313	N/A	4.4
62 kW PV + 132 kWh BESS	1,829,363	84,313	3,334	4.4

3.6 Cost Summary

Cost performance for the three systems is provided in Table 3-12

Table 3-12. Administrative Building II Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	2,000,000	N/A	N/A
62 kW PV Only	116,000	2,050,000	2.4	18.7
62 kW PV + 132 kWh BESS	332,000	2,250,000	N/A	>25
Cost Summary with ITC Included				
62 kW PV Only	81,000	2,010,000	5.7	13.1
62 kW PV + 132 kWh BESS	232,000	2,150,000	N/A	>25

3.6.1 Electric Vehicle

The Administrative Building II was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 3-5. A total of five (5) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 36 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

3.7 Electrical Infrastructure Demand Feasibility Summary

Table 3-13. Administrative Building II Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	444.00 kW	444.00 kW
HVAC Electrification Pathway 1		3,518.37 kW
HVAC Electrification Pathway 2		2,260.84 kW
DHW Electrification Pathway 1		474.38 kW
DHW Electrification Pathway 2		449.40 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

3.7.1 Building HVAC Electrification Implementation Feasibility

The existing distribution panelboards can accommodate the equipment required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. New circuit breakers will be required.

3.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards can accommodate the equipment required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required.

3.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

4 Agriculture Building

Durham County | Agriculture Building | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	721 Foster St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Gas Furnaces
Building Type	Office	**Cooling Generation**	DX RTUs
Year Built	1970	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	16,772	**Heating / Cooling / Vent Distribution**	CV Air-Handlers
Stories	2	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 4-1. Agriculture Building



4.1 Existing Building Performance & Condition

4.1.1 Past Conservation Projects and Successes

- HVAC replaced in 2017/2018.
- Exterior wall envelope refurbished in 2021.
- Durham County currently has a proposal to replace all lights with LED and add new thermostat controls for HVAC.

4.1.2 Condition Assessment Summary

The condenser coils on the rooftop mechanical equipment have damaged fins, likely from a hail storm. The extent of the damage should not dramatically reduce the units' capacities and may be repairable. Condenser coil hail-guards are often removed from a project as "Value Engineering", with the risk of the equipment life being shortened through damage. It is recommended that Durham County include condenser coil hail guards for any new outdoor equipment.

The steam boiler is missing its flue and would be exhaust to the room if it is in-use. It is not apparent if it is still in service, but the gas supply is still connected. If it is permanently out of service, then the gas supply should be disconnected and capped. If it is still in service, then the flue needs to be repaired immediately.

The remainder of the mechanical and plumbing systems appear well maintained. There were no other noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 4-1. Agriculture Building Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Provide condenser coil hail guards on new equipment.
Fix.1	Comb out damaged condenser coil fins.
Fix.2	Repair steam boiler flue, or disconnect and cap gas supply to take out-of-service.

4.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 4-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

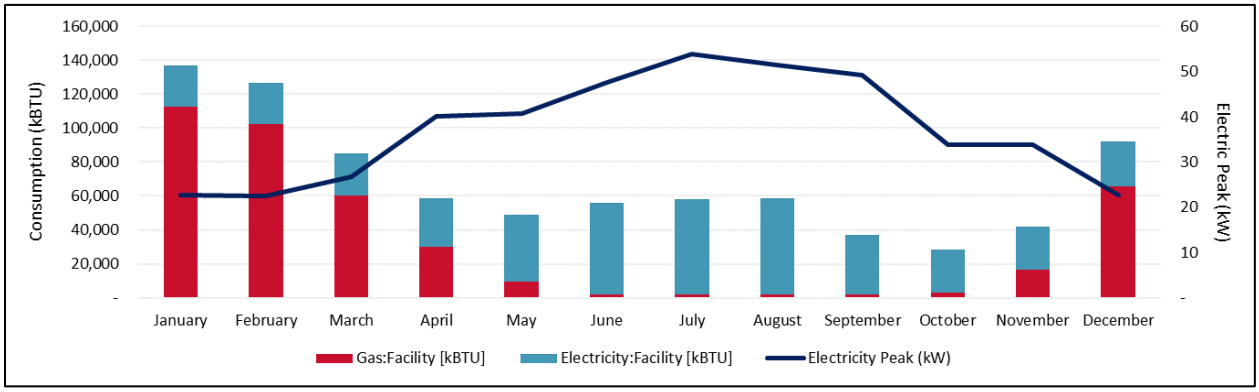
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 4-2. Agriculture Building Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	7,200	1,125	137	22.7	$732	$1,356	$2,088	2,044	5,975	8,019
February	7,062	1,024	127	22.6	$722	$1,131	$1,853	2,005	5,439	7,444
March	7,240	604	85	26.7	$735	$651	$1,386	2,055	3,208	5,264
April	8,410	301	59	40.2	$852	$331	$1,183	2,388	1,599	3,986
May	11,513	98	49	40.7	$1,066	$120	$1,186	3,269	518	3,787
June	15,834	21	56	47.6	$1,392	$30	$1,422	4,495	112	4,607
July	16,516	18	58	53.8	$1,448	$29	$1,477	4,689	96	4,784
August	16,656	19	59	51.4	$1,492	$30	$1,522	4,729	101	4,830
September	10,296	19	37	49.1	$1,144	$30	$1,174	2,923	101	3,024
October	7,516	29	29	33.7	$848	$55	$904	2,134	151	2,285
November	7,386	168	42	33.8	$830	$222	$1,052	2,097	890	2,986
December	7,858	655	92	22.8	$866	$832	$1,698	2,231	3,479	5,710
ANNUAL	123,486	4,080	829	-	$12,127	$4,816	$16,943	35,058	21,668	56,726
PEAK	-	-	-	53.8	-	-	-	-	-	-

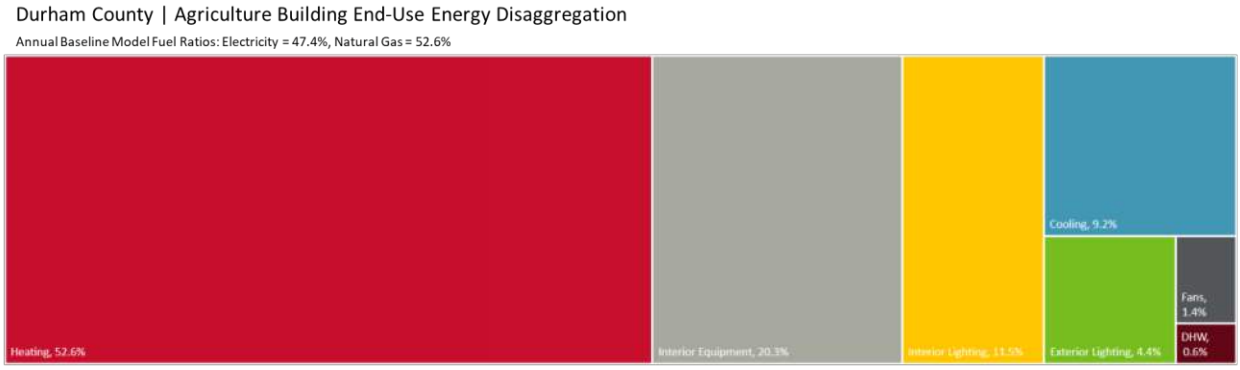
The data in Table 4-2 is represented in graphical format in Figure 4-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 4-2. Agriculture Building Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



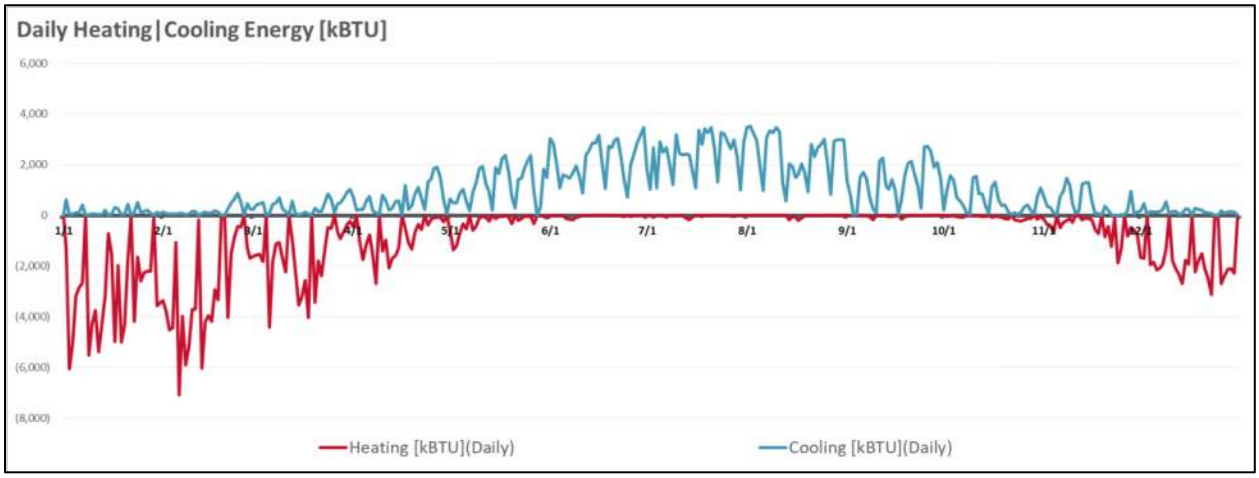
While Table 4-2 and Figure 4-2 encompasses “whole” building data, Figure 4-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 4-3. Agriculture Building Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 4-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 4-4. Agriculture Building Baseline Model Heating & Cooling Annual Load Profile



4.2 HVAC Refrigerants

The Durham County Agriculture Building utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 4-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 4-3. Agriculture Building HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(2) Mini-split	Air-Cooled Condenser	Carrier 38AN009	3/4 Tons	R-22	1.32 lbs	Exterior
(1) RTU-1	Rooftop Unit	Carrier 48TCEA07	6 Tons	R-410A	14.2 lbs	Exterior
(1) RTU-2	Rooftop Unit	Carrier 48TCDD08	7.5 Tons	R-410A	16.4 lbs	Exterior
(1) RTU-3	Rooftop Unit	Carrier 48KCDA06	5 Tons	R-410A	14.5 lbs	Exterior
(2) RTU-4,6	Rooftop Unit	Carrier 48TCED09	8.5 Tons	R-410A	21.1 lbs	Exterior
(1) RTU-5	Rooftop Unit	Carrier 48TCDA06	6 Tons	R-410A	9 lbs	Exterior

4.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 4-4. Agriculture Building Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Agriculture Building	Baseline	122,599.28	3,140.00	732.43	$16,696.90	51.48

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	8,854.39	226.78	52.90	$1,205.89	3.72	Potential Annual Energy Savings (%)	7.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	955.81	0.00	3.26	$99.52	0.27	NA	NA	
	Smart Thermostat	2,680.96	209.02	30.05	$540.87	1.87	Total Cooling Capacity Controled	498.00	kBTU/hr
	Air Conditioner Tune-up	3,388.74	0.00	11.57	$352.83	0.96	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.48	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	34,249.09	-227.29	94.16	$3,281.40	8.52	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	9,166.67	-60.83	25.20	$878.26	2.28	Applicable Area %	50.0%	%
	LED Exit Signs	423.98	-2.81	1.17	$40.62	0.11	Quantity of Exit Signs	4	#
	Daylight Dimming Control	2,750.00	-18.25	7.56	$263.48	0.68	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.93	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	564.90	0.00	1.93	$58.82	0.16	Quantity of Power Strips	21	#
Decarbonization Measure Savings Totals (predicted)		**63,288.19**	**126.61**	**228.66**	**$6,748.09**	**18.64**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**51.6%**	**4.0%**	**31.2%**	**40.4%**	**36.2%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

4.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 4-5. Agriculture Building Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU-6 gas furnace, 180 mbh input, 148 mbh output; (1) RTU-1 gas furnace, 115mbh input, 93 mbh output; (1) RTU-2 gas furnace, 125 mbh input, 103 mbh output; (1) RTU-4 gas furnace, 180 mbh input, 148 mbh output; (1) RTU-3 gas furnace, 72 mbh input, 59 mbh output; (1) RTU-5 gas furnace, 72 mbh input, 59 mbh output; (1) Abandoned? steam boiler, 2163 mbh input, 1310 mbh net
Domestic Hot Water	(1) Electric storage water heater, 50 gallon, 3380 W element, 208V/1ph, Rheem model PROE50, mfg 2012; HW recirc pump;

Table 4-6. Agriculture Building HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace rooftop units with electric resistance heaters

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	0.0	(4,670.4)	95,677.8	NA	NA	219,163.8	0.0	44.6	15.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	888.5 MMBTU								748.0 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$26,824.59	$0.00	$1.60	-45.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,469.65 $US								$26,824.59 $US			
Carbon	35.1	24.8	3.57	0.0	(24.8)	27.2	NA	NA	62.2	0.0	3.71	-3.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	59.9 MT CO2e								62.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 4-7. Agriculture Building HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace rooftop units with heat-pump units; (1) 5-ton heat-pump unit, w/ economizer, 18kw elec heat, Trane model WHC060; (2) 6-ton heat-pump unit, w/ economizer, 18kw elec heat, Trane model WHC074; (1) 7.5T heat pump RTU, economizer, 36kw elec heat, Trane WHC092; (2) 8.5T heat pump RTUs, economizer, 54kw elec heat, Trane WHC102;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	0.0	(4,670.4)	44,276.7	NA	NA	167,762.8	0.0	34.1	35.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	888.5 MMBTU								572.6 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$18,602.80	$0.00	$1.11	-0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,469.65 $US								$18,602.80 $US			
Carbon	35.1	24.8	3.57	0.0	(24.8)	12.6	NA	NA	47.6	0.0	2.84	20.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	59.9 MT CO2e								47.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 4-8. Agriculture Building DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	NA	NA	NA	0.0	0.0	123,486.0	4,670.4	53.0	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	888.5 MMBTU								888.5 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$12,903.39	$5,566.26	$1.10	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,469.65 $US								$18,469.65 $US			
Carbon	35.1	24.8	3.57	NA	NA	NA	0.0	0.0	35.1	24.8	3.57	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	59.9 MT CO2e								59.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 4-9. Agriculture Building DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**123,486.0**	**4,670.4**	**53.0**	**NA**	**NA**	**NA**	**0.0**	**(1,002.5)**	**122,483.5**	**4,670.4**	**52.8**	**0.4%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	888.5 MMBTU								885.1 MMBTU			
Energy Cost	**$12,903.39**	**$5,566.26**	**$1.10**						**$12,810.68**	**$5,566.26**	**$1.10**	**0.5%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,469.65 $US								$18,376.94 $US			
Carbon	**35.1**	**24.8**	**3.57**	**NA**	**NA**	**NA**	**0.0**	**(0.3)**	**34.8**	**24.8**	**3.55**	**0.5%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	59.9 MT CO2e								59.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 4-10. Agriculture Building Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	-$35,838.00	($13,921.20)	$5,566.26	($8,354.94)	($114,602.17)	NA	NA	NA	NA	NA	($120.18)
HVAC Pathway 2	$29,319.00	($5,699.41)	$5,566.26	($133.15)	($29,165.55)	-3.0418%	-0.3744%	0.2638	NA	NA	$624.06
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$10,127.00	$92.71	$0.00	$92.71	($11,728.44)	-5.8579%	-1.8892%	0.1429	NA	NA	$14.52

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$268,487.00
DHW Existing Replacement:	$3,698.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

4.5 Renewable Energy, Energy Storage, and Electric Vehicles

4.5.1 Solar and BESS Analysis

The two-story Agriculture Building rooftop has various large pieces of equipment located on the roof with some surrounding trees taller than the roof height that will produce shading and impact to the available solar footprint. The roof has a parapet wall surrounding the perimeter. The roof is scheduled to be replaced in 2035. The estimated roof capacity is 170 kW DC with potential available footprint for BESS equipment on the Eastern wall of the building (Figure 4-5).

Figure 4-5. Agriculture Building Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual energy consumption for the past year is approximately 122,466 kWh with a July peak load of 54.1 kW. The estimated roof solar capacity is 170 kW DC; however, the initial HOMER analysis indicates an optimal potential PV system nameplate size of 113 kW. HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 4-11. Costs of technology will continue to decrease, and while the ROI is not

current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Despite a long simple payback period, the PV + BESS system configuration possesses preferred results compared to the standalone PV system configuration due to a high renewable fraction.

Table 4-11. Agriculture Building Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	122,466	N/A	N/A	N/A
113 kW PV Only	54,745	154,120	N/A	73.8
113 kW PV + 132 kWh BESS	23,618	154,120	34,867	86.1

4.6 Cost Summary

Cost performance for the three systems is provided in Table 4-12.

Table 4-12. Agriculture Building Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	161,000	N/A	N/A
113 kW PV Only	209,000	267,000	0.3	24
113 kW PV + 132 kWh BESS	425,000	493,000	N/A	>25
Cost Summary with ITC Included				
113 kW PV Only	146,000	204,000	3.3	16.8
113 kW PV + 132 kWh BESS	297,000	366,000	N/A	>25

4.6.1 Electric Vehicle

The Agricultural Building was identified for fleet electrification and further recommended as an ideal location for future public charging. Potential location for EV charging equipment is detailed in Figure 4-5. A total of two (2) Level 2 7.2 kW EV chargers were identified for public charging usage for a total load of 14.4 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

4.7 Electrical Infrastructure Demand Feasibility Summary

Table 4-13. Agriculture Building Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	53.84 kW	53.84 kW
HVAC Electrification Pathway 1		325.41 kW
HVAC Electrification Pathway 2		148.35 kW
DHW Electrification Pathway 1		53.84 kW
DHW Electrification Pathway 2		53.56 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

4.7.1 Building HVAC Electrification Implementation Feasibility

The existing distribution panelboards cannot accommodate the equipment required by HVAC Electrification Pathway 2. A new branch circuit panel will be required to feed the additional loads being added. Additionally new circuit breakers will be required for all equipment to be added.

4.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the equipment required by DHW Electrification Pathway 2. New circuit breakers will be required for all equipment being added.

4.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the equipment required for the PV and BESS systems. New circuit breakers will be required for all equipment being added.

5 Animal Control Office

Durham County | Animal Control Office | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	3005 Glenn Rd, Durham, NC 27704	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Split-System Heat Pump
Building Type	Office	**Cooling Generation**	Split-System DX
Year Built	2009	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	3,488	**Heating / Cooling / Vent Distribution**	CV Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 5-1. Animal Control Office



5.1 Existing Building Performance & Condition

5.1.1 Past Conservation Projects and Successes

None.

5.1.2 Condition Assessment Summary

The HVAC systems were recently replaced, near the end of 2023. The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 5-1. Animal Control Office Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

5.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 5-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

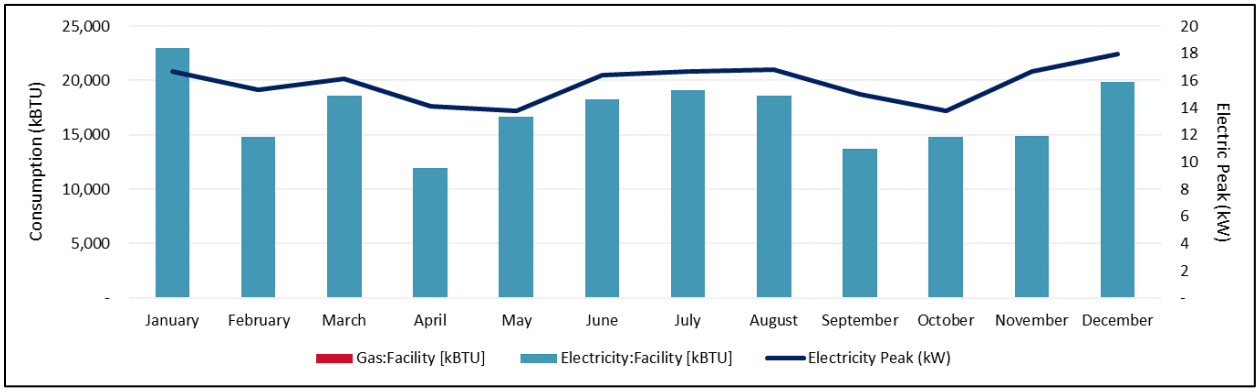
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 5-2. Animal Control Office Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	6,732	0	23	16.6	$543	$0	$543	1,911	0	1,911
February	4,348	0	15	15.3	$445	$0	$445	1,234	0	1,234
March	5,448	0	19	16.2	$505	$0	$505	1,547	0	1,547
April	3,508	0	12	14.1	$410	$0	$410	996	0	996
May	4,878	0	17	13.8	$522	$0	$522	1,385	0	1,385
June	5,346	0	18	16.4	$650	$0	$650	1,518	0	1,518
July	5,607	0	19	16.7	$665	$0	$665	1,592	0	1,592
August	5,455	0	19	16.8	$669	$0	$669	1,549	0	1,549
September	4,014	0	14	15.0	$570	$0	$570	1,139	0	1,139
October	4,329	0	15	13.7	$491	$0	$491	1,229	0	1,229
November	4,358	0	15	16.7	$497	$0	$497	1,237	0	1,237
December	5,825	0	20	18.0	$569	$0	$569	1,654	0	1,654
ANNUAL	59,847	0	204	-	$6,536	$0	$6,536	16,991	0	16,991
PEAK	-	-	-	18.0	-	-	-	-	-	-

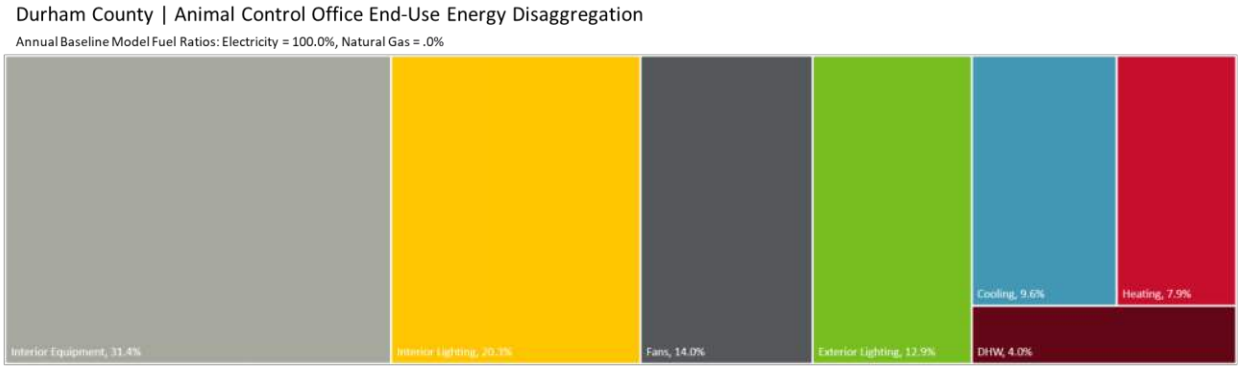
The data in Table 5-2 is represented in graphical format in Figure 5-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 5-2. Animal Control Office Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



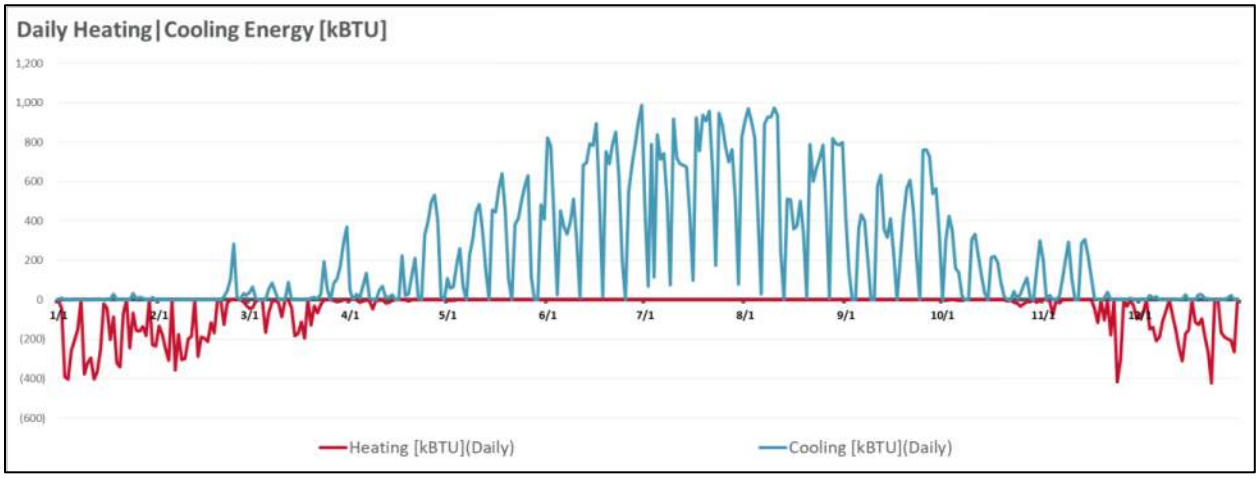
While Table 5-2 and Figure 5-2 encompasses “whole” building data, Figure 5-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 5-3. Animal Control Office Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 5-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 5-4. Animal Control Office Baseline Model Heating & Cooling Annual Load Profile



5.2 HVAC Refrigerants

The Durham County Animal Control Office utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 5-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 5-3. Animal Control Office HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) CU-1	Split-System Condensing Unit	Trane 4TWA4048	4 Tons	R-410A	9.0 lbs	Exterior
(2) CU-2 & 3	Split-System Condensing Unit	Trane 4TWR4030	2.5 Tons	R-410A	6.2 lbs	Exterior
(1) CU-4	Split-System Condensing Unit	Trane 4TWA4060	5 Tons	R-410A	10.9 lbs	Exterior

5.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 5-4. Animal Control Office Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Animal Control Office	Baseline	58,895.28	0.00	201.01	$6,824.73	16.72

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	4,253.55	0.00	14.52	$492.90	1.21	Potential Annual Energy Savings (%)	7.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	25.24	0.00	0.09	$2.92	0.01	NA	NA	
	Smart Thermostat	673.34	0.00	2.30	$78.03	0.19	Total Cooling Capacity Controled	138.00	kBTU/hr
	Air Conditioner Tune-up	711.50	0.00	2.43	$82.45	0.20	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$17.22	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	2,362.57	0.00	8.06	$273.77	0.67	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	1,063.16	0.00	3.63	$123.20	0.30	Applicable Area %	50.0%	%
	LED Exit Signs	106.00	0.00	0.36	$12.28	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	318.95	0.00	1.09	$36.96	0.09	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	1,037.95	0.00	3.54	$120.28	0.29	Quantity of Outdoor Fixtures	4	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,254.96	0.00	4.28	$145.42	0.36	Transformer Size	75.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$12.17	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$15.59	0.04	Quantity of Power Strips	5	#
Decarbonization Measure Savings Totals (predicted)		**12,195.34**	**0.00**	**41.62**	**$1,413.19**	**3.46**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**20.7%**	**0.0%**	**20.7%**	**20.7%**	**20.7%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

5.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 5-5. Animal Control Office Existing HVAC/DHW Systems

HVAC | Space Heating	14 SEER Split-systems, CV AHUs; (1) 5-ton heat-pump, condensing unit, Trane 4TWA4060, mfg 2022; (2) 2.5-ton heat-pump, condensing unit, Trane 4TWR4030, mfg 2023; (1) 4-ton heat-pump, condensing unit, Trane 4TWA4048, mfg 2023;
Domestic Hot Water	(1) electric storage water heater, 34 gallon, Rheem ELDS40-C, mfg 2015

Table 5-6. Animal Control Office HVAC Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**59,979.4**	**0.0**	**58.7**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**59,979.4**	**0.0**	**58.7**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	204.7 MMBTU								204.7 MMBTU			
Energy Cost	**$7,179.52**	**$0.00**	**$2.06**						**$7,179.52**	**$0.00**	**$2.06**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,179.52 $US								$7,179.52 $US			
Carbon	**17.0**	**0.0**	**4.88**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**17.0**	**0.0**	**4.88**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.0 MT CO2e								17.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 5-7. Animal Control Office HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - systems are already heat-pump (and all replaced late 2023)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**59,979.4**	**0.0**	**58.7**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**59,979.4**	**0.0**	**58.7**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	204.7 MMBTU								204.7 MMBTU			
Energy Cost	**$7,179.52**	**$0.00**	**$2.06**						**$7,179.52**	**$0.00**	**$2.06**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,179.52 $US								$7,179.52 $US			
Carbon	**17.0**	**0.0**	**4.88**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**17.0**	**0.0**	**4.88**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.0 MT CO2e								17.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 5-8. Animal Control Office DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**59,979.4**	**0.0**	**58.7**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**59,979.4**	**0.0**	**58.7**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	204.7 MMBTU								204.7 MMBTU			
Energy Cost	**$7,179.52**	**$0.00**	**$2.06**						**$7,179.52**	**$0.00**	**$2.06**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,179.52 $US								$7,179.52 $US			
Carbon	**17.0**	**0.0**	**4.88**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**17.0**	**0.0**	**4.88**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.0 MT CO2e								17.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 5-9. Animal Control Office DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,979.4	0.0	58.7	NA	NA	NA	0.0	(1,669.2)	58,310.2	0.0	57.1	2.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	204.7 MMBTU								199.0 MMBTU			
Energy Cost	$7,179.52	$0.00	$2.06						$7,039.22	$0.00	$2.02	2.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,179.52 $US								$7,039.22 $US			
Carbon	17.0	0.0	4.88	NA	NA	NA	0.0	(0.5)	16.6	0.0	4.75	2.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.0 MT CO2e								16.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 5-10. Animal Control Office Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$26,617.00	$0.00	$0.00	$0.00	($35,967.66)	NA	-100.0000%	0.0000	NA	NA	$0.00
HVAC Pathway 2	$26,617.00	$0.00	$0.00	$0.00	($35,967.66)	NA	-100.0000%	0.0000	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$2,772.00	$140.30	$0.00	$140.30	($785.39)	1.0706%	2.3959%	0.7903	22.00	NA	$24.17

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$6,092.00
DHW Existing Replacement:	$7,069.00

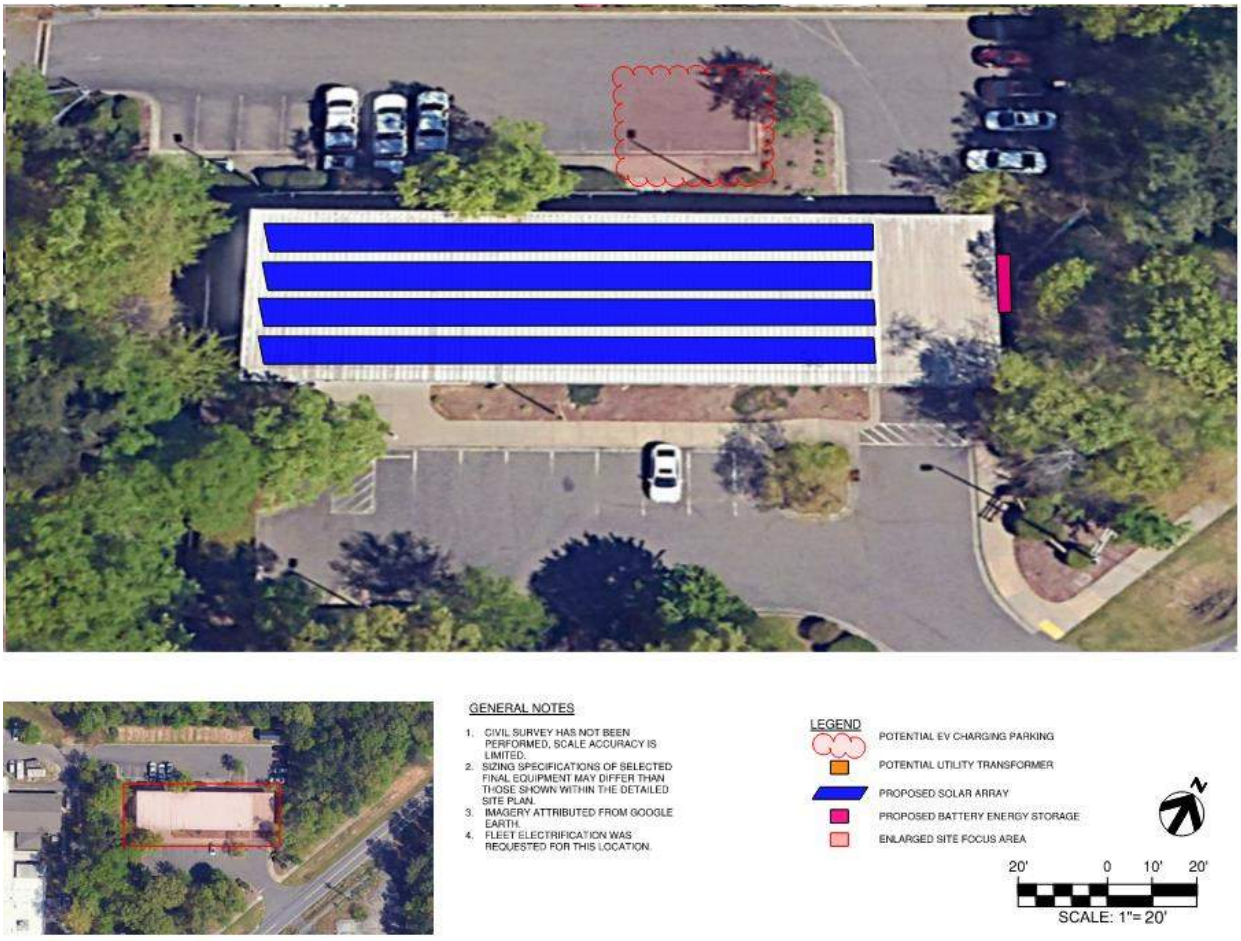
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

5.5 Renewable Energy, Energy Storage, and Electric Vehicles

5.5.1 Solar and BESS Analysis

The Animal Control Office is a rectangular facility with one roof level, a peak running approximately North-South and gradual slopes to the East and West. The roof is scheduled to be replaced in 2030. The sloped and metal material roof has trees surrounding the East and West edges of the rooftop with shading implications. As shown on Figure 5-5, the single roof level has an estimated available capacity of 43 kW DC. The Eastern side of the building is identified for placement of BESS equipment.

Figure 5-5. Animal Control Office Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 58,946 kWh with a peak March load of 20.4 kW. The estimated roof solar capacity is 43 kW DC; however, the initial HOMER analysis indicates that only a 30 kW DC nameplate PV system would be optimal. HOMER model results indicate that PV and hybrid system configurations possess favorable renewable fractions, but unfavorable payback periods, IRR. PV and hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of

BESS. Standalone PV systems tend to have more favorable payback periods when incentives are considered in the cost analysis. The base case, PV only and PV+BESS system configurations with the fastest payback periods are provided in Table 5-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 5-11. Animal Control Office Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	58,946	N/A	N/A	N/A
30kW PV Only	33,446	40,797	N/A	55
30kW PV + 53 kWh BESS	23,210	40,797	11,421	62.3

5.6 Cost Summary

Cost performance for the three systems is provided in Table 5-12.

Table 5-12. Animal Control Office Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	77,000	N/A	N/A
30kW PV Only	63,000	110,000	N/A	>25
30kW PV + 53 kWh BESS	150,000	204,000	N/A	>25
Cost Summary with ITC Included				
30kW PV Only	44,000	91,000	2.8	17.8
30kW PV + 53 kWh BESS	104,000	159,000	N/A	>25

5.6.1 Electric Vehicle

The Animal Control Office was identified for fleet electrification but not for public charging. Three (3) charging locations are shown in Figure 5-5 should chargers be considered in the future. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, see the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

5.7 Electrical Infrastructure Demand Feasibility Summary

Table 5-13. Animal Control Office Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	17.96 kW	17.96 kW
HVAC Electrification Pathway 1		17.96 kW
HVAC Electrification Pathway 2		17.96 kW
DHW Electrification Pathway 1		17.96 kW
DHW Electrification Pathway 2		17.93 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

5.7.1 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards can accommodate the equipment required by DHW Electrification Pathway 2. New circuit breakers will be required.

5.7.2 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard cannot accommodate the PV or BESS systems. A new main distribution panel associated overcurrent protected devices will be required to accommodate either system.

6 Animal Shelter

Durham County | Animal Shelter | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	2117 E Club Blvd, Durham, NC 27704	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Animal Shelter	**Cooling Generation**	Packaged DX
Year Built	1970	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	22,968	**Heating / Cooling / Vent Distribution**	CV Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	6.5
		Weekday Opening Time	Monday-Friday, 10:30am
		Weekend Operating Hours	4
		Weekend Opening Time	Saturday, 10:00am; Sunday, Closed

Figure 6-1. Animal Shelter



6.1 Existing Building Performance & Condition

6.1.1 Past Conservation Projects and Successes

None.

6.1.2 Condition Assessment Summary

The HVAC, mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age. During the site visit, Durham County informed the HDR team know that a new Animal Shelter will be built within a five (5) year timeframe, therefor this building was not prioritized in the analysis. However, it was also noted that the Sherriff's Department may take over the building to hold animals required to be detained during their investigations.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 6-1. Animal Shelter Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

6.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 6-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

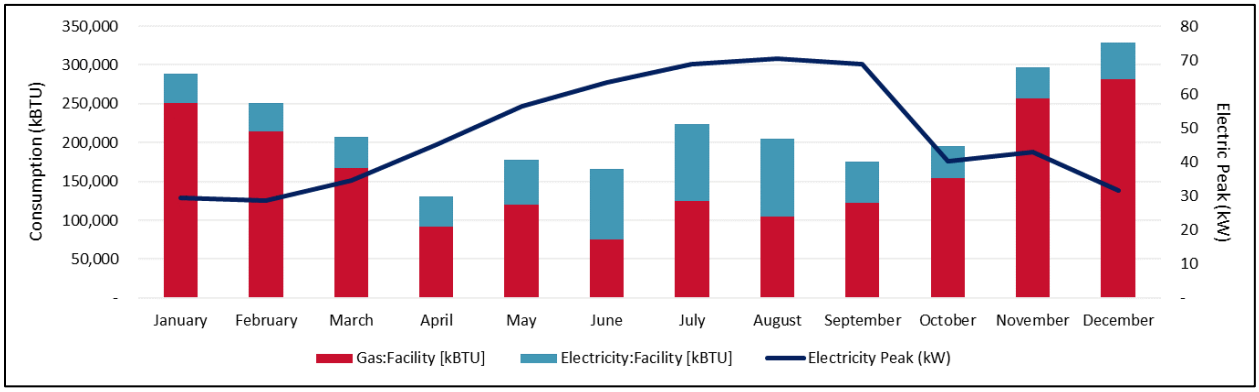
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 6-2. Animal Shelter Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	11,128	2,509	289	29.5	$935	$2,720	$3,655	3,159	13,327	16,486
February	10,516	2,147	251	28.7	$904	$2,094	$2,999	2,986	11,401	14,387
March	11,959	1,670	208	34.5	$1,081	$1,600	$2,681	3,395	8,870	12,265
April	11,460	920	131	45.1	$1,114	$915	$2,028	3,253	4,884	8,137
May	17,044	1,199	178	56.3	$1,534	$1,195	$2,729	4,839	6,368	11,207
June	26,545	755	166	63.5	$2,508	$816	$3,323	7,536	4,010	11,546
July	28,850	1,252	224	68.7	$2,715	$1,275	$3,990	8,191	6,647	14,838
August	29,554	1,044	205	70.4	$2,888	$1,133	$4,021	8,390	5,543	13,933
September	15,477	1,228	176	68.8	$1,896	$1,389	$3,285	4,394	6,522	10,917
October	12,058	1,543	195	40.2	$1,245	$1,839	$3,083	3,423	8,193	11,616
November	11,642	2,570	297	43.0	$1,133	$2,990	$4,123	3,305	13,651	16,956
December	13,553	2,820	328	31.6	$1,182	$3,237	$4,419	3,848	14,978	18,826
ANNUAL	199,786	19,655	2,647	-	$19,133	$21,204	$40,337	56,720	104,394	161,114
PEAK	-	-	-	70.4	-	-	-	-	-	-

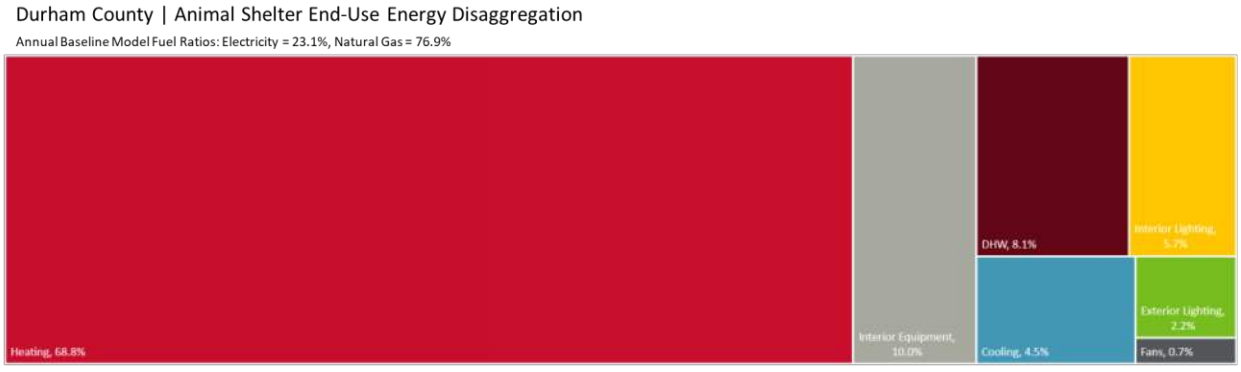
The data in Table 6-2 is represented in graphical format in Figure 6-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 6-2. Animal Shelter Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



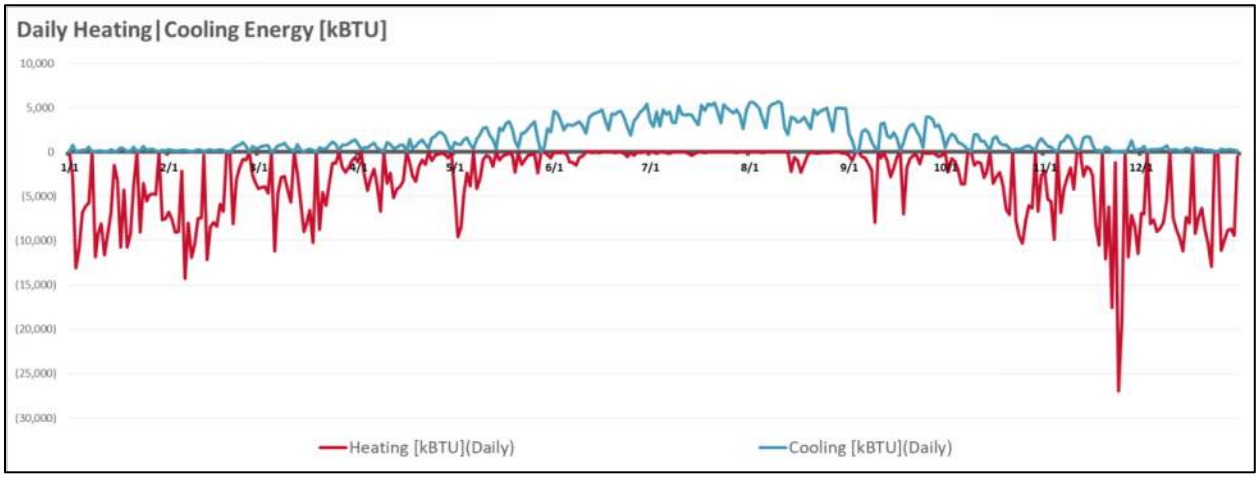
While Table 6-2 and Figure 6-2 encompasses “whole” building data, Figure 6-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 6-3. Animal Shelter Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 6-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 6-4. Animal Shelter Baseline Model Heating & Cooling Annual Load Profile



6.2 HVAC Refrigerants

The Durham County Animal Shelter utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 6-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 6-3. Animal Shelter HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location

6.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 6-4. Animal Shelter Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Animal Shelter	Baseline	194,045.16	18,474.00	2,509.67	$38,513.48	153.21

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	15,092.40	1,436.87	195.20	$2,995.49	11.92	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	1,926.38	0.00	6.57	$197.59	0.55	NA	NA	
	Smart Thermostat	1,317.35	77.44	12.24	$213.13	0.79	Total Cooling Capacity Controled	216.00	kBTU/hr
	Air Conditioner Tune-up	1,665.13	0.00	5.68	$170.80	0.47	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.26	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$902.47	5.10	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	50,903.52	-337.81	139.95	$4,881.01	12.66	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	9,915.12	-65.80	27.26	$950.74	2.47	Applicable Area %	10.0%	%
	LED Exit Signs	529.98	-3.52	1.46	$50.82	0.13	Quantity of Exit Signs	5	#
	Daylight Dimming Control	9,915.12	-65.80	27.26	$950.74	2.47	Applicable Area %	10.0%	%
	LED Outdoor Pole/Arm	1,556.93	0.00	5.31	$159.70	0.44	Quantity of Outdoor Fixtures	6	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.77	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	780.10	0.00	2.66	$80.02	0.22	Quantity of Power Strips	29	#
Decarbonization Measure Savings Totals (predicted)		**92,373.48**	**2,079.26**	**523.19**	**$11,569.53**	**37.27**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**47.6%**	**11.3%**	**20.8%**	**30.0%**	**24.3%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

6.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 6-5. Animal Shelter Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU-? gas furnace, 120 mbh input, 96 mbh output; (1) RTU-1 gas furnace, 60 mbh input, 48 mbh output; (2) RTU-? gas furnace, 120 mbh input, 96 mbh output; (1) gas-fired large commercial clothes dryer;
Domestic Hot Water	(1) DHW storage tank, 119 gal, Lochinvar model RJS120; (1) DHW boiler, power-draft, Lochinvar model EWN250PM, 250 mbh input, 210 mbh output, 255 gph recovery, mfg 2003, recirc pump; (1) electric storage water heater, 50 gal, 9kw, State model PCE-52-2ORTA 110, mfg 2016; (1) Gas-fired storage water heater, natural draft, Rheem-Ruud model G100-200, 100 gal, 199.9 mbh input, 194 gph recovery, mfg 2010; (1) Electric storage water heater, 20 gal, 3 kw, AO Smith model DEL 20 102, mfg 2003;

Table 6-6. Animal Shelter HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace (4) RTUs with (1) 3-ton heat pump RTU, w/ economizer, 18 kw elec heat, Trane model WHC036; (3) 7.5-ton heat pump RTU, w/ economizer, 27 kw elec heat, Trane model WHC092; *Replace (1) gas clothes dryer with (1) lrg commercial electric dryer, 60kw;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D %
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**199,786.0**	**22,710.1**	**128.6**	**0.0**	**(17,148.6)**	**162,961.6**	**NA**	**NA**	**362,747.6**	**5,561.5**	**78.1**	**39.2%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,952.9 MMBTU								1,794.2 MMBTU			
Energy Cost	**$19,309.29**	**$24,500.02**	**$1.91**						**$45,693.90**	**$5,999.79**	**$2.25**	**-18.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$43,809.31 $US								$51,693.70 $US			
Carbon	**56.7**	**120.6**	**7.72**	**0.0**	**(91.1)**	**46.3**	**NA**	**NA**	**103.0**	**29.5**	**5.77**	**25.3%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	177.3 MT CO2e								132.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 6-7. Animal Shelter HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	0.0	(17,148.6)	162,961.6	NA	NA	362,747.6	5,561.5	78.1	39.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,952.9 MMBTU								1,794.2 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$45,693.90	$5,999.79	$2.25	-18.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$43,809.31 $US								$51,693.70 $US			
Carbon	56.7	120.6	7.72	0.0	(91.1)	46.3	NA	NA	103.0	29.5	5.77	25.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	177.3 MT CO2e								132.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 6-8. Animal Shelter DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace (1) gas DHW boiler with (1) electric boiler, 60 kw input, Bradford White "Brute" model BEB-60; *Replace (1) gas storage water heater with (1) electric storage water heater, 119 gallon, 30kw input, Bradford White model CEHD120(A)30 3*CF; (total 90kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	NA	NA	NA	(5,561.5)	121,394.2	321,180.2	17,148.6	122.4	4.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,952.9 MMBTU								2,811.0 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$30,535.88	$18,500.23	$2.13	-11.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$43,809.31 $US								$49,036.10 $US			
Carbon	56.7	120.6	7.72	NA	NA	NA	(29.5)	34.5	91.2	91.1	7.94	-2.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	177.3 MT CO2e								182.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 6-9. Animal Shelter DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas boiler with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) back-up electric boiler, 60 kw input, Bradford White "Brute" model BEB-60; *Replace (1) gas water heaters with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) electric storage water heater, 119 gallon, 30kw input, Bradford White model CEHD120(A)30 3*CF; (Total simultaneous 130kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	NA	NA	NA	(5,561.5)	26,875.0	226,661.0	17,148.6	108.3	15.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,952.9 MMBTU								2,488.4 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$21,688.12	$18,500.23	$1.75	8.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$43,809.31 $US								$40,188.34 $US			
Carbon	56.7	120.6	7.72	NA	NA	NA	(29.5)	7.6	64.3	91.1	6.77	12.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	177.3 MT CO2e								155.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 6-10. Animal Shelter Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$10,252.00	($26,384.61)	$18,500.23	($7,884.39)	($136,136.64)	NA	NA	-8.8268	NA	NA	$2,285.78
HVAC Pathway 2	$10,252.00	($26,384.61)	$18,500.23	($7,884.39)	($136,136.64)	NA	NA	-8.8268	NA	NA	$2,285.78
DHW Pathway 1	$63,613.00	($11,226.58)	$5,999.79	($5,226.79)	($181,952.36)	NA	NA	-1.1167	NA	NA	($251.16)
DHW Pathway 2	$619,472.00	($2,378.83)	$5,999.79	$3,620.97	($746,395.13)	-6.0902%	-2.5666%	0.1084	NA	NA	$1,117.39

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$133,110.00
DHW Existing Replacement:	$61,817.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

6.5 Renewable Energy, Energy Storage, and Electric Vehicles

6.5.1 Solar and BESS Analysis

The Animal Shelter has a large sized roof shaded by adjacent trees on the East side of the facility. The roof is divided into two (2) main levels with varying material. The lowest rooftop level has a parapet wall surrounding the perimeter and a large quantity of various pieces of equipment in the center, impacting the total capacity of rooftop solar strings placed on this level. The upper roof level is composed of shingles and is gabled. The roof was replaced in 2021. As shown in Figure 6-5, the estimated total capacity is 135 kW DC with the potential for BESS equipment placement adjacent to existing utility equipment on the northeastern corner of the building.

Figure 6-5. Animal Shelter Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 187,991 kWh with a peak July load of 72.8 kW. The estimated roof solar capacity is 135 kW DC and initial HOMER analysis indicates that only a 100 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess

unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV and hybrid system both tend to have more favorable periods if ITCs are factored into the system cost. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 6-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 6-11. Animal Shelter Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy MGS)	187,991	N/A	N/A	N/A
100 kW PV Only	93,513	136,059	N/A	59.3
100 kW PV + 53 kW BESS	86,851	136,059	7,772	60.7

6.6 Cost Summary

Cost performance for the three systems is provided in Table 6-12.

Table 6-12. Animal Shelter Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	229,000	N/A	N/A
100 kW PV Only	187,000	318,000	0.8	23
100 kW PV + 26.4kW BESS	230,000	353,000	N/A	>25
Cost Summary with ITC Included				
100 kW PV Only	131,000	262,000	3.9	16
100 kW PV + 26.4kW BESS	161,000	285,000	2.6	18

6.6.1 Electric Vehicle

The Animal Shelter was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 6-5. A total of four (4) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 28.4 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional

evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

6.7 Electrical Infrastructure Demand Feasibility Summary

Table 6-13. Animal Shelter Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	70.42 kW	70.42 kW
HVAC Electrification Pathway 1		557.48 kW
HVAC Electrification Pathway 2		557.48 kW
DHW Electrification Pathway 1		165.17 kW
DHW Electrification Pathway 2		82.34 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

6.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the number circuit breakers required for the roof top units, and electric dryer required by HVAC Electrification Pathways 1. A new main distribution panelboard will be required along with associated circuit breaker for each new piece of equipment.

6.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard cannot accommodate the circuit breakers required to supply power for the heat pump water heater, heat pump storage water heater, electric storage water heater and boiler for DHW Electrification Pathways 1 and 2. A new main distribution panelboard will be required along with associated circuit breakers for each new piece of equipment.

6.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the BESS system but not the PV system. Incorporating the PV system would require the replacement of the main distribution system. New circuit breakers will be required for each system.

7 Bethesda VFD

Durham County | Bethesda VFD | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	1724 S Miami Blvd, Durham, NC 27703	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Direct-Vent Gas Furnaces
Building Type	Emergency Services	**Cooling Generation**	Split-system DX
Year Built	1983	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	10,800	**Heating / Cooling / Vent Distribution**	Single Zone Units
Stories	2	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 7-1. Bethesda VFD



7.1 Existing Building Performance & Condition

7.1.1 Past Conservation Projects and Successes

None.

7.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 7-1. Bethesda VFD Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

7.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 7-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was not available in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was predicted via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

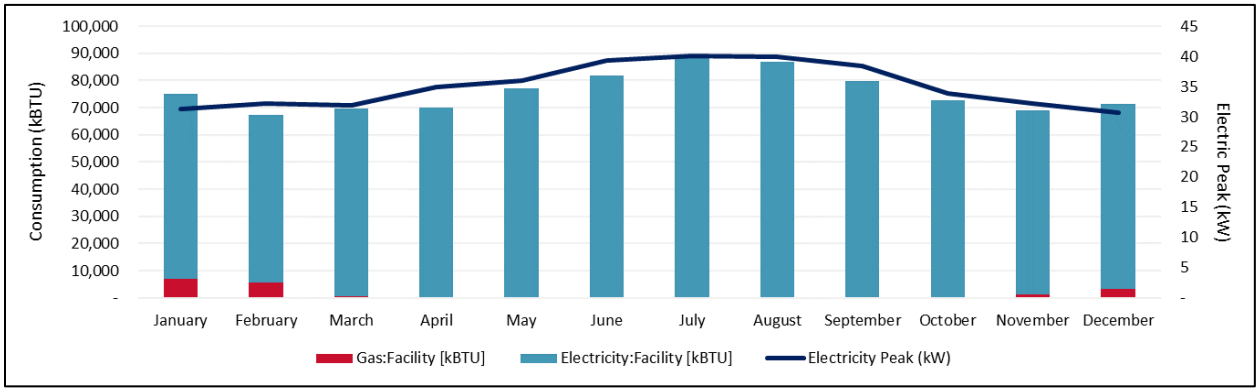
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 7-2. Bethesda VFD Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	19,935	70	75	31.2	$0	$86	$86	5,660	370	6,029
February	18,019	57	67	32.3	$0	$70	$70	5,116	303	5,419
March	20,238	7	70	31.9	$0	$9	$9	5,746	37	5,783
April	20,480	0	70	35.0	$0	$0	$0	5,814	0	5,814
May	22,578	0	77	36.0	$0	$0	$0	6,410	0	6,410
June	23,975	0	82	39.4	$0	$0	$0	6,807	0	6,807
July	25,928	0	88	40.1	$0	$0	$0	7,361	0	7,361
August	25,501	0	87	39.9	$0	$0	$0	7,240	0	7,240
September	23,395	0	80	38.3	$0	$0	$0	6,642	0	6,642
October	21,309	0	73	33.8	$0	$0	$0	6,050	0	6,050
November	19,830	14	69	32.3	$0	$17	$17	5,630	73	5,703
December	19,942	32	71	30.7	$0	$39	$39	5,662	169	5,830
ANNUAL	261,130	179	909	-	$0	$220	$220	74,136	951	75,087
PEAK	-	-	-	40.1	-	-	-	-	-	-

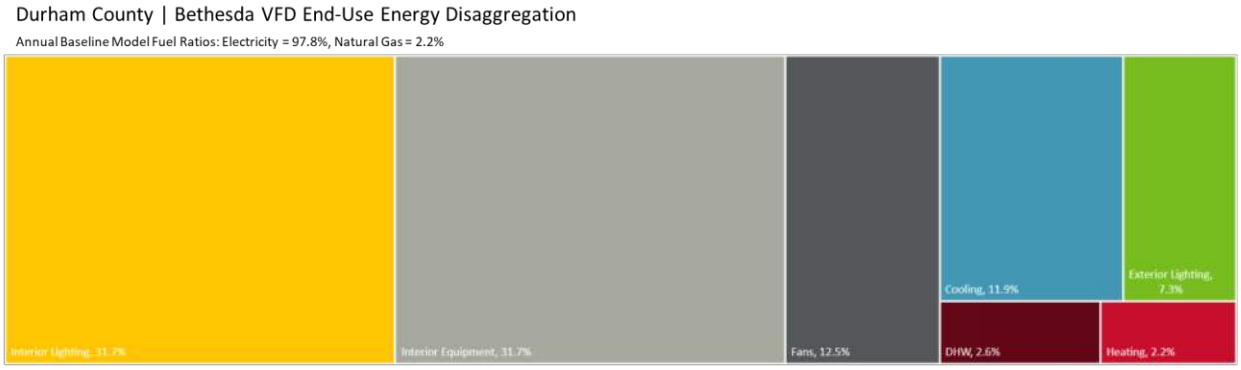
The data in Table 7-2 is represented in graphical format in Figure 7-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 7-2. Bethesda VFD Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



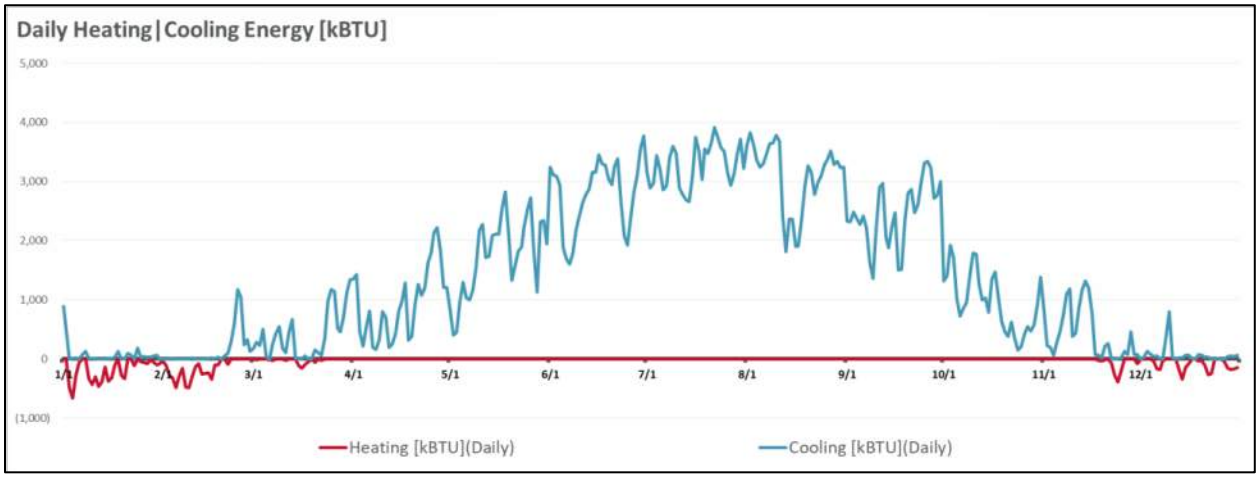
While Table 7-2 and Figure 7-2 encompasses “whole” building data, Figure 7-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 7-3. Bethesda VFD Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 7-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 7-4. Bethesda VFD Baseline Model Heating & Cooling Annual Load Profile



7.2 HVAC Refrigerants

The Durham County Bethesda VFD utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 7-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 7-3. Bethesda VFD HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) AC-1	Split-System Condensing Unit	Carrier 24ABB348	4 Tons	R-410A	7.0 lbs	Exterior
(1) AC-2	Split-System Condensing Unit	Carrier 24ABB360	5 Tons	R-410A	8.0 lbs	Exterior
(1) OCU-1	Split-System Condensing Unit	Carrier 24ABR360	5 Tons	R-22	10.1 lbs	Exterior
(1) OCU-2	Split-System Condensing Unit	Carrier 24ABR330	2.5 Tons	R-22	5.3 lbs	Exterior
(1) OCU-3	Split-System Condensing Unit	Carrier 24ABR360	5 Tons	R-22	10.1 lbs	Exterior

7.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every

reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 7-4. Bethesda VFD Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Bethesda VFD	Baseline	261,130.01	179.10	909.14	$23,182.89	75.09

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	17,408.67	11.94	60.61	$1,545.53	5.01	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	749.85	0.00	2.56	$65.85	0.21	NA	NA	
	Smart Thermostat	2,070.17	78.01	14.87	$290.66	1.00	Total Cooling Capacity Controled	198.00	kBTU/hr
	Air Conditioner Tune-up	2,616.69	0.00	8.93	$229.80	0.74	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$13.05	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$207.95	0.67	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	3,788.10	-25.14	10.41	$297.60	0.94	Applicable Area %	10.0%	%
	LED Exit Signs	317.99	-2.11	0.87	$24.98	0.08	Quantity of Exit Signs	3	#
	Daylight Dimming Control	5,682.16	-37.71	15.62	$446.41	1.41	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.22	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$23.62	0.08	Quantity of Power Strips	10	#
Decarbonization Measure Savings Totals (predicted)		**35,524.12**	**25.00**	**123.74**	**$3,154.68**	**10.22**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**13.6%**	**14.0%**	**13.6%**	**13.6%**	**13.6%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

7.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 7-5. Bethesda VFD Existing HVAC/DHW Systems

HVAC | Space Heating	(2?) Gas fired unit heater, 170 mbh input, 150.9 mbh output; (1) "AC-1" direct-vent gas furnace, Carrier model 59SC5A100S21, 100 mbh input, 97 mbh output, mfg 2017; (1) "Unit 2" direct-vent gas furnace, Lennox model G26Q4/5-125-6, 125 mbh input, mfg 1999; (1) "AHU-1" dirct-vent gas furnace, Carrier model 58MCB080, 80 mbh input, 74 mbh output, mfg 2006; (1) "AHU-2" direct-vent gas furnace, Carrier model 58MCB060, 60 mbh input, 56 mbh output, mfg 2006; (1) "AHU-3" direct vent gas furnace, Carrier model 58MCB080, 80 mbh input, 74 mbh output, mfg 2006; (1) 6-burner gas range in kitchen
Domestic Hot Water	(1) electric storage water heater, AO Smith model ELJF-40-913, 40 gallon, 4.5 kw, mfg. 1993; (1) gas instantaneous, Navien model NPE-240A2, 200 mbh input, approx 8 gpm;

Table 7-6. Bethesda VFD HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (2) electric 40kw unit heater, Modine PTE400; *Replace split-systems with heat pump systems w/ electric resistance backup (3) 5-ton HP condensing unit & AHU w/ 30kw heat, (1) 4 ton HP condensing unit & AHU w/20kw heat, (1) 2.5-ton HP condensing unit & AHU w/7.5kw heat; *Replace gas range with electric 36" 6-burner induction range (240V, 22kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	0.0	(203.3)	3,059.1	NA	NA	264,189.1	0.0	83.5	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	911.6 MMBTU								901.7 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$23,334.12	$0.00	$2.16	-0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$23,182.89 $US								$23,334.12 $US			
Carbon	74.1	1.1	6.96	0.0	(1.1)	0.9	NA	NA	75.0	0.0	6.94	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	75.2 MT CO2e								75.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 7-7. Bethesda VFD HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	NA

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	0.0	(203.3)	3,059.1	NA	NA	264,189.1	0.0	83.5	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	911.6 MMBTU								901.7 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$23,334.12	$0.00	$2.16	-0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$23,182.89 $US								$23,334.12 $US			
Carbon	74.1	1.1	6.96	0.0	(1.1)	0.9	NA	NA	75.0	0.0	6.94	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	75.2 MT CO2e								75.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 7-8. Bethesda VFD DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace (1) gas instantaneous WH with (1) electric storage water heater, 119 gallon, 54kw; +I17:N17

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	NA	NA	NA	0.0	0.0	261,130.0	203.3	84.4	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	911.6 MMBTU								911.6 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$22,933.00	$249.89	$2.15	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$23,182.89 $US								$23,182.89 $US			
Carbon	74.1	1.1	6.96	NA	NA	NA	0.0	0.0	74.1	1.1	6.96	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	75.2 MT CO2e								75.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 7-9. Bethesda VFD DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace (1) gas WHs with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ x 119 gallon storage tank each; *Replace (1) electric WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**261,130.0**	**203.3**	**84.4**	**NA**	**NA**	**NA**	**0.0**	**(4,651.4)**	**256,478.6**	**203.3**	**82.9**	**1.7%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	911.6 MMBTU								895.7 MMBTU			
Energy Cost	**$22,933.00**	**$249.89**	**$2.15**						**$22,553.07**	**$249.89**	**$2.11**	**1.6%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$23,182.89 $US								$22,802.96 $US			
Carbon	**74.1**	**1.1**	**6.96**	**NA**	**NA**	**NA**	**0.0**	**(1.3)**	**72.8**	**1.1**	**6.84**	**1.8%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	75.2 MT CO2e								73.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 7-10. Bethesda VFD Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$136,459.00	($401.12)	$249.89	($151.24)	($186,993.36)	-7.3870%	NA	-0.0141	NA	NA	$10.77
HVAC Pathway 2	$136,459.00	($401.12)	$249.89	($151.24)	($186,993.36)	-7.3870%	NA	-0.0141	NA	NA	$10.77
DHW Pathway 1	$32,603.00	$0.00	$0.00	$0.00	($44,056.57)	NA	-100.0000%	0.0000	NA	NA	$0.00
DHW Pathway 2	$265,117.00	$379.93	$0.00	$379.93	($350,237.05)	-7.0550%	-6.3339%	0.0224	NA	NA	$67.35

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$56,448.00
DHW Existing Replacement:	$6,129.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

7.5 Renewable Energy, Energy Storage, and Electric Vehicles

7.5.1 Solar and BESS Analysis

Bethesda VFD is a small building with three (3) levels for the roof of various materials. Two (2) of the roof levels have a high quantity of HVAC equipment for the small footprint, resulting in recommendation for solar equipment to be only placed on the middle level. The age of the roof was not confirmed, and the replacement cycle was not identified. Shading from the higher roof level to the South further reduced the available footprint for solar equipment. As shown on Figure 7-5, the middle roof level has an estimated available capacity of 32 kW DC. The Western side of the building is identified for placement of BESS equipment adjacent to potential existing utility infrastructure.

Figure 7-5. **Bethesda VFD Conceptual Renewables and EV Visual Aid**



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. No load data was provided for Bethesda VFD; thus, it was assumed that the load was optimal comparable to the EMS #2 building load. The annual building consumption for the past year is approximately 60,402 kWh with a peak July load of 15.7 kW. The estimated roof solar capacity is 32 kW DC, and the initial HOMER analysis indicates that a 32 kW DC

nameplate PV system would be optimal. HOMER model results indicate that multiple PV and hybrid system configurations possess favorable renewable fractions, but unfavorable payback periods, and IRR. PV and hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods if incentives are included in the cost analysis. The base case, PV only and PV+BESS system configurations with the fastest payback periods are provided in Table 7-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 7-11. Bethesda VFD Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	60,402	N/A	N/A	N/A
32 kW PV Only	37,960	43,539	N/A	53.4
32 kW PV + 66 kWh BESS	24,131	43,539	15,431	62.5

7.6 Cost Summary

Cost performance for the three systems is provided in Table 7-12.

Table 7-12. Bethesda VFD Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	70,000	N/A	N/A
32 kW PV Only	66,000	110,000	N/A	>25
32 kW PV + 66 kWh BESS	174,000	230,000	N/A	>25
Cost Summary with ITC Included				
32 kW PV Only	46,000	91,000	1.2	21.4
32 kW PV + 66 kWh BESS	122,000	178,000	N/A	>25

7.6.1 Electric Vehicle

The Bethesda VFD was identified for fleet electrification but not for public charging. Two (2) charging locations are shown in Figure 7-5 should chargers be considered in the future. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers,

see the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

7.7 Electrical Infrastructure Demand Feasibility Summary

Table 7-13. Bethesda VFD Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	40.09 kW	40.09 kW
HVAC Electrification Pathway 1		41.74 kW
HVAC Electrification Pathway 2		41.74 kW
DHW Electrification Pathway 1		40.09 kW
DHW Electrification Pathway 2		39.60 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

7.7.1 Building HVAC Electrification Implementation Feasibility

The existing distribution panelboards cannot accommodate the equipment required by HVAC Electrification Pathway 1. A new Main Distribution Panel with associated overcurrent protection devices will be required to allow for the addition of new equipment.

7.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards cannot accommodate the equipment required by DHW Electrification Pathways 1 and 2. A new Main Distribution Panel with associated overcurrent protection devices will be required to allow for the addition of new equipment/system.

7.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard cannot accommodate the PV or BESS systems. A new Main Distribution Panel with associated overcurrent protection devices will be required to allow for the addition of new equipment/system.

8 Bragtown Library

Durham County | Bragtown Library | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	3200 Dearborn Dr, Durham, NC 27704	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Heat Pump
Building Type	Library	**Cooling Generation**	DX Mini-Split
Year Built	1964	**Domestic Hot Water Generation**	Electric Instantaneous Water Heater
Floor Area (ft2)	1,092	**Heating / Cooling / Vent Distribution**	Mini-Split
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

Figure 8-1. Bragtown Library



8.1 Existing Building Performance & Condition

8.1.1 Past Conservation Projects and Successes

None.

8.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 8-1. Bragtown Library Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

8.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 8-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

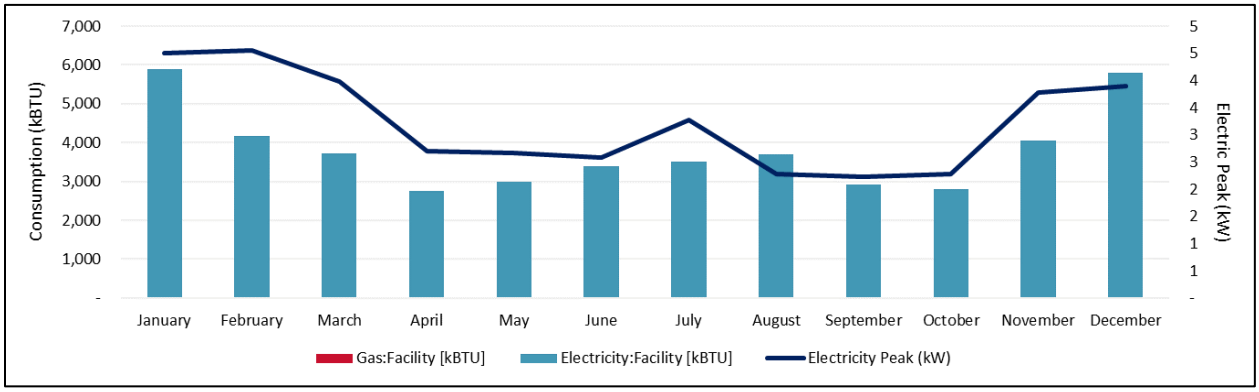
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 8-2. Bragtown Library Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	1,726	0	6	4.5	$254	$0	$254	490	0	490
February	1,222	0	4	4.6	$190	$0	$190	347	0	347
March	1,092	0	4	4.0	$174	$0	$174	310	0	310
April	808	0	3	2.7	$138	$0	$138	229	0	229
May	880	0	3	2.7	$152	$0	$152	250	0	250
June	992	0	3	2.6	$166	$0	$166	282	0	282
July	1,031	0	4	3.3	$172	$0	$172	293	0	293
August	1,081	0	4	2.3	$181	$0	$181	307	0	307
September	857	0	3	2.2	$159	$0	$159	243	0	243
October	817	0	3	2.3	$154	$0	$154	232	0	232
November	1,185	0	4	3.8	$204	$0	$204	336	0	336
December	1,696	0	6	3.9	$274	$0	$274	482	0	482
ANNUAL	13,387	0	46	-	$2,217	$0	$2,217	3,801	0	3,801
PEAK	-	-	-	4.6	-	-	-	-	-	-

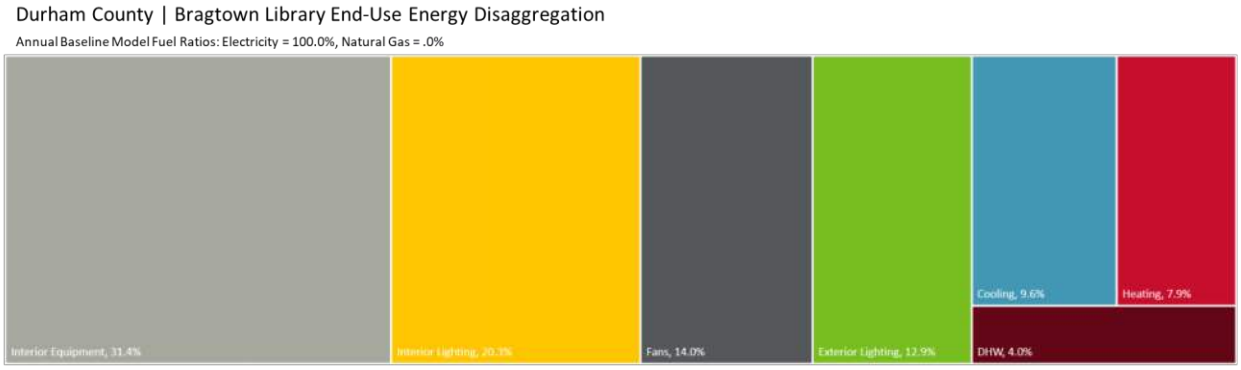
The data in Table 8-2 is represented in graphical format in Figure 8-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 8-2. Bragtown Library Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



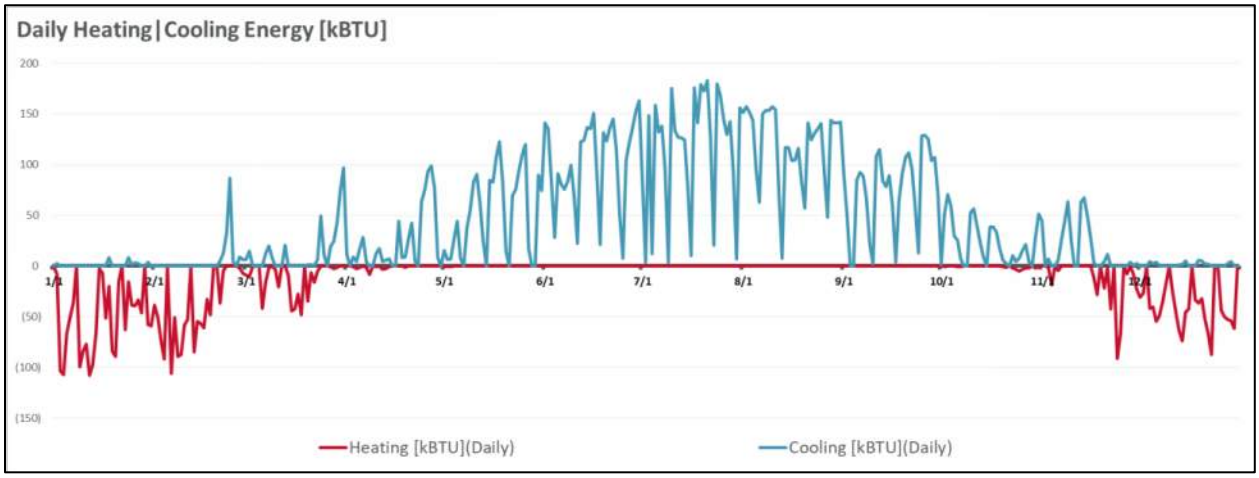
While Table 8-2 and Figure 8-2 encompasses “whole” building data, Figure 8-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 8-3. Bragtown Library Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 8-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 8-4. Bragtown Library Baseline Model Heating & Cooling Annual Load Profile



8.2 HVAC Refrigerants

The Durham County Bragtown Library utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 8-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 8-3. Bragtown Library HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) CU-1	Air-Cooled Condenser	LG LMU24CHV	2 Tons	R-410A	4.0 lbs	Exterior

8.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 8-4. Bragtown Library Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Bragtown Library	Baseline	12,943.53	0.00	44.18	$2,259.68	3.67

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	862.90	0.00	2.95	$150.65	0.24	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	9.94	0.00	0.03	$1.74	0.00	NA	NA	
	Smart Thermostat	223.41	0.00	0.76	$39.00	0.06	Total Cooling Capacity Controled	42.00	kBTU/hr
	Air Conditioner Tune-up	237.04	0.00	0.81	$41.38	0.07	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	0.00	0.00	$0.00	0.00	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	368.35	0.00	1.26	$64.31	0.10	Applicable Area %	50.0%	%
	LED Exit Signs	106.00	0.00	0.36	$18.50	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	36.83	0.00	0.13	$6.43	0.01	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	53.80	0.00	0.18	$9.39	0.02	Quantity of Power Strips	2	#
Decarbonization Measure Savings Totals (predicted)		**1,898.27**	**0.00**	**6.48**	**$331.40**	**0.54**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**14.7%**	**0.0%**	**14.7%**	**14.7%**	**14.7%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

8.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 8-5. Bragtown Library Existing HVAC/DHW Systems

HVAC | Space Heating	Inverter drive heat pump, w/o electric resistance back-up
Domestic Hot Water	(1) instantaneous electric tankless water heater

Table 8-6. Bragtown Library HVAC Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D %
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**13,414.8**	**0.0**	**41.9**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**13,414.8**	**0.0**	**41.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	**$1,918.56**	**$0.00**	**$1.76**						**$1,918.56**	**$0.00**	**$1.76**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$1,918.56 $US								$1,918.56 $US			
Carbon	**3.8**	**0.0**	**3.49**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**3.8**	**0.0**	**3.49**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 8-7. Bragtown Library HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**13,414.8**	**0.0**	**41.9**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**13,414.8**	**0.0**	**41.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	**$1,918.56**	**$0.00**	**$1.76**						**$1,918.56**	**$0.00**	**$1.76**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$1,918.56 $US								$1,918.56 $US			
Carbon	**3.8**	**0.0**	**3.49**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**3.8**	**0.0**	**3.49**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 8-8. Bragtown Library DHW Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**13,414.8**	**0.0**	**41.9**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**13,414.8**	**0.0**	**41.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	**$1,918.56**	**$0.00**	**$1.76**						**$1,918.56**	**$0.00**	**$1.76**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$1,918.56 $US								$1,918.56 $US			
Carbon	**3.8**	**0.0**	**3.49**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**3.8**	**0.0**	**3.49**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 8-9. Bragtown Library DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	NA, already electric instantaneous

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**13,414.8**	**0.0**	**41.9**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**13,414.8**	**0.0**	**41.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	**$1,918.56**	**$0.00**	**$1.76**						**$1,918.56**	**$0.00**	**$1.76**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$1,918.56 $US								$1,918.56 $US			
Carbon	**3.8**	**0.0**	**3.49**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**3.8**	**0.0**	**3.49**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 8-10. Bragtown Library Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
HVAC Pathway 2	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$14,492.00
DHW Existing Replacement:	$3,764.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

8.5 Renewable Energy, Energy Storage, and Electric Vehicles

8.5.1 Solar and BESS Analysis

The small Bragtown Library has a simple gabled shingle roof with no surrounding structures or overhanging trees for shading. Due to the recommendation for solar equipment to be Southern facing, the estimated available capacity of this roof is 4 kW DC with space on the Eastern wall of the building for BESS equipment, Figure 8-5. The roof was replaced in 2021.

Figure 8-5. Bragtown Library Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 11,787 kWh with a peak January load of 4.3 kW. The estimated roof solar capacity is 4 kW DC and initial HOMER analysis indicates that a 4 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple PV and hybrid system configurations possess favorable renewable fractions, but unfavorable payback periods andIRR. Standalone PV and hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 8-11. Costs of technology will continue to decrease, and

while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and negligible difference with added BESS, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 8-11. Bragtown Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	11,787	N/A	N/A	N/A
4 kW PV Only	7,810	5,442	N/A	41.1
4 kW PV + 13.2 kWh BESS	6,647	5,442	1,298	43.7

8.6 Cost Summary

Cost performance for the three systems is provided in Table 8-12.

Table 8-12. Bragtown Library Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	20,000	N/A	N/A
4 kW PV Only	23,000	40,000	N/A	>25
4 kW PV + 13.2 kWh BESS	45,000	64,000	N/A	>25
Cost Summary with Incentives Included				
4 kW PV Only	16,000	33,000	N/A	>25
4 kW PV + 13.2 kWh BESS	31,000	51,000	N/A	>25

8.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, this facility was identified for long lay-over periods and recommended for consideration of public charging. A single (1) charging location is shown in Figure 8-5 should chargers be considered in the future.

8.7 Electrical Infrastructure Demand Feasibility Summary

Table 8-13. Bragtown Library Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	4.56 kW	4.56 kW
HVAC Electrification Pathway 1		4.56 kW
HVAC Electrification Pathway 2		4.56 kW
DHW Electrification Pathway 1		4.56 kW
DHW Electrification Pathway 2		4.56 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

8.7.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard cannot accommodate the PV or BESS systems because of the lack of space for any new loads on the existing panelboard. A new Main Distribution Panel with associated overcurrent protection devices will be required to allow for the addition of new equipment/systems.

9 Center for Senior Life

Durham County | Center for Senior Life | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	406 Rigsbee Ave, Durham, NC 27701	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Electric Resistance
Building Type	Senior Center	**Cooling Generation**	Split-System DX
Year Built	2006 (2020 reno)	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	35,180	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	2	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	11
		Weekday Opening Time	Monday-Friday, 8:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 9-1. Center for Senior Life



9.1 Existing Building Performance & Condition

9.1.1 Past Conservation Projects and Successes

- Possible roof replacement in CY2024, currently finalizing new HVAC BAS.

9.1.2 Condition Assessment Summary

There was evidence of water on the mechanical room floor near the domestic water heaters, which may be originating from a leaking tank. Based on the serial number, the two water heaters were manufactured in 2005 and have exceed their expected life. The source of the water should be investigated. If a water heater is the source, a replacement water heater should be installed with a drain pan piped to a nearby floor drain.

The remainder of the mechanical and plumbing systems appear well maintained. There were no other noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 9-1. Center for Senior Life Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	Replace water heater, if leaking.

9.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 9-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was not available in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was predicted via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

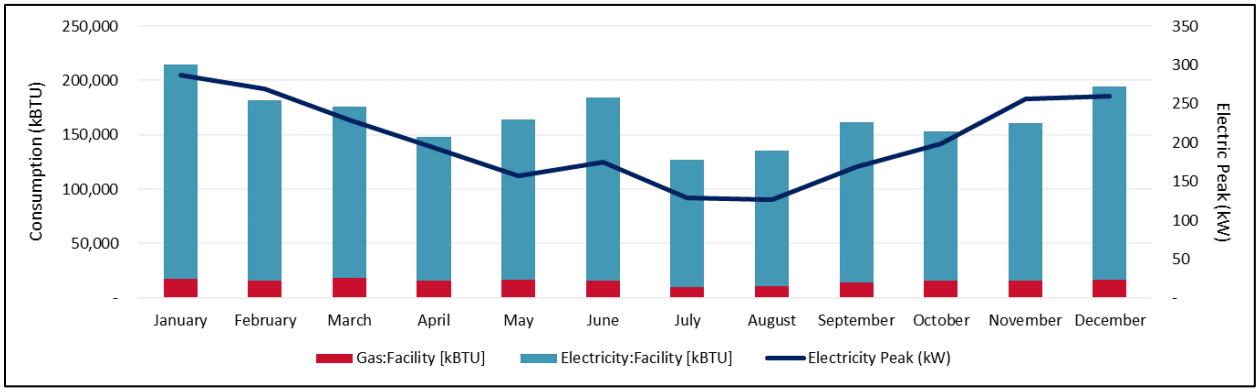
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 9-2. Center for Senior Life Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	57,859	173	215	287.2	$0	$213	$213	16,426	921	17,347
February	48,729	158	182	269.5	$0	$194	$194	13,834	838	14,672
March	46,106	183	176	229.4	$0	$225	$225	13,090	973	14,062
April	38,803	160	148	193.6	$0	$196	$196	11,016	847	11,864
May	43,196	165	164	157.4	$0	$203	$203	12,263	877	13,140
June	49,395	156	184	175.4	$0	$192	$192	14,023	830	14,853
July	34,294	100	127	129.2	$0	$123	$123	9,736	532	10,268
August	36,673	107	136	126.6	$0	$132	$132	10,412	568	10,980
September	43,107	142	161	168.9	$0	$174	$174	12,238	752	12,990
October	40,305	156	153	198.1	$0	$191	$191	11,443	826	12,269
November	42,362	161	161	256.5	$0	$198	$198	12,027	853	12,880
December	52,284	163	195	260.0	$0	$201	$201	14,844	868	15,711
ANNUAL	533,114	1,823	2,002	-	$0	$2,241	$2,241	151,353	9,684	161,037
PEAK	-	-	-	287.2	-	-	-	-	-	-

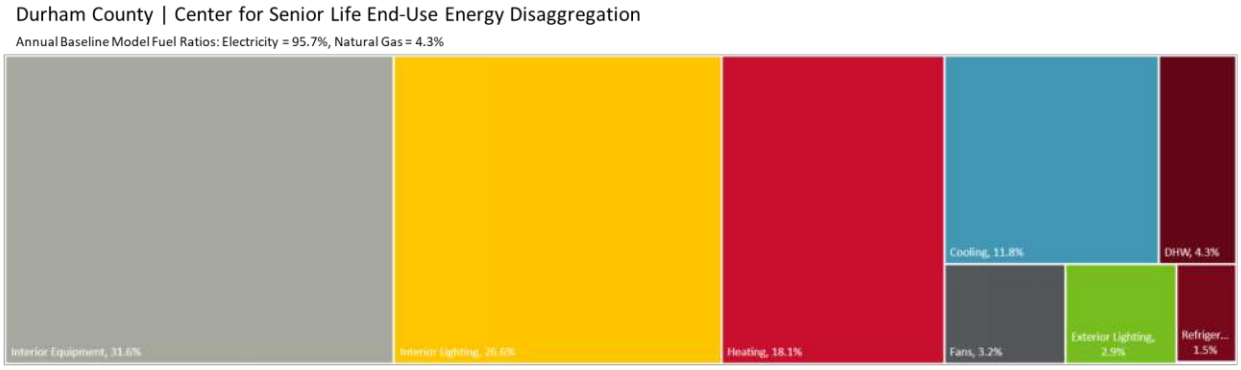
The data in Table 9-2 is represented in graphical format in Figure 9-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 9-2. Center for Senior Life Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



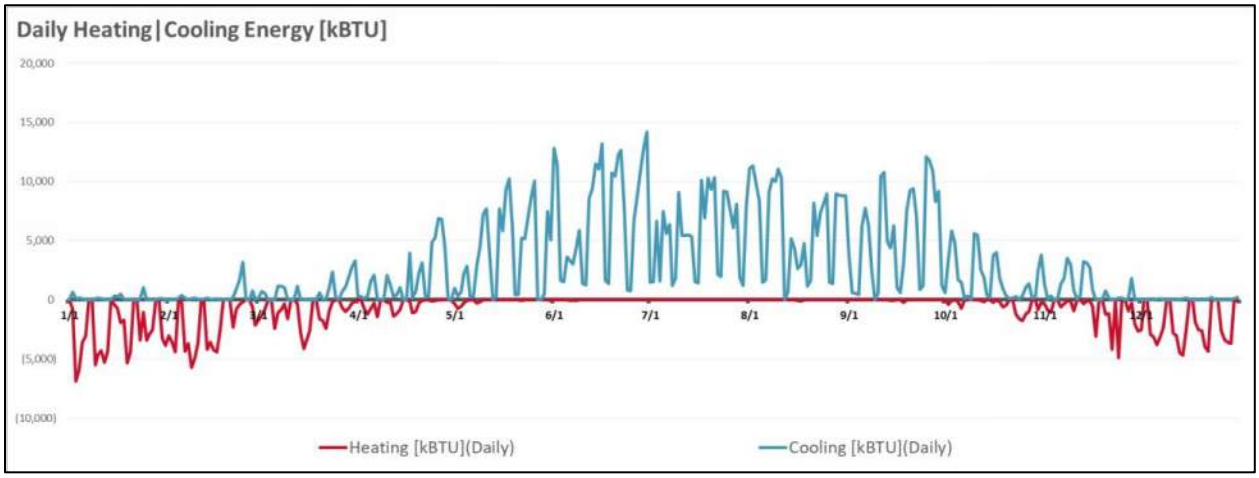
While Table 9-2 and Figure 9-2 encompasses “whole” building data, Figure 9-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 9-3. Center for Senior Life Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 9-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 9-4. Center for Senior Life Baseline Model Heating & Cooling Annual Load Profile



9.2 HVAC Refrigerants

The Durham County Center for Senior Life utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 9-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 9-3. Center for Senior Life HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) CU-1	Air-Cooled Condenser	Trane RAUJC804BB	80 Tons	R-410A	Not marked	Exterior
(1) CU-2	Air-Cooled Condenser	Carrier 38APS03065A	30 Tons	R-410A	Not marked	Exterior
(1) CU-3	Air-Cooled Condenser	Carrier 38APS03065A	30 Tons	R-410A	Not marked	Exterior

9.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 9-4. Center for Senior Life Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Center For Senior Life	Baseline	533,114.28	1,823.27	2,001.83	$58,142.76	161.04

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	38,502.70	131.68	144.58	$4,199.20	11.63	Potential Annual Energy Savings (%)	7.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	574.25	0.00	1.96	$61.55	0.16	NA	NA	
	Smart Thermostat	8,140.08	0.00	27.78	$872.55	2.31	Total Cooling Capacity Controled	1,680.00	kBTU/hr
	Air Conditioner Tune-up	8,247.42	0.00	28.15	$884.05	2.34	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$6.80	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	515.84	47.03	$139.30	2.36	# Solar Thermal Panels	10	#
Lighting	LED Retrofit	1,945.22	0.00	6.64	$208.51	0.55	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	939.54	0.00	3.21	$100.71	0.27	Applicable Area %	5.0%	%
	LED Exit Signs	847.97	0.00	2.89	$90.89	0.24	Quantity of Exit Signs	8	#
	Daylight Dimming Control	2,818.62	0.00	9.62	$302.13	0.80	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	3,113.86	0.00	10.63	$333.78	0.88	Quantity of Outdoor Fixtures	12	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$11.26	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$14.42	0.04	Quantity of Power Strips	5	#
Decarbonization Measure Savings Totals (predicted)		**64,035.61**	**659.94**	**284.55**	**$7,225.14**	**21.69**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**12.0%**	**36.2%**	**14.2%**	**12.4%**	**13.5%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

9.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 9-5. Center for Senior Life Existing HVAC/DHW Systems

HVAC | Space Heating	(1) AHU-1 electric pre-heating coil, 40kw; (1) AHU-2 electric pre-heating coil, 20kw; (1) AHU-3 electric pre-heating coil, 20kw; (mult.) single-duct VAV terminal electric reheat, step control, approx. 300kw total;
Domestic Hot Water	(2) direct-vent condensing gas storage water heaters, 100 gallon, AO Smith BTH-199-970, 199 MBH input, 228 gph recovery, mfg. 2005, recirc pumps, 120F loop and 140F loop, water heaters manifolded

Table 9-6. Center for Senior Life HVAC Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**533,114.3**	**811.5**	**54.0**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**533,114.3**	**811.5**	**54.0**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,900.7 MMBTU								1,900.7 MMBTU			
Energy Cost	**$57,174.15**	**$997.61**	**$1.65**						**$57,174.15**	**$997.61**	**$1.65**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$58,171.76 $US								$58,171.76 $US			
Carbon	**151.4**	**4.3**	**4.42**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**151.4**	**4.3**	**4.42**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	155.7 MT CO2e								155.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 9-7. Center for Senior Life HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace condensing unit CU-1 with (3) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 180 FLA @ 460V/3ph); *Replace condensing units CU-2&3 with (2) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 120 FLA @ 460V/3ph); *Replace (3) AHU DX coil sections, with hydronic coils; *Add (3) vertical inline pumps with VFDs (assume 3hp each)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	533,114.3	811.5	54.0	0.0	0.0	(42,005.1)	NA	NA	491,109.2	811.5	50.0	7.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,900.7 MMBTU								1,757.3 MMBTU			
Energy Cost	$57,174.15	$997.61	$1.65						$51,847.62	$997.61	$1.50	9.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$58,171.76 $US								$52,845.23 $US			
Carbon	151.4	4.3	4.42	0.0	0.0	(11.9)	NA	NA	139.4	4.3	4.09	7.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	155.7 MT CO2e								143.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 9-8. Center for Senior Life DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas water heaters with (2) electric storage, 119 gallon, 54kw input, Bradford White model CEHD120(A)54 3*CF (total 108kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	533,114.3	811.5	54.0	NA	NA	NA	(811.5)	18,151.5	551,265.8	0.0	53.5	1.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,900.7 MMBTU								1,881.5 MMBTU			
Energy Cost	$57,174.15	$997.61	$1.65						$58,751.72	$0.00	$1.67	-1.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$58,171.76 $US								$58,751.72 $US			
Carbon	151.4	4.3	4.42	NA	NA	NA	(4.3)	5.2	156.5	0.0	4.45	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	155.7 MT CO2e								156.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 9-9. Center for Senior Life DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas boiler WH-1 with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (2) electric storage, 119 gallon, 54kw input, Bradford White model CEHD120(A)54 3*CF; (total 130kw + 108kw - non simultaneous)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	533,114.3	811.5	54.0	NA	NA	NA	(811.5)	3,696.5	536,810.8	0.0	52.1	3.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,900.7 MMBTU								1,832.1 MMBTU			
Energy Cost	$57,174.15	$997.61	$1.65						$57,492.50	$0.00	$1.63	1.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$58,171.76 $US								$57,492.50 $US			
Carbon	151.4	4.3	4.42	NA	NA	NA	(4.3)	1.0	152.4	0.0	4.33	2.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	155.7 MT CO2e								152.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 9-10. Center for Senior Life Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$644,452.00	$0.00	$0.00	$0.00	($870,850.66)	NA	-100.0000%	0.0000	NA	NA	$0.00
HVAC Pathway 2	$3,764,558.00	$5,326.53	$0.00	$5,326.53	($4,974,670.67)	-7.0578%	-6.3638%	0.0221	NA	NA	$608.19
DHW Pathway 1	$31,823.00	($1,577.58)	$997.61	($579.96)	($52,863.02)	-9.0183%	NA	-0.2293	NA	NA	($42.99)
DHW Pathway 2	$560,639.00	($318.35)	$997.61	$679.26	($740,884.01)	-7.0356%	-6.3677%	0.0221	NA	NA	$166.31

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$37,697.00
DHW Existing Replacement:	$51,840.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

9.5 Renewable Energy, Energy Storage, and Electric Vehicles

9.5.1 Solar and BESS Analysis

The Center for Senior Life possesses a uniquely shaped roof with minimal HVAC equipment and concern for shading from surrounding objects (roof material unknown). The single level of this roof is flat with a small parapet wall surrounding the perimeter. The roof is scheduled to be replaced in 2027. The estimated solar capacity for the structure is 85 kW DC with available space for BESS equipment adjacent to the existing electrical infrastructure found on the Eastern side of the structure, shown in Figure 9-5.

Figure 9-5. Center for Senior Life Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. No load data was provided for the Center for Senior Life building; thus, it was assumed that the building load was similar to the Community Shelter building. The annual building consumption for the past year is approximately 193,696 kWh with a peak July load of 46.6 kW. The estimated roof solar capacity is 85 kW DC and initial HOMER analysis indicates that an 85 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and hybrid systems possess favorable renewable fractions, but tend to have unfavorable payback periods and IRR. PV and BESS hybrid systems possess

unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods if incentives are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 9-11. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 9-11. Center for Senior Life Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	193,696	N/A	N/A	N/A
85 kW PV Only	122,109	115,651	N/A	48.6
85 kW PV + 106 kWh BESS	98,443	115,651	26,492	52.7

9.6 Cost Summary

Cost performance for the three systems is provided in Table 9-12.

Table 9-12. Center for Senior Life Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	210,000	N/A	N/A
85 kW PV Only	156,000	295,000	N/A	>25
85 kW PV + 106 kWh BESS	328,000	478,000	N/A	>25
Cost Summary With ITC Included				
85 kW PV Only	108,000	248,000	2.6	18.2
85 kW PV + 106 kWh BESS	229,000	380,000	N/A	>25

9.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, this facility was identified for long lay-over periods and recommended for consideration of public charging. Seven (7) charging locations are shown in Figure 9-5 should chargers be considered in the future.

9.7 Electrical Infrastructure Demand Feasibility Summary

Table 9-13. Center for Senior Life Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	287.18 kW	287.18 kW
HVAC Electrification Pathway 1		287.18 kW
HVAC Electrification Pathway 2		274.12 kW
DHW Electrification Pathway 1		288.48 kW
DHW Electrification Pathway 2		287.53 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

9.7.1 Building HVAC Electrification Implementation Feasibility

Additional information will need to be gathered for HVAC Electrification Pathway 1 to determine if the additional load from the kitchen equipment will be able to be added to the electrical distribution system. HVAC Electrification Pathway 2 can be accommodated by the existing electrical distribution system. New circuit breakers will be required for each piece of equipment as part of that pathway.

9.7.2 Building DHW Electrification Implementation Feasibility

DHW Electrification Pathway 1 and 2 can be accommodated by the existing electrical distribution system. New circuit breakers will be required for each piece of equipment as part of that pathway.

9.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

PV and BESS systems can be accommodated by the existing electrical distribution system. New circuit breakers will be required for each piece of equipment as part of that pathway.

10 Community Shelter

Durham County | Community Shelter | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	412 Liberty St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Gas Furnace RTUs
Building Type	Shelter	**Cooling Generation**	DX RTUs
Year Built	2002	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	17,816	**Heating / Cooling / Vent Distribution**	CV Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 10-1. Community Shelter



10.1 Existing Building Performance & Condition

10.1.1 Past Conservation Projects and Successes

None.

10.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 10-1. Community Shelter Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

10.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 10-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

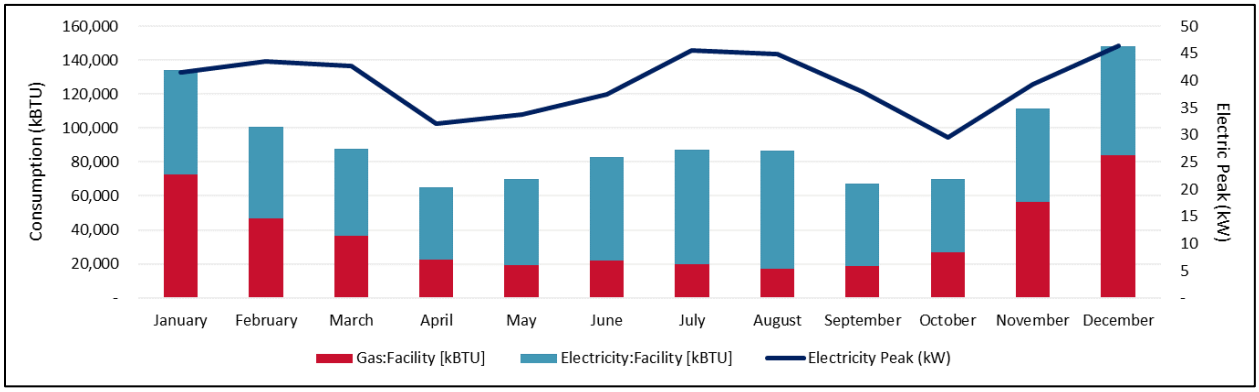
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 10-2. Community Shelter Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	17,974	727	134	41.4	$1,309	$864	$2,173	5,103	3,861	8,964
February	15,861	467	101	43.5	$1,229	$517	$1,746	4,503	2,480	6,983
March	15,084	366	88	42.7	$1,214	$395	$1,610	4,282	1,941	6,224
April	12,485	228	65	32.0	$959	$250	$1,209	3,545	1,208	4,753
May	14,809	196	70	33.8	$1,070	$221	$1,290	4,204	1,038	5,243
June	17,843	221	83	37.5	$1,602	$250	$1,852	5,066	1,174	6,239
July	19,727	198	87	45.6	$1,814	$232	$2,045	5,601	1,052	6,652
August	20,426	170	87	44.9	$1,850	$202	$2,052	5,799	903	6,702
September	14,279	188	67	38.0	$1,505	$236	$1,742	4,054	996	5,050
October	12,570	270	70	29.5	$1,098	$357	$1,455	3,569	1,434	5,003
November	16,157	564	112	39.4	$1,360	$705	$2,065	4,587	2,996	7,583
December	18,919	839	148	46.3	$1,585	$1,038	$2,623	5,371	4,454	9,825
ANNUAL	196,134	4,432	1,113	-	$16,597	$5,265	$21,862	55,683	23,538	79,221
PEAK	-	-	-	46.3	-	-	-	-	-	-

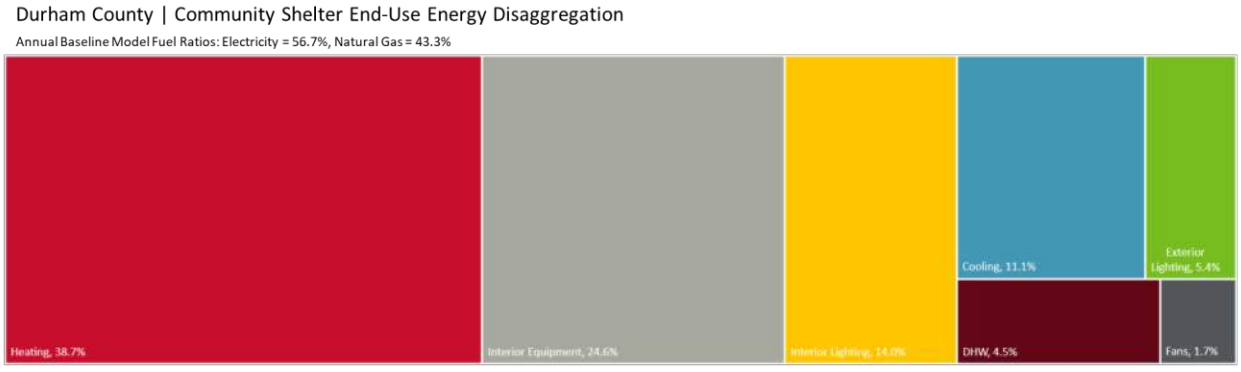
The data in Table 10-2 is represented in graphical format in Figure 10-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 10-2. Community Shelter Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



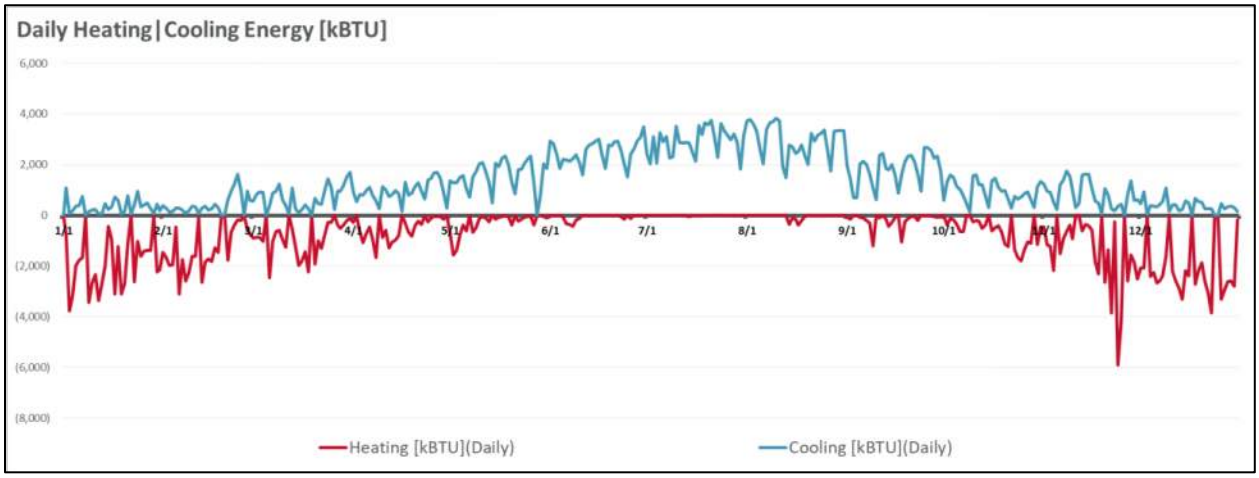
While Table 10-2 and Figure 10-2 encompasses “whole” building data, Figure 10-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 10-3. Community Shelter Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 10-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 10-4. Community Shelter Baseline Model Heating & Cooling Annual Load Profile



10.2 HVAC Refrigerants

The Durham County Community Shelter utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 10-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 10-3. Community Shelter HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) RTU-3	Rooftop Unit	Carrier 48KCEA05	4 Tons	R-410A	10.5 lbs	Exterior
(2) RTU	Rooftop Unit	Carrier 50TCQD12A	10 Tons	R-410A	29.3 lbs	Exterior
(1) AHU-5	Rooftop Unit	Carrier 48TCEA07A	6 Tons	R-410A	14.2 lbs	Exterior
(3) RTU	Rooftop Unit	Carrier 48KCDA04A	3 Tons	R-410A	7.1 lbs	Exterior

10.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 10-4. Community Shelter Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Community Shelter	Baseline	193,415.84	4,323.00	1,092.42	$22,383.19	77.87

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	15,043.45	336.23	84.97	$1,740.91	6.06	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	4,011.86	0.00	13.69	$365.40	1.14	NA	NA	
	Smart Thermostat	1,903.71	81.86	14.68	$263.66	0.98	Total Cooling Capacity Controled	276.00	kBTU/hr
	Air Conditioner Tune-up	2,406.29	0.00	8.21	$219.16	0.68	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$13.70	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	972.74	92.72	$951.20	4.79	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	39,485.24	-262.04	108.56	$3,307.32	9.82	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	4,806.90	-31.90	13.22	$402.63	1.20	Applicable Area %	10.0%	%
	LED Exit Signs	423.98	-2.81	1.17	$35.51	0.11	Quantity of Exit Signs	4	#
	Daylight Dimming Control	7,210.35	-47.85	19.82	$603.95	1.79	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	420.00	0.00	1.43	$38.25	0.12	$0.00	4	#
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$12.25	0.04	Quantity of Power Strips	5	#
Decarbonization Measure Savings Totals (predicted)		**74,512.74**	**1,058.65**	**360.17**	**$7,953.94**	**26.78**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**38.5%**	**24.5%**	**33.0%**	**35.5%**	**34.4%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

10.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 10-5. Community Shelter Existing HVAC/DHW Systems

HVAC | Space Heating	RTU gas furnaces, (1) RTU-3, 115 mbh input, 93 mbh ouptut; RTU heat-pump (2) nominal 10-ton heat pump; (1) "AHU-5" gas furnace, 115 mbh input, 93 mbh output; (3) RTU gas furnace, 72 mbh input, 59 mbh output; (2) Large commercial gas clothes dryers, 50-lb capacity, 145 mbh input each; (2) standard residential gas clothes dryers;
Domestic Hot Water	(1) Direct-vent condensing gas storage water heater, Rheem model GHE100SU-400A, mfg 2019, 100 gallon, 399 mbh input, 456 gph recovery, recirc pump; (1) Natural draft gas storage water heater, AO Smith model BTR-400A-118, 100 gallon, 390 mbh input, 378 gph recovery, mfg 1992, recirc pump;

Table 10-6. Community Shelter HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas-fired RTUs with electric resistance coils.

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	0.0	(4,052.4)	81,884.7	NA	NA	278,018.7	1,049.7	59.2	10.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,179.6 MMBTU								1,053.8 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$31,962.08	$1,247.11	$1.86	-35.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$24,512.14 $US								$33,209.19 $US			
Carbon	55.7	27.1	4.65	0.0	(21.5)	23.2	NA	NA	78.9	5.6	4.74	-2.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	82.8 MT CO2e								84.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 10-7. Community Shelter HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace (5) gas-fired RTUs with new heat-pump RTUs, (3) 3-ton heat-pump unit, w/ economizer, 9kw elec heat, Trane model WHC036; (1) 4-ton heat-pump unit, w/ economizer, 27kw elec heat, Trane model WHC048; (1) 6-ton heat-pump unit, w/ economizer, 27kw elec heat, Trane model WHC074; *Replace (3) gas clothes dryers with (1) lrg commercial electric dryer, 60kw, (2) standard residential electric clothes dryers

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	0.0	(4,052.4)	38,249.4	NA	NA	234,383.4	1,049.7	50.8	23.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,179.6 MMBTU								904.9 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$23,623.92	$1,247.11	$1.40	-1.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$24,512.14 $US								$24,871.03 $US			
Carbon	55.7	27.1	4.65	0.0	(21.5)	10.9	NA	NA	66.5	5.6	4.05	12.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	82.8 MT CO2e								72.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 10-8. Community Shelter DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace (2) gas water heaters with (4) electric storage water heaters, 119 gallon, 54kw input each (216 kw total)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	NA	NA	NA	(1,049.7)	23,031.3	219,165.2	4,052.4	64.7	2.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,179.6 MMBTU								1,153.2 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$20,550.66	$4,814.67	$1.42	-3.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$24,512.14 $US								$25,365.33 $US			
Carbon	55.7	27.1	4.65	NA	NA	NA	(5.6)	6.5	62.2	21.5	4.70	-1.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	82.8 MT CO2e								83.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 10-9. Community Shelter DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace (2) gas water heaters with (4) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (4) electric storage, 119 gallon, 54kw input, Bradford White model CEHD120(A)54 3*CF; (total 260kw + 216kw - non simultaneous)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	NA	NA	NA	(1,049.7)	5,012.4	201,146.3	4,052.4	61.3	7.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	1,179.6 MMBTU								1,091.7 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$18,892.19	$4,814.67	$1.33	3.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$24,512.14 $US								$23,706.86 $US			
Carbon	55.7	27.1	4.65	NA	NA	NA	(5.6)	1.4	57.1	21.5	4.41	5.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	82.8 MT CO2e								78.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 10-10. Community Shelter Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	-$76,192.17	($13,511.71)	$4,814.67	($8,697.04)	($69,080.76)	NA	NA	NA	NA	NA	($87.89)
HVAC Pathway 2	-$45,939.17	($5,173.56)	$4,814.67	($358.89)	$65,977.09	NA	NA	NA	NA	NA	$543.91
DHW Pathway 1	$86,338.00	($2,100.30)	$1,247.11	($853.19)	($131,700.06)	-8.3164%	NA	-0.1288	NA	NA	($49.13)
DHW Pathway 2	$1,147,479.00	($441.83)	$1,247.11	$805.28	($1,530,629.86)	-7.1341%	-7.6194%	0.0129	NA	NA	$211.76

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$210,211.00
DHW Existing Replacement:	$84,548.00

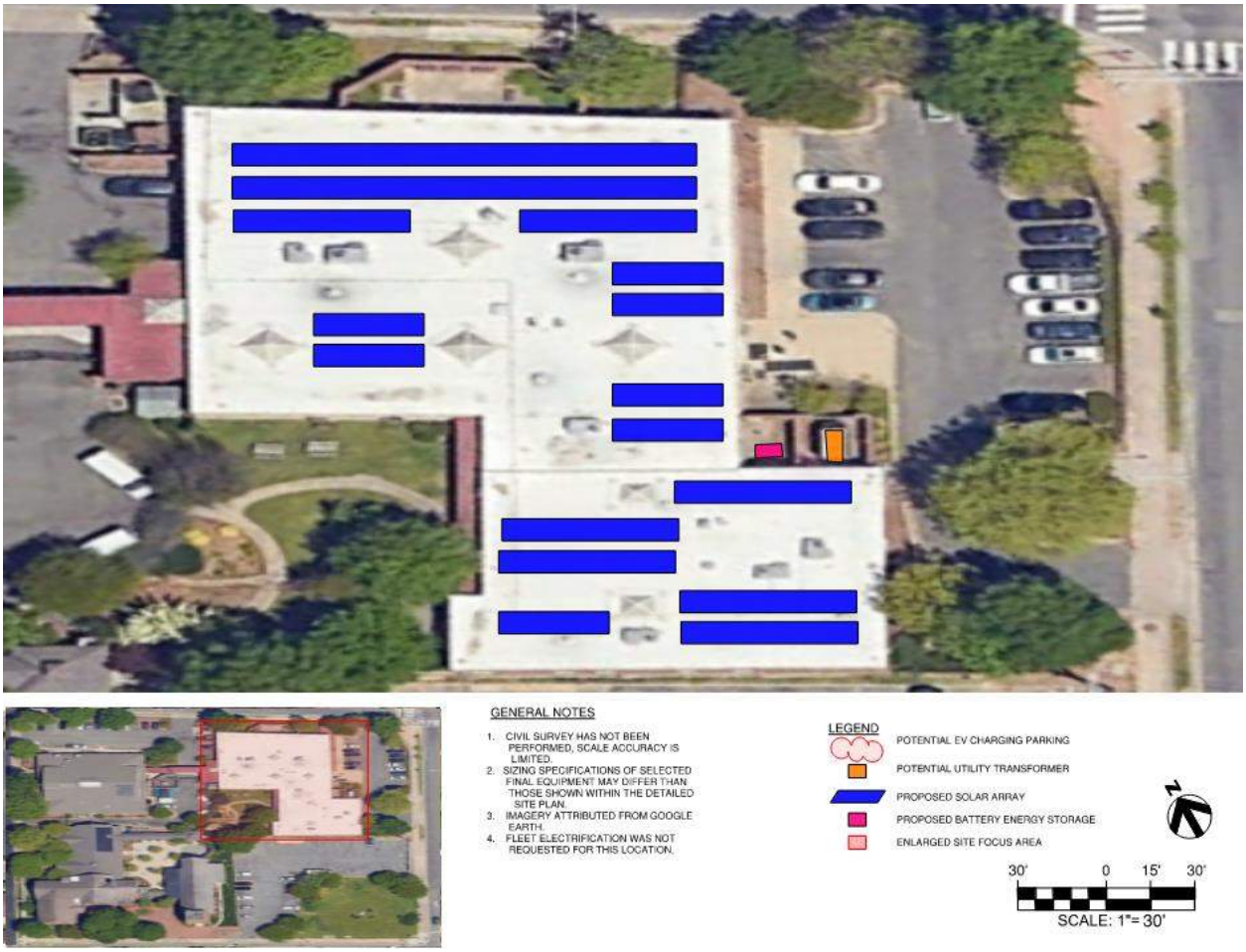
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

10.5 Renewable Energy, Energy Storage, and Electric Vehicles

10.5.1 Solar and BESS Analysis

The Community Shelter roof contains various levels, HVAC equipment, and sun tunnels. The entirety of the roof is composed of the same unknown material and has a parapet wall around the perimeter with potential for minimal shading on solar equipment. The roof is scheduled to be replaced in 2037. The differing levels of the roof also pose shading concerns, further reducing the available solar equipment footprint. The available footprint for solar is approximately 125 kW DC capacity. Potential BESS equipment can be located on the North facing wall on the Easternmost portion of the building adjacent to existing utility infrastructure, as shown on Figure 10-5.

Figure 10-5. Community Shelter Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 193,696 kWh with a peak July load of 46.6 kW. The estimated roof solar capacity is 85 kW DC and initial HOMER analysis indicates that an 85 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and hybrid systems possess favorable

renewable fractions, but tend to have unfavorable payback periods and IRR. PV and BESS hybrid systems possess unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods if incentives are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 10-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 10-11.Community Shelter Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	193,696	N/A	N/A	N/A
85 kW PV Only	122,109	115,651	N/A	48.6
85 kW PV + 106 kWh BESS	98,443	115,651	26,492	52.7

10.6 Cost Summary

Cost performance for the three systems is provided in Table 10-12.

Table 10-12. Community Shelter Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	210,000	N/A	N/A
85 kW PV Only	156,000	295,000	N/A	>25
85 kW PV + 106 kWh BESS	328,000	478,000	N/A	>25
Cost Summary With ITC Included				
85 kW PV Only	108,000	248,000	2.6	18.2
85 kW PV + 106 kWh BESS	229,000	380,000	N/A	>25

10.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

10.7 Electrical Infrastructure Demand Feasibility Summary

Table 10-13. Community Shelter Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	46.32 kW	46.32 kW
HVAC Electrification Pathway 1		288.20 kW
HVAC Electrification Pathway 2		139.01 kW
DHW Electrification Pathway 1		58.48 kW
DHW Electrification Pathway 2		47.71 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

10.7.1 Building HVAC Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the HVAC Electrification Pathway 1 updates. Removing the existing Mechanical equipment as mentioned above will provide enough space on the panelboard for the new equipment's incorporation. New circuit breakers will be required for each new piece of equipment.

10.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the DHW Electrification Pathway 1 updates. To incorporate the changes for the DHW Electrification Pathway 2 will likely need the inclusion of a new feeder panel from the main distribution system.

10.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required for each system.

11 Detention Center

Durham County | Detention Center | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	219 S Mangum St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Steam Boiler
Building Type	Detention Center	**Cooling Generation**	Water-Cooled Chiller
Year Built	1996	**Domestic Hot Water Generation**	Steam Conversation Water Heater
Floor Area (ft2)	290,919	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	8	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 11-1. Detention Center



11.1 Existing Building Performance & Condition

11.1.1 Past Conservation Projects and Successes

- Performance contracting upgrades in 2012 w/Brady/Trane (Cooling Towers/Chillers/boilers/DHW heater/water saving devices in cells/lighting upgrades)
- 1 new chiller in 2022 due to a 2012 chiller hard breaking.
- Currently replacing 2012 boilers with new boilers.
- 2012 DHW heater replaced in 2022, Back up DHW heater installed.
- Roof replaced in 2016, Detention cell windows replaced in South tower in 2023 (North tower to be completed in 2024), Lobby and street side office windows replaced with ballistic glass in 2019/20.
- AHU's and MUA's replaced in 2023.
- Kitchen coolers refurbished in 2022.
- Elevators replaced in 2018.
- Generator Transfer switch replaced in 2019.
- Upcoming- replacing entire F/A system.

11.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 11-1. Detention Center Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

11.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 11-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

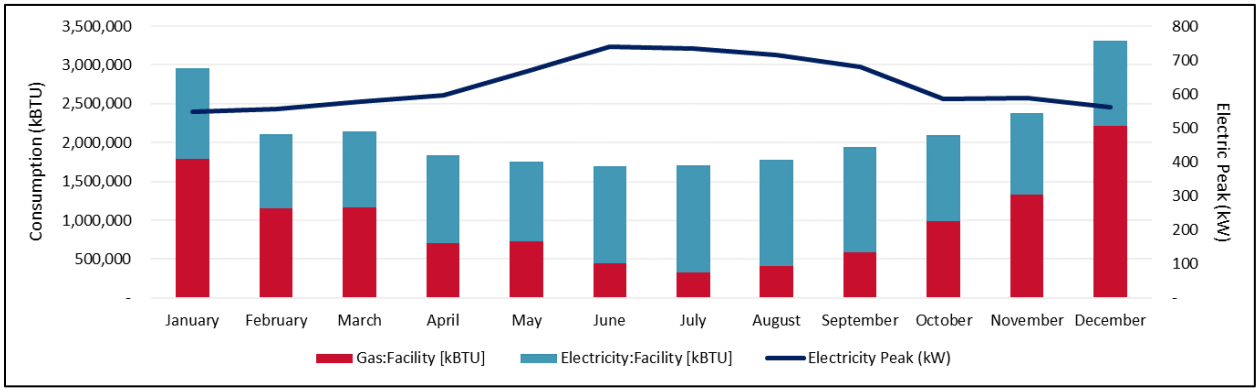
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 11-2. Detention Center Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	340,673	17,910	2,954	546.8	$22,070	$3,354	$25,424	96,718	95,129	191,847
February	277,107	11,590	2,105	556.6	$19,124	$2,309	$21,433	78,672	61,560	140,232
March	286,112	11,705	2,147	577.8	$19,549	$2,359	$21,908	81,228	62,171	143,399
April	332,653	7,005	1,836	597.2	$21,365	$1,527	$22,892	94,441	37,207	131,648
May	299,911	7,295	1,753	666.0	$20,417	$1,581	$21,998	85,146	38,747	123,893
June	363,469	4,510	1,692	739.8	$26,949	$1,093	$28,042	103,190	23,955	127,145
July	403,602	3,275	1,705	733.0	$31,852	$875	$32,727	114,584	17,395	131,979
August	398,195	4,155	1,775	715.0	$31,662	$1,031	$32,693	113,049	22,069	135,118
September	397,278	5,915	1,947	679.3	$32,777	$3,053	$35,830	112,788	31,417	144,206
October	325,185	9,845	2,094	586.1	$26,741	$4,761	$31,503	92,321	52,292	144,613
November	310,485	13,250	2,385	588.6	$23,842	$5,987	$29,829	88,148	70,377	158,525
December	319,425	22,190	3,309	562.0	$24,124	$8,714	$32,838	90,686	117,862	208,547
ANNUAL	4,054,095	118,645	25,701	-	$300,472	$36,643	$337,115	1,150,971	630,181	1,781,151
PEAK	-	-	-	739.8	-	-	-	-	-	-

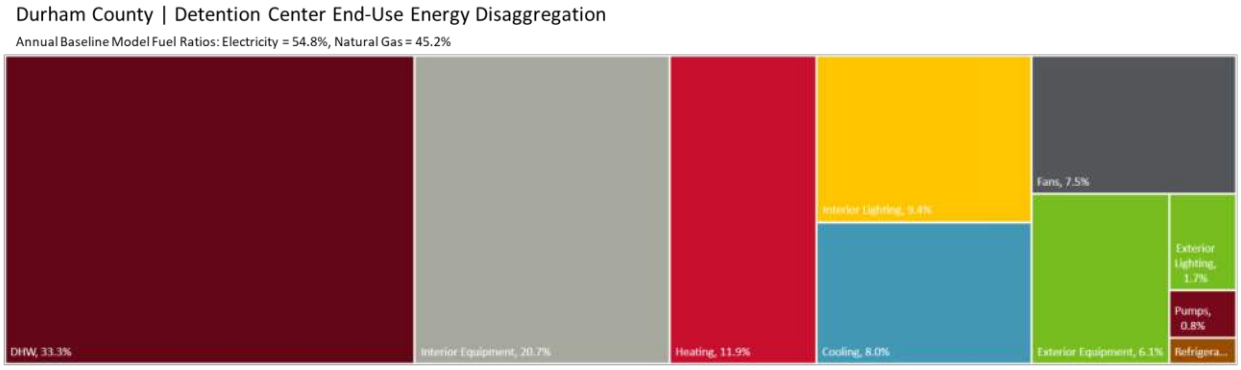
The data in Table 11-2 is represented in graphical format in Figure 11-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 11-2. Detention Center Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



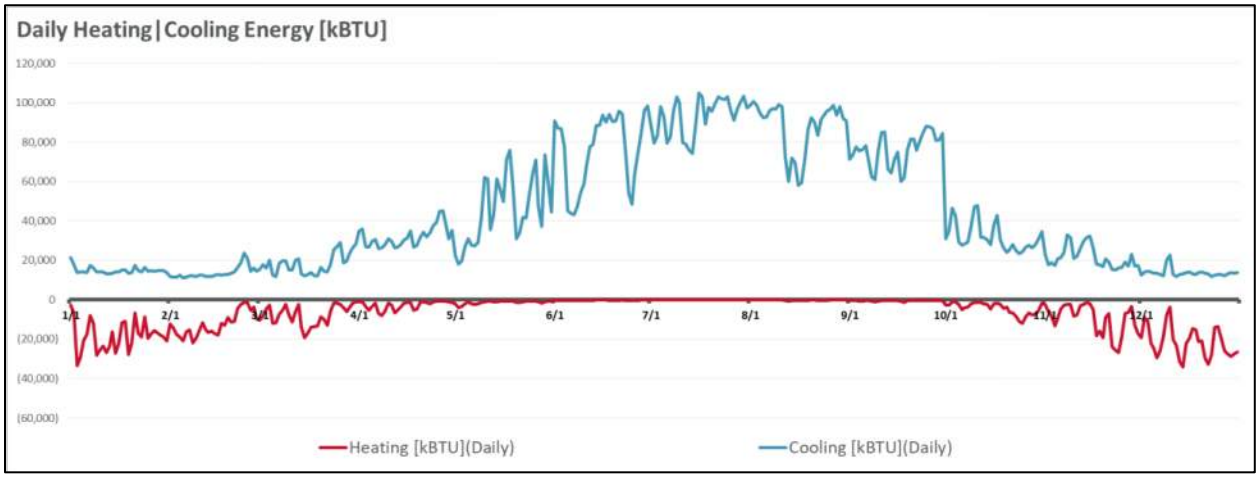
While Table 11-2 and Figure 11-2 encompasses “whole” building data, Figure 11-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 11-3. Detention Center Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 11-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 11-4. Detention Center Baseline Model Heating & Cooling Annual Load Profile



11.2 HVAC Refrigerants

The Durham County Detention Center utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 11-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 11-3. Detention Center HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Water-Cooled Chiller	Trane CVHE400	400 Tons	R-123	650 lbs.	Interior
CH-2	Water-Cooled Chiller	Trane CVHE400	400 Tons	R-123	650 lbs.	Interior
CU-2	Air-Cooled Condenser	Trane TWA09044D	7.5 Tons	R-410A	Not marked	Exterior
	Refrigerator	Everest ESR1		R-290	4.6 oz	Interior
CU-1	Air-Cooled Condenser	Trane				Exterior
	Air-Cooled Condenser	Premium PIAW12170B	1 Ton	R-410A	33.9 oz	Exterior

11.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every

reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 11-4. Detention Center Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Detention Center	Baseline	4,051,640.88	123,530.00	26,181.12	$367,338.53	1,806.40

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	427,673.20	13,039.28	2,763.56	$38,774.62	190.68	Potential Annual Energy Savings (%)	10.6%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	93,890.12	0.00	320.44	$7,349.39	26.66	NA	NA	
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00	kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	18,982.37	1,898.24	$7,712.53	100.82	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$5.05	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$314.78	5.10	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	1,541,812.52	-10,232.03	4,238.96	$116,530.44	383.38	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	47,095.36	-312.54	129.48	$3,559.48	11.71	Applicable Area %	5.0%	%
	LED Exit Signs	6,253.76	-41.50	17.19	$472.66	1.56	Quantity of Exit Signs	59	#
	Daylight Dimming Control	47,095.36	-312.54	129.48	$3,559.48	11.71	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	5,189.76	0.00	17.71	$406.24	1.47	Quantity of Outdoor Fixtures	20	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$16.44	0.06	$0.00	2	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$42.11	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		2,168,424.54	22,167.14	9,617.48	$178,743.22	733.36			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		53.5%	17.9%	36.7%	48.7%	40.6%			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

11.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 11-5. Detention Center Existing HVAC/DHW Systems

HVAC | Space Heating	(2) Steam boilers, unknown capacity, assumed 500 BHP each, 17250 lbs/hr, 20922 mbh nat. gas input each, estimated based on feedwater pump nameplate; Heating water boilers - (2?) Camus "DynaForce" 2000 Mbh input, 1896 Mbh output, direct-vent condensing, unknown design water temps;(3?) Laundry clothes dryers - 270 Mbh input nat. gas;
Domestic Hot Water	1000 gallon storage tank, unkown heating capacity, assumed to be steam converters

Table 11-6. Detention Center HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace steam boilers with (4) electric steam boilers, 2480kw each, 9.92 MW total, Cleaver-Brooks HSB-425, 2987A @ 460V/3ph each; *Replace heating water boilers with (2) electric boilers, 445kw each (890 kw total), 8-step control, Lochinvar BWX3-445C; *Replace (3?) laundry clothes dryers with electric, 60kw input each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D %
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	0.0	(34,751.1)	770,103.1	NA	NA	4,824,197.7	79,419.6	83.9	3.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	25,253.6 MMBTU								24,406.8 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$432,443.62	$24,528.61	$1.57	-16.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$392,299.19 $US								$456,972.23 $US			
Carbon	1,151.0	606.4	6.04	0.0	(184.6)	218.6	NA	NA	1,369.6	421.8	6.16	-1.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	1,757.4 MT CO2e								1,791.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 11-7. Detention Center HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace steam boilers with (4) electric steam boilers, 2480kw each, 9.92 MW total, Cleaver-Brooks HSB-425, 2987A @ 460V/3ph each; *Replace heating water boilers with (8) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 480 FLA @ 460V/3ph);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	0.0	(34,751.1)	734,031.8	NA	NA	4,788,126.4	79,419.6	83.5	3.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	25,253.6 MMBTU								24,283.7 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$429,212.93	$24,528.61	$1.56	-15.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$392,299.19 $US								$453,741.55 $US			
Carbon	1,151.0	606.4	6.04	0.0	(184.6)	208.4	NA	NA	1,359.4	421.8	6.12	-1.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	1,757.4 MT CO2e								1,781.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 11-8. Detention Center DHW Electrification Pathway 1

Pathway 1 | Electrification	*Included in HVAC electrification via assumed steam to DHW converters

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	NA	NA	NA	(79,419.6)	1,750,598.5	5,804,693.1	34,751.1	80.0	7.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	25,253.6 MMBTU								23,286.4 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$526,094.61	$10,732.84	$1.85	-36.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$392,299.19 $US								$536,827.45 $US			
Carbon	1,151.0	606.4	6.04	NA	NA	NA	(421.8)	497.0	1,648.0	184.6	6.30	-4.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	1,757.4 MT CO2e								1,832.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 11-9. Detention Center DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Included in HVAC electrification via assumed steam to DHW converters

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	NA	NA	NA	(79,419.6)	1,750,598.5	5,804,693.1	34,751.1	80.0	7.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	25,253.6 MMBTU								23,286.4 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$526,094.61	$10,732.84	$1.85	-36.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$392,299.19 $US								$536,827.45 $US			
Carbon	1,151.0	606.4	6.04	NA	NA	NA	(421.8)	497.0	1,648.0	184.6	6.30	-4.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	1,757.4 MT CO2e								1,832.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 11-10. Detention Center Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$1,130,715.00	($75,405.88)	$10,732.84	($64,673.04)	($2,866,997.42)	NA	NA	-0.8764	NA	NA	($1,736.79)
HVAC Pathway 2	$1,746,436.00	($72,175.20)	$10,732.84	($61,442.36)	($3,630,854.81)	NA	NA	-0.5385	NA	NA	($1,214.51)
DHW Pathway 1	$0.00	($169,056.87)	$24,528.61	($144,528.26)	($2,991,167.86)	NA	NA	NA	NA	NA	($3,833.43)
DHW Pathway 2	$0.00	($169,056.87)	$24,528.61	($144,528.26)	($2,991,167.86)	NA	NA	NA	NA	NA	($3,833.43)

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$1,108,440.00
DHW Existing Replacement:	$6,633.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

11.5 Renewable Energy, Energy Storage, and Electric Vehicles

11.5.1 Solar and BESS Analysis

The Detention Center roof has a flat unknown surface with a parapet wall surrounding the perimeter that is recognized as having minimal shading. The large roof is divided into various sections of different heights and limited HVAC equipment. The lower rooftop levels were not reviewed for solar equipment due to concern of shading from the tall surrounding buildings. An adjacent large building may impose shading on the Southernmost panels during hours of the day and result in reduced capacity. The four sections, shown in Figure 11-5, total to an estimated solar capacity of 240 kW. Due to the large amount of traffic surrounding the exterior of the facility, it is recommended for the BESS equipment to be placed in a secure lower roof level location adjacent to existing electrical equipment. The roof is scheduled to be replaced in 2037.

Figure 11-5. Detention Center Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 4,062,142 kWh with a peak June load of 671.8 kW. The estimated roof solar capacity is 240 kW

DC; however, initial HOMER analysis indicates that only a 200 kW DC nameplate PV system would be optimal. For optimal performance, the potential PV system should utilize South, East, and West facing roofs when possible. HOMER model results indicate that multiple combinations of PV systems possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS and low excess PV generation. Standalone PV and hybrid systems tend to have more favorable payback periods if incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 11-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the low renewable fraction and relatively high simple payback period for both configurations, it is recommended to wait until the energy density of PV and BESS technology improves.

Table 11-11. Detention Center Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	4,062,142	N/A	N/A	N/A
200 kW PV Only	3,791,425	270,747	N/A	6.7
200 kW PV + 53 kWh BESS	3,791,561	270,747	754	6.7

11.6 Cost Summary

Cost performance for the three systems is provided in Table 11-12.

Table 11-12. Detention Center Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	3,950,000	N/A	N/A
200 kW PV Only	356,000	4,090,000	2	19.4
200 kW PV + 53 kWh BESS	442,000	4,230,000	N/A	>25
Cost Summary with ITC Included				
200 kW PV Only	249,000	3,980,000	5.3	13.6
200 kW PV + 53 kWh BESS	370,000	4,070,000	2.8	17.6

11.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, this facility was identified for long lay-over periods and recommended for consideration of public charging. Ten (10) charging locations are shown in Figure 3.8-5 should chargers be considered in the future.

11.7 Electrical Infrastructure Demand Feasibility Summary

Table 11-13. Detention Center Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	739.80 kW	739.80 kW
HVAC Electrification Pathway 1		1,112.60 kW
HVAC Electrification Pathway 2		1,102.01 kW
DHW Electrification Pathway 1		1,447.15 kW
DHW Electrification Pathway 2		1,447.15 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

11.7.1 Building HVAC Electrification Implementation Feasibility

The current Electrical distribution system cannot accommodate the inclusion of the electric steam boilers as depicted in HVAC Electrification Pathway 1 and 2. An estimated load of 9.92 MW would require its own dedicated substation which will require substantial coordination with the utilities outside this project's scope. The addition of Electric Boilers as described in HVAC Electrification Pathway 1 would require an added switchboard being fed from a new service transformer.

11.7.2 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing Electrical Distribution System can accommodate the PV and BESS System with the inclusion of the properly sized circuit breakers.

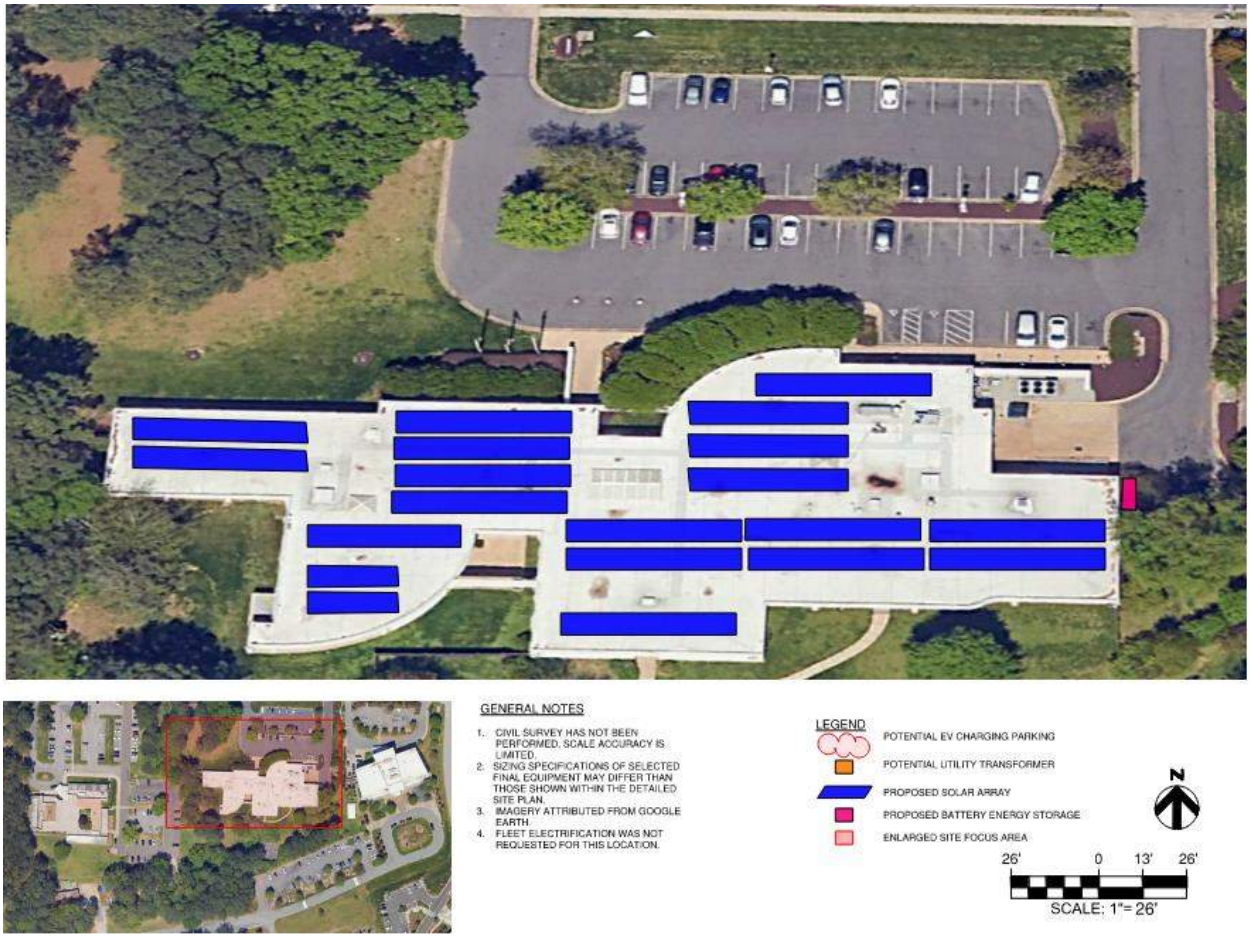
12 Durham Center Access

12.1 Renewable Energy, Energy Storage, and Electric Vehicles

12.1.1 Solar and BESS Analysis

The Durham Center Access facility has a rectangular shaped roof with two (2) unique curve protrusions. The rooftop possesses various HVAC equipment, sun tunnels, skylights, and large surrounding trees that introduce shading and reduce the available solar footprint. The roof is scheduled to be replaced in 2028. The roof is flat with a small parapet wall surrounding the perimeter (roof material unknown). The estimated solar capacity for the structure is 130 kW DC with available space for BESS equipment on the Eastern side of the structure, shown in Figure 12-1.

Figure 12-1. Durham Center Access Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 433,864 kWh with a peak July load of 96.6 kW. The estimated roof solar capacity is 130 kW DC and initial HOMER analysis indicates that a 130 kW DC nameplate PV system would be optimal.

HOMER model results indicate that multiple combinations of PV systems possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems possess unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods if incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 12-1. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 12-1. Durham Center Access Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	433,864	N/A	N/A	N/A
130 kW PV	283,790	176,877	N/A	38.4
130 kW PV + 119 kWh BESS	265,615	176,877	20,338	39.4

12.2 Cost Summary

Cost performance for the three systems is provided in Table 12-2.

Table 12-2. Durham Center Access Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	451,000	N/A	N/A
130 kW PV	238,000	571,000	0.4	23.8
130 kW PV + 119 kWh BESS	432,000	769,000	N/A	>25
Cost Summary with ITC Included				
130 kW PV	166,000	500,000	3.4	16.6
130 kW PV + 119 kWh BESS	302,000	640,000	N/A	>25

12.2.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

12.3 Electrical Infrastructure Demand Feasibility Summary

12.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required for each system.

13 Durham County Courthouse

Durham County | Durham County Courthouse | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	510 S Dillard St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Fire-Tube Boiler
Building Type	Courthouse	**Cooling Generation**	Water-Cooled Chiller
Year Built	2013	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	318,533	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	10	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 13-1. Durham County Courthouse



13.1 Existing Building Performance & Condition

13.1.1 Past Conservation Projects and Successes

- Roof redone in 2016 due to uplifting (warranty).

13.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age. At the time of the site visit, a heating water pump was in the process of being repaired or replaced and was backed up by a rental pump.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 13-1. Durham County Courthouse Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

13.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 13-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

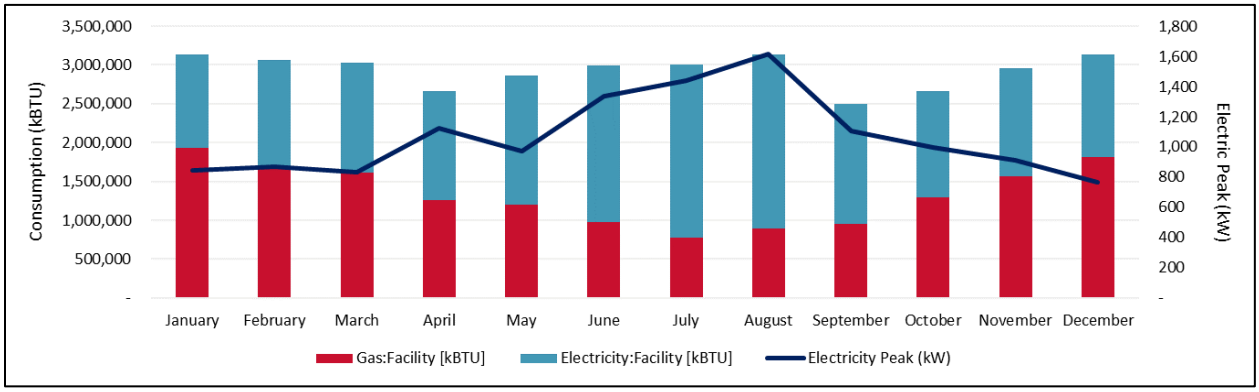
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 13-2. Durham County Courthouse Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	352,211	19,280	3,130	843.6	$28,041	$3,546	$31,587	99,994	102,405	202,399
February	406,627	16,725	3,060	868.0	$31,164	$3,149	$34,313	115,443	88,835	204,277
March	413,037	16,135	3,023	832.8	$31,191	$3,097	$34,288	117,263	85,701	202,963
April	410,062	12,610	2,661	1,122.8	$32,994	$2,510	$35,505	116,418	66,978	183,396
May	487,784	11,945	2,859	970.8	$37,439	$2,394	$39,833	138,483	63,446	201,929
June	590,510	9,810	2,996	1,336.4	$46,125	$2,027	$48,151	167,648	52,106	219,753
July	654,505	7,730	3,007	1,437.2	$51,338	$1,658	$52,996	185,816	41,058	226,874
August	654,228	8,965	3,129	1,618.0	$52,659	$1,877	$54,535	185,738	47,617	233,355
September	454,100	9,520	2,502	1,105.2	$40,816	$3,943	$44,758	128,921	50,565	179,486
October	400,857	12,985	2,667	994.8	$35,103	$5,574	$40,678	113,805	68,970	182,774
November	408,730	15,630	2,958	912.8	$35,600	$6,678	$42,278	116,040	83,018	199,058
December	387,885	18,130	3,137	767.6	$33,697	$7,152	$40,849	110,122	96,297	206,419
ANNUAL	5,620,537	159,465	35,129	-	$456,166	$43,605	$499,772	1,595,689	846,995	2,442,684
PEAK	-	-	-	1,618.0	-	-	-	-	-	-

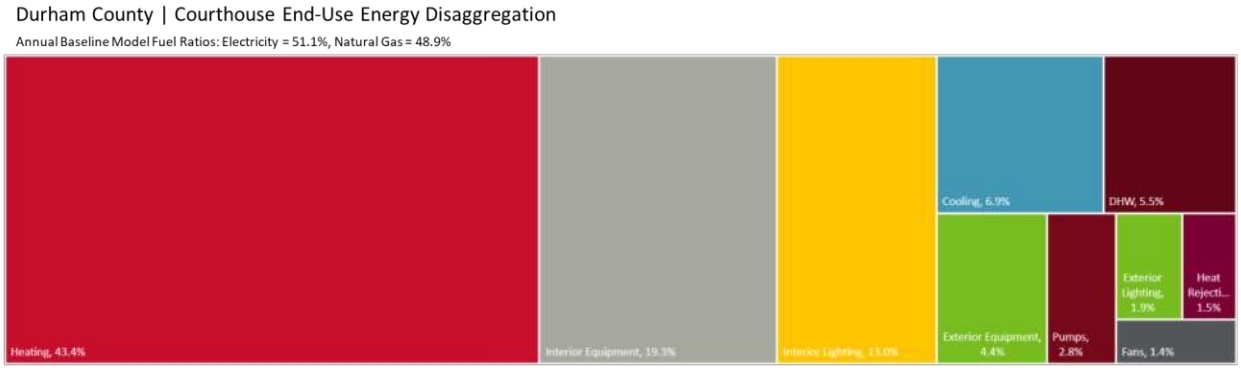
The data in Table 13-2 is represented in graphical format in Figure 13-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 13-2. Durham County Courthouse Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



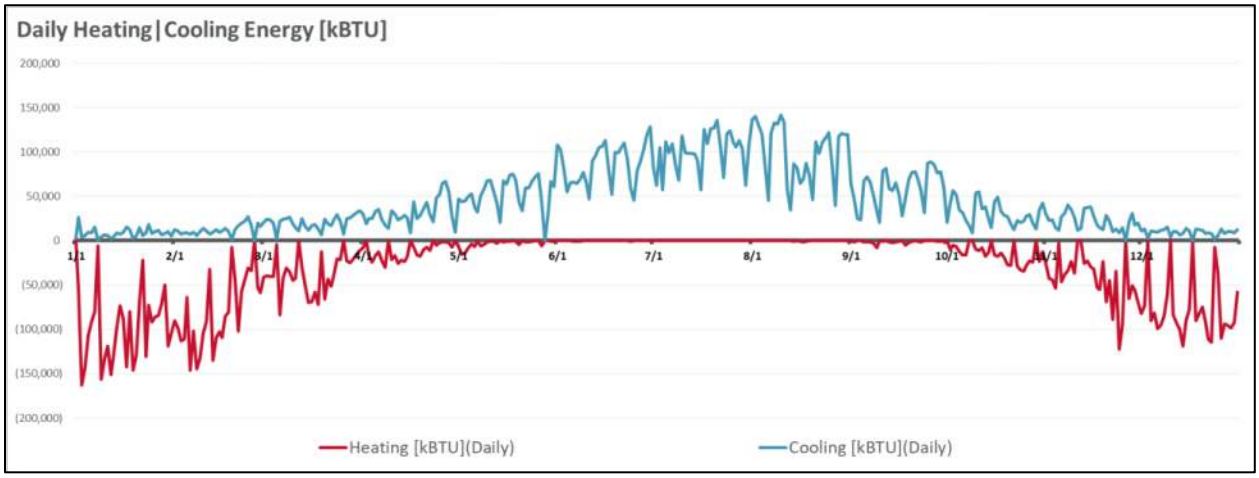
While Table 13-2 and Figure 13-2 encompasses “whole” building data, Figure 13-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 13-3. Durham County Courthouse Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 13-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 13-4. Durham County Courthouse Baseline Model Heating & Cooling Annual Load Profile



13.2 HVAC Refrigerants

The Durham County Courthouse utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 13-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 13-3. Durham County Courthouse HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Water-Cooled Chiller	Trane CVHF077FA4A0PCR	654 Tons	R-123	1700 lbs.	Interior
CH-2	Water-Cooled Chiller	Trane CVHF077FA4A0PCR	654 Tons	R-123	1700 lbs.	Interior
CU-09	Air-Cooled Condenser	McQuay RCS20F240D	20 Tons	R-410A	Not marked	Exterior
CU-11	Air-Cooled Condenser	Daikin RCS12F150D	12 Tons	R-410A	Not marked	Exterior

13.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 13-4. Durham County Courthouse Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Durham County Courthouse	Baseline	5,730,530.40	153,180.00	34,876.12	$548,184.36	2,440.53

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	732,234.44	19,573.00	4,456.39	$70,045.78	311.85	Potential Annual Energy Savings (%)	12.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	59,089.79	0.00	201.67	$5,082.22	16.78	NA	NA	
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00	kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	4,252.11	425.21	$1,535.37	22.58	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	27.96	2.80	$10.09	0.15	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$257.83	5.10	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	248,704.20	-1,650.49	683.77	$20,794.67	61.84	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	135,256.82	-897.61	371.87	$11,309.10	33.63	Applicable Area %	50.0%	%
	LED Exit Signs	6,783.74	-45.02	18.65	$567.20	1.69	Quantity of Exit Signs	64	#
	Daylight Dimming Control	40,577.05	-269.28	111.56	$3,392.73	10.09	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	3,892.32	0.00	13.28	$334.77	1.11	Quantity of Outdoor Fixtures	15	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,482.02	0.00	5.06	$127.47	0.42	Transformer Size	112.5	kVA
	Vending Machine Controller | Beverage	3,224.00	0.00	11.00	$277.29	0.92	Quantity of Beverage Vending Machines	2	#
	Vending Machine Controller | Snack	574.00	0.00	1.96	$49.37	0.16	Quantity of Snack Vending Machines	2	#
	EnergyStar Refrigerator Upgrade	1,050.00	0.00	3.58	$90.31	0.30	$0.00	10	#
	Tier 1 Advanced Power Strip	5,380.00	0.00	18.36	$462.72	1.53	Quantity of Power Strips	200	#
Decarbonization Measure Savings Totals (predicted)		**1,236,914.82**	**22,022.33**	**6,423.79**	**$114,336.92**	**468.14**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**21.6%**	**14.4%**	**18.4%**	**20.9%**	**19.2%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

13.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 13-5. Durham County Courthouse Existing HVAC/DHW Systems

HVAC | Space Heating	(2) fire-tube heating water boilers, 300BHP, Superior Boiler W7-X-1500, 12553 mbh input nat. gas, design 180F LWT 160F EWT, CV primary pumps, VV secondary pumps w/ VFDs
Domestic Hot Water	(2) gas-fired storage domestic water heaters w/ recirc pumps; design scheduled 400 gallon storage, 399 MBH input nat. gas, no nameplate info

Table 13-6. Durham County Courthouse HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace boilers with (3) electric steam boilers, 1960 kw each, 5.88 MW total, Cleaver-Brooks HSB-424, 2361A @ 460V/3ph each;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	0.0	(165,123.4)	3,515,901.3	NA	NA	9,136,438.5	18,631.4	103.7	12.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	37,558.2 MMBTU								33,045.5 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$959,428.74	$5,094.72	$3.03	-71.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$563,902.92 $US								$964,523.45 $US			
Carbon	1,595.7	976.0	8.07	0.0	(877.0)	998.2	NA	NA	2,593.9	99.0	8.45	-4.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,571.7 MT CO2e								2,692.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 13-7. Durham County Courthouse HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Heat pump chillers are not feasible due to 180F hot water supply temp required for existing coils

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	0.0	(165,123.4)	3,515,901.3	NA	NA	9,136,438.5	18,631.4	103.7	12.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	37,558.2 MMBTU								33,045.5 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$959,428.74	$5,094.72	$3.03	-71.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$563,902.92 $US								$964,523.45 $US			
Carbon	1,595.7	976.0	8.07	0.0	(877.0)	998.2	NA	NA	2,593.9	99.0	8.45	-4.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,571.7 MT CO2e								2,692.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 13-8. Durham County Courthouse DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace WHs with (2) electric storage water heater, 400 gallon, 108 kw; Lochinvar CHVX108-400, 130A @ 480V/3ph

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	NA	NA	NA	(18,631.4)	426,240.7	6,046,777.9	165,123.4	116.6	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	37,558.2 MMBTU								37,149.8 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$552,895.02	$45,152.76	$1.88	-6.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$563,902.92 $US								$598,047.78 $US			
Carbon	1,595.7	976.0	8.07	NA	NA	NA	(99.0)	121.0	1,716.7	877.0	8.14	-0.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,571.7 MT CO2e								2,593.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 13-9. Durham County Courthouse DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WHs with (4) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (2) 400 gallon HW storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	NA	NA	NA	(18,631.4)	79,796.3	5,700,333.5	165,123.4	112.9	4.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	37,558.2 MMBTU								35,967.4 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$520,868.37	$45,152.76	$1.78	-0.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$563,902.92 $US								$566,021.13 $US			
Carbon	1,595.7	976.0	8.07	NA	NA	NA	(99.0)	22.7	1,618.3	877.0	7.83	3.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,571.7 MT CO2e								2,495.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 13-10. Durham County Courthouse Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$1,476,209.22	($445,773.30)	$45,152.76	($400,620.54)	($10,340,498.81)	NA	NA	-4.1837	NA	NA	($6,177.44)
HVAC Pathway 2	$1,476,209.22	($445,773.30)	$45,152.76	($400,620.54)	($10,340,498.81)	NA	NA	-4.1837	NA	NA	($6,177.44)
DHW Pathway 1	$22,350.00	($39,239.58)	$5,094.72	($34,144.86)	($738,534.62)	NA	NA	-23.4535	NA	NA	($1,124.60)
DHW Pathway 2	$939,038.00	($7,212.93)	$5,094.72	($2,118.21)	($1,301,481.86)	-7.4524%	NA	-0.0257	NA	NA	$3,891.59

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$597,976.00
DHW Existing Replacement:	$161,933.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

13.5 Renewable Energy, Energy Storage, and Electric Vehicles

13.5.1 Solar and BESS Analysis

The top roof level of the Durham County Courthouse is a flat, unknown material roof with no concern of shading from surrounding structures or trees. The lower levels of the rooftop were not considered for solar equipment due to shading concerns. There are various pieces of large HVAC equipment on the Eastern side of the roof, reducing availability for solar equipment. The roof is scheduled to be replaced in 2033. The height of the structure is important to note potential challenges and increased costs associated with construction. The main level of the roof has an estimated available solar footprint of 145 kW DC, Figure 13-5. Due to the architecture of the building, having windows on the majority of the exterior as well as high public foot traffic surrounding the facility, it is recommended for the BESS equipment to be placed in a secure interior location.

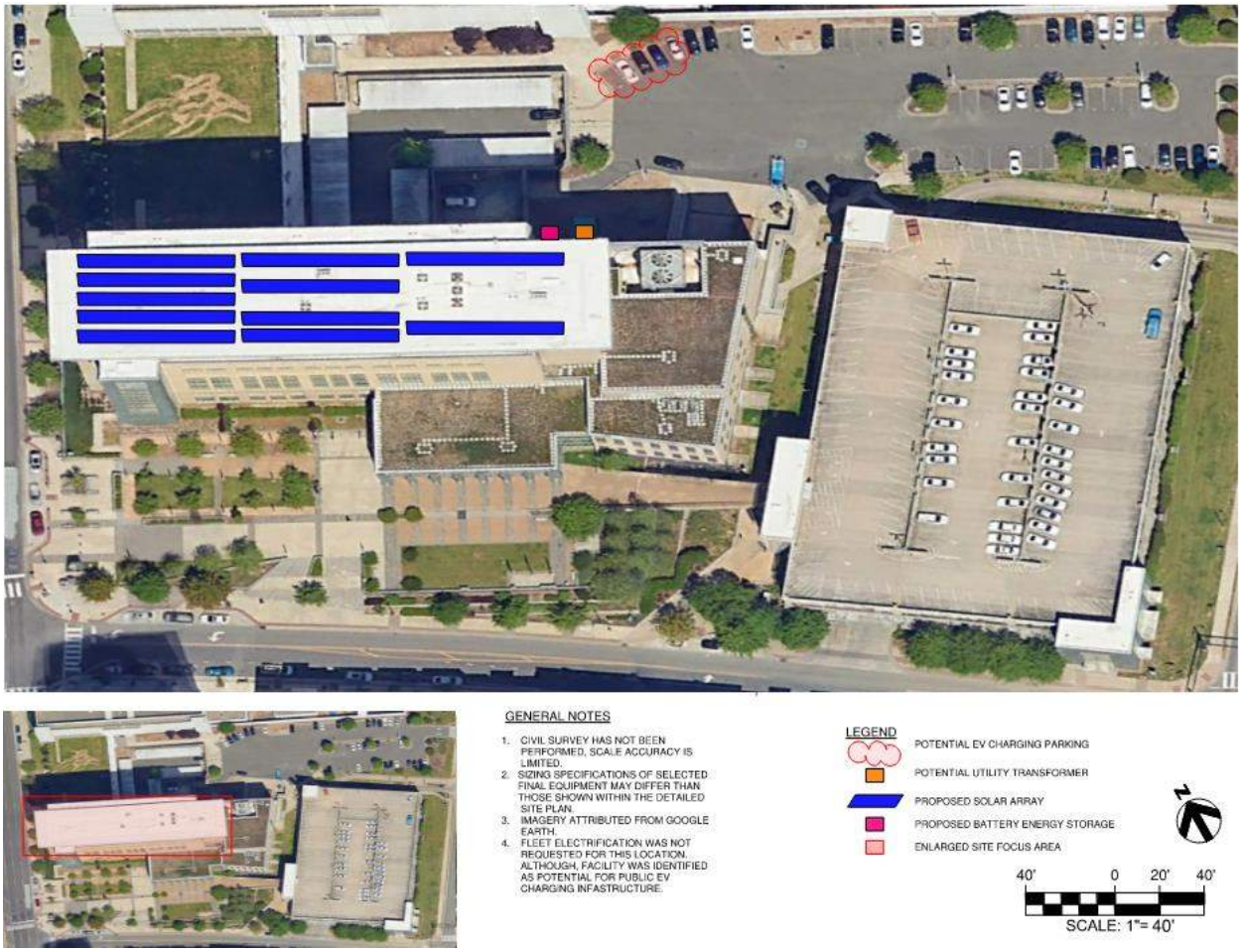


Figure 13-5. **Durham County Courthouse Conceptual Renewables and EV Visual Aid**

The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 5,751,956 kWh with a peak August load of 1,590 kW. The estimated roof solar capacity is 145

kW DC and initial HOMER analysis indicates that a 145 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV systems possess favorable payback periods and IRR. PV and BESS hybrid systems possess unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods when incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 13-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the low renewable fraction and relatively high simple payback period for both configurations, it is recommended to wait until the energy density of PV and BESS technology improves.

Table 13-11. Durham County Courthouse Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	5,751,956	N/A	N/A	N/A
145 kW PV Only	5,555,687	196,291	N/A	3.4
145 kW PV + 330 kWh BESS	5,557,159	196,291	6,807	3.4

13.6 Cost Summary

Cost performance for the three systems is provided in Table 13-12.

Table 13-12. Durham County Courthouse Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	5,900,000	N/A	N/A
145 kW PV Only	263,000	5,990,000	2.6	18.2
145 kW PV + 330 kWh BESS	803,000	6,460,000	N/A	>25
Cost Summary with ITC Included				
145 kW PV Only	184,000	5,910,000	6	12.8
145 kW PV + 330 kWh BESS	562,000	6,220,000	N/A	>25

13.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, this facility was identified for long lay-over periods and recommended for consideration of public charging. Ten

(10) charging locations are shown between the Durham Center Access and the Durham County Courthouse in Figure 13-5, should chargers be considered in the future.

13.7 Electrical Infrastructure Demand Feasibility Summary

Table 13-13. Durham County Courthouse Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	1,618 kW	1,618 kW
HVAC Electrification Pathway 1		6,617.05 kW
HVAC Electrification Pathway 2		6,617.05 kW
DHW Electrification Pathway 1		1,685.09 kW
DHW Electrification Pathway 2		1,629.77 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

13.7.1 Building HVAC Electrification Implementation Feasibility

The current Electrical distribution system cannot accommodate the inclusion of the electric steam boilers as depicted in HVAC Electrification Pathway 1. An estimated load of 5.88 MW would require its own dedicated substation which will require substantial coordination with the utilities outside this project's scope.

13.7.2 Building DHW Electrification Implementation Feasibility

The current Electrical distribution system can accommodate the equipment as outlined in DHW Electrification Pathways 1 and 2. Properly sized circuit breakers will need to be provided for equipment added as part of DHW Electrification Pathways 1 and 2.

13.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The current Electrical distribution system can accommodate the inclusion of the PV and BESS Systems. Properly sized circuit breakers will need to be provided for both systems.

14 Durham County Stadium

Durham County | Durham County Stadium | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	750 Stadium Dr, Durham, NC 27704	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Direct Fired MAU
Building Type	Stadium/Arena	**Cooling Generation**	Packaged DX
Year Built	2010 renovation	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	14,773	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	2	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Metal Panel	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	Varies
		Weekday Opening Time	Varies
		Weekend Operating Hours	Varies
		Weekend Opening Time	Varies

Figure 14-1. Durham County Stadium





14.1 Existing Building Performance & Condition

14.1.1 Past Conservation Projects and Successes

No historical data available.

14.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 14-1. Durham County Stadium Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

14.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 14-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

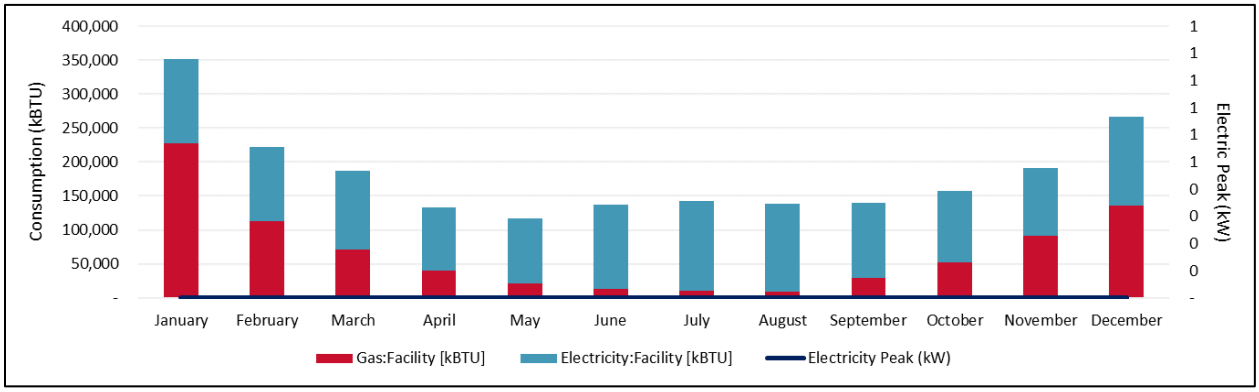
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 14-2. Durham County Stadium Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	36,168	2,279	351	0.0	$4,248	$2,492	$6,740	10,268	12,102	22,371
February	32,115	1,123	222	0.0	$3,969	$1,174	$5,143	9,118	5,962	15,080
March	33,813	715	187	0.0	$4,211	$738	$4,949	9,600	3,798	13,397
April	27,347	395	133	0.0	$3,676	$419	$4,095	7,764	2,095	9,859
May	27,983	210	117	0.0	$3,817	$234	$4,051	7,944	1,115	9,060
June	36,237	136	137	0.0	$4,494	$160	$4,653	10,288	722	11,010
July	38,586	105	142	0.0	$4,709	$129	$4,838	10,955	558	11,512
August	37,861	96	139	0.0	$4,822	$121	$4,944	10,749	510	11,259
September	32,416	289	140	0.0	$4,573	$361	$4,934	9,203	1,535	10,738
October	30,891	518	157	0.0	$4,397	$657	$5,055	8,770	2,749	11,519
November	29,481	911	192	0.0	$4,187	$1,124	$5,311	8,370	4,836	13,206
December	38,429	1,354	267	0.0	$5,048	$1,616	$6,664	10,910	7,189	18,099
ANNUAL	401,327	8,128	2,183	-	$52,153	$9,225	$61,378	113,938	43,172	157,110
PEAK	-	-	-	0.0	-	-	-	-	-	-

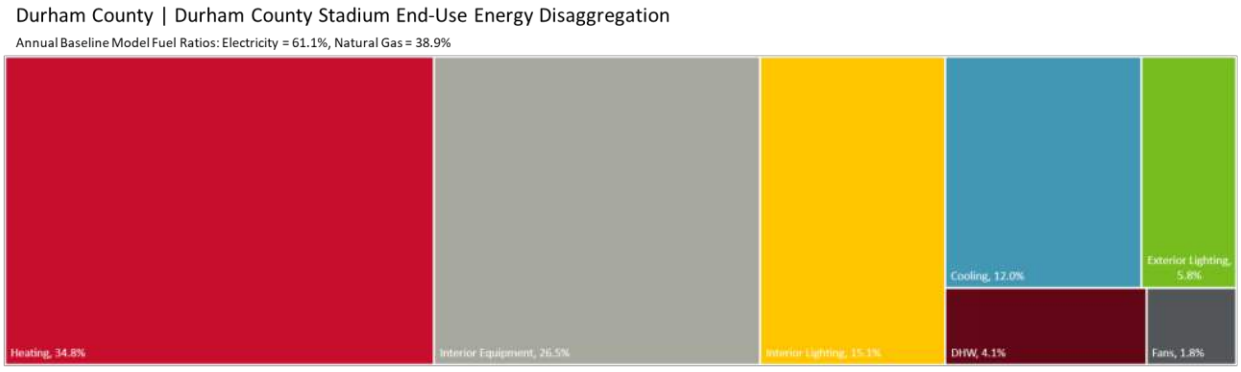
The data in Table 14-2 is represented in graphical format in Figure 14-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 14-2. Durham County Stadium Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



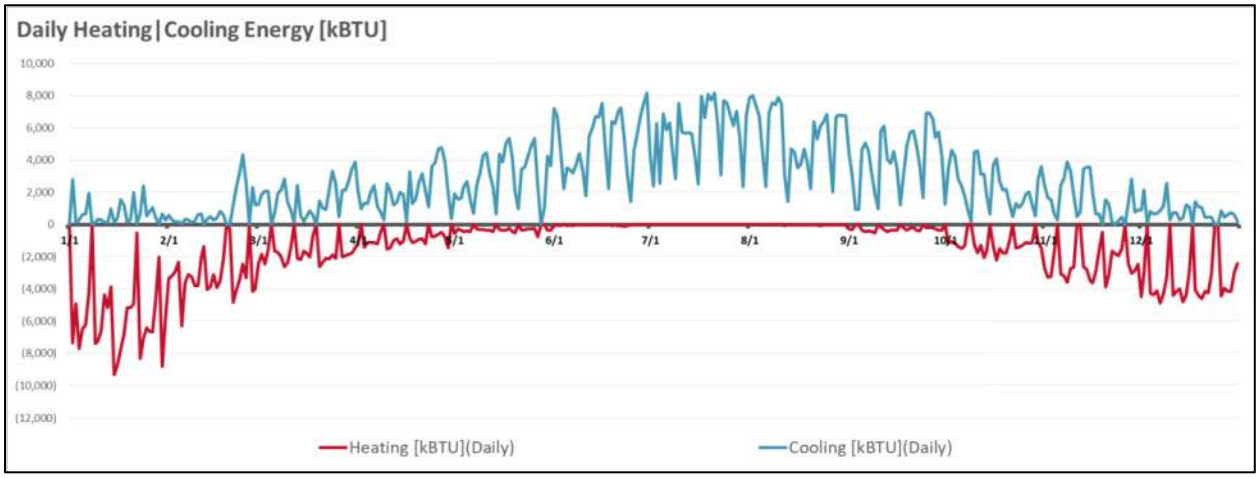
While Table 14-2 and Figure 14-2 encompasses “whole” building data, Figure 14-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 14-3. Durham County Stadium Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 14-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 14-4. Durham County Stadium Baseline Model Heating & Cooling Annual Load Profile



14.2 HVAC Refrigerants

The Durham County Stadium utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 14-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 14-3. Durham County Stadium HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
Split-System	Air-Cooled Condenser	Mitsubishi MSZ-GL12NA	1 ton	R-410A	22 lbs	Exterior
Multiple RTU	Rooftop Unit	Trane		R-410A	Unavailable	Exterior

14.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 14-4. Durham County Stadium Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Durham County Stadium	Baseline	416,169.20	6,899.00	2,110.27	$63,998.14	154.80

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	34,680.77	574.92	175.86	$5,333.18	12.90	Potential Annual Energy Savings (%)	8.3%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	5,315.89	0.00	18.14	$722.58	1.51	NA	NA	
	Smart Thermostat	1,297.69	1,007.92	105.22	$1,261.72	5.72	Total Cooling Capacity Controled	210.00	kBTU/hr
	Air Conditioner Tune-up	1,640.28	0.00	5.60	$222.96	0.47	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$13.38	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	773.76	72.82	$651.91	3.73	# Solar Thermal Panels	15	#
Lighting	LED Retrofit	2,746.30	-18.23	7.55	$353.68	0.68	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	5,997.92	-39.80	16.49	$772.43	1.49	Applicable Area %	50.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	3	#
	Daylight Dimming Control	1,199.58	-7.96	3.30	$154.49	0.30	Applicable Area %	10.0%	%
	LED Outdoor Pole/Arm	1,297.44	0.00	4.43	$176.36	0.37	Quantity of Outdoor Fixtures	5	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$658.21	1.37	Transformer Size	500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$36.56	0.08	Quantity of Power Strips	10	#
Decarbonization Measure Savings Totals (predicted)		**57,953.67**	**2,303.03**	**428.10**	**$10,357.46**	**28.69**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**13.9%**	**33.4%**	**20.3%**	**16.2%**	**18.5%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

14.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 14-5. Durham County Stadium Existing HVAC/DHW Systems

HVAC | Space Heating	(3) Indoor make-up air units, 140 MBH direct-fired natural gas; (6) Outdoor make-up air units, 140 MBH direct-fired natural gas; (4) Gas-fired tube radiant heaters, total 210 mbh input; (13) Electric unit heaters, various capacity, total 28 kw; (5) PTAC elec heaters, 18.6 kw total; (5) VRF heat-pump w/o resistance heat, nominal 3-ton outdoor units
Domestic Hot Water	(2) direct-vent NG storage water heaters, 130 gallon, 399 mbh input, 465 gph recovery, paralleled, with recirc pump; State model SUF130400NE, mfg. 2010 (1) direct-vent NG storage water heaters, 100 gallon, 150 mbh input, 178 gph recovery, with recirc pump; State model SUF100150NE, mfg 2021 (1) electric storage water heater, 19 gallon, 1650 W; State model ES620, mfg. 2010; (1) electric storage water heater, 80 gallon, 6 kW, State model PCE822, mfg. 2010; (1) electric storage water heater, 40 gallon, 9 kW, State model PCE402, mfg. 2009;

Table 14-6. Durham County Stadium HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace (3) indoor make-up air units w/ electric heat, 35kw resistance heater, Greenheck model # MSX-P115-H12-MF *Replace gas-fired tube radiant heaters with (18) electric radiant - Wattco JAD Series Type 1, 3.8kw each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	0.0	(7,649.1)	170,356.6	NA	NA	571,683.5	1,067.5	139.3	8.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,241.4 MMBTU								2,057.9 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$53,489.42	$1,211.60	$3.70	-14.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$47,829.37 $US								$54,701.02 $US			
Carbon	113.9	46.3	10.85	0.0	(40.6)	48.4	NA	NA	162.3	5.7	11.37	-4.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	160.2 MT CO2e								168.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 14-7. Durham County Stadium HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	"Simple" + *Replace outdoor make-up air units with (6) Heat-pump DOAS 10-ton nominal, AAON model RN-010, 35kw electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	0.0	(7,649.1)	59,539.4	NA	NA	460,866.3	1,067.5	113.7	25.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,241.4 MMBTU								1,679.7 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$43,039.15	$1,211.60	$3.00	7.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$47,829.37 $US								$44,250.75 $US			
Carbon	113.9	46.3	10.85	0.0	(40.6)	16.9	NA	NA	130.8	5.7	9.24	14.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	160.2 MT CO2e								136.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 14-8. Durham County Stadium DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace 119gal gas WHs with (1) electric boiler, 220 kw input w/ 2 x 119 gallon storage tanks. *Replace 100gal gas WH with (1) electric storage water heater, 119 gallon, 13.5 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	NA	NA	NA	(1,067.5)	24,386.6	425,713.5	7,649.1	150.1	1.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,241.4 MMBTU								2,217.9 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$39,861.03	$8,681.73	$3.29	-1.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$47,829.37 $US								$48,542.76 $US			
Carbon	113.9	46.3	10.85	NA	NA	NA	(5.7)	6.9	120.9	40.6	10.93	-0.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	160.2 MT CO2e								161.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 14-9. Durham County Stadium DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace 119gal gas WHs with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ 2 x 119 gallon storage tanks. *Replace 100gal gas WH with (1) air-source heat pump water heater (Lochinvar model AHP060, 13.5 kw input, 4.6 COP) + (1) 75 gallon storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**401,326.9**	**8,716.6**	**151.7**	**NA**	**NA**	**NA**	**(1,067.5)**	**4,594.6**	**405,921.5**	**7,649.1**	**145.6**	**4.1%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,241.4 MMBTU								2,150.3 MMBTU			
Energy Cost	**$37,936.03**	**$9,893.34**	**$3.24**						**$38,301.80**	**$8,681.73**	**$3.18**	**1.8%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$47,829.37 $US								$46,983.54 $US			
Carbon	**113.9**	**46.3**	**10.85**	**NA**	**NA**	**NA**	**(5.7)**	**1.3**	**115.2**	**40.6**	**10.55**	**2.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	160.2 MT CO2e								155.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 14-10. Durham County Stadium Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	-$154,609.52	($15,553.39)	$8,681.73	($6,871.65)	$84,615.67	NA	NA	NA	NA	NA	($394.58)
HVAC Pathway 2	-$48,042.02	($5,103.11)	$8,681.73	$3,578.62	$161,116.23	NA	NA	NA	NA	NA	$1,209.95
DHW Pathway 1	-$6,825.00	($1,924.99)	$1,211.60	($713.39)	($2,943.32)	NA	NA	NA	NA	NA	($63.93)
DHW Pathway 2	$459,502.00	($365.77)	$1,211.60	$845.84	($600,192.52)	-6.9138%	-5.3919%	0.0334	NA	NA	$222.64

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$510,183.00
DHW Existing Replacement:	$120,722.00

Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

14.5 Renewable Energy, Energy Storage, and Electric Vehicles

14.5.1 Solar and BESS Analysis

The Durham County Stadium is a large facility, but only has one structure with available footprint for solar. The structure located on the South side of the stadium is sloped and composed of a metal material. The roof has minimal equipment and no surrounding trees for shading. The roof is scheduled for replacement in 2032. The unique shape of the roof, as seen in Figure 14-5, has an estimated available capacity of 106 kW DC. Due to the high public foot traffic for this facility, it is recommended that BESS equipment be located in a secure area within the building.

Figure 14-5. Durham County Stadium Conceptual Renewables and EV Visual Aid



*BESS equipment to be installed in a secure interior location. Durham County to determine final location.

The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. Only monthly energy consumption data was provided for Durham County Stadium. Hourly peak load data was not provided for this building; thus, it is assumed that this building follows a similar load profile to Durham County Warehouse. The current annual stadium consumption is approximately 379,038 kWh with an assumed peak July load of 118.6 kW. The estimated roof solar capacity is 106 kW DC and initial HOMER analysis indicates that 106 kW

DC nameplate PV system would be optimal. HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS and small amount of excess PV generation. Standalone PV and hybrid system both tend to have more favorable periods if ITCs are factored into the system cost. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 14-11. Cost performance of the three system configurations is provided in Table 14-12. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 14-11. Durham County Stadium Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	379,038	N/A	N/A	N/A
106 kW PV Only	261,273	144,223	N/A	35.6
106 kW PV + 106 kWh BESS	246,230	144,223	17,989	36.3

14.6 Cost Summary

Table 14-12. Durham County Stadium Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	459,000	N/A	N/A
106 kW PV Only	197,000	552,000	0.9	22
106 kW PV + 106 kWh BESS	369,000	726,000	N/A	>25
Cost Summary With ITC Included				
106 kW PV Only	138,000	493,000	4	16
106 kW PV + 106 kWh BESS	258,000	616,000	N/A	>25

14.6.1 Electric Vehicle

The Durham County Stadium was identified for fleet electrification and for public charging. Ideal locations for fleet and public EV chargers are indicated in Figure 14-5. A total of twelve (12) Level 2, 7.2 kW EV chargers were identified for public charging usage for a total load of 86.4 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. Please see the self-assessment tool (Figure 1-9) in Section 1.3.3.4. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

14.7 Electrical Infrastructure Demand Feasibility Summary

Table 14-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	Not Available	125.93 kW
HVAC Electrification Pathway 1		252.14 kW
HVAC Electrification Pathway 2		141.93 kW
DHW Electrification Pathway 1		127.92 kW
DHW Electrification Pathway 2		126.34 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

14.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard may accommodate the required breaker size to supply power for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. Additional information is required as existing peak demand was not available through Enpira.

14.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards may accommodate the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required. Additional information is required as existing peak demand was not available through Enpira.

14.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard cannot accommodate the PV or BESS systems as the main service panel has no available space to provide a connection and subsequent downstream panel do not have a large enough frame to house the required circuit breaker. Therefore, a new main service panelboard will be required.

15 Durham County Warehouse

Durham County | Durham County Warehouse | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	4527 Hillsborough Rd, Durham, NC 27705	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Warehouse	**Cooling Generation**	Packaged DX
Year Built	2000	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	53,520	**Heating / Cooling / Vent Distribution**	RTUs
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Varies		
Wall Type	Metal	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED/Fluorescent	**Weekday Operating Hours**	Varies
		Weekday Opening Time	Varies
		Weekend Operating Hours	Varies
		Weekend Opening Time	Varies

Figure 15-1. Durham County Warehouse



15.1 Existing Building Performance & Condition

15.1.1 Past Conservation Projects and Successes

No historical data available.

15.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age. The facility is currently controlled via the original electromechanical non-programmable thermostats.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 15-1. Durham County Warehouse Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace thermostats with 7-day programmable auto-changeover thermostats.
Fix.1	

15.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 15-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

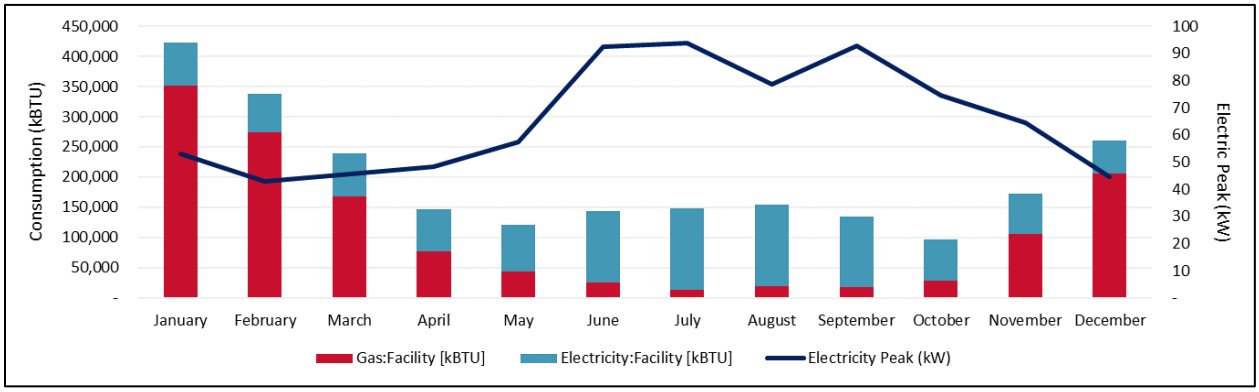
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 15-2. Durham County Warehouse Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	20,513	3,520	422	53.0	$2,007	$4,186	$6,193	5,824	18,696	24,520
February	18,744	2,738	338	42.8	$1,846	$2,909	$4,755	5,321	14,540	19,862
March	20,769	1,684	239	45.5	$2,083	$1,695	$3,777	5,896	8,945	14,841
April	20,565	765	147	48.3	$2,106	$768	$2,874	5,838	4,061	9,899
May	22,803	431	121	57.4	$2,271	$434	$2,705	6,474	2,289	8,763
June	34,798	249	144	92.6	$3,255	$267	$3,522	9,879	1,323	11,202
July	39,401	132	148	93.8	$3,546	$149	$3,695	11,186	698	11,884
August	39,485	189	154	78.7	$3,513	$206	$3,718	11,210	1,004	12,214
September	33,923	183	134	92.7	$3,485	$200	$3,685	9,631	972	10,603
October	20,071	283	97	74.7	$2,418	$346	$2,764	5,698	1,503	7,201
November	19,673	1,052	172	64.6	$2,300	$1,326	$3,626	5,585	5,588	11,173
December	15,689	2,065	260	44.7	$1,994	$2,463	$4,457	4,454	10,966	15,420
ANNUAL	306,434	13,289	2,375	-	$30,824	$14,949	$45,773	86,998	70,584	157,582
PEAK	-	-	-	93.8	-	-	-	-	-	-

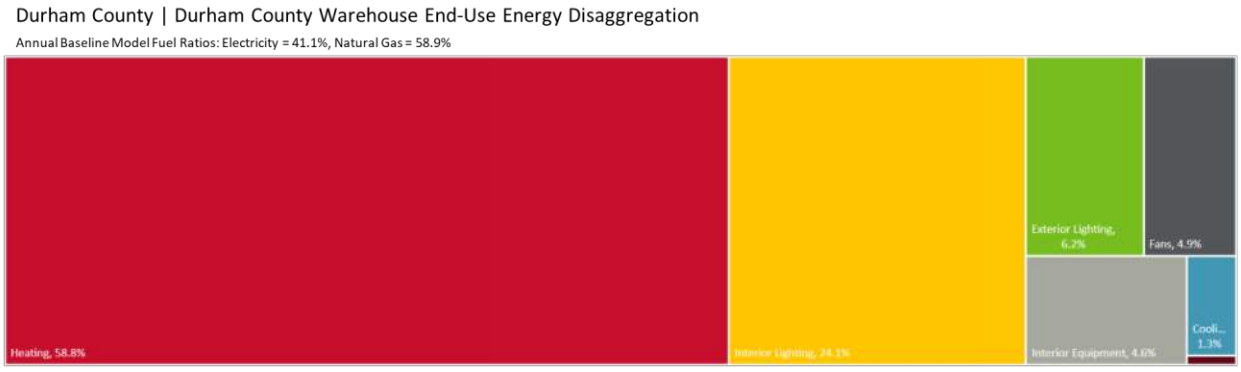
The data in Table 15-2 is represented in graphical format in Figure 15-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 15-2. Durham County Warehouse Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



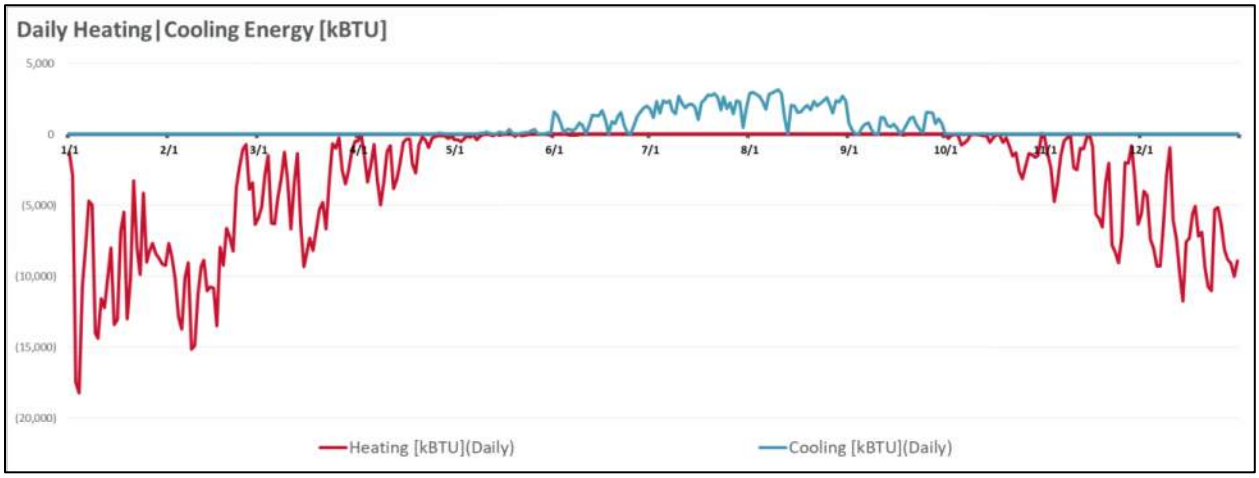
While Table 15-2 and Figure 15-2 encompasses “whole” building data, Figure 15-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 15-3. Durham County Warehouse Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 15-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 15-4. Durham County Warehouse Baseline Model Heating & Cooling Annual Load Profile



15.2 HVAC Refrigerants

The Durham County Warehouse utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 15-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 15-3. Durham County Warehouse HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
Split-System	Air-Cooled Condenser	LG LSU091HSV2	0.75 ton	R-410A	2.2 lbs	Exterior
RTU 1,2,3	Rooftop Unit	Trane YSH150F4RLA	12.5 tons	R-410A	12.7 lbs	Exterior
RTU 4	Rooftop Unit	Trane YCH480A4LF1	40 tons	R-22	67 lbs	Exterior
RTU 5	Rooftop Unit	Trane YCH120	10 tons	R-410A	24.6 lbs	Exterior
RTU 4	Rooftop Unit	Trane YCH210C3L0EA	17.5 tons	R-22	36 lbs	Exterior

15.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 15-4. Durham County Warehouse Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Durham County Warehouse	Baseline	300,333.60	14,537.00	2,478.73	$49,764.27	162.48

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	21,690.76	1,049.89	179.02	$3,594.09	11.73	Potential Annual Energy Savings (%)	7.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	0.00	0.00	0.00	$0.00	0.00	NA	NA	
	Smart Thermostat	1,936.18	339.83	40.59	$592.50	2.35	Total Cooling Capacity Controled	810.00	kBTU/hr
	Air Conditioner Tune-up	2,447.33	0.00	8.35	$274.75	0.69	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.86	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	77,357.81	-513.37	212.68	$8,117.92	19.24	Applicable Area %	20.0%	%
	Lighting Occupancy Sensor	8,664.07	-57.50	23.82	$909.21	2.15	Applicable Area %	5.0%	%
	LED Exit Signs	1,165.96	-7.74	3.21	$122.36	0.29	Quantity of Exit Signs	11	#
	Daylight Dimming Control	8,664.07	-57.50	23.82	$909.21	2.15	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$11.79	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$30.20	0.08	Quantity of Power Strips	10	#
Decarbonization Measure Savings Totals (predicted)		**122,300.18**	**759.83**	**493.39**	**$14,568.87**	**38.76**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**40.7%**	**5.2%**	**19.9%**	**29.3%**	**23.9%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

15.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 15-5. Durham County Warehouse Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU gas furnace, 200mbh input; (3) RTU gas furnace, 150mbh input; (1) RTU gas furnace, 400mbh input; (4) Gas-fired unit heaters, unknown capacity
Domestic Hot Water	(1) gas-fired natural draft storage water heater, 50 gallon, 36 mbh input, Rheem model PROG50-36N, mfg. date 09/2023

Table 15-6. Durham County Warehouse HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (4) electric 3.5kw unit heater. *Replace RTUs with heat-pump units w/ elec heat- (1) 10T heat pump RTU, 54kw electric heat, Trane WHC120; (5) 20T heat pump RTU, 36kw electric heat, Trane WHJ240;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	0.0	(14,963.6)	308,196.9	NA	NA	614,631.2	25.0	39.2	17.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,544.7 MMBTU								2,100.2 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$64,509.79	$28.18	$1.21	-40.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$45,799.63 $US								$64,537.96 $US			
Carbon	87.0	79.6	3.11	0.0	(79.5)	87.5	NA	NA	174.5	0.1	3.26	-4.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	166.6 MT CO2e								174.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 15-7. Durham County Warehouse HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas unit heaters with (4) electric 3.5kw unit heater. *Replace RTUs with heat-pump units (1) 10T heat pump RTU, Trane WHC120; (5) 20T heat pump RTU, Trane WHJ240;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	0.0	(14,963.6)	225,497.0	NA	NA	531,931.3	25.0	34.0	28.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,544.7 MMBTU								1,818.0 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$54,726.37	$28.18	$1.02	-19.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$45,799.63 $US								$54,754.54 $US			
Carbon	87.0	79.6	3.11	0.0	(79.5)	64.0	NA	NA	151.0	0.1	2.82	9.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	166.6 MT CO2e								151.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 15-8. Durham County Warehouse DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 50 gallon, 9 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	NA	NA	NA	(25.0)	582.5	307,016.8	14,963.6	47.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,544.7 MMBTU								2,544.2 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$28,990.50	$16,832.51	$0.86	-0.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$45,799.63 $US								$45,823.01 $US			
Carbon	87.0	79.6	3.11	NA	NA	NA	(0.1)	0.2	87.2	79.5	3.11	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	166.6 MT CO2e								166.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 15-9. Durham County Warehouse DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 119 gallon, 12 kw input, 4.2 COP, Lochinvar CHPA120PD

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	NA	NA	NA	(25.0)	104.6	306,538.9	14,963.6	47.5	0.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,544.7 MMBTU								2,542.6 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$28,948.03	$16,832.51	$0.86	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$45,799.63 $US								$45,780.54 $US			
Carbon	87.0	79.6	3.11	NA	NA	NA	(0.1)	0.0	87.0	79.5	3.11	0.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	166.6 MT CO2e								166.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 15-10. Durham County Warehouse Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$371,471.30	($35,570.84)	$16,832.51	($18,738.33)	($857,250.77)	NA	NA	-0.7078	NA	NA	($408.99)
HVAC Pathway 2	$560,236.30	($25,787.42)	$16,832.51	($8,954.91)	($905,895.07)	-8.7356%	NA	-0.1966	NA	NA	$788.42
DHW Pathway 1	$6,346.00	($51.55)	$28.18	($23.38)	($9,001.51)	-7.6970%	NA	-0.0497	NA	NA	($1.65)
DHW Pathway 2	$40,407.00	($9.09)	$28.18	$19.09	($54,132.21)	-7.1808%	-8.5449%	0.0086	NA	NA	$5.27

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$324,778.00
DHW Existing Replacement:	$3,712.00

Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

15.5 Renewable Energy, Energy Storage, and Electric Vehicles

15.5.1 Solar and BESS Analysis

The Durham County Warehouse is a large facility with one roof level, a peak running North-South and gradual slopes to the East and West. The sloped and metal material roof has limited HVAC equipment and no surrounding trees for shading. The roof is scheduled for replacement in 2035. As shown on Figure 15-5, the large single roof level has an estimated available capacity of 420 kW DC. Existing equipment on the South and Eastern walls of the building leave the Northern wall as a possible location for BESS equipment.

Figure 15-5. Durham County Warehouse Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 278,704 kWh with a peak June load of 118.6 kW. The estimated roof solar capacity is 420 kW DC, and the initial HOMER analysis indicates that only a 280 kW DC nameplate PV system would be optimal. HOMER model results indicate that standalone PV and hybrid systems have favorable renewable fractions, but unfavorable payback periods without incentives included. Both systems tend to have more favorable payback periods and IRR when including incentives in the cost analysis. . The base case, PV only and PV+BESS system configurations with the

fastest payback periods are provided in Table 15-11. Cost performance of the three system configurations is provided in Table 15-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 15-11. Durham County Warehouse Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	278,704	N/A	N/A	N/A
280 kW PV Only	135,139	354,809	N/A	72.4
280 kW PV + 79 kWh BESS	110,804	354,809	27,245	75.9

15.6 Cost Summary

Table 15-12. Durham County Warehouse Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	328,000	N/A	N/A
280 kW PV Only	509,000	614,000	N/A	>25
280 kW PV + 79 kWh BESS	638,000	743,000	N/A	>25
Cost Summary with ITC Included				
280 kW PV Only	356,000	461,000	2.3	19
280 kW PV + 79 kWh BESS	447,000	552,000	0.4	24

15.6.1 Electric Vehicle

The Durham County Warehouse was identified for fleet electrification but not for public charging. Ideal locations for EV chargers are indicated in Figure 15-5. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, please see the self-assessment tool (Figure 1-9) in section 1.3.3.4. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

15.7 Electrical Infrastructure Demand Feasibility Summary

Table 15-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	93.80 kW	93.80 kW
HVAC Electrification Pathway 1		512.71 kW
HVAC Electrification Pathway 2		402.73 kW
DHW Electrification Pathway 1		93.84 kW
DHW Electrification Pathway 2		93.81 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

15.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the required breaker size to supply power for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. New circuit breakers will need to be provided.

15.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards may accommodate the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required.

15.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the PV or BESS systems as the main service panel has available space to provide connection to house the required circuit breaker. New circuit breakers will be required.

16 East Regional Library

Durham County | East Regional Library | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	211 Lick Creek Ln, Durham, NC 27703	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Natural Draft Boiler
Building Type	Library	**Cooling Generation**	Air-Cooled Chiller
Year Built	2005	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	26,649	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

Figure 16-1. East Regional Library





16.1 Existing Building Performance & Condition

16.1.1 Past Conservation Projects and Successes

The East Regional Library was built in 2005. Based on available information, HDR found no past energy conservation projects and/or analysis reports conducted since its opening.

16.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 16-1. East Regional Library Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

16.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 16-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

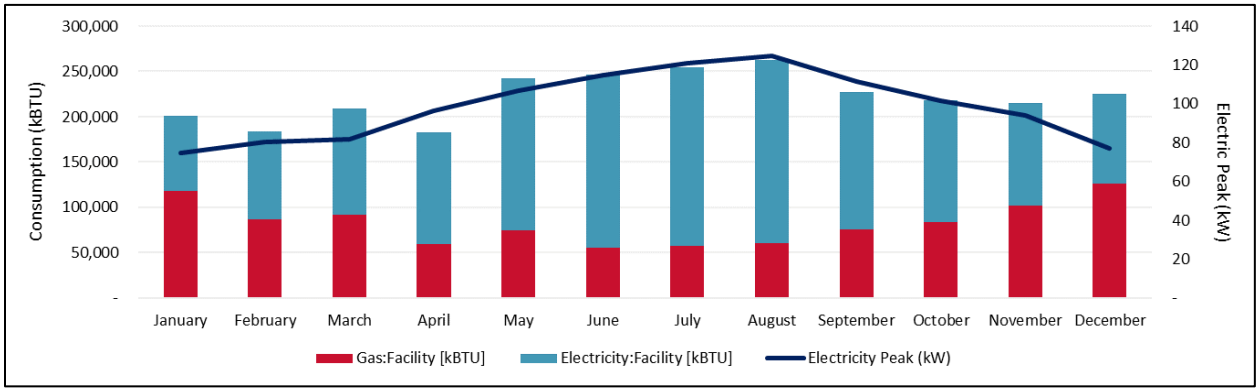
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 16-2. East Regional Library Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	24,468	1,178	201	74.8	$1,930	$1,384	$3,314	6,946	6,257	13,203
February	28,558	865	184	80.3	$2,170	$921	$3,090	8,108	4,594	12,702
March	34,277	919	209	81.8	$2,440	$932	$3,372	9,731	4,879	14,610
April	36,136	595	183	96.2	$2,618	$619	$3,237	10,259	3,158	13,417
May	49,141	744	242	106.8	$3,550	$764	$4,314	13,951	3,952	17,903
June	55,891	556	246	114.8	$4,805	$597	$5,402	15,868	2,953	18,821
July	57,768	578	255	120.7	$4,988	$624	$5,612	16,400	3,070	19,470
August	59,363	601	263	124.8	$5,109	$653	$5,762	16,853	3,190	20,043
September	44,433	760	228	111.6	$4,089	$840	$4,929	12,615	4,037	16,651
October	39,450	838	218	101.4	$3,226	$1,038	$4,264	11,200	4,448	15,648
November	33,112	1,021	215	93.9	$2,752	$1,290	$4,042	9,401	5,423	14,824
December	29,010	1,259	225	77.2	$2,428	$1,506	$3,934	8,236	6,684	14,921
ANNUAL	491,606	9,912	2,669	-	$40,104	$11,168	$51,272	139,569	52,645	192,213
PEAK	-	-	-	124.8	-	-	-	-	-	-

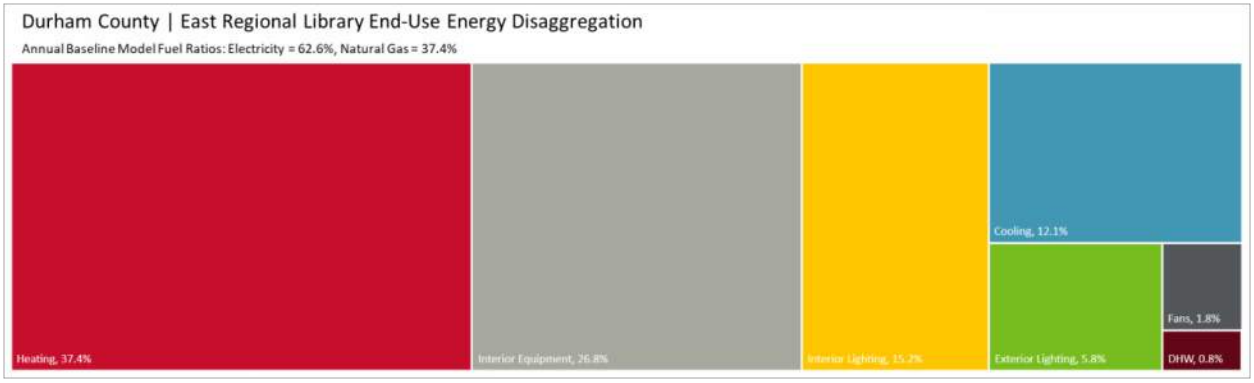
The data in Table 16-2 is represented in graphical format in Figure 16-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 16-2. East Regional Library Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



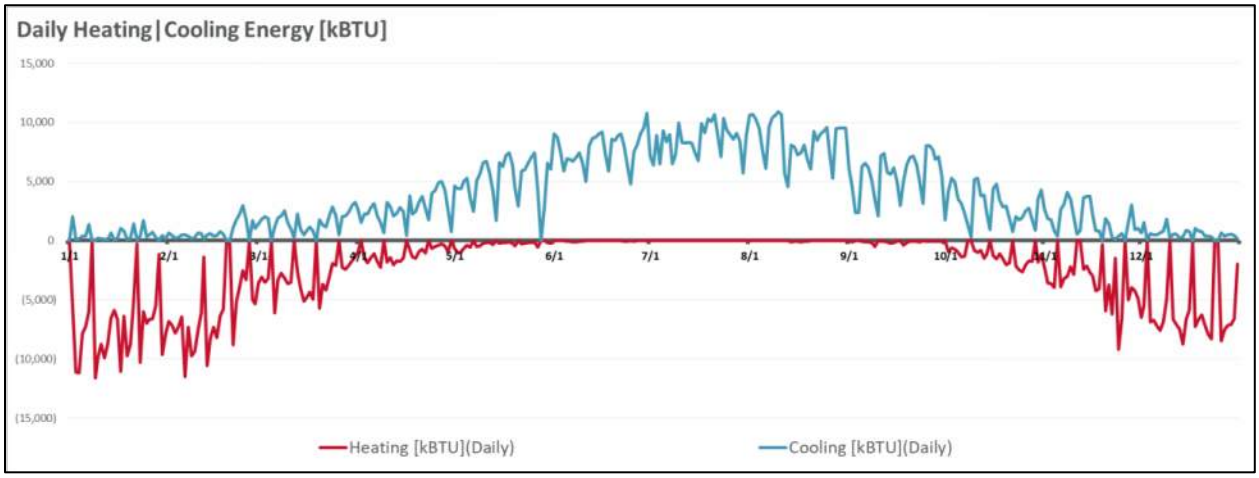
While Table 16-2 and Figure 16-2 encompasses “whole” building data, Figure 16-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 16-3. East Regional Library Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 16-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 16-4. East Regional Library Baseline Model Heating & Cooling Annual Load Profile



16.2 HVAC Refrigerants

The Durham County East Regional Library utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 16-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 16-3. East Regional Library HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Air-Cooled Chiller	Carrier 30GXN083-E-661FZ	80 tons	R-134A	Circuit 1: 128 lbs, Circuit 2: 123 lbs	Exterior
CU-3	Air-Cooled Condenser	Liebert PFH020A	18 MBH	R-407C	8 lbs, 6 oz	Roof

16.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 16-4. East Regional Library Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
East Regional Library	Baseline	489,883.16	10,047.00	2,676.66	$52,426.47	192.44

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	54,431.46	1,116.33	297.41	$5,825.16	21.38	Potential Annual Energy Savings (%)	11.1%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,137.67	0.00	27.77	$697.98	2.31	NA	NA	
	Smart Thermostat	136.87	0.00	0.47	$11.74	0.04	Total Cooling Capacity Controled	18.00	kBTU/hr
	Air Conditioner Tune-up	173.00	0.00	0.59	$14.84	0.05	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	284.66	28.47	$294.89	1.51	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$25.50	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$203.10	0.67	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	45,135.20	-299.53	124.09	$3,561.04	11.22	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	17,477.89	-115.99	48.05	$1,378.95	4.35	Applicable Area %	50.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	6	#
	Daylight Dimming Control	13,982.31	-92.79	38.44	$1,103.16	3.48	Applicable Area %	40.0%	%
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$222.57	0.74	Quantity of Outdoor Fixtures	10	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$415.34	1.37	Transformer Size	500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.01	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$46.15	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		**150,219.76**	**892.67**	**601.96**	**$13,809.42**	**47.39**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**30.7%**	**8.9%**	**22.5%**	**26.3%**	**24.6%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

16.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 16-5. East Regional Library Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 1530 MBH, Output: 1265 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 160 deg F, LWT: 180 deg F, Controls: Heat-Timer SQ Elite 8T Sequencing Controller (for multi-stage control)
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE8220RTA), fuel: electric resistance, capacity: 4000W 1PH/3PH Interlock & 8000W 1PH-3PH Simultaneous, Volume: 80 gal rated, Location: Janitor's Closet off of Lobby

Table 16-6. East Regional Library HVAC Electrification Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	0.0	(10,041.5)	261,576.0	NA	NA	753,182.4	0.0	96.5	4.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,682.0 MMBTU								2,570.6 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$75,698.13	$0.00	$2.84	-32.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$56,961.47 $US								$75,698.13 $US			
Carbon	139.6	53.3	7.24	0.0	(53.3)	74.3	NA	NA	213.8	0.0	8.02	-10.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	192.9 MT CO2e								213.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 16-7. East Regional Library HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	0.0	(10,041.5)	116,425.6	NA	NA	608,032.0	0.0	77.9	22.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,682.0 MMBTU								2,075.2 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$60,597.68	$0.00	$2.27	-6.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$56,961.47 $US								$60,597.68 $US			
Carbon	139.6	53.3	7.24	0.0	(53.3)	33.1	NA	NA	172.6	0.0	6.48	10.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	192.9 MT CO2e								172.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 16-8. East Regional Library DHW Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	NA	NA	NA	0.0	0.0	491,606.4	10,041.5	100.6	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,682.0 MMBTU								2,682.0 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$45,647.44	$11,314.03	$2.14	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$56,961.47 $US								$56,961.47 $US			
Carbon	139.6	53.3	7.24	NA	NA	NA	0.0	0.0	139.6	53.3	7.24	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	192.9 MT CO2e								192.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 16-9. East Regional Library DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Commercial Storage Tank Water Heater, fuel: electric heat pump, capacity: 4000W, Volume: 80 gal rated, Efficiency: 3.50 COP, Location: Janitor's Closet off of Lobby

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**491,606.4**	**10,041.5**	**100.6**	**NA**	**NA**	**NA**	**0.0**	**(3,993.6)**	**487,612.8**	**10,041.5**	**100.1**	**0.5%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,682.0 MMBTU								2,668.4 MMBTU			
Energy Cost	**$45,647.44**	**$11,314.03**	**$2.14**						**$45,270.56**	**$11,314.03**	**$2.12**	**0.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$56,961.47 $US								$56,584.59 $US			
Carbon	**139.6**	**53.3**	**7.24**	**NA**	**NA**	**NA**	**0.0**	**(1.1)**	**138.4**	**53.3**	**7.20**	**0.6%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	192.9 MT CO2e								191.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 16-10. East Regional Library Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$136,189.00	($30,050.69)	$11,314.03	($18,736.66)	($552,426.72)	NA	NA	-2.0018	NA	NA	($1,067.28)
HVAC Pathway 2	$132,641.00	($14,950.25)	$11,314.03	($3,636.22)	($229,005.92)	-8.7287%	NA	-0.2777	NA	NA	$1,034.36
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	-$3,866.00	$376.88	$0.00	$376.88	$13,176.50	NA	NA	NA	NA	NA	$57.82

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$38,740.00
DHW Existing Replacement:	$5,965.00

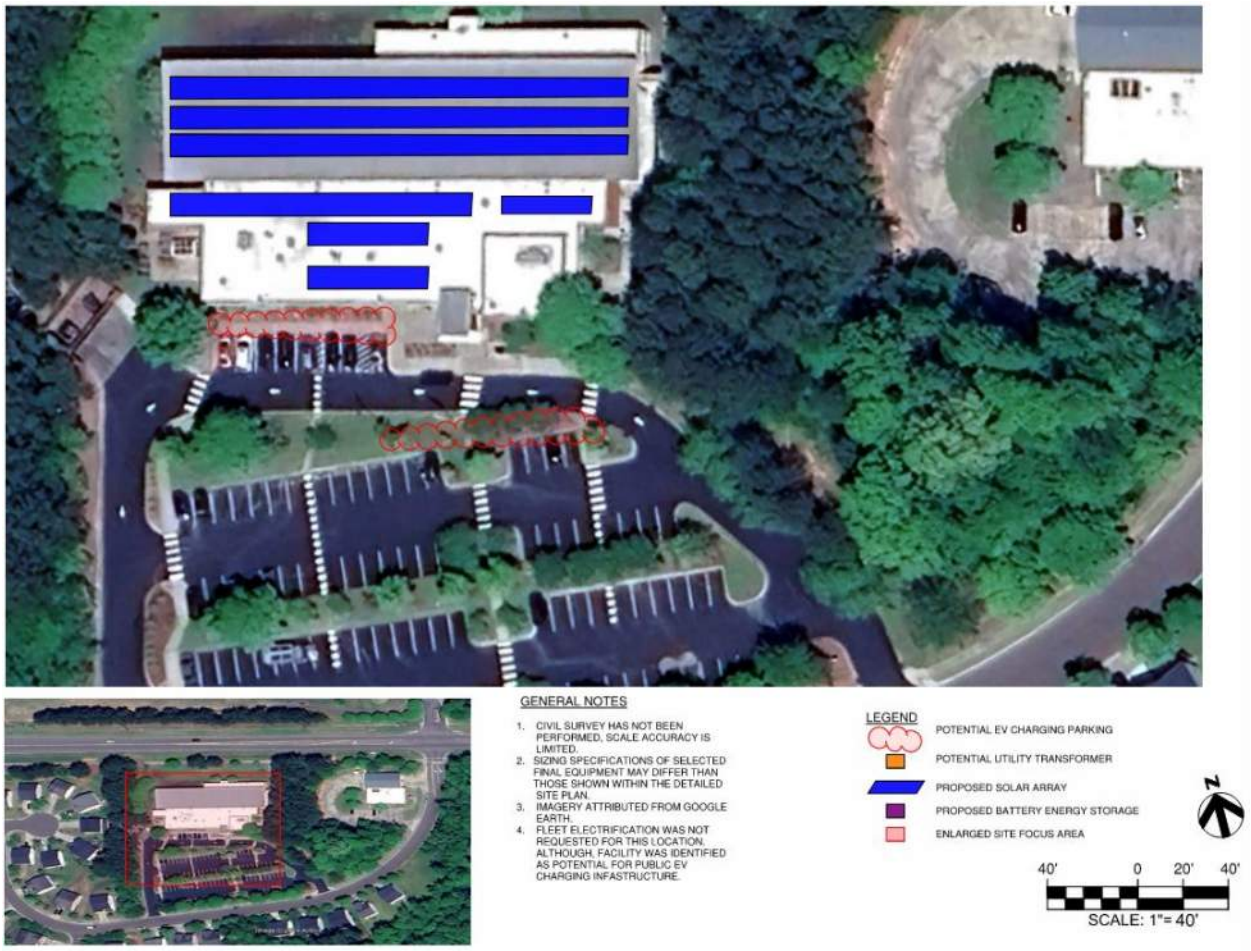
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

16.5 Renewable Energy, Energy Storage, and Electric Vehicles

16.5.1 Solar and BESS Analysis

The East Regional Library was recognized as having a large southeast facing roof with potential for shading from large surrounding trees. The large roof is divided into two main levels with varying material. The large upper level is a slanted metal roof. The roof is scheduled to be replaced in 2027. The lower roof level contains a parapet height of roughly 12 inches and various roof-mounted equipment casts shade and further reduces the potential solar generation (Figure 16-5). The large upper roof has an estimated capacity of 99.5 kW DC, and the lower roof has an estimated capacity of 30.5 kW DC. The roof age was not confirmed, and the replacement timeline undetermined.

Figure 16-5. East Regional Library Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual energy consumption for the past year is approximately 414,151 kWh with an August peak load of 115.4 kW. The estimated roof solar capacity is 130 kW DC, and the initial HOMER analysis indicates an equivalent maximum potential PV system nameplate size. HOMER model results indicate that multiple combinations of PV and BESS

systems do not currently possess favorable payback periods and IRR. Standalone PV systems tend to have more favorable payback periods if incentives are factored into the system cost. The base case and two other system configurations with the fastest payback period are provided in Table 16-11. Cost performance for the three systems is provided in Table 16-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 16-11. East Regional Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	414,151	N/A	N/A	N/A
130 kW PV	278,463	176,877	N/A	38.8
130 kW PV + 119 kWh BESS	260,598	176,877	24,019	40

16.6 Cost Summary

Table 16-12. East Regional Library Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	437,000	N/A	N/A
130 kW PV	237,000	569,000	N/A	>25
130 kW PV + 119 kWh BESS	431,000	791,000	N/A	>25
Cost Summary with ITC Included				
130 kW PV	166,000	498,000	2.4	18.6
130 kW PV + 119 kWh BESS	302,000	661,000	N/A	>25

16.6.1 Electric Vehicle

The East Regional library location was not identified for fleet electrification. The location is ideal for public charging.

16.7 Electrical Infrastructure Demand Feasibility Summary

Table 16-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	124.80 kW	124.80 kW
HVAC Electrification Pathway 1		387.92 kW
HVAC Electrification Pathway 2		351.74 kW
DHW Electrification Pathway 1		124.80 kW
DHW Electrification Pathway 2		124.12 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

16.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the required breaker size to supply power for the electric heat required by Electrification Pathway 1 or for Electrification Pathway 2. Therefore, a new main service panelboard will be required.

16.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the water heaters required for DHW Electrification Pathway 2. A new main distribution panel will be required.

16.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard cannot accommodate the size breaker required to interconnect the PV and BESS system. A new main distribution panel will be required.

17 Eastern Sheriff's Station

Durham County | Eastern Sheriff's Station | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	5323 Wake Forest Hwy, Durham, NC 27704	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Emergency Services	**Cooling Generation**	Packaged DX
Year Built	1991	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	3,038	**Heating / Cooling / Vent Distribution**	Multi-Zone RTU
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Small General Service
Window Type	Varies		
Wall Type	Brick	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	12:00am-12:00am
		Weekend Operating Hours	24
		Weekend Opening Time	12:00am-12:00am

Figure 17-1. Eastern Sheriff's Station





17.1 Existing Building Performance & Condition

17.1.1 Past Conservation Projects and Successes

No historical data available.

17.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 17-1. Eastern Sheriff's Station Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

17.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 17-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

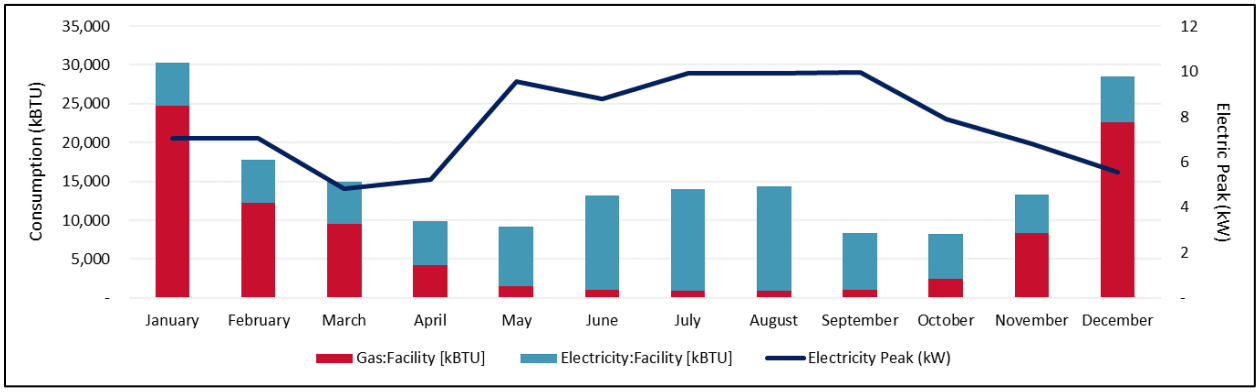
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 17-2. Eastern Sheriff's Station Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	1,648	247	30	7.0	$270	$304	$574	468	1,312	1,780
February	1,627	123	18	7.1	$268	$150	$418	462	651	1,113
March	1,607	95	15	4.8	$266	$117	$383	456	505	961
April	1,660	43	10	5.2	$268	$62	$330	471	226	697
May	2,264	15	9	9.6	$328	$34	$362	643	77	720
June	3,546	11	13	8.8	$466	$30	$496	1,007	56	1,062
July	3,824	10	14	9.9	$483	$29	$512	1,086	50	1,136
August	3,932	10	14	9.9	$500	$29	$529	1,116	50	1,167
September	2,128	11	8	10.0	$384	$30	$414	604	56	660
October	1,709	24	8	7.9	$289	$47	$336	485	127	613
November	1,466	84	13	6.8	$275	$117	$392	416	444	860
December	1,727	227	29	5.6	$290	$297	$587	490	1,203	1,693
ANNUAL	27,138	896	182	-	$4,087	$1,246	$5,333	7,705	4,756	12,461
PEAK	-	-	-	10.0	-	-	-	-	-	-

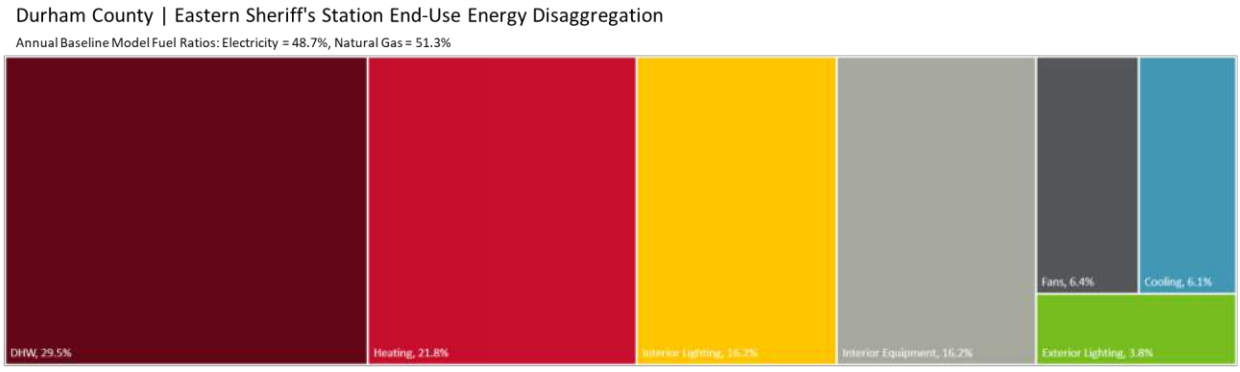
The data in Table 17-2 is represented in graphical format in Figure 17-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 17-2. Eastern Sheriff's Station Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



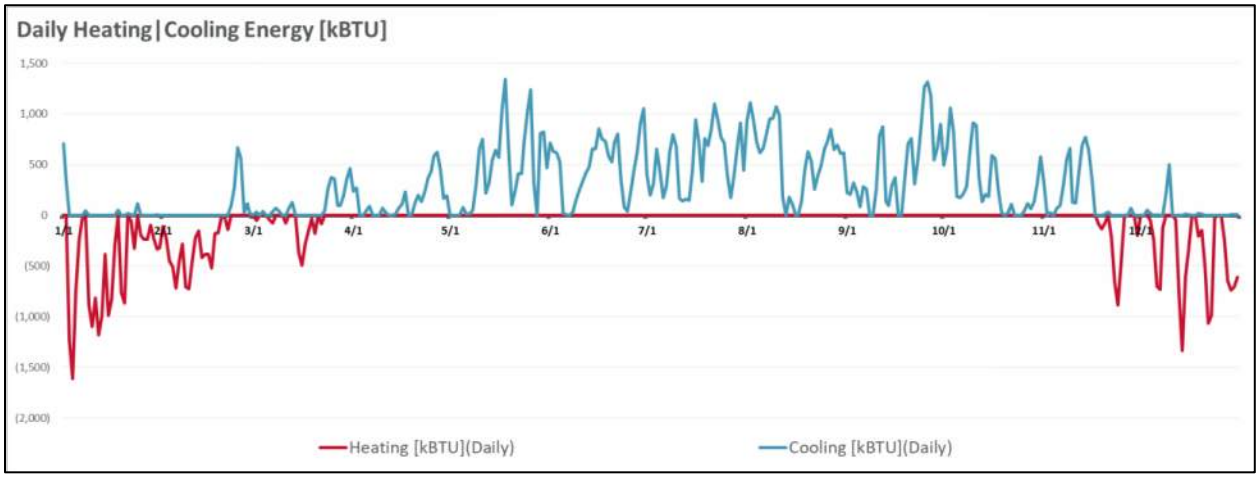
While Table 17-2 and Figure 17-2 encompasses "whole" building data, Figure 17-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 17-3. Eastern Sheriff's Station Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 17-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 17-4. Eastern Sheriff's Station Baseline Model Heating & Cooling Annual Load Profile



17.2 HVAC Refrigerants

The Durham County Eastern Sheriff's Station utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 17-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 17-3. Eastern Sheriff's Station HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
RTU 1	Rooftop Unit	Trane YSC060	5 tons	R-410A	Unavailable	Exterior

17.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 17-4. Eastern Sheriff's Station Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Eastern Sheriff's Station	Baseline	26,422.08	741.00	164.28	$5,237.86	11.44

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	1,908.26	53.52	11.86	$378.29	0.83	Potential Annual Energy Savings (%)	7.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	120.60	0.00	0.41	$19.20	0.03	NA	NA	
	Smart Thermostat	264.12	23.79	3.28	$75.15	0.20	Total Cooling Capacity Controled	60.00	kBTU/hr
	Air Conditioner Tune-up	333.85	0.00	1.14	$53.15	0.09	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$8.64	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	257.92	21.24	$146.57	0.99	# Solar Thermal Panels	5	#
Lighting	LED Retrofit	19,906.43	-132.11	54.73	$2,985.56	4.95	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	532.79	-3.54	1.46	$79.91	0.13	Applicable Area %	5.0%	%
	LED Exit Signs	106.00	-0.70	0.29	$15.90	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	532.79	-3.54	1.46	$79.91	0.13	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	518.98	0.00	1.77	$82.63	0.15	Quantity of Outdoor Fixtures	2	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$16.72	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	53.80	0.00	0.18	$8.57	0.02	Quantity of Power Strips	2	#
Decarbonization Measure Savings Totals (predicted)		**23,049.07**	**201.55**	**98.82**	**$3,950.20**	**7.61**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**87.2%**	**27.2%**	**60.2%**	**75.4%**	**66.6%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

17.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 17-5. Eastern Sheriff's Station Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU gas furnace, 130 mbh input; (1) gas-fired unit heater, Trane 12mbh input
Domestic Hot Water	(1) gas-fired natural draft storage water heater, 50 gallon, 38 mbh input, Rheen model RHLN11105002141, mfg. date 11/2010, w/ recirc pump

Table 17-6. Eastern Sheriff's Station HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace unit heater with electric 3.5kw unit heater. *Replace RTU with electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	0.0	(535.8)	11,136.7	NA	NA	38,274.5	439.4	57.5	8.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	190.1 MMBTU								174.6 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$5,148.34	$611.49	$1.90	-12.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,104.58 $US								$5,759.83 $US			
Carbon	7.7	5.2	4.24	0.0	(2.8)	3.2	NA	NA	10.9	2.3	4.34	-2.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	12.9 MT CO2e								13.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 17-7. Eastern Sheriff's Station HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace unit heater with electric 3.5kw unit heater. *Replace RTU with 5-ton heat-pump unit, w/ economizer, 23kw elec heat, Trane model WHC060

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	0.0	(535.8)	6,110.7	NA	NA	33,248.5	439.4	51.8	17.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	190.1 MMBTU								157.4 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$4,536.24	$611.49	$1.69	-0.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,104.58 $US								$5,147.73 $US			
Carbon	7.7	5.2	4.24	0.0	(2.8)	1.7	NA	NA	9.4	2.3	3.88	8.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	12.9 MT CO2e								11.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 17-8. Eastern Sheriff's Station DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 50 gallon, 9 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	NA	NA	NA	(439.4)	10,062.2	37,200.0	535.8	59.4	5.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	190.1 MMBTU								180.5 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$5,072.42	$745.62	$1.92	-14.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,104.58 $US								$5,818.04 $US			
Carbon	7.7	5.2	4.24	NA	NA	NA	(2.3)	2.9	10.6	2.8	4.41	-4.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	12.9 MT CO2e								13.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 17-9. Eastern Sheriff's Station DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 119 gallon, 12 kw input, 4.2 COP, Lochinvar CHPA120PD

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**27,137.8**	**975.2**	**62.6**	**NA**	**NA**	**NA**	**(439.4)**	**1,927.2**	**29,065.0**	**535.8**	**50.3**	**19.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	190.1 MMBTU								152.8 MMBTU			
Energy Cost	**$3,747.46**	**$1,357.11**	**$1.68**						**$4,011.02**	**$745.62**	**$1.57**	**6.8%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,104.58 $US								$4,756.64 $US			
Carbon	**7.7**	**5.2**	**4.24**	**NA**	**NA**	**NA**	**(2.3)**	**0.5**	**8.3**	**2.8**	**3.65**	**13.9%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	12.9 MT CO2e								11.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 17-10. Eastern Sheriff's Station Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$6,035.25	($1,400.88)	$745.62	($655.25)	($20,204.98)	NA	NA	-1.4775	NA	NA	($16.12)
HVAC Pathway 2	$17,980.00	($788.78)	$745.62	($43.15)	($23,430.36)	-6.4235%	-5.2372%	0.0356	NA	NA	$56.66
DHW Pathway 1	$4,739.00	($1,324.95)	$611.49	($713.46)	($20,001.20)	NA	NA	-2.1233	NA	NA	($26.67)
DHW Pathway 2	$39,061.00	($263.56)	$611.49	$347.94	($43,984.68)	-5.4427%	-1.5116%	0.1667	NA	NA	$91.12

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$41,210.00
DHW Existing Replacement:	$5,663.00

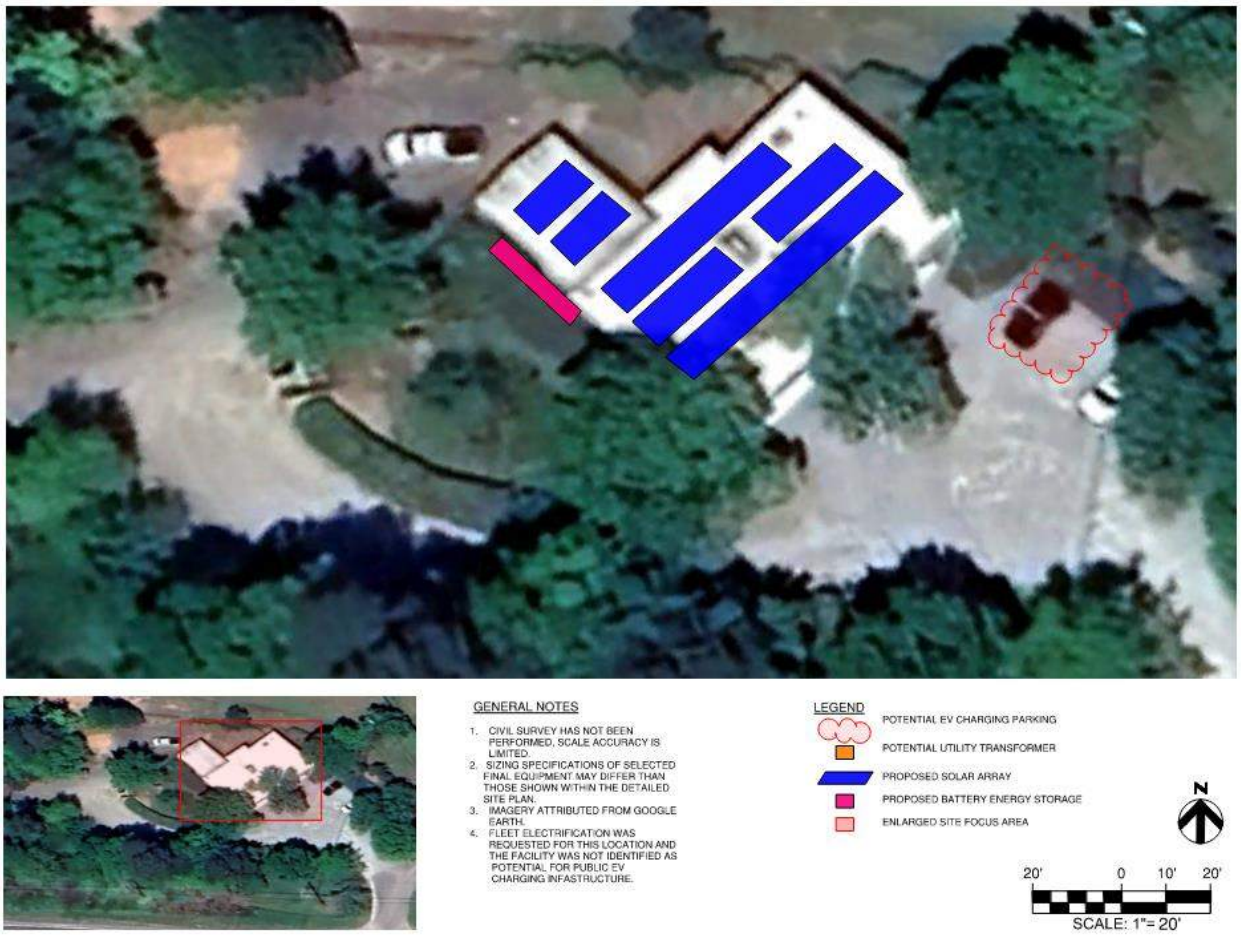
Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

17.5 Renewable Energy, Energy Storage, and Electric Vehicles

17.5.1 Solar and BESS Analysis

The Eastern Sheriff's Station is a small building surrounded by large trees. The large surrounding trees present concern for shading on the low height flat roof structure (material unknown). The roof was scheduled for replacement in 2018. A parapet wall surrounding the perimeter of the roof has the potential to cause increased shading on equipment. While rooftop solar is not recommended for this location, the roof has an estimated solar capacity of 34 kW DC and the potential for BESS equipment to be placed on the Southwestern facing wall of the facility, Figure 17-5.

Figure 17-5. Eastern Sheriff's Station Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 26,444 kWh with a peak September load of 12.3 kW. The estimated roof solar capacity is 34 kW DC and initial HOMER analysis indicates that only a 25 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and BESS possess favorable renewable fractions, but unfavorable payback periods and IRR.. Standalone PV

systems tend to have more favorable payback periods if incentives are factored into the system cost. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 17-11. Cost performance of the three system configurations is provided in Table 17-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 17-11. Eastern Sheriff's Station Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	26,444	N/A	N/A	N/A
25 kW PV Only	14,966	33,754	N/A	69.3
25 kW PV + 13.2 kWh BESS	11,029	33,754	4,393	74.8

17.6 Cost Summary

Table 17-12. Eastern Sheriff's Station Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	43,000	N/A	N/A
25 kW PV Only	56,000	70,000	N/A	>25
25 kW PV + 13.2 kWh BESS	77,000	95,000	N/A	>25
Cost Summary with ITC Included				
25 kW PV Only	39,000	54,000	2.1	19
25 kW PV + 13.2 kWh BESS	54,000	72,000	N/A	>25

17.6.1 Electric Vehicle

The Eastern Sheriff's Storage Station was identified for fleet electrification. Ideal locations for EV chargers are indicated in Figure 17-5. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, please see the self-assessment tool (Figure 1-9) in section 1.3.3.4. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

17.7 Electrical Infrastructure Demand Feasibility Summary

Table 17-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	9.96 kW8.70 kW	9.96 kW
HVAC Electrification Pathway 1		45.35 kW
HVAC Electrification Pathway 2		28.70 kW
DHW Electrification Pathway 1		10.31 kW
DHW Electrification Pathway 2		10.06 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

17.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. A new main distribution panel will be required.

17.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. A new main distribution panel will be required.

17.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard does not have enough space for the PV or BESS systems as the main service panel has available space to provide connection to house the required circuit breaker. A new main distribution panel will be required.

18 EMS #1 - Stadium Drive (Headquarters)

18.1 Renewable Energy, Energy Storage, and Electric Vehicles

18.1.1 Solar and BESS Analysis

The EMS #1 Stadium Drive (Headquarters) has three (3) main roof levels varying in materials and slope. The tallest roof level is gabled and composed of metal. The next tallest roof level is also composed of metal but sloped in various directions. The remaining two (2) sections of rooftop at the same level are flat with short parapet walls surrounding the perimeter and various structures for additional equipment. The facility has large surrounding trees to the Northwest corner that may provide shading throughout the day. Available footprint for solar equipment was identified at the tallest roof level and Southeastern lower roof level to avoid shading. The total estimated capacity for solar equipment for the various roof levels is 55 kW DC with potential for BESS equipment to be placed on the Southern wall of the facility Figure 18-1. The roof was replaced in 2020.

Figure 18-1. EMS #1 at Stadium Drive (Headquarters) Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. Only annual energy consumption was provided for the EMS #1 building; thus, the load profile from EMS #2 was utilized and scaled to match the energy consumption for this building. The annual building consumption for the past year is approximately 104,609 kWh with a peak August load of 15.7 kW. The estimated roof solar capacity is 55 kW DC and initial HOMER analysis indicates that a 55 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and hybrid systems possess favorable renewable fractions, but tend to have unfavorable payback periods andIRR. PV and BESS hybrid systems possess unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods if incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 18-1. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 18-1. EMS #1 at Stadium Drive (Headquarters) Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	104,609	N/A	N/A	N/A
55 kW PV Only	66,305	69,437	N/A	51.2
55 kW PV + 79.2 kWh BESS	48,680	69,437	19,670	57.2

18.2 Cost Summary

Cost performance for the three systems is provided in Table 18-2.

Table 18-2. EMS #1 at Stadium Drive (Headquarters) Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	115,000	N/A	N/A
55 kW PV Only	103,000	178,000	N/A	>25
55 kW PV + 79.2 kWh BESS	232,000	319,000	N/A	>25
Cost Summary with ITC Included				
55 kW PV Only	72,000	147,000	1.3	21.3
55 kW PV + 79.2 kWh BESS	162,000	249,000	N/A	>25

18.2.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

18.3 Electrical Infrastructure Demand Feasibility Summary

18.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required for each system.

19 EMS #2 – Old Fayetteville Road

Durham County | EMS #2 | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	615 Old Fayetteville St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Emergency Services	**Cooling Generation**	Packaged DX
Year Built	2007	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	6,990	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Small General Service
Window Type	Varies		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED/Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	12:00am-12:00am
		Weekend Operating Hours	24
		Weekend Opening Time	12:00am-12:00am

Figure 19-1. EMS #2





19.1 Existing Building Performance & Condition

19.1.1 Past Conservation Projects and Successes

No historical data available.

19.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 19-1. EMS #2 Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

19.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 19-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

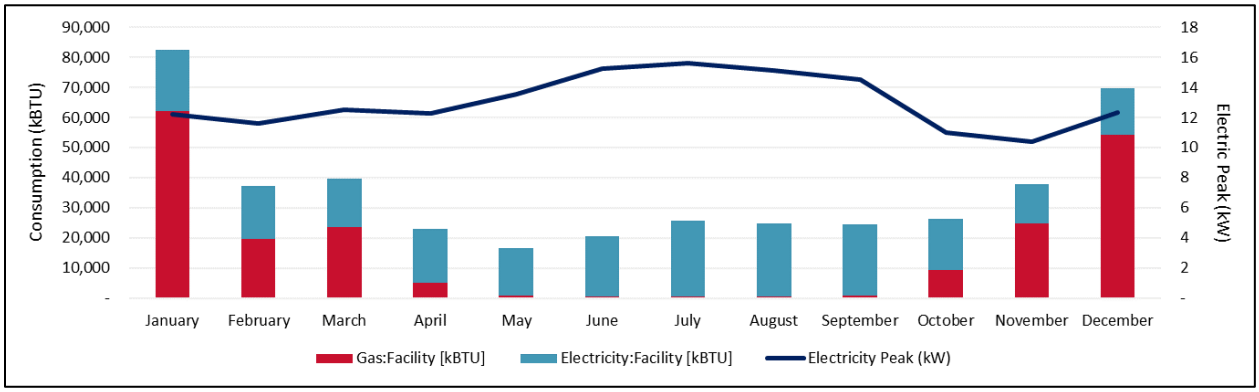
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 19-2. EMS #2 Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	5,998	620	82	12.2	$482	$721	$1,204	1,703	3,293	4,996
February	5,154	196	37	11.6	$445	$228	$674	1,463	1,041	2,504
March	4,711	235	40	12.5	$426	$261	$687	1,338	1,248	2,586
April	5,277	50	23	12.3	$445	$71	$515	1,498	266	1,764
May	4,577	9	16	13.5	$414	$28	$442	1,299	45	1,344
June	5,851	5	20	15.2	$538	$24	$563	1,661	27	1,688
July	7,370	5	26	15.6	$684	$24	$708	2,092	27	2,119
August	7,122	6	25	15.1	$679	$25	$703	2,022	32	2,054
September	6,933	9	25	14.5	$692	$29	$721	1,968	45	2,014
October	4,977	94	26	11.0	$545	$136	$681	1,413	499	1,912
November	3,821	249	38	10.4	$428	$335	$762	1,085	1,323	2,407
December	4,516	542	70	12.3	$464	$674	$1,138	1,282	2,879	4,161
ANNUAL	66,307	2,019	428	-	$6,243	$2,555	$8,798	18,825	10,724	29,549
PEAK	-	-	-	15.6	-	-	-	-	-	-

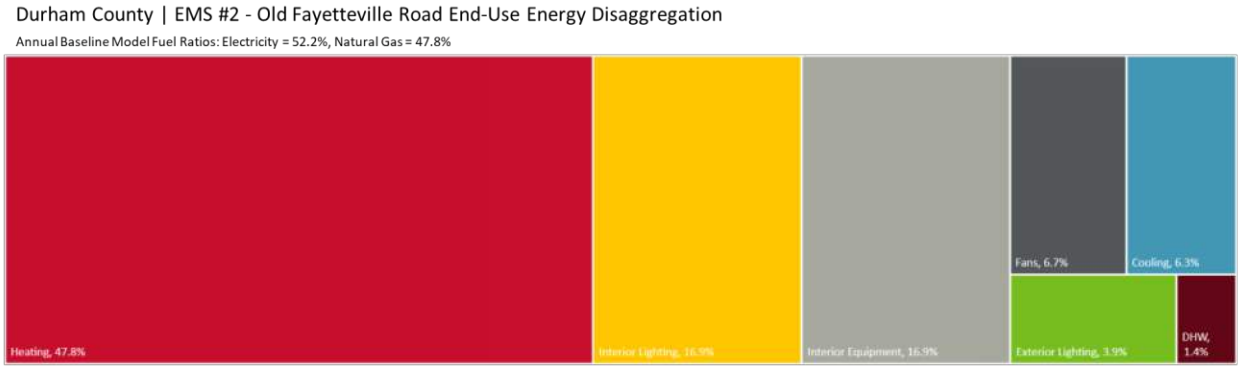
The data in Table 19-2 is represented in graphical format in Figure 19-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 19-2. EMS #2 Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



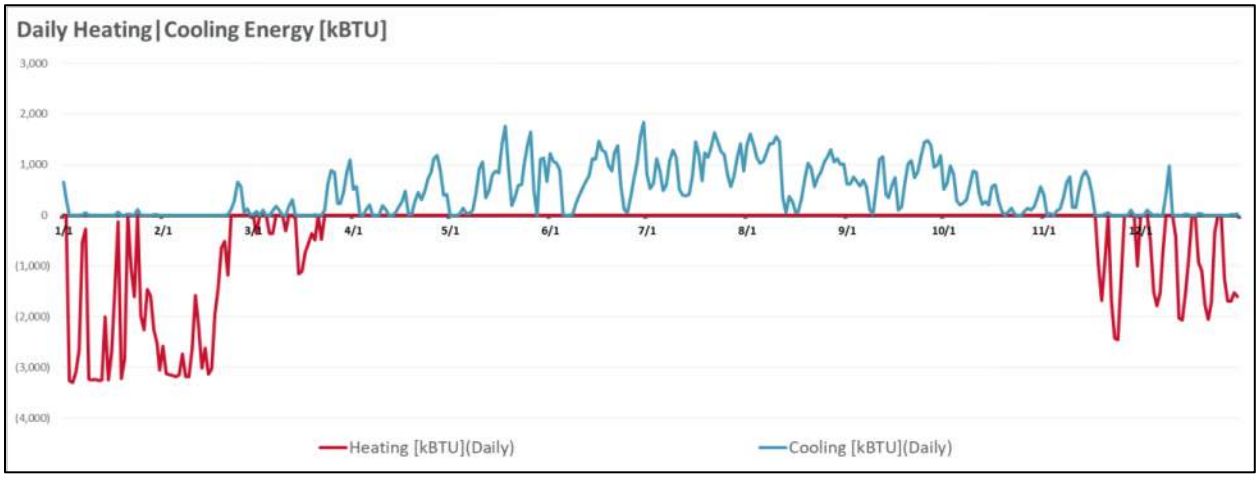
While Table 19-2 and Figure 19-2 encompasses “whole” building data, Figure 19-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 19-3. EMS #2 Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 19-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 19-4. EMS #2 Baseline Model Heating & Cooling Annual Load Profile



19.2 HVAC Refrigerants

The Durham County EMS #2 utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 19-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 19-3. EMS #2 HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CU-1	Air-Cooled Condenser	Trane 2TTB3060	5 tons	R-22	8.7 lbs	Exterior
CU-2	Air-Cooled Condenser	Trane 2TTB3048	4 tons	R-22	8.9 lbs	Exterior

19.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 19-4. EMS #2 Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
EMS #2 - Old Fayetteville Road	Baseline	63,278.44	1,654.00	381.37	$8,481.53	26.75

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	4,570.11	119.46	27.54	$612.55	1.93	Potential Annual Energy Savings (%)	7.2%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	27.41	0.00	0.09	$2.79	0.01	NA	NA	
	Smart Thermostat	628.79	56.09	7.75	$133.02	0.48	Total Cooling Capacity Controled	108.00	kBTU/hr
	Air Conditioner Tune-up	794.79	0.00	2.71	$80.99	0.23	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.15	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	19,856.44	-131.77	54.59	$1,861.47	4.94	Applicable Area %	67.0%	%
	Lighting Occupancy Sensor	1,885.96	-12.52	5.19	$176.80	0.47	Applicable Area %	10.0%	%
	LED Exit Signs	211.99	-1.41	0.58	$19.87	0.05	Quantity of Exit Signs	2	#
	Daylight Dimming Control	2,828.94	-18.77	7.78	$265.20	0.70	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,254.96	0.00	4.28	$127.89	0.36	Transformer Size	75.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.70	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$27.41	0.08	Quantity of Power Strips	10	#
Decarbonization Measure Savings Totals (predicted)		**32,582.02**	**11.07**	**112.31**	**$3,333.86**	**9.31**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**51.5%**	**0.7%**	**29.4%**	**39.3%**	**34.8%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

19.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 19-5. EMS #2 Existing HVAC/DHW Systems

HVAC | Space Heating	(2) Split-system gas furnace, Trane model TUX1C080, 80mbh input; (1) Gas-fired unit heater, Trane model GAND010, 100mbh input;
Domestic Hot Water	(1) electric storage water heater, 50 gallon, 6kw, State model CSB526, mfg. date 9/2006;

Table 19-6. EMS #2 HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas unit heater with (1) electric 30kw unit heater. *Replace split-systems with electric heat.

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	0.0	(2,068.5)	47,803.4	NA	NA	114,110.4	0.0	55.7	10.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	433.2 MMBTU								389.5 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$11,752.91	$0.00	$1.68	-13.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$10,335.93 $US								$11,752.91 $US			
Carbon	18.8	11.0	4.26	0.0	(11.0)	13.6	NA	NA	32.4	0.0	4.63	-8.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	29.8 MT CO2e								32.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 19-7. EMS #2 HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas unit heater with (1) electric 30kw unit heater. *Replace split-systems with heat-pumps- (1) 5-ton HP condensing unit + AHU w/ 20kw electric heater; (1) 4-ton HP condensing unit + AHU w/ 15kw electric heater;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	0.0	(2,068.5)	34,585.5	NA	NA	100,892.5	0.0	49.3	20.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	433.2 MMBTU								344.3 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$10,588.00	$0.00	$1.51	-2.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$10,335.93 $US								$10,588.00 $US			
Carbon	18.8	11.0	4.26	0.0	(11.0)	9.8	NA	NA	28.6	0.0	4.10	3.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	29.8 MT CO2e								28.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 19-8. EMS #2 DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	NA	NA	NA	0.0	0.0	66,307.0	2,068.5	62.0	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	433.2 MMBTU								433.2 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$7,718.03	$2,617.90	$1.48	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$10,335.93 $US								$10,335.93 $US			
Carbon	18.8	11.0	4.26	NA	NA	NA	0.0	0.0	18.8	11.0	4.26	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	29.8 MT CO2e								29.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 19-9. EMS #2 DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**66,307.0**	**2,068.5**	**62.0**	**NA**	**NA**	**NA**	**0.0**	**(1,173.0)**	**65,134.0**	**2,068.5**	**61.4**	**0.9%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	433.2 MMBTU								429.1 MMBTU			
Energy Cost	**$7,718.03**	**$2,617.90**	**$1.48**						**$7,618.72**	**$2,617.90**	**$1.46**	**1.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$10,335.93 $US								$10,236.61 $US			
Carbon	**18.8**	**11.0**	**4.26**	**NA**	**NA**	**NA**	**0.0**	**(0.3)**	**18.5**	**11.0**	**4.22**	**1.1%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	29.8 MT CO2e								29.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 19-10. EMS #2 Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$18,469.25	($4,034.88)	$2,617.90	($1,416.98)	($48,618.74)	NA	NA	-0.9481	NA	NA	($131.83)
HVAC Pathway 2	$39,793.00	($2,869.97)	$2,617.90	($252.07)	($52,853.54)	-6.3201%	-6.9632%	0.0171	NA	NA	$59.55
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$11,611.00	$99.32	$0.00	$99.32	($13,594.38)	-5.9523%	-2.0556%	0.1336	NA	NA	$16.98

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$59,759.00
DHW Existing Replacement:	$3,461.00

Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

19.5 Renewable Energy, Energy Storage, and Electric Vehicles

19.5.1 Solar and BESS Analysis

The EMS #2 building possesses a uniquely shaped roof with minimal HVAC equipment and concern for shading from surrounding objects (roof material unknown). The roof is scheduled for replacement in 2027. The single level of this roof is flat with a small parapet wall surrounding the perimeter. The estimated solar capacity for the structure is 65 kW DC with available space for BESS equipment adjacent to the existing electrical infrastructure, Figure 19-5.

Figure 19-5. EMS #2 Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 60,402 kWh with a peak July load of 15.7 kW. The estimated roof solar capacity is 65 kW DC and initial HOMER analysis indicates that only a 47 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and BESS possess favorable renewable fractions, but unfavorable payback periods and IRR. Standalone PV system tend to have more favorable payback periods with incentives included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 19-11. Cost performance of the three system

configurations is provided in Table 19-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 19-11. EMS #2 Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	60,402	N/A	N/A	N/A
47 kW PV Only	35,913	63,948	N/A	64
47 kW PV + 13.2 kWh BESS	31,878	63,948	4,503	66.4

19.6 Cost Summary

Table 19-12. EMS #2 Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	70,000	N/A	N/A
47 kW PV Only	89,000	121,000	N/A	>25
47 kW PV + 13.2 kWh BESS	110,000	144,000	N/A	>25
Cost Summary with ITC Included				
47 kW PV Only	62,000	95,000	1.9	20
47 kW PV + 13.2 kWh BESS	77,000	111,000	N/A	>25

19.6.1 Electric Vehicle

The EMS #2 was identified for fleet electrification. Ideal locations for EV chargers are indicated in Figure 205. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, please see the self-assessment tool (Figure 1-9) in Section 1.3.3.4. The potential additional load for fleet and/or public EV chargers was not considered in the building load review or cost estimation.

19.7 Electrical Infrastructure Demand Feasibility Summary

Table 19-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	15.60 kW	15.60 kW
HVAC Electrification Pathway 1		52.26 kW
HVAC Electrification Pathway 2		44.11 kW
DHW Electrification Pathway 1		15.60 kW
DHW Electrification Pathway 2		15.46 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

19.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. Subsequent downstream panels are Life Safety panels, so HVAC loads are not appropriate to be placed there. A new branch panel will be required to feed the several existing and any additional loads.

19.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. Subsequent downstream panels are Life Safety panels, so DHW loads are not appropriate to be placed there. A new branch panel will be required to feed the several existing and any additional loads.

19.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard does not have enough space for the PV or BESS systems. Subsequent downstream panels are Life Safety panels, so non-life safety loads are not appropriate to be placed there. A new main distribution panel will be required.

20 EMS #6 - Milton Road

Durham County | EMS #6 – Milton Road | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	226 Milton Rd, Durham, NC 27712	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Emergency Services	**Cooling Generation**	Split-System DX
Year Built	1990	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	7,805	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent/LED	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 20-1. EMS #6 – Milton Road



20.1 Existing Building Performance & Condition

20.1.1 Past Conservation Projects and Successes

- New roof installed in 2015.

20.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 20-1. EMS #6 – Milton Road Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

20.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 20-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

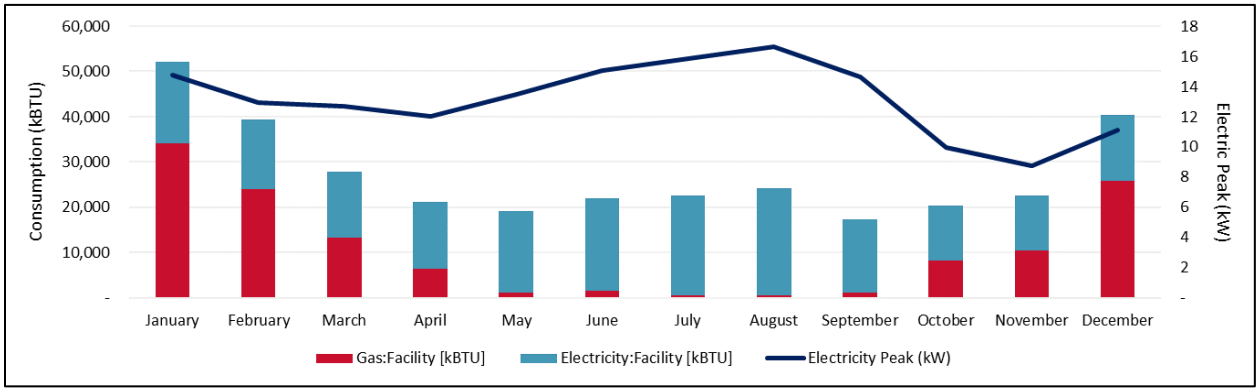
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 20-2. EMS #6 – Milton Road Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	5,227	342	52	14.8	$482	$450	$932	1,484	1,817	3,301
February	4,495	241	39	12.9	$438	$285	$723	1,276	1,280	2,556
March	4,297	132	28	12.7	$431	$157	$588	1,220	701	1,921
April	4,294	65	21	12.0	$428	$86	$514	1,219	345	1,564
May	5,278	13	19	13.5	$499	$31	$531	1,498	66	1,565
June	6,030	15	22	15.1	$654	$35	$689	1,712	80	1,792
July	6,432	7	23	15.8	$675	$26	$701	1,826	35	1,861
August	6,888	7	24	16.6	$720	$26	$746	1,955	35	1,990
September	4,783	11	17	14.7	$605	$31	$636	1,358	58	1,416
October	3,542	83	20	10.0	$436	$117	$553	1,005	438	1,444
November	3,511	106	23	8.8	$433	$154	$586	997	560	1,557
December	4,285	258	40	11.1	$480	$332	$812	1,217	1,368	2,584
ANNUAL	59,061	1,277	329	-	$6,281	$1,729	$8,010	16,768	6,783	23,550
PEAK	-	-	-	16.6	-	-	-	-	-	-

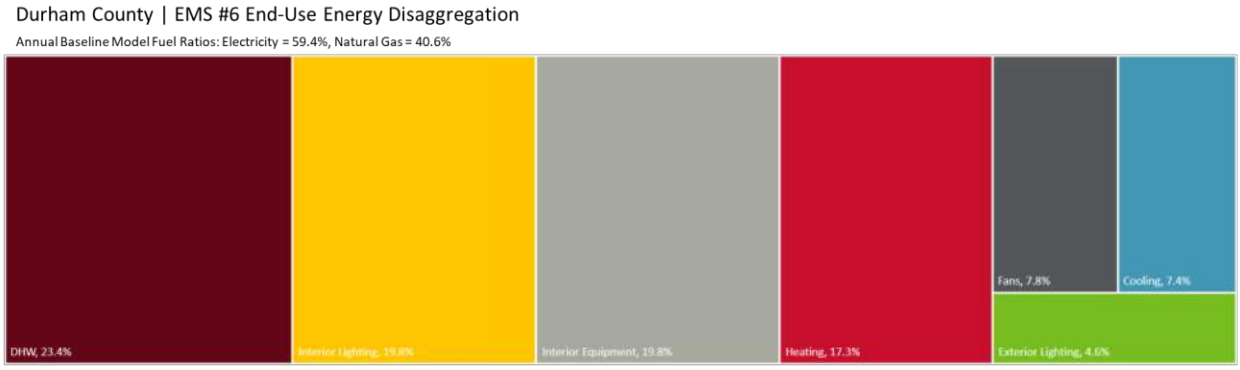
The data in Table 20-2 is represented in graphical format in Figure 20-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 20-2. EMS #6 – Milton Road Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



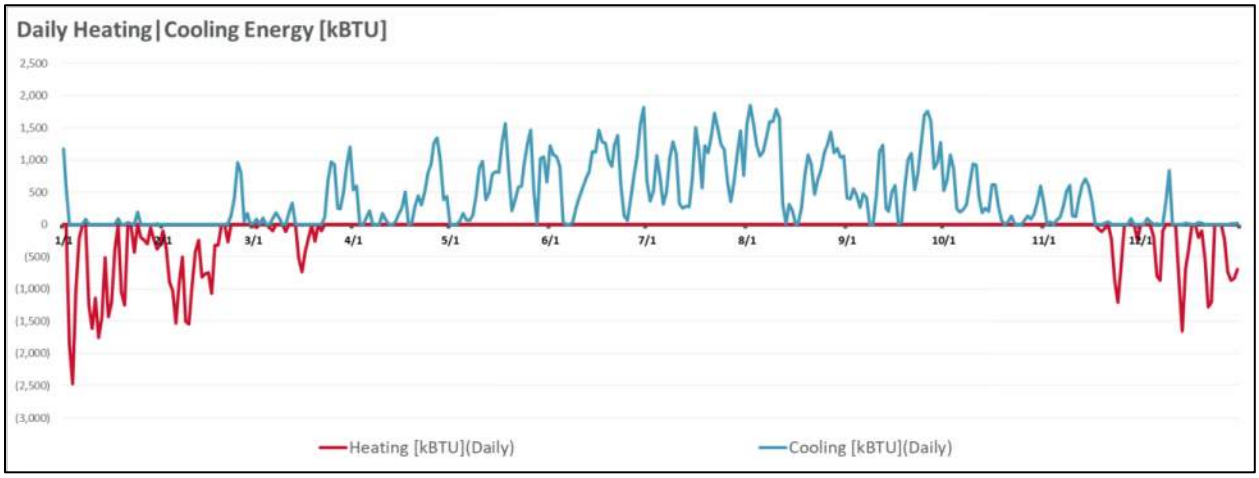
While Table 20-2 and Figure 20-2 encompasses “whole” building data, Figure 20-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 20-3. EMS #6 – Milton Road Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 20-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 20-4. EMS #6 – Milton Road Baseline Model Heating & Cooling Annual Load Profile



20.2 HVAC Refrigerants

The Durham County EMS #6 – Milton Road utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 20-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 20-3. EMS #6 – Milton Road HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(2) CU	Split-System Condensing Unit	Trane 4TTB3036E	3 Tons	R-410A	5.8 lbs	Exterior
(1) CU	Split-System Condensing Unit	Trane 4TTB3030G	2.5 Tons	R-410A	4.9 lbs	Exterior
	Ice Maker	Asbury MIM75		R-134a	6.4 oz.	Interior

20.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 20-4. EMS #6 – Milton Road Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
EMS #6 - Milton Road	Baseline	52,682.00	1,254.00	305.20	$7,909.27	21.62

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	3,512.13	83.60	20.35	$527.28	1.44	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	24.68	0.00	0.08	$2.92	0.01	NA	NA	
	Smart Thermostat	551.23	31.40	5.02	$107.25	0.32	Total Cooling Capacity Controled	102.00	kBTU/hr
	Air Conditioner Tune-up	696.76	0.00	2.38	$82.38	0.20	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$8.33	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	515.84	47.03	$533.70	2.36	# Solar Thermal Panels	10	#
Lighting	LED Retrofit	23,013.95	-152.73	63.27	$2,516.23	5.72	Applicable Area %	90.0%	%
	Lighting Occupancy Sensor	1,368.80	-9.08	3.76	$149.66	0.34	Applicable Area %	5.0%	%
	LED Exit Signs	211.99	-1.41	0.58	$23.18	0.05	Quantity of Exit Signs	2	#
	Daylight Dimming Control	1,368.80	-9.08	3.76	$149.66	0.34	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	518.98	0.00	1.77	$61.36	0.15	Quantity of Outdoor Fixtures	2	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$24.83	0.06	$0.00	2	#
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$15.90	0.04	Quantity of Power Strips	5	#
Decarbonization Measure Savings Totals (predicted)		**30,278.27**	**464.75**	**149.81**	**$4,202.67**	**11.06**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**57.5%**	**37.1%**	**49.1%**	**53.1%**	**51.2%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

20.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 20-5. EMS #6 – Milton Road Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Gas-fired unit heater, Sterling; (2) Gas furnace, direct vent, 3-ton indoor AHU, Trane, 80 mbh input; (1) Gas-fired unit heater, Dayton model 3E228B, 100 mbh input, 80 mbh output, mfg 1994; (1) Electric 2.5-ton indoor AHU, Trane model GAM2A0A30S, 7.2 kw, mfg 2013;
Domestic Hot Water	(1) Gas-fired storage water heater, natural draft, 75 gal, Rheem model 42V75F, 75.1 mbh input, 73 gph recovery, installed 2011;

Table 20-6. EMS #6 – Milton Road HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (2) electric 30kw unit heater, Modine PTE300 (60kw total); *Replace (2) split-systems with (2) 3-ton split-system heat pump condensing unit and AHU with 20 kw heater (40 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	0.0	(757.5)	12,688.3	NA	NA	71,749.7	622.0	39.3	9.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	339.5 MMBTU								307.1 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$8,520.59	$842.17	$1.20	-4.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,970.76 $US								$9,362.76 $US			
Carbon	16.8	7.3	3.09	0.0	(4.0)	3.6	NA	NA	20.4	3.3	3.03	1.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	24.1 MT CO2e								23.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 20-7. EMS #6 – Milton Road HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas unit heaters with (2) electric 30kw unit heater, Modine PTE300 (60kw total); *Replace (3) split-systems with (1) 10-ton VRF system inverter heat pump condensing unit + (3) indoor AHUs [condensing unit 55 MCA, 90 MOP @ 208V/3ph, AHUs each 6 MCA, 15 MOP @ 208V/1ph] {Vendor estimate for system equip cost - $100k};

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	0.0	(757.5)	12,395.9	NA	NA	71,457.2	622.0	39.2	9.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	339.5 MMBTU								306.1 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$8,476.33	$842.17	$1.19	-3.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,970.76 $US								$9,318.50 $US			
Carbon	16.8	7.3	3.09	0.0	(4.0)	3.5	NA	NA	20.3	3.3	3.02	2.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	24.1 MT CO2e								23.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 20-8. EMS #6 – Milton Road DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 80 gallon, 18kw input, Bradford White model CEHD80(A)18 3*CF (total 18kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	NA	NA	NA	(622.0)	14,444.2	73,505.5	757.5	41.8	3.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	339.5 MMBTU								326.6 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$8,328.47	$1,025.67	$1.20	-4.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,970.76 $US								$9,354.13 $US			
Carbon	16.8	7.3	3.09	NA	NA	NA	(3.3)	4.1	20.9	4.0	3.19	-3.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	24.1 MT CO2e								24.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 20-9. EMS #6 – Milton Road DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WH with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**59,061.4**	**1,379.5**	**43.5**	**NA**	**NA**	**NA**	**(622.0)**	**2,903.3**	**61,964.7**	**757.5**	**36.8**	**15.4%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	339.5 MMBTU								287.2 MMBTU			
Energy Cost	**$7,102.93**	**$1,867.83**	**$1.15**						**$7,350.19**	**$1,025.67**	**$1.07**	**6.6%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,970.76 $US								$8,375.85 $US			
Carbon	**16.8**	**7.3**	**3.09**	**NA**	**NA**	**NA**	**(3.3)**	**0.8**	**17.6**	**4.0**	**2.77**	**10.3%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	24.1 MT CO2e								21.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 20-10. EMS #6 – Milton Road Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$64,827.67	($1,417.66)	$1,025.67	($392.00)	($93,429.31)	-7.7087%	NA	-0.0665	NA	NA	$21.48
HVAC Pathway 2	$347,409.67	($1,373.40)	$1,025.67	($347.74)	($474,349.69)	-7.3370%	NA	-0.0104	NA	NA	$25.72
DHW Pathway 1	$5,220.00	($1,225.54)	$842.17	($383.37)	($13,136.46)	NA	NA	-0.8623	NA	NA	($40.65)
DHW Pathway 2	$14,619.00	($247.26)	$842.17	$594.91	($5,195.27)	0.6706%	2.2172%	0.7370	24.00	NA	$126.45

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$34,888.00
DHW Existing Replacement:	$8,274.00

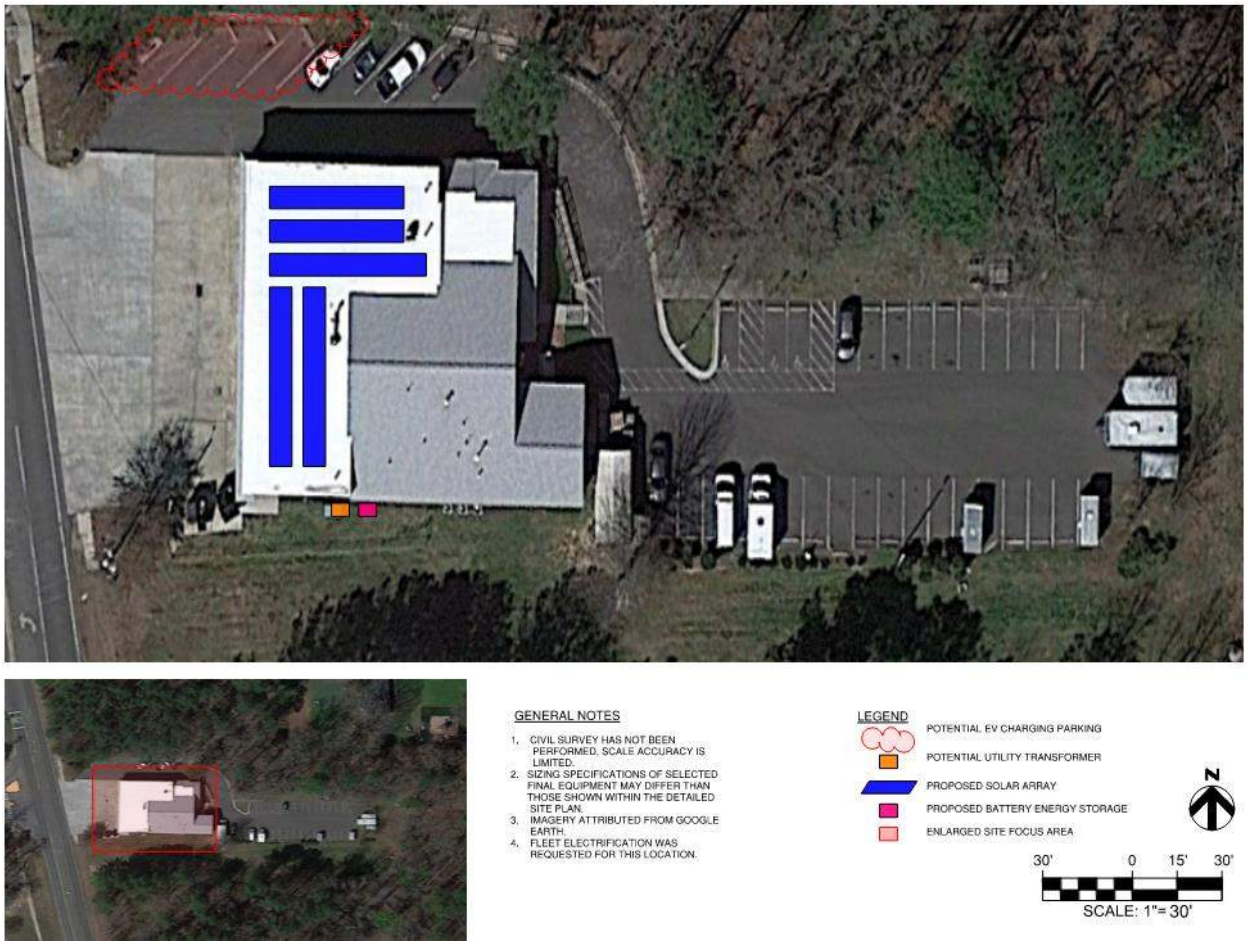
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

20.5 Renewable Energy, Energy Storage, and Electric Vehicles

20.5.1 Solar and BESS Analysis

The EMS #6 – Milton Road facility has a taller L shaped portion as well as a lower gabled roof with various pieces of equipment on the roof footprint. The taller rooftop level has a parapet wall surrounding the perimeter and no concerns for shading. The age of the roof was not confirmed, and the replacement cycle was not identified. As shown in **Error! Not a valid bookmark self-reference.**, the estimated total capacity is 25 kW DC with the potential for BESS equipment placement adjacent to existing utility equipment on the southeastern corner of the building.

Figure 20-5. EMS #6 – Milton Road Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 51,670 kWh with a peak August load of 15.1 kW. The estimated roof solar capacity is 25 kW DC and initial HOMER analysis indicates that a 25 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of

excess PV generation. Standalone PV and hybrid system both tend to have more favorable periods if ITCs are factored into the system cost. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 20-11. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. A standalone PV system would be recommended at EMS #6 due to the marginal impact of including BESS on the system renewable fraction.

Table 20-11. EMS #6 – Milton Road Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	51,670	N/A	N/A	N/A
25 kW PV Only	31,079	34,015	N/A	52
25 kW PV + 13.2 kWh BESS	27,596	34,015	4,026	54.6

20.6 Cost Summary

Cost performance for the three systems is provided in Table 20-12.

Table 20-12. EMS #6 – Milton Road Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	66,000	N/A	N/A
25 kW PV Only	55,000	100,000	1.5	21
25 kW PV + 13.2 kWh BESS	77,000	121,000	N/A	>25
Cost Summary with ITC Included				
25 kW PV Only	39,000	83,000	4.8	15
25 kW PV + 13.2 kWh BESS	54,000	98,000	0.8	24

20.6.1 Electric Vehicle

The EMS #6 – Milton Road was identified for fleet electrification. Ideal locations for EV chargers are indicated in The EMS #6 – Milton Road facility has a taller L shaped portion as well as a lower gabled roof with various pieces of equipment on the roof footprint. The taller rooftop level has a parapet wall surrounding the perimeter and no concerns for shading. The age of the roof was not confirmed, and the replacement cycle was not identified. As shown in **Error! Not a valid bookmark self-reference.**, the estimated total capacity is 25 kW DC with the potential for BESS equipment placement adjacent to existing utility equipment on the southeastern corner of the building.

Figure 20-5. A total of four (4) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 28.4 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet EV Chargers was not considered in the building load review or cost estimation.

20.7 Electrical Infrastructure Demand Feasibility Summary

Table 20-13. EMS #6 – Milton Road Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	16.64 kW	16.64 kW
HVAC Electrification Pathway 1		64.40 kW
HVAC Electrification Pathway 2		63.07 kW
DHW Electrification Pathway 1		17.37 kW
DHW Electrification Pathway 2		16.71 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

20.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard may be able to accommodate the circuit breakers required to supply power for the electric unit heaters, heat pump condensing units, air handling units required by HVAC Electrification Pathways 1 and 2. Further information is required to make this definitive. New circuit breakers will be required.

20.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard may be able to accommodate the circuit breakers required to supply power for the electric storage water heater and heat pump storage Water Heater for DHW Electrification Pathways 1 and 2. Further information is required to make this definitive. New circuit breakers will be required.

20.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

21 Fire Marshall

Durham County | Fire Marshall | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	120 E Parrish St, Durham, NC 27701	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Electric Resistance
Building Type	Office	**Cooling Generation**	Split-System DX
Year Built	1985	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	3,872	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	3	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 21-1. Fire Marshall



21.1 Existing Building Performance & Condition

21.1.1 Past Conservation Projects and Successes

- New roof installed in 2019.

21.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained; however, the equipment is beyond its expected service life. There are signs of water on the concrete floor around the domestic water heater which does not have a drain pan but does have a nearby floor drain. The water heater was manufactured in 2003 is beyond its expected service life. There were no other noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 21-1. Fire Marshall Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace water heater and provide drain pan.
Fix.1	

21.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 21-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

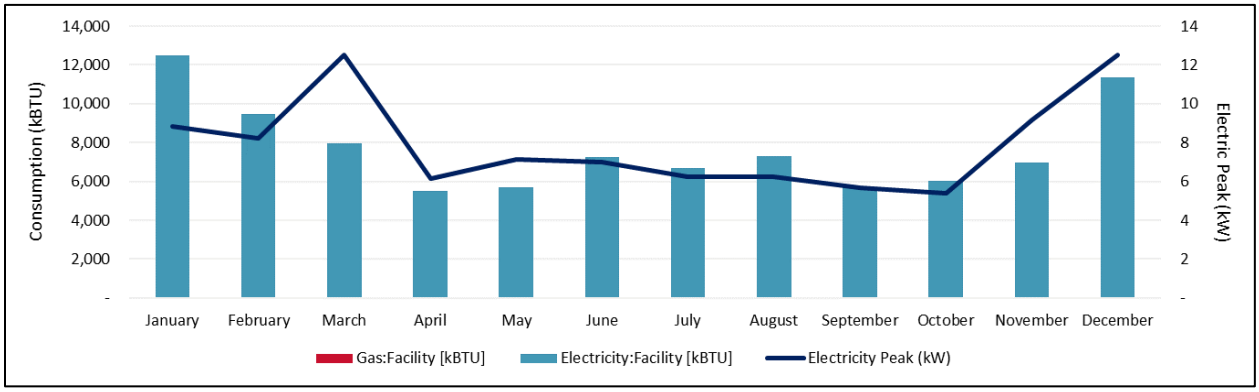
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 21-2. Fire Marshall Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	3,663	0	13	8.8	$514	$0	$514	1,040	0	1,040
February	2,776	0	9	8.2	$404	$0	$404	788	0	788
March	2,339	0	8	12.5	$349	$0	$349	664	0	664
April	1,618	0	6	6.1	$258	$0	$258	459	0	459
May	1,665	0	6	7.1	$264	$0	$264	473	0	473
June	2,130	0	7	7.0	$324	$0	$324	605	0	605
July	1,960	0	7	6.2	$305	$0	$305	557	0	557
August	2,143	0	7	6.2	$331	$0	$331	608	0	608
September	1,671	0	6	5.7	$281	$0	$281	474	0	474
October	1,765	0	6	5.4	$294	$0	$294	501	0	501
November	2,039	0	7	9.2	$328	$0	$328	579	0	579
December	3,323	0	11	12.5	$505	$0	$505	943	0	943
ANNUAL	27,093	0	92	-	$4,158	$0	$4,158	7,692	0	7,692
PEAK	-	-	-	12.5	-	-	-	-	-	-

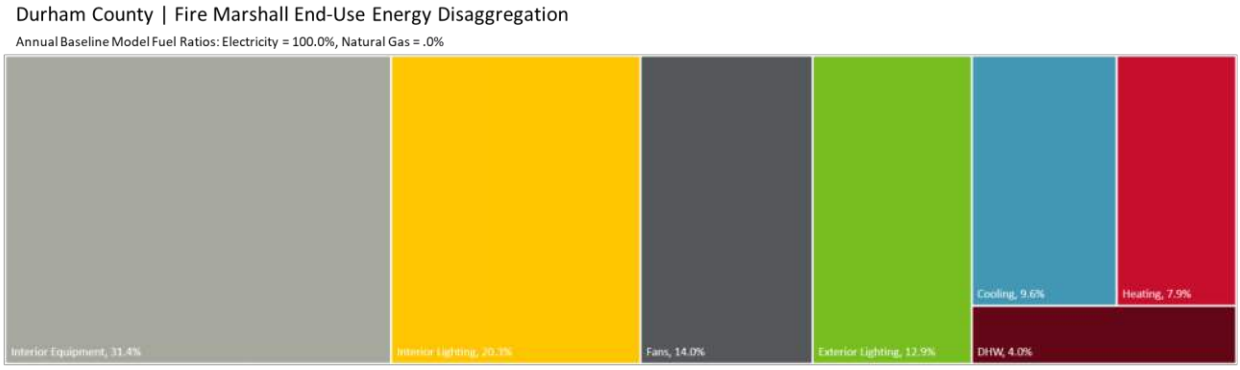
The data in Table 21-2 is represented in graphical format in Figure 21-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 21-2. Fire Marshall Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



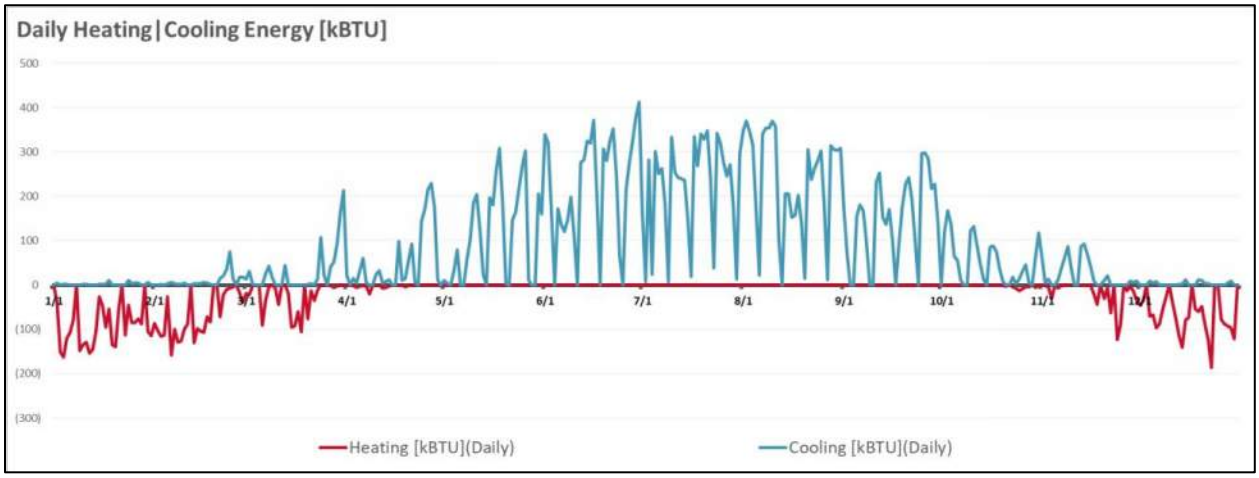
While Table 21-2 and Figure 21-2 encompasses “whole” building data, Figure 21-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 21-3. Fire Marshall Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 21-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 21-4. Fire Marshall Baseline Model Heating & Cooling Annual Load Profile



21.2 HVAC Refrigerants

The Durham County Fire Marshall utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 21-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 21-3. Fire Marshall HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) CU	Split-System Condensing Unit	Concord RH10B30A-1	2.5 Tons	R-22	Unknown	Exterior
(1) CU	Split-System Condensing Unit	Lennox SHP10C60A	5 Tons	R-22	6.7 lbs	Exterior

21.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 21-4. Fire Marshall Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Fire Marshall	Baseline	25,429.62	0.00	86.79	$4,083.98	7.22

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	1,977.86	0.00	6.75	$317.64	0.56	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	16.95	0.00	0.06	$2.72	0.00	NA	NA	
	Smart Thermostat	1,482.01	0.00	5.06	$238.01	0.42	Total Cooling Capacity Controled	90.00	kBTU/hr
	Air Conditioner Tune-up	604.07	0.00	2.06	$97.01	0.17	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$23.87	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	6,369.34	0.00	21.74	$1,022.91	1.81	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	340.95	0.00	1.16	$54.76	0.10	Applicable Area %	10.0%	%
	LED Exit Signs	106.00	0.00	0.36	$17.02	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	340.95	0.00	1.16	$54.76	0.10	Applicable Area %	10.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$16.86	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	80.70	0.00	0.28	$12.96	0.02	Quantity of Power Strips	3	#
Decarbonization Measure Savings Totals (predicted)		**11,572.46**	**0.00**	**39.50**	**$1,858.53**	**3.29**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**45.5%**	**0.0%**	**45.5%**	**45.5%**	**45.5%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

21.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 21-5. Fire Marshall Existing HVAC/DHW Systems

HVAC | Space Heating	(1) 2.5-ton AHU electric heater, Goodman model ARUF030-00A, 10 kw; (1) 5-ton AHU electric heater, Goodman model ARUF61D14, 20 kw; (1) electric baseboard heater;
Domestic Hot Water	(1) Electric storage water heater, 40 gal, American Water Heater model E61-40R-045DV, mfg 2003;

Table 21-6. Fire Marshall HVAC Electrification Pathway 1

Pathway 1 | Electrification	N/A - already electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**27,092.5**	**0.0**	**23.9**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**27,092.5**	**0.0**	**23.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	92.5 MMBTU								92.5 MMBTU			
Energy Cost	**$3,817.04**	**$0.00**	**$0.99**						**$3,817.04**	**$0.00**	**$0.99**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,817.04 $US								$3,817.04 $US			
Carbon	**7.7**	**0.0**	**1.99**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**7.7**	**0.0**	**1.99**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.7 MT CO2e								7.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 21-7. Fire Marshall HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**27,092.5**	**0.0**	**23.9**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**27,092.5**	**0.0**	**23.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	92.5 MMBTU								92.5 MMBTU			
Energy Cost	**$3,817.04**	**$0.00**	**$0.99**						**$3,817.04**	**$0.00**	**$0.99**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,817.04 $US								$3,817.04 $US			
Carbon	**7.7**	**0.0**	**1.99**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**7.7**	**0.0**	**1.99**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.7 MT CO2e								7.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 21-8. Fire Marshall DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**27,092.5**	**0.0**	**23.9**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**27,092.5**	**0.0**	**23.9**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	92.5 MMBTU								92.5 MMBTU			
Energy Cost	**$3,817.04**	**$0.00**	**$0.99**						**$3,817.04**	**$0.00**	**$0.99**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,817.04 $US								$3,817.04 $US			
Carbon	**7.7**	**0.0**	**1.99**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**7.7**	**0.0**	**1.99**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.7 MT CO2e								7.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 21-9. Fire Marshall DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) water heaters with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,092.5	0.0	23.9	NA	NA	NA	0.0	(714.6)	26,377.9	0.0	23.3	2.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	92.5 MMBTU								90.0 MMBTU			
Energy Cost	$3,817.04	$0.00	$0.99						$3,725.56	$0.00	$0.96	2.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,817.04 $US								$3,725.56 $US			
Carbon	7.7	0.0	1.99	NA	NA	NA	0.0	(0.2)	7.5	0.0	1.93	2.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.7 MT CO2e								7.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 21-10. Fire Marshall Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$2,187.78	$0.00	$0.00	$0.00	($2,956.35)	NA	-100.0000%	0.0000	NA	NA	$0.00
HVAC Pathway 2	$2,187.78	$0.00	$0.00	$0.00	($2,956.35)	NA	-100.0000%	0.0000	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$17,688.00	$91.48	$0.00	$91.48	($21,971.51)	-6.4795%	-3.2798%	0.0808	NA	NA	$10.35

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$7,214.00
DHW Existing Replacement:	$4,970.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

21.5 Electrical Infrastructure Demand Feasibility Summary

Table 21-11. Fire Marshall Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	12.53 kW	12.53 kW
HVAC Electrification Pathway 1		12.53 kW
HVAC Electrification Pathway 2		12.53 kW
DHW Electrification Pathway 1		12.53 kW
DHW Electrification Pathway 2		12.45 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

21.5.1 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the Heat Pump Storage Water Heaters for DHW Electrification Pathway 2. New circuit breakers will be required.

22 General Services

Durham County | General Services | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	310 S Dillard, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Gas Furnace RTUs
Building Type	Office	**Cooling Generation**	DX RTUs
Year Built	1994	**Domestic Hot Water Generation**	Electric Instantaneous Water Heater
Floor Area (ft2)	10,387	**Heating / Cooling / Vent Distribution**	CV Air-Handlers
Stories	2	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 22-1. General Services



22.1 Existing Building Performance & Condition

22.1.1 Past Conservation Projects and Successes

- Part of the 2012 Performance Contract to upgrade lighting to T8 fluorescents.
- Low flow plumbing fixtures and HVAC controls upgrades.
- Whole building back up by generator.
- HVAC units have been replaced, individually, between 2015-2020.

22.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 22-1. General Services Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

22.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 22-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

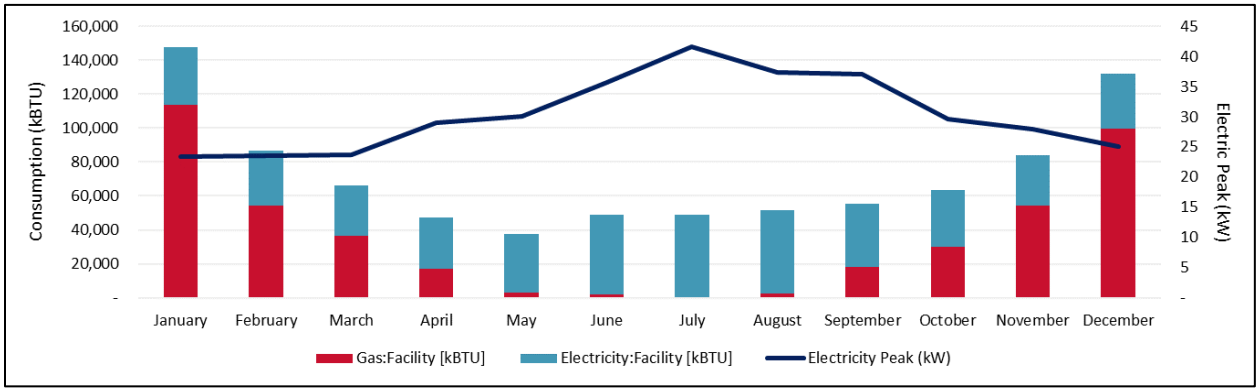
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 22-2. General Services Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	9,887	1,139	148	23.5	$756	$1,297	$2,053	2,807	6,047	8,854
February	9,503	545	87	23.6	$741	$596	$1,336	2,698	2,895	5,593
March	8,700	365	66	23.7	$714	$396	$1,109	2,470	1,939	4,409
April	8,878	170	47	29.0	$766	$194	$961	2,521	903	3,424
May	10,094	31	38	30.0	$841	$51	$892	2,866	162	3,028
June	13,785	18	49	35.6	$1,368	$39	$1,407	3,914	96	4,009
July	14,320	2	49	41.6	$1,468	$20	$1,488	4,066	8	4,074
August	14,379	24	51	37.4	$1,403	$46	$1,449	4,082	125	4,207
September	10,814	185	55	37.1	$1,259	$245	$1,504	3,070	980	4,050
October	9,881	298	64	29.7	$904	$411	$1,315	2,805	1,583	4,388
November	8,723	543	84	27.9	$838	$696	$1,534	2,476	2,884	5,361
December	9,599	994	132	25.1	$872	$1,190	$2,063	2,725	5,280	8,005
ANNUAL	128,563	4,312	870	-	$11,931	$5,181	$17,112	36,499	22,900	59,400
PEAK	-	-	-	41.6	-	-	-	-	-	-

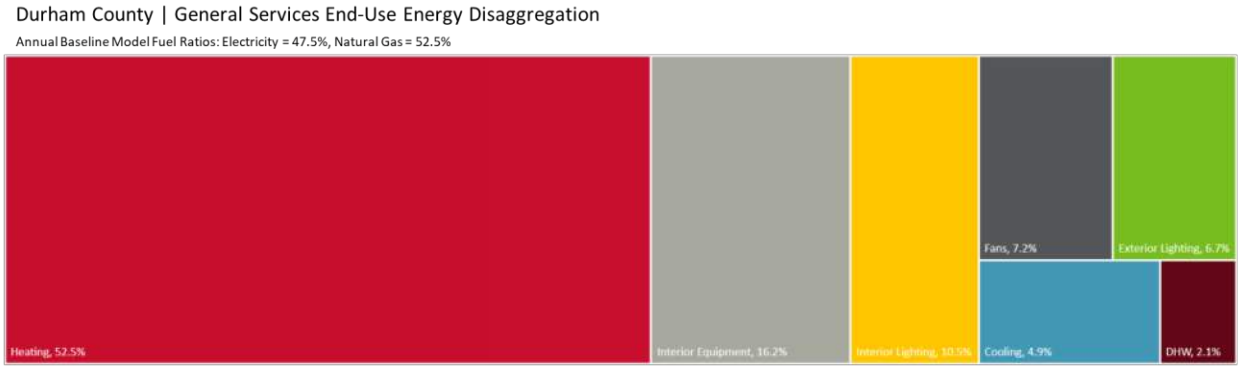
The data in Table 22-2 is represented in graphical format in Figure 22-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 22-2. General Services Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



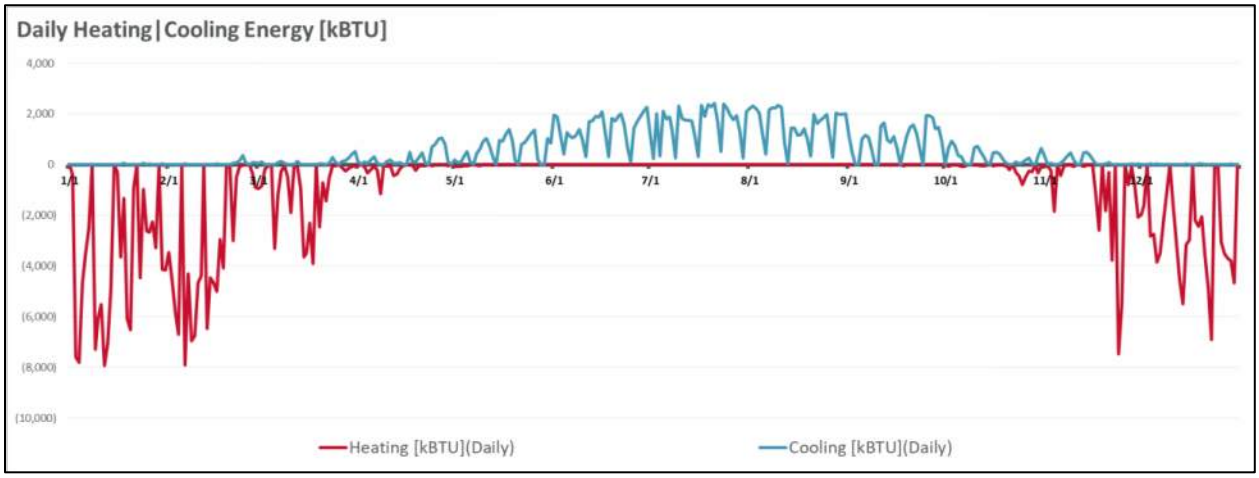
While Table 22-2 and Figure 22-2 encompasses “whole” building data, Figure 22-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 22-3. General Services Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 22-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 22-4. General Services Baseline Model Heating & Cooling Annual Load Profile



22.2 HVAC Refrigerants

The Durham County General Services utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 22-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 22-3. General Services HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) RTU-2	Rooftop Unit	Trane YSC036G3RLB	3 Tons	R-410A	10.5 lbs	Exterior
(1) RTU-1	Rooftop Unit	Trane YSH240F3RHA	20 Tons	R-410A	20.5 lbs	Exterior
(1) RTU	Rooftop Unit	Carrier 48TCED16A	15 Tons	R-410A	32.7 lbs	Exterior

22.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 22-4. General Services Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
General Services	Baseline	120,917.92	3,526.00	765.29	$16,295.56	53.06

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	9,404.73	274.24	59.52	$1,267.43	4.13	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	97.95	0.00	0.33	$9.94	0.03	NA	NA	
	Smart Thermostat	2,041.30	137.56	20.72	$364.04	1.31	Total Cooling Capacity Controled	456.00	kBTU/hr
	Air Conditioner Tune-up	2,580.21	0.00	8.81	$261.96	0.73	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$7.08	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	154.75	10.92	$41.00	0.44	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	21,210.67	-140.76	58.32	$1,993.01	5.27	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	5,676.97	-37.67	15.61	$533.42	1.41	Applicable Area %	50.0%	%
	LED Exit Signs	317.99	-2.11	0.87	$29.88	0.08	Quantity of Exit Signs	3	#
	Daylight Dimming Control	1,703.09	-11.30	4.68	$160.03	0.42	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$263.45	0.74	Quantity of Outdoor Fixtures	10	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.66	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	349.70	0.00	1.19	$35.50	0.10	Quantity of Power Strips	13	#
Decarbonization Measure Savings Totals (predicted)		**44,748.94**	**380.92**	**190.82**	**$4,977.42**	**14.73**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**37.0%**	**10.8%**	**24.9%**	**30.5%**	**27.8%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

22.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 22-5. General Services Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU-2 gas furnace, 80 mbh input, 64.8 mbh output; (1) RTU-1 gas furnace, 400 mbh input, 324 mbh output; (1) RTU gas furnace, 240 mbh input, 195 mbh output; (1) electric nunit heater;
Domestic Hot Water	(2) undersink electric instantaneous, Stiebel Eltron, 3 kw; (1) electric storage water heater, AO Smith model DEN-52-100, 55 gallon, 6 kw, mfg 2022;

Table 22-6. General Services HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace (3) RTUs with electric resistance heating coils.

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	0.0	(4,843.2)	102,082.4	NA	NA	230,645.4	0.0	75.8	14.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	923.1 MMBTU								787.2 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$31,470.07	$0.00	$3.03	-67.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,770.38 $US								$31,470.07 $US			
Carbon	36.5	25.7	5.99	0.0	(25.7)	29.0	NA	NA	65.5	0.0	6.30	-5.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	62.2 MT CO2e								65.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 22-7. General Services HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (3) RTUs with (1) 3-ton heat pump RTU, w/ economizer, 18 kw elec heat, Trane model WHC036; ; (1) 15-ton heat pump RTU w/ economizer, 54 kw electric heat, Trane WHJ180; (1) 20-Ton heat pump RTU w/ economizer, 72 kw electric heat, Trane WHJ240;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	0.0	(4,843.2)	45,827.3	NA	NA	174,390.4	0.0	57.3	35.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	923.1 MMBTU								595.2 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$20,941.19	$0.00	$2.02	-11.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,770.38 $US								$20,941.19 $US			
Carbon	36.5	25.7	5.99	0.0	(25.7)	13.0	NA	NA	49.5	0.0	4.77	20.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	62.2 MT CO2e								49.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 22-8. General Services DHW Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	NA	NA	NA	0.0	0.0	128,563.0	4,843.2	88.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	923.1 MMBTU								923.1 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$12,950.66	$5,819.72	$1.81	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,770.38 $US								$18,770.38 $US			
Carbon	36.5	25.7	5.99	NA	NA	NA	0.0	0.0	36.5	25.7	5.99	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	62.2 MT CO2e								62.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 22-9. General Services DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**128,563.0**	**4,843.2**	**88.9**	**NA**	**NA**	**NA**	**0.0**	**(3,655.8)**	**124,907.3**	**4,843.2**	**87.7**	**1.4%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	923.1 MMBTU								910.6 MMBTU			
Energy Cost	**$12,950.66**	**$5,819.72**	**$1.81**						**$12,658.64**	**$5,819.72**	**$1.78**	**1.6%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$18,770.38 $US								$18,478.36 $US			
Carbon	**36.5**	**25.7**	**5.99**	**NA**	**NA**	**NA**	**0.0**	**(1.0)**	**35.5**	**25.7**	**5.89**	**1.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	62.2 MT CO2e								61.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 22-10. General Services Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$77,777.25	($18,519.41)	$5,819.72	($12,699.69)	($359,203.25)	NA	NA	-2.4177	NA	NA	($166.10)
HVAC Pathway 2	$114,659.00	($7,990.53)	$5,819.72	($2,170.81)	($186,877.54)	-8.5442%	NA	-0.2061	NA	NA	$648.42
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$1,020.00	$292.02	$0.00	$292.02	$4,783.42	36.5378%	6.9291%	4.4704	4.00	5.00	$52.93

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$202,449.00
DHW Existing Replacement:	$9,132.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

22.5 Renewable Energy, Energy Storage, and Electric Vehicles

22.5.1 Solar and BESS Analysis

The small General Services facility possess a unique shaped roof with sloping in a variety of angles and directions. Due to the sectionalized characteristics of the roof, there is limited footprint for solar equipment. It is recommended for solar equipment to be only placed on the Southernmost faces of the roof. The roof is scheduled to be replaced in 2033. The total estimated capacity for solar equipment for the various roof levels is 9 kW DC with potential for BESS equipment to be placed on the Northern corner of the facility, Figure 22-5.

Figure 22-5. General Services Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 120,918 kWh with a peak July load of 15.7 kW. The estimated roof solar capacity is 9 kW DC, and initial HOMER analysis indicates that a 9 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and hybrid systems possess unfavorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems possess unfavorable payback periods and IRR due to the high capital cost of BESS. Standalone PV systems tend to have more favorable payback periods if incentives are considered in the

cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 22-11. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the low renewable fraction and relatively high simple payback period for both configurations, it is recommended to wait until the energy density of PV and BESS technology improves.

Table 22-11. General Services Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	120,918	N/A	N/A	N/A
9 kW PV Only	108,690	12,245	N/A	10.1
9 kW PV + 39.6 kWh BESS	108,678	12,245	24.5	10.1

22.6 Cost Summary

Cost performance for the three systems is provided in Table 22-12.

Table 22-12. General Services Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	147,000	N/A	N/A
9 kW PV Only	31,000	167,000	N/A	>25
9 kW PV + 39.6 kWh BESS	96,000	230,000	N/A	>25
Cost Summary with ITC Included				
9 kW PV Only	22,000	158,000	0.5	23.4
9 kW PV + 39.6 kWh BESS	67,000	201,000	N/A	>25

22.6.1 Electric Vehicle

The General Services facility was identified for fleet electrification but not for public charging. Ideal locations for EV chargers are indicated behind the fleet vehicle parking lot access gate. Six (6) charging locations are shown in Figure 22-5 should chargers be considered in the future. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, see the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

22.7 Electrical Infrastructure Demand Feasibility Summary

Table 22-13. General Services Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	41.56 kW	41.56 kW
HVAC Electrification Pathway 1		430.43 kW
HVAC Electrification Pathway 2		243.12 kW
DHW Electrification Pathway 1		41.56 kW
DHW Electrification Pathway 2		40.97 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

22.7.1 Building HVAC Electrification Implementation Feasibility

The current electrical distribution system cannot accommodate the inclusion of the HVAC Electrification Pathway 1 equipment. A new feeder panel will be required to have enough space on the panelboard to provide power for the new equipment. New circuit breakers will be required for each new piece of equipment.

22.7.2 Building DHW Electrification Implementation Feasibility

The current electrical distribution system can accommodate the inclusion of the DHW Electrification Pathway 2 equipment. New circuit breakers will be required for the new piece of equipment.

22.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. Because of limited space, a new feeder panel will be required if both systems are decided to be added. New circuit breakers will be required for each system.

23 Head Start

Durham County | Head Start | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	215 W Seminary, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Daycare	**Cooling Generation**	Packaged DX
Year Built	2003	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	13,370	**Heating / Cooling / Vent Distribution**	Single-Zone Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	11
		Weekday Opening Time	Monday-Friday, 7:00am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 23-1. Head Start





23.1 Existing Building Performance & Condition

23.1.1 Past Conservation Projects and Successes

No historical data available.

23.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age. A p-trap is not installed on the cooling coil condensate drain for the rooftop units which can prevent proper drainage of the drain pan for draw-through units.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 23-1. Head Start Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	Install condensate drain P-traps.

23.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 23-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

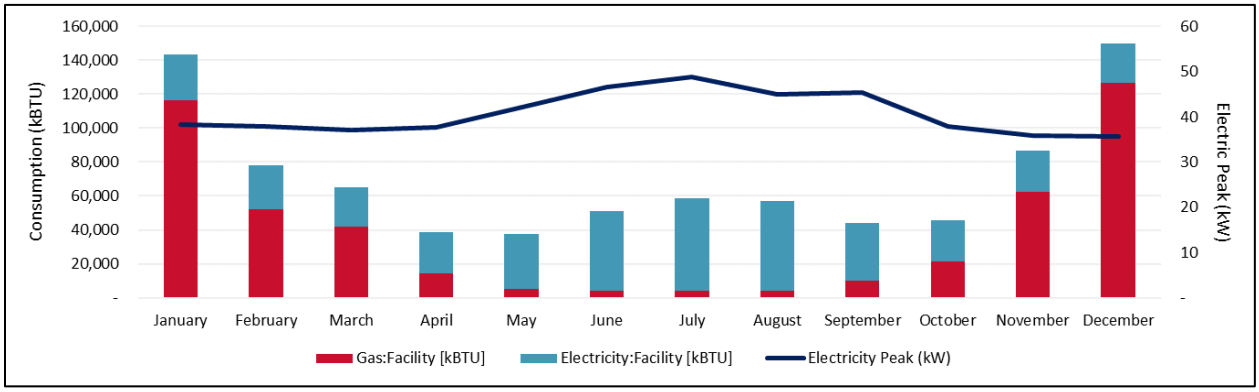
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 23-2. Head Start Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	7,884	1,163	143	38.2	$801	$1,327	$2,129	2,238	6,177	8,416
February	7,622	520	78	37.8	$785	$572	$1,357	2,164	2,762	4,926
March	6,820	417	65	37.1	$724	$448	$1,172	1,936	2,215	4,151
April	7,173	142	39	37.8	$772	$163	$935	2,037	754	2,791
May	9,444	54	38	42.1	$937	$74	$1,010	2,681	284	2,965
June	13,720	44	51	46.6	$1,236	$65	$1,301	3,895	231	4,126
July	15,946	41	59	48.7	$1,392	$62	$1,454	4,527	218	4,745
August	15,348	44	57	44.9	$1,363	$66	$1,429	4,357	234	4,591
September	10,038	99	44	45.3	$1,108	$135	$1,242	2,850	523	3,373
October	7,072	217	46	37.9	$808	$287	$1,096	2,008	1,153	3,160
November	7,094	625	87	35.9	$814	$799	$1,613	2,014	3,317	5,331
December	6,801	1,265	150	35.6	$789	$1,516	$2,305	1,931	6,716	8,647
ANNUAL	114,960	4,629	855	-	$11,530	$5,514	$17,044	32,637	24,584	57,222
PEAK	-	-	-	48.7	-	-	-	-	-	-

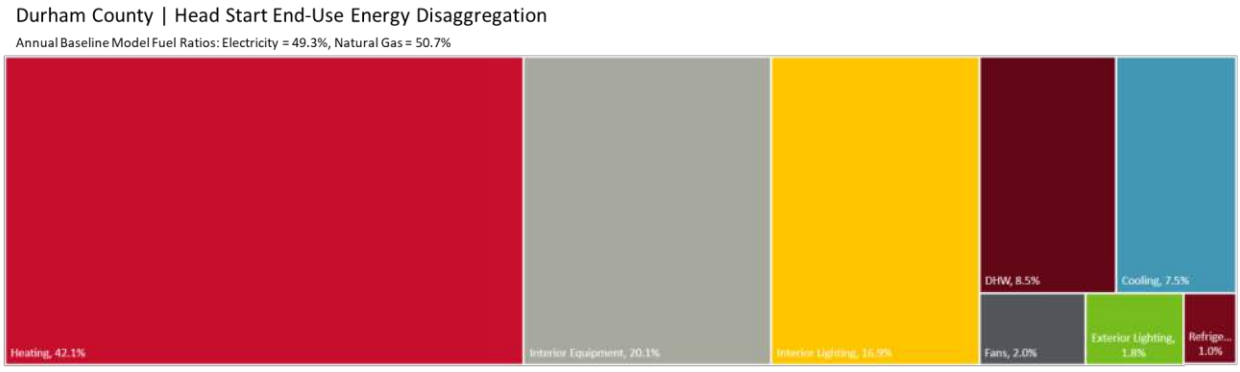
The data in Table 23-2 is represented in graphical format in Figure 23-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 23-2. Head Start Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



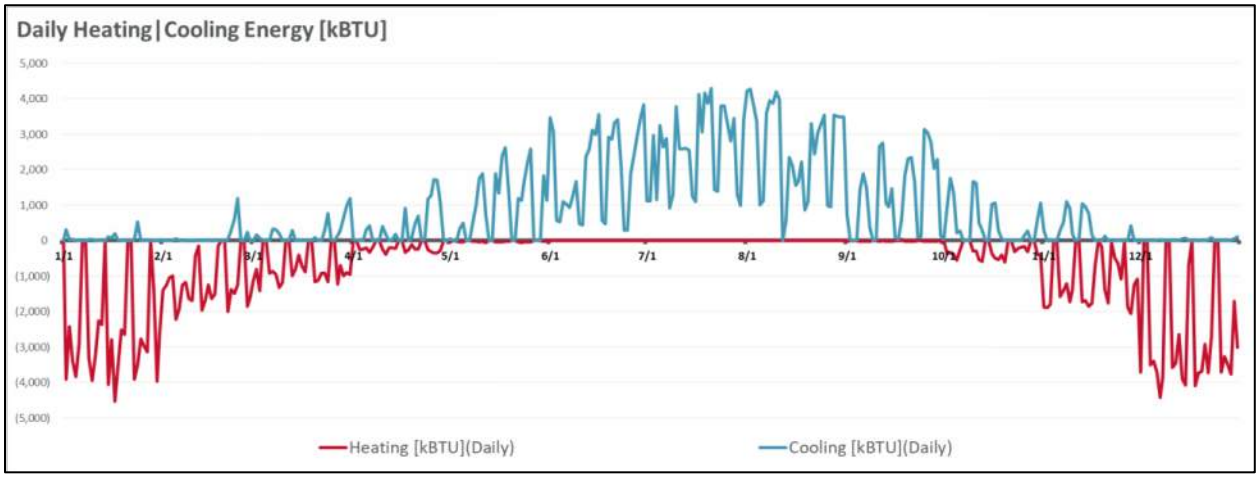
While Table 23-2 and Figure 23-2 encompasses “whole” building data, Figure 23-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 23-3. Head Start Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 23-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 23-4. Head Start Baseline Model Heating & Cooling Annual Load Profile



23.2 HVAC Refrigerants

The Durham County Head Start utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 23-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 23-3. Head Start HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
RTU 1	Rooftop Unit	Trane YHD210	17.5 tons	R-410A	21.3 lbs	Exterior
RTU 2	Rooftop Unit	Trane YSC092	7.5 tons	R-410A	7.5 lbs	Exterior
RTU 3	Rooftop Unit	Trane YSD150	12.5 tons	R-410A	11.83 lbs	Exterior

23.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 23-4. Head Start Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Head Start	Baseline	113,499.20	4,202.00	807.57	$16,734.69	54.54

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	8,827.72	326.82	62.81	$1,301.59	4.24	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	164.60	0.00	0.56	$17.46	0.05	NA	NA	
	Smart Thermostat	1,538.39	328.90	38.14	$530.54	2.18	Total Cooling Capacity Controled	450.00	kBTU/hr
	Air Conditioner Tune-up	1,944.52	0.00	6.64	$206.31	0.55	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.94	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	533.60	48.81	$454.45	2.46	# Solar Thermal Panels	15	#
Lighting	LED Retrofit	22,942.92	-152.26	63.08	$2,264.10	5.70	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	1,541.76	-10.23	4.24	$152.15	0.38	Applicable Area %	10.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	3	#
	Daylight Dimming Control	2,312.65	-15.35	6.36	$228.22	0.58	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$513.75	1.37	Transformer Size	500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	53.80	0.00	0.18	$5.71	0.02	Quantity of Power Strips	2	#
Decarbonization Measure Savings Totals (predicted)		**42,835.16**	**1,017.70**	**247.96**	**$5,681.22**	**17.57**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**37.7%**	**24.2%**	**30.7%**	**33.9%**	**32.2%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

23.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 23-5. Head Start Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU#1 gas furnace, 250mbh input; (1) RTU#3 gas furnace, 250mbh input; (1) RTU#2 gas furnace, 120mbh input; (1) air curtain elec heater, 13kw input, Mars model LPV272
Domestic Hot Water	(1) gas-fired storage water heater, 100 gallon, 199 mbh input, State model SBD100199NET, mfg. 2007; (1) gas-fired storage water heater, 89 gallon, 154 mbh input, AO Smith model BTC154964, mfg. 1996

Table 23-6. Head Start HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace RTUs with w/ elec heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**114,959.8**	**4,028.0**	**59.5**	**0.0**	**(3,479.9)**	**78,084.0**	**NA**	**NA**	**193,043.8**	**548.2**	**53.4**	**10.2%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	795.2 MMBTU								713.7 MMBTU			
Energy Cost	**$12,344.27**	**$4,798.37**	**$1.28**						**$20,112.88**	**$653.02**	**$1.55**	**-21.1%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$17,142.64 $US								$20,765.89 $US			
Carbon	**32.6**	**21.4**	**4.04**	**0.0**	**(18.5)**	**22.2**	**NA**	**NA**	**54.8**	**2.9**	**4.32**	**-6.8%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	54.0 MT CO2e								57.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 23-7. Head Start HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace RTUs with heat-pump units w/ elec heat-(1) 20T heat pump RTU, 54kw electric heat, Trane WHJ240; (1) 12.5T heat pump RTU, 54kw electric heat, Trane WHJ180; (1) 7.5T heat pump RTU, 27kw elec heat, Trane WHC092;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	114,959.8	4,028.0	59.5	0.0	(3,479.9)	28,280.6	NA	NA	143,240.4	548.2	40.7	31.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	795.2 MMBTU								543.7 MMBTU			
Energy Cost	$12,344.27	$4,798.37	$1.28						$15,112.80	$653.02	$1.18	8.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$17,142.64 $US								$15,765.82 $US			
Carbon	32.6	21.4	4.04	0.0	(18.5)	8.0	NA	NA	40.7	2.9	3.26	19.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	54.0 MT CO2e								43.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 23-8. Head Start DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 119 gallon, 54kw; (1) electric storage water heater, 119 gallon, 36kw;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	114,959.8	4,028.0	59.5	NA	NA	NA	(548.2)	12,633.8	127,593.6	3,479.9	58.6	1.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	795.2 MMBTU								783.5 MMBTU			
Energy Cost	$12,344.27	$4,798.37	$1.28						$13,402.71	$4,145.35	$1.31	-2.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$17,142.64 $US								$17,548.06 $US			
Carbon	32.6	21.4	4.04	NA	NA	NA	(2.9)	3.6	36.2	18.5	4.09	-1.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	54.0 MT CO2e								54.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 23-9. Head Start DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas WHs with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ x 119 gallon storage tank each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**114,959.8**	**4,028.0**	**59.5**	**NA**	**NA**	**NA**	**(548.2)**	**2,308.5**	**117,268.3**	**3,479.9**	**56.0**	**5.9%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	795.2 MMBTU								748.2 MMBTU			
Energy Cost	**$12,344.27**	**$4,798.37**	**$1.28**						**$12,539.31**	**$4,145.35**	**$1.25**	**2.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$17,142.64 $US								$16,684.66 $US			
Carbon	**32.6**	**21.4**	**4.04**	**NA**	**NA**	**NA**	**(2.9)**	**0.7**	**33.3**	**18.5**	**3.87**	**4.2%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	54.0 MT CO2e								51.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 23-10. Head Start Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$80,002.50	($7,768.61)	$4,145.35	($3,623.26)	($174,682.82)	NA	NA	-0.6158	NA	NA	($187.94)
HVAC Pathway 2	$158,116.00	($2,768.53)	$4,145.35	$1,376.82	($174,734.05)	-5.1746%	-1.2924%	0.1822	NA	NA	$533.17
DHW Pathway 1	-$2,111.00	($1,058.44)	$653.02	($405.42)	($4,145.97)	NA	NA	NA	NA	NA	($34.43)
DHW Pathway 2	$487,107.00	($195.04)	$653.02	$457.98	($647,010.17)	-7.0902%	-6.9691%	0.0170	NA	NA	$115.07

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$173,946.00
DHW Existing Replacement:	$43,300.00

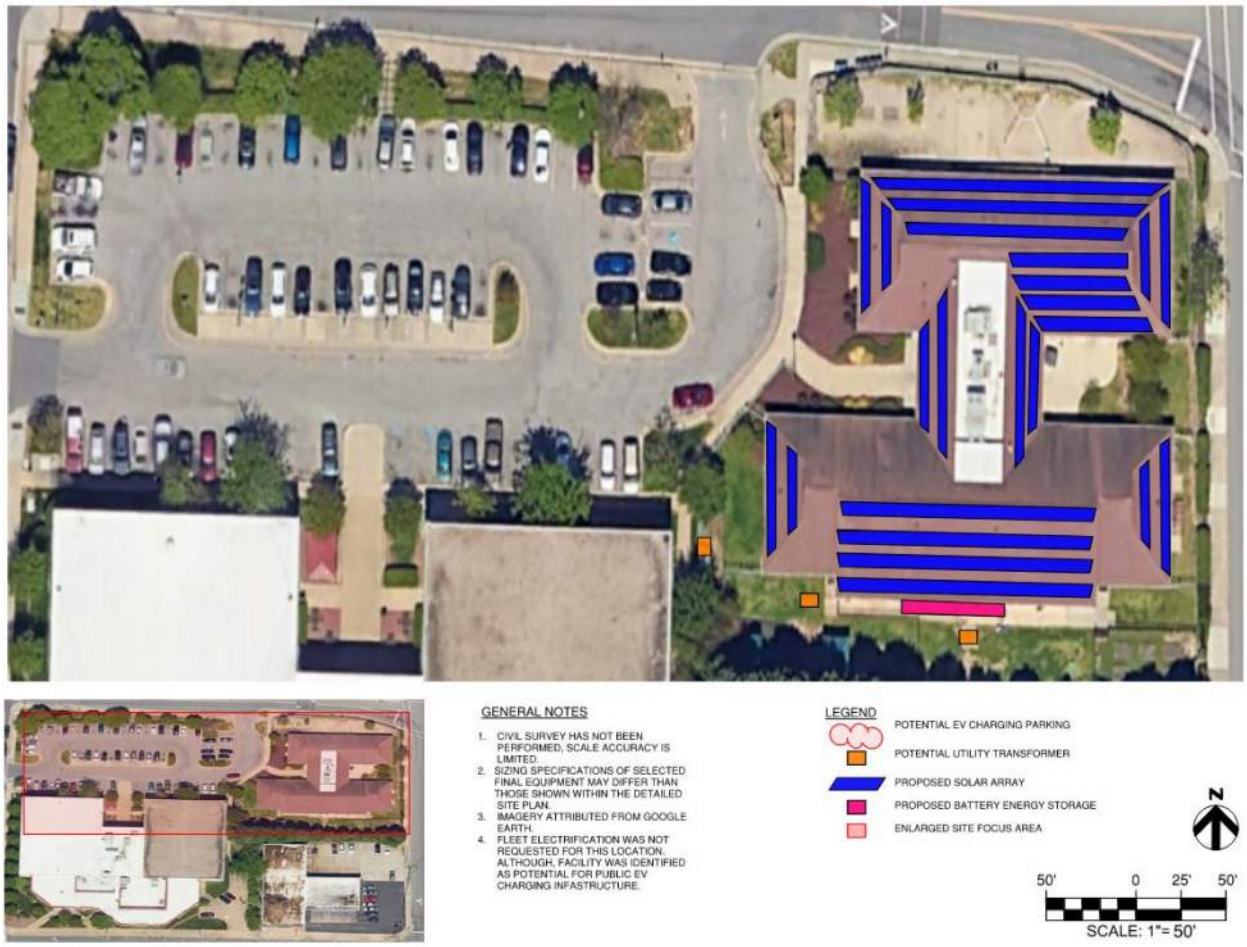
Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

23.5 Renewable Energy, Energy Storage, and Electric Vehicles

23.5.1 Solar and BESS Analysis

The Head Start facility is shaped in an “I” structure and split into 3 main sections. The roof material is assumed as shingles. The top and bottom of the “I” at the Northern and Southern ends of the facility are pyramid in shape with minimal HVAC equipment located on the roof. The roof is scheduled for replacement in 2037. The center of the roof has HVAC equipment taking up the majority of the available footprint for solar equipment. The entirety of the roof was estimated with a solar capacity of 90 kW DC, with available placement of BESS equipment on the South wall of the facility (Figure 245).

Figure 23-5. Head Start Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 113,328 kWh with a peak July load of 50.6 kW. The estimated roof solar capacity is 90 kW DC and initial HOMER analysis indicates that only a 75 kW DC nameplate PV system would be optimal. To optimize production, the potential PV system should utilize south facing roof sections where possible. HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid

systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS. PV and hybrid systems tend to have more favorable payback periods when incentives are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 23-11 . Cost performance of the three system configurations is provided in Table 23-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 23-11. Head Start Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	113,328	N/A	N/A	N/A
75 kW PV Only	51,811	102,045	N/A	66.3
75 kW PV + 39.6 kWh BESS	41,693	102,045	11,289	70.5

23.6 Cost Summary

Table 23-12. Head Start Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	159,000	N/A	N/A
75 kW PV Only	140,000	222,000	1.2	21
75 kW PV + 39.6 kWh BESS	205,000	281,000	N/A	>25
Cost Summary with ITC Included				
75 kW PV Only	98,000	180,000	4.3	15
75 kW PV + 39.6 kWh BESS	143,000	219,000	1.6	22

23.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

23.7 Electrical Infrastructure Demand Feasibility Summary

Table 23-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	48.72 kW	48.72 kW
HVAC Electrification Pathway 1		135.01 kW
HVAC Electrification Pathway 2		62.39 kW
DHW Electrification Pathway 1		49.01 kW
DHW Electrification Pathway 2		48.81 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

23.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. Subsequent downstream panels also have no spare capacity for the new loads. A new branch circuit panel will be required to provide power to this equipment.

23.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. Subsequent downstream panels also have no spare capacity for the new loads. A new branch circuit panel will be required to provide power to this equipment.

23.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

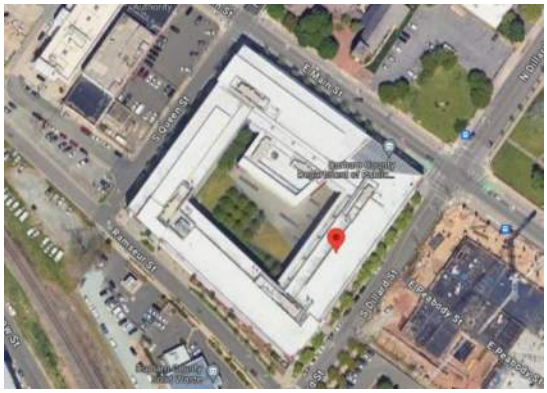
The existing main distribution panelboard does not have enough space for the PV or BESS systems. Subsequent downstream panels also have no spare capacity for the new loads. A new main distribution panel will be required to provide power to this equipment.

24 Health and Human Services

Durham County | Health and Human Services | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	414 E Main St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Condensing Boilers
Building Type	Office	**Cooling Generation**	Water-Cooled Chiller
Year Built	2010	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	293,507	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	3	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Metal Panel	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 24-1. Health and Human Services





24.1 Existing Building Performance & Condition

24.1.1 Past Conservation Projects and Successes

No historical data available.

24.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 24-1. Health and Human Services Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

24.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 24-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

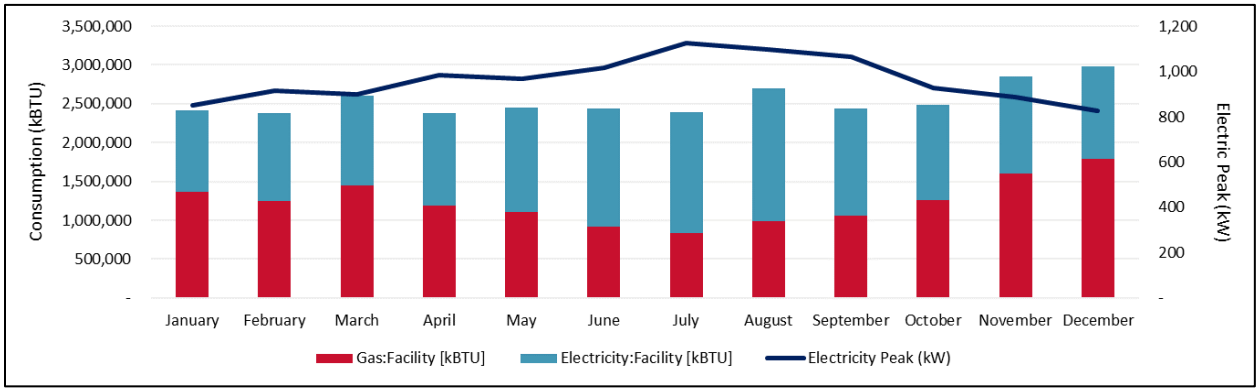
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 24-2. Health and Human Services Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	306,492	13,640	2,410	849.2	$25,679	$2,688	$28,367	87,014	72,449	159,463
February	334,399	12,445	2,386	916.8	$27,500	$2,461	$29,961	94,937	66,101	161,038
March	339,764	14,470	2,607	898.8	$27,695	$2,838	$30,533	96,460	76,857	173,317
April	346,739	11,935	2,377	983.2	$28,358	$2,396	$30,753	98,440	63,393	161,833
May	393,708	11,050	2,449	968.8	$31,187	$2,241	$33,428	111,775	58,692	170,467
June	446,508	9,135	2,437	1,017.2	$35,164	$1,907	$37,071	126,765	48,520	175,285
July	455,865	8,350	2,391	1,124.4	$36,198	$1,766	$37,964	129,421	44,351	173,772
August	502,478	9,870	2,702	1,095.6	$39,774	$2,035	$41,809	142,655	52,424	195,079
September	404,732	10,620	2,443	1,063.2	$36,715	$4,482	$41,197	114,905	56,408	171,313
October	360,537	12,575	2,488	926.0	$32,969	$5,523	$38,492	102,358	66,792	169,150
November	368,721	15,970	2,855	888.4	$33,564	$6,961	$40,525	104,681	84,824	189,505
December	348,900	17,875	2,978	827.6	$32,083	$7,396	$39,479	99,054	94,943	193,996
ANNUAL	4,608,842	147,935	30,523	-	$386,885	$42,695	$429,580	1,308,465	785,754	2,094,219
PEAK	-	-	-	1,124.4	-	-	-	-	-	-

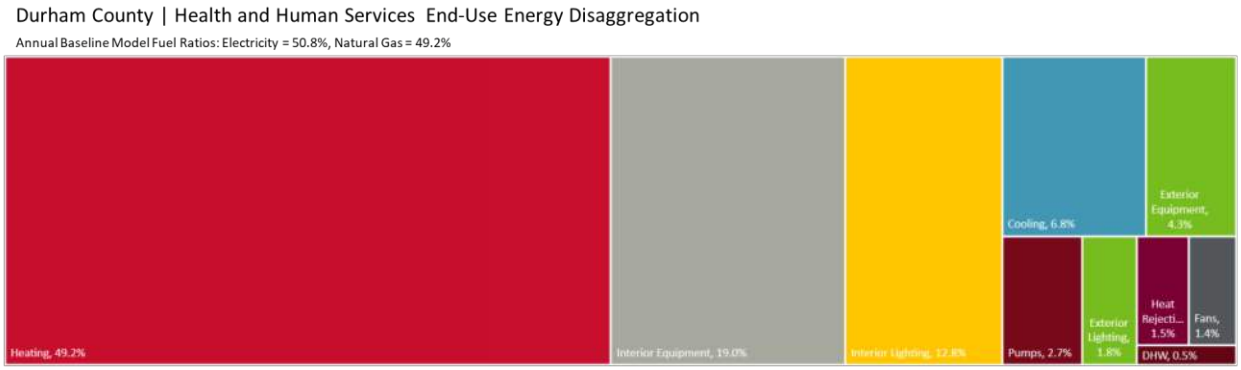
The data in Table 24-2 is represented in graphical format in Figure 24-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 24-2. Health and Human Services Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



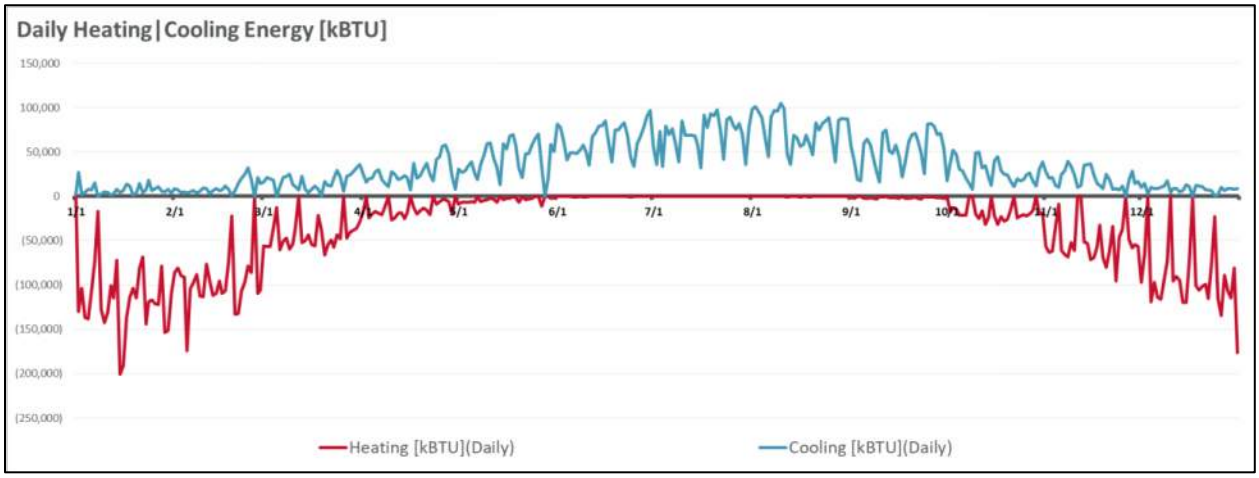
While Table 24-2 and Figure 24-2 encompasses “whole” building data, Figure 24-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 24-3. Health and Human Services Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 24-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 24-4. Health and Human Services Baseline Model Heating & Cooling Annual Load Profile



24.2 HVAC Refrigerants

The Durham County Health and Human Services utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 24-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 24-3. Health and Human Services HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Water-Cooled Chiller	York YKDRDRQ4-CMGS	375 tons	R-134A	1430 lbs	Interior
CH-2	Water-Cooled Chiller	York YKDRDRQ4-CMGS	375 tons	R-134A	1430 lbs	Interior
(4) Mini-split	Air-Cooled Condenser	Daikin RZQ18PVJU	1.5 tons	R-410A	5.1 lbs	Exterior
(5) VRV	Air-Cooled Condenser	Sanyo CHDX09663		R-410A	26 lbs	Exterior
CU	Air-Cooled Condenser	York YLUA0095ZE	91 tons	R-410A	107 lbs	Exterior

24.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every

reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 24-4. Health and Human Services Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Health and Human Services	Baseline	4,771,019.20	151,660.00	31,449.34	$480,567.12	2,160.05

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	556,618.91	17,693.67	3,669.09	$56,066.16	252.01	Potential Annual Energy Savings (%)	11.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	113,976.85	0.00	389.00	$10,123.21	32.36	NA	NA	
	Smart Thermostat	7,505.68	0.00	25.62	$666.64	2.13	Total Cooling Capacity Controled	1,060.40	kBTU/hr
	Air Conditioner Tune-up	9,487.17	0.00	32.38	$842.63	2.69	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	3,158.42	315.84	$1,183.20	16.78	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	668.88	0.00	2.28	$59.41	0.19	NA	NA	
	Solar Thermal Domestic Hot Water	23,342.48	0.00	79.67	$2,073.23	6.63	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	246,792.43	-1,637.80	678.51	$21,306.08	61.37	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	111,056.59	-737.01	305.33	$9,587.74	27.61	Applicable Area %	50.0%	%
	LED Exit Signs	6,253.76	-41.50	17.19	$539.90	1.56	Quantity of Exit Signs	59	#
	Daylight Dimming Control	33,316.98	-221.10	91.60	$2,876.32	8.28	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	5,189.76	0.00	17.71	$460.94	1.47	Quantity of Outdoor Fixtures	20	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	6,519.28	0.00	22.25	$579.03	1.85	Transformer Size	2500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	525.00	0.00	1.79	$46.63	0.15	$0.00	5	#
	Tier 1 Advanced Power Strip	9,872.30	0.00	33.69	$876.84	2.80	Quantity of Power Strips	367	#
Decarbonization Measure Savings Totals (predicted)		1,131,126.06	18,214.67	5,681.97	$107,287.97	417.88			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		23.7%	12.0%	18.1%	22.3%	19.3%			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

24.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 24-5. Health and Human Services Existing HVAC/DHW Systems

HVAC | Space Heating	(4) HW gas-fired boilers, Hydrotherm KN-2, 1999 mbh input, 1799 output, 120F EWT 160F LWT, CV primary pumps; (2) 10hp VV secondary pumps w/ VFDs;
Domestic Hot Water	(1) Electric storage water heater, State model PCE302OLSA, 30 gallon, 9kw, mfg. 2015; (1) Electric storage water heater, Bradford White model LE140L3, 38 gallon, 4.5kw; mfg. 8/2021; (1) Electric storage water heater, State model CSB12018IFEAB, 119 gallon, 18kw, mfg.

Table 24-6. Health and Human Services HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace boilers with (4) 520 kw electric boilers, 8-step control, Lochinvar BWX24-520F

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	0.0	(152,254.0)	3,939,073.6	NA	NA	8,547,915.8	0.0	99.4	5.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	30,955.2 MMBTU								29,173.8 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$803,806.11	$0.00	$2.74	-69.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$473,170.39 $US								$803,806.11 $US			
Carbon	1,308.5	808.7	7.21	0.0	(808.7)	1,118.3	NA	NA	2,426.8	0.0	8.27	-14.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,117.2 MT CO2e								2,426.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 24-7. Health and Human Services HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	"Simple" + *Replace chillers with (2) 375-ton magnetic bearing centrifugal heat-recover chillers, Trane "Agility" HDWA400, full load 0.65 kw/ton, IPLV 0.32 kw/ton; *Add 1200 gpm plate & frame heat exchanger

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	(51,829.8)	(152,254.0)	1,300,823.4	NA	NA	5,857,835.8	0.0	68.1	35.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	30,955.2 MMBTU								19,992.6 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$550,510.36	$0.00	$1.88	-16.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$473,170.39 $US								$550,510.36 $US			
Carbon	1,308.5	808.7	7.21	(14.7)	(808.7)	369.3	NA	NA	1,663.1	0.0	5.67	21.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,117.2 MT CO2e								1,663.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 24-8. Health and Human Services DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	NA	NA	NA	0.0	0.0	4,608,842.2	152,254.0	105.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	30,955.2 MMBTU								30,955.2 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$429,229.24	$43,941.15	$1.61	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$473,170.39 $US								$473,170.39 $US			
Carbon	1,308.5	808.7	7.21	NA	NA	NA	0.0	0.0	1,308.5	808.7	7.21	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,117.2 MT CO2e								2,117.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 24-9. Health and Human Services DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**4,608,842.2**	**152,254.0**	**105.5**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**4,608,842.2**	**152,254.0**	**105.5**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	30,955.2 MMBTU								30,955.2 MMBTU			
Energy Cost	**$429,229.24**	**$43,941.15**	**$1.61**						**$429,229.24**	**$43,941.15**	**$1.61**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$473,170.39 $US								$473,170.39 $US			
Carbon	**1,308.5**	**808.7**	**7.21**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**1,308.5**	**808.7**	**7.21**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	2,117.2 MT CO2e								2,117.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 24-10. Health and Human Services Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$1,995,310.47	($374,576.87)	$43,941.15	($330,635.72)	($9,568,137.49)	NA	NA	-2.5487	NA	NA	($15,790.71)
HVAC Pathway 2	$3,716,647.47	($121,281.12)	$43,941.15	($77,339.97)	($6,549,530.05)	-9.9870%	NA	-0.3041	NA	NA	$23,159.13
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$22,501.00	$0.00	$0.00	$0.00	($30,405.69)	NA	-100.0000%	0.0000	NA	NA	$0.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$221,144.00
DHW Existing Replacement:	$20,735.00

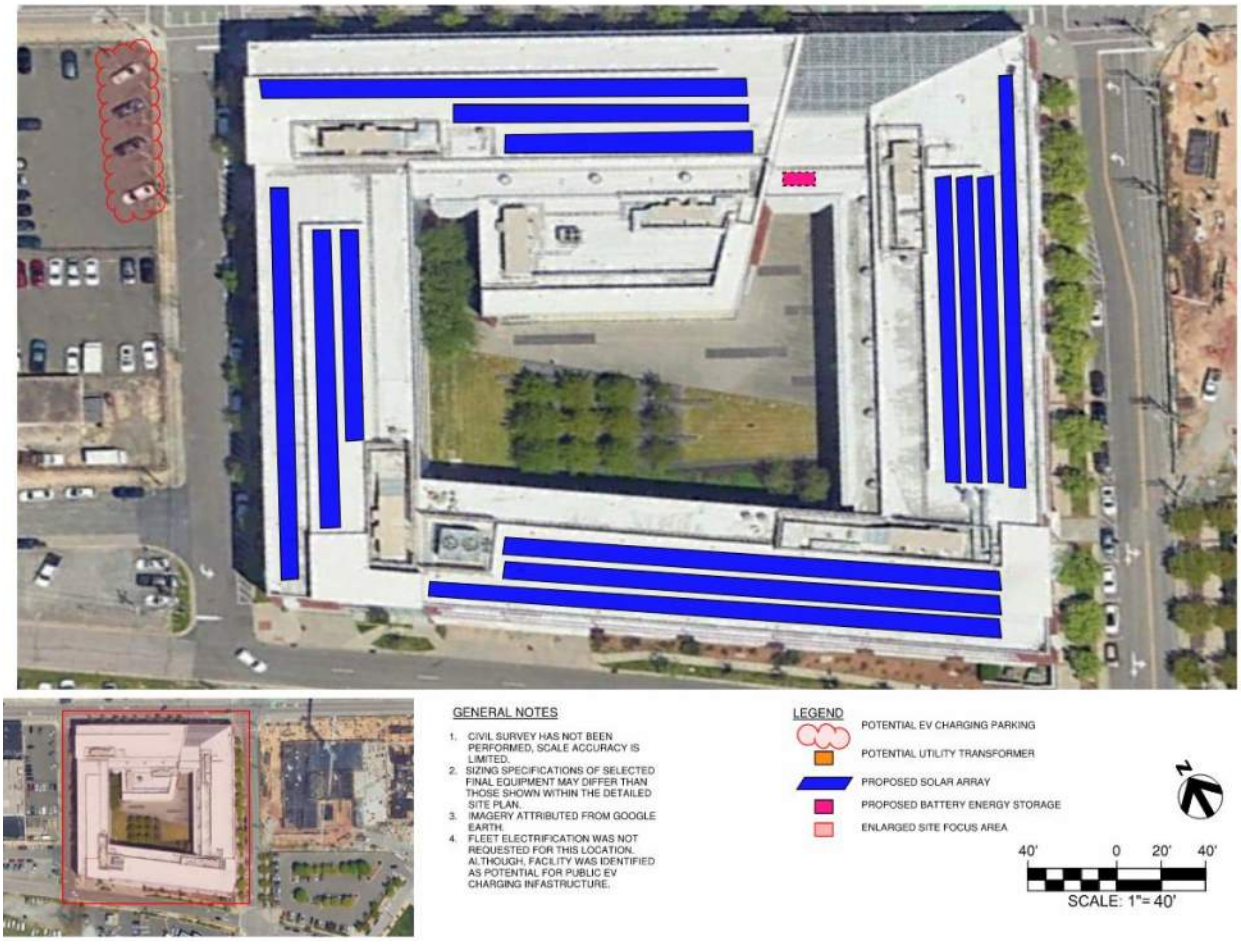
Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

24.5 Renewable Energy, Energy Storage, and Electric Vehicles

24.5.1 Solar and BESS Analysis

The Health and Human Services facility roof has a flat unknown surface with a parapet wall surrounding the perimeter that is recognized as having minimal shading. The roof is scheduled for replacement in 2031. The large roof is divided into four (4) main sections with varying quantities of HVAC equipment and levels. The lowest rooftop level was not reviewed for solar equipment due to concern of shading from the tall surrounding buildings. The four sections total to an estimated solar capacity of 325 kW, Figure 24-5. Due to the large amount of public traffic surrounding the interior and exterior of the facility, it is recommended for the BESS equipment to be placed in a secure interior location of the facility.

Figure 24-5. Health and Human Services Conceptual Renewables and EV Visual Aid



*BESS system to be located in a secure interior location. Durham County to determine installation location.

The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 4,779,765 kWh with a peak August load of 1,097.6 kW. The estimated roof solar capacity is 325 kW DC and initial HOMER analysis indicates that only a 300 kW DC nameplate PV system

would be optimal. For optimal performance, the potential PV system should utilize South, East, and West facing roofs when possible. HOMER model results indicate that multiple combinations of PV and BESS possess favorable payback periods, IRR. Standalone PV and hybrid systems tend to have more favorable payback periods when incentives are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 24-11. Cost performance of the three system configurations is provided in Table 24-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only or PV+BESS system configurations do not possess a preferred results compared to the base. These system configurations should be re-evaluated once it is believed costs may be more preferable.

Table 24-11. Health and Human Services Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	4,779,765	N/A	N/A	N/A
300 kW PV Only	4,374,203	406,120	N/A	8.5
300 kW PV + 39.6 kWh BESS	4,373,980	406,120	632	8.5

24.6 Cost Summary

Table 24-12. Health and Human Services Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	5,140,000	N/A	N/A
300 kW PV Only	537,000	5,330,000	2.4	19
300 kW PV + 39.6 kWh BESS	602,000	5,390,000	1.7	21
Cost Summary with ITC Included				
300 kW PV Only	376,000	5,170,000	5.8	13
300 kW PV + 39.6 kWh BESS	421,000	5,210,000	5	14

24.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, this facility was identified for long lay-over periods and recommended for consideration of public charging.

24.7 Electrical Infrastructure Demand Feasibility Summary

Table 24-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	1,124.40 kW	1,124.40 kW
HVAC Electrification Pathway 1		3,357.84 kW
HVAC Electrification Pathway 2		2,418.65 kW
DHW Electrification Pathway 1		1,124.40 kW
DHW Electrification Pathway 2		1,124.40 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

24.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the required breaker size to supply power for the electric heater required by HVAC Electrification Pathway 1 and 2. New circuit breakers will be required.

24.7.2 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution system can accommodate the PV and BESS system. Branch circuit panels have available space to provide a connection to house the required circuit breaker.

25 Judicial Building Annex

Durham County | Judicial Building Annex | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	201 N Roxboro St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Condensing Boilers
Building Type	Office	**Cooling Generation**	Packaged DX
Year Built	1974	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	25,692	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	3	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 25-1. Judicial Building Annex





25.1 Existing Building Performance & Condition

25.1.1 Past Conservation Projects and Successes

No historical data available.

25.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 25-1. Judicial Building Annex Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

25.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 25-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

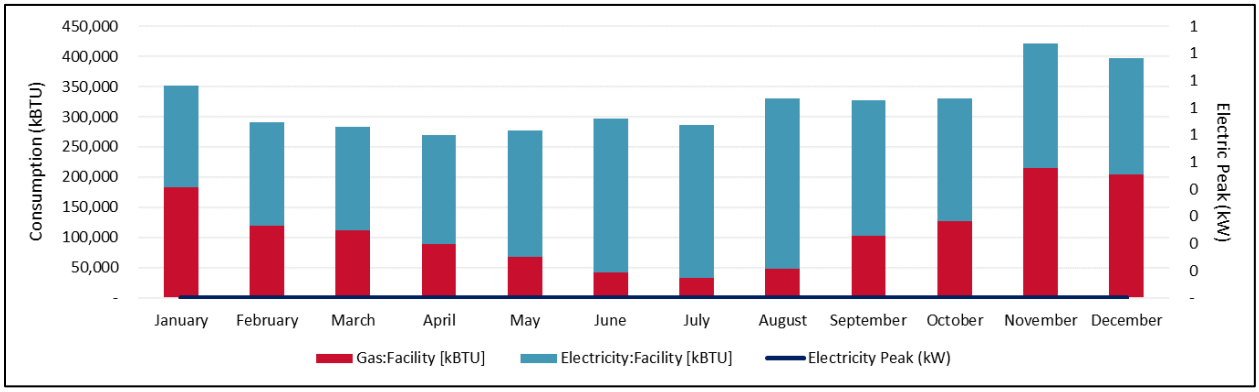
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 25-2. Judicial Building Annex Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	49,292	1,835	352	0.0	$3,322	$2,070	$5,392	13,994	9,744	23,738
February	49,949	1,201	291	0.0	$3,364	$1,252	$4,616	14,181	6,379	20,560
March	50,535	1,115	284	0.0	$3,415	$1,124	$4,539	14,347	5,922	20,269
April	52,791	891	269	0.0	$3,593	$882	$4,475	14,988	4,730	19,717
May	61,489	675	277	0.0	$4,555	$672	$5,227	17,457	3,583	21,039
June	74,551	423	297	0.0	$6,185	$454	$6,639	21,165	2,247	23,412
July	74,424	326	287	0.0	$6,279	$356	$6,635	21,129	1,732	22,861
August	82,740	477	330	0.0	$6,801	$528	$7,329	23,490	2,534	26,024
September	66,018	1,025	328	0.0	$6,295	$1,138	$7,433	18,743	5,444	24,187
October	59,394	1,277	330	0.0	$4,704	$1,503	$6,207	16,862	6,780	23,642
November	60,557	2,143	421	0.0	$4,595	$2,471	$7,066	17,192	11,383	28,575
December	56,626	2,043	398	0.0	$4,272	$2,405	$6,677	16,076	10,849	26,925
ANNUAL	738,365	13,429	3,863	-	$57,382	$14,853	$72,235	209,624	71,325	280,949
PEAK	-	-	-	0.0	-	-	-	-	-	-

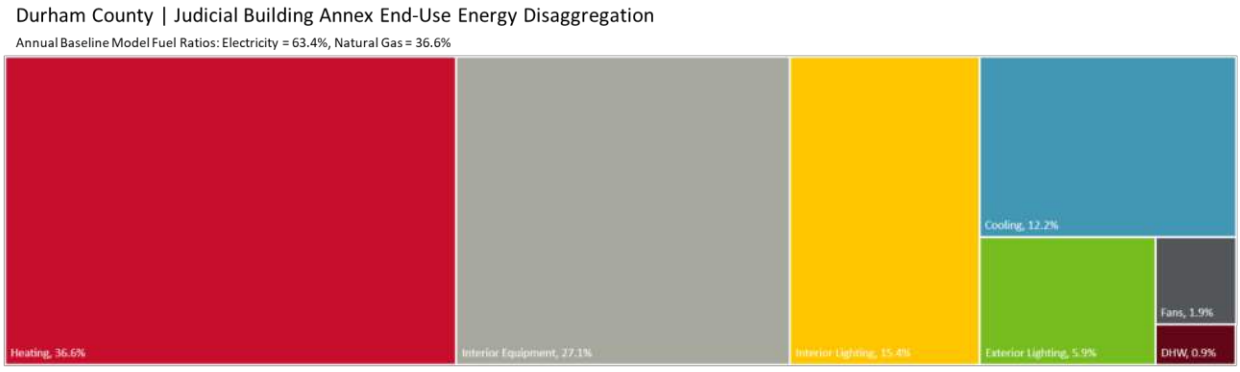
The data in Table 25-2 is represented in graphical format in Figure 25-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 25-2. Judicial Building Annex Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



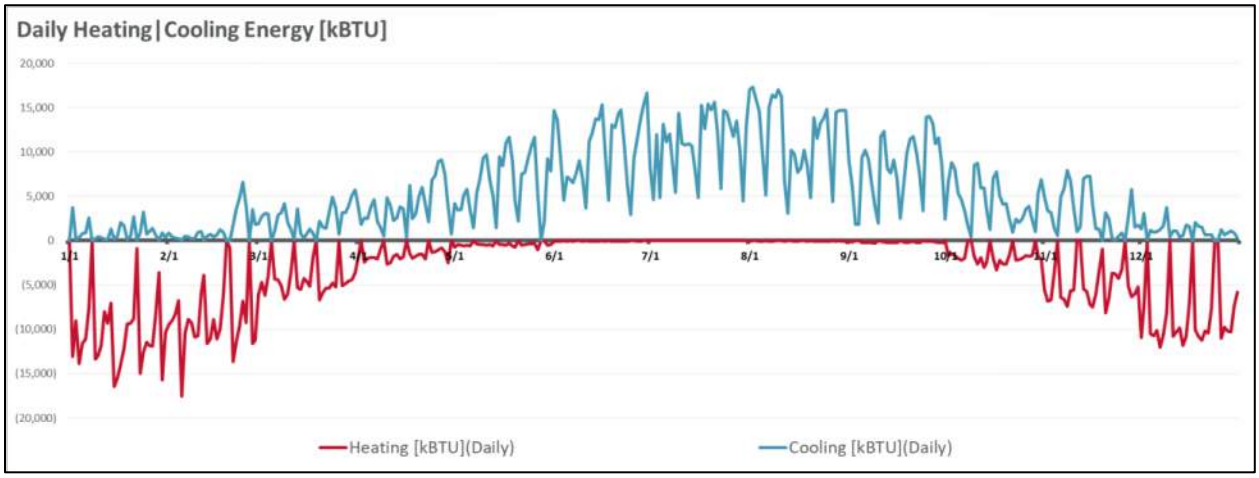
While Table 25-2 and Figure 25-2 encompasses “whole” building data, Figure 25-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 25-3. Judicial Building Annex Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 25-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 25-4. Judicial Building Annex Baseline Model Heating & Cooling Annual Load Profile



25.2 HVAC Refrigerants

The Durham County Judicial Building Annex utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 25-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 25-3. Judicial Building Annex HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
RTU 1	Rooftop Unit	Trane SEHLF754NR	75 tons	R-410A	92 lbs	Exterior
Mini-split	Air-Cooled Condenser	Mitsubishi PUY-A24NHA7	2 tons	R-410A	7.7 lbs	Exterior

25.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 25-4. Judicial Building Annex Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Judicial Building Annex	Baseline	776,369.84	14,633.00	4,113.03	$78,297.03	298.14

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	86,263.32	1,625.89	457.00	$8,699.67	33.13	Potential Annual Energy Savings (%)	11.1%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,747.46	0.00	29.85	$715.69	2.48	NA	NA	
	Smart Thermostat	10,367.04	0.00	35.38	$848.20	2.94	Total Cooling Capacity Controled	900.00	kBTU/hr
	Air Conditioner Tune-up	6,840.22	0.00	23.35	$559.64	1.94	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	281.50	28.15	$284.27	1.50	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$24.32	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	4,835.46	0.00	16.50	$395.62	1.37	# Solar Thermal Panels	5	#
Lighting	LED Retrofit	37,612.12	-249.61	103.41	$2,825.24	9.35	Applicable Area %	75.0%	%
	Lighting Occupancy Sensor	15,122.00	-100.36	41.58	$1,135.89	3.76	Applicable Area %	50.0%	%
	LED Exit Signs	635.98	-4.22	1.75	$47.77	0.16	Quantity of Exit Signs	6	#
	Daylight Dimming Control	4,536.60	-30.11	12.47	$340.77	1.13	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	3,703.38	0.00	12.64	$303.00	1.05	Transformer Size	300.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	315.00	0.00	1.08	$25.77	0.09	$0.00	3	#
	Tier 1 Advanced Power Strip	1,748.50	0.00	5.97	$143.06	0.50	Quantity of Power Strips	65	#
Decarbonization Measure Savings Totals (predicted)		**181,024.36**	**1,523.10**	**770.14**	**$16,348.91**	**59.48**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**23.3%**	**10.4%**	**18.7%**	**20.9%**	**20.0%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

25.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 25-5. Judicial Building Annex Existing HVAC/DHW Systems

HVAC | Space Heating	(1) RTU-1 electric resistance pre-heat, 90 kw (smallest available from manuf.); Basment - electric reheat at terminal units; 1st & 2nd floors - hot water reheat at terminal units, electric baseboard heat in entrance lobbies; (2) Outdoor gas-fired HW boilers on roof, Lochinvar "KnightXL" outdoor condensing boilers, model & serial numbers not visible, assumed 400mbh input, 30 gpm CV primary pumps, 75 gpm VV secondary pump
Domestic Hot Water	(1) electric storage water heater, 50 gallon, 12kw, State model CSB5212, mfg. date 2019; recirc pump and master TMV

Table 25-6. Judicial Building Annex HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace (2) gas boilers with (2) electric boilers, 96kw each (192 kw total)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	738,364.8	14,558.1	154.7	0.0	(14,558.1)	368,409.8	NA	NA	1,106,774.5	0.0	147.0	5.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,975.8 MMBTU								3,777.4 MMBTU			
Energy Cost	$68,811.62	$16,102.77	$3.31						$102,398.26	$0.00	$3.99	-20.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$84,914.39 $US								$102,398.26 $US			
Carbon	209.6	77.3	11.17	0.0	(77.3)	104.6	NA	NA	314.2	0.0	12.23	-9.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	286.9 MT CO2e								314.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 25-7. Judicial Building Annex HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) gas boilers with (2) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 120 FLA @ 460V/3ph)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**738,364.8**	**14,558.1**	**154.7**	**0.0**	**(14,558.1)**	**174,428.5**	**NA**	**NA**	**912,793.2**	**0.0**	**121.3**	**21.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,975.8 MMBTU								3,115.3 MMBTU			
Energy Cost	**$68,811.62**	**$16,102.77**	**$3.31**						**$84,432.37**	**$0.00**	**$3.29**	**0.6%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$84,914.39 $US								$84,432.37 $US			
Carbon	**209.6**	**77.3**	**11.17**	**0.0**	**(77.3)**	**49.5**	**NA**	**NA**	**259.1**	**0.0**	**10.09**	**9.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	286.9 MT CO2e								259.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 25-8. Judicial Building Annex DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**738,364.8**	**14,558.1**	**154.7**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**738,364.8**	**14,558.1**	**154.7**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,975.8 MMBTU								3,975.8 MMBTU			
Energy Cost	**$68,811.62**	**$16,102.77**	**$3.31**						**$68,811.62**	**$16,102.77**	**$3.31**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$84,914.39 $US								$84,914.39 $US			
Carbon	**209.6**	**77.3**	**11.17**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**209.6**	**77.3**	**11.17**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	286.9 MT CO2e								286.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 25-9. Judicial Building Annex DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 119 gallon, 12 kw input, 4.2 COP, Lochinvar CHPA120PD

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	738,364.8	14,558.1	154.7	NA	NA	NA	0.0	(6,366.3)	731,998.4	14,558.1	153.9	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,975.8 MMBTU								3,954.1 MMBTU			
Energy Cost	$68,811.62	$16,102.77	$3.31						$68,233.02	$16,102.77	$3.28	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$84,914.39 $US								$84,335.78 $US			
Carbon	209.6	77.3	11.17	NA	NA	NA	0.0	(1.8)	207.8	77.3	11.10	0.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	286.9 MT CO2e								285.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 25-10. Judicial Building Annex Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$188,135.89	($33,586.64)	$16,102.77	($17,483.87)	($584,777.93)	NA	NA	-1.3002	NA	NA	($1,390.66)
HVAC Pathway 2	$1,844,360.89	($15,620.75)	$16,102.77	$482.02	($2,443,753.15)	-6.9732%	-6.6585%	0.0195	NA	NA	$1,418.01
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$0.00	$578.60	$0.00	$578.60	$12,208.81	NA	NA	NA	NA	NA	$92.18

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$51,304.00
DHW Existing Replacement:	$3,880.00

Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

25.5 Renewable Energy, Energy Storage, and Electric Vehicles

25.5.1 Solar and BESS Analysis

The Judicial Building Annex facility is a flat unknown roof with no concern of shading from surrounding structures. There is a large protruding structure in the center of the roof with HVAC equipment, this area is avoided for solar equipment footprint. The roof was scheduled for replacement in 2019. The main level of the roof has an estimated available solar footprint for 50 kW DC, Figure 25-5. Due to the architecture of the building, having windows on the majority of the exterior, it is recommended for the BESS equipment to be placed in a secure interior location.

Figure 25-5. Judicial Building Annex Conceptual Renewables and EV Visual Aid



*BESS system to be located in a secure interior location. Durham County to determine installation location.

The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. Only monthly energy consumption data was provided for the Judicial Building Annex. Hourly peak load data was not provided for this building; thus, it is assumed that this building follows a similar load profile to South Regional Library. The current annual

building consumption is approximately 713,670 kWh with an assumed peak July load of 115.4 kW The estimated roof solar capacity is 50 kW DC and initial HOMER analysis indicates that a 50 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS and small amount of excess PV generation. Standalone PV systems tend to have more favorable payback periods when incentives are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 25-11. Cost performance of the three system configurations is provided in Table 25-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only or PV+BESS system configurations do not possess a preferred results compared to the base. These system configurations should be re-evaluated once it is believed costs may be more preferable.

Table 25-11. Judicial Building Annex Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	713,670	N/A	N/A	N/A
50kW PV Only	645,640	68,030	N/A	9.5
50kW PV + 92 kWh BESS	646,478	68,030	3,817	9.4

25.6 Cost Summary

Table 25-12. Judicial Building Annex Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	752,000	N/A	N/A
50kW PV Only	93,000	795,000	1.1	22
50kW PV + 92 kWh BESS	244,000	944,000	N/A	>25
Cost Summary with ITC Included				
50kW PV Only	65,000	767,000	4.3	15
50kW PV + 92 kWh BESS	171,000	871,000	N/A	>25

25.6.1 Electric Vehicle

The Judicial Building Annex was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 25-5. A total of six (6) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 43.2 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, please see the self-assessment tool (Figure 1-9) in section 1.3.3.4. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

25.7 Electrical Infrastructure Demand Feasibility Summary

Table 25-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	Not Available	248.80 kW
HVAC Electrification Pathway 1		405.03 kW
HVAC Electrification Pathway 2		286.59 kW
DHW Electrification Pathway 1		248.80 kW
DHW Electrification Pathway 2		247.46 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

25.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard has enough space for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. New circuit breakers will be required.

25.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard has enough space for the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required.

25.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard has enough space for the PV or BESS systems. New circuit breakers will be required.

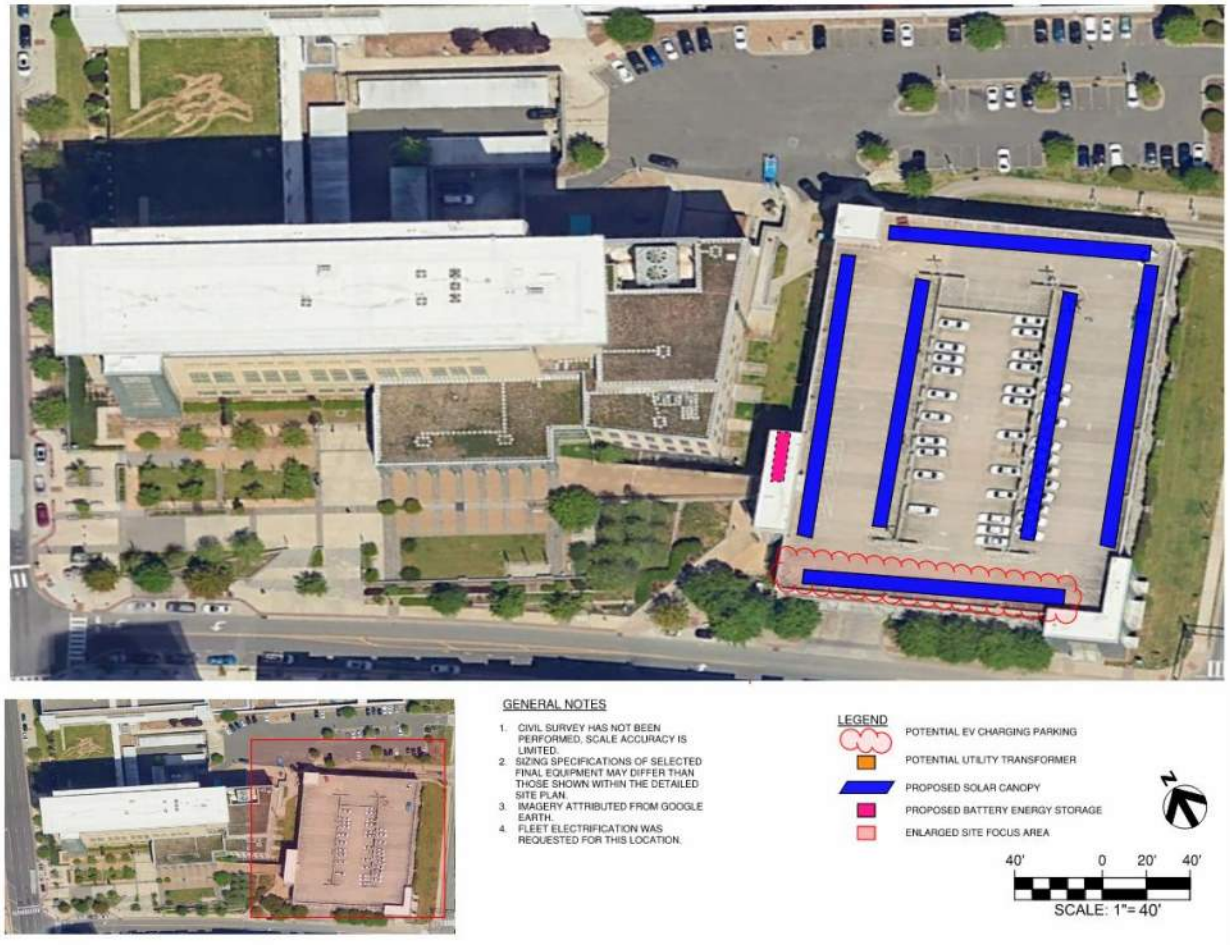
26 Justice Center Parking Deck

26.1 Renewable Energy, Energy Storage, and Electric Vehicles

26.1.1 Solar and BESS Analysis

The Justice Center Parking Deck is located adjacent to the Durham County Courthouse where 145 kW DC of potential solar capacity was identified on the rooftop. The Justice Center parking deck solar canopies were reviewed for the main parking stalls of the top level for an estimated available solar footprint of 78 kW DC.

Figure 26-1. Justice Center Parking Deck Conceptual Renewables and EV Visual Aid



*BESS system to be located in a secure interior location. Durham County to determine installation location.

The current parking garage load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 209,753 kWh with a peak January load of 58.2 kW. The estimated roof solar capacity is 78 kW DC and initial HOMER analysis indicates that only a 52 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and

BESS possess unfavorable payback periods and IRR due to the high capital cost of canopy solar and BESS. The base case and PV system configuration with the fastest payback period are provided in Table 26-1. It should be noted that the PV capital cost for this building is increased to account for a more expensive mounting structure. It is also important to note that this estimation does not include the potential increase for structural analysis costs associated with implementation of solar canopies on the top level of a parking garage. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and negligible difference with added BESS, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 26-1. Justice Center Parking Deck Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	290,753	N/A	N/A	N/A
52 kW PV Only	223,204	70,394	N/A	24
52 kW PV + 79 kWh BESS	221,372	70,394	4,611	23.9

26.2 Cost Summary

Cost performance for the three systems is provided in Table 26-2.

Table 26-2. Justice Center Parking Deck Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	303,000	N/A	N/A
52 kW PV Only	1,320,000	1,570,000	N/A	>25
52 kW PV + 79 kWh BESS	1,450,000	1,700,000	N/A	>25
Cost Summary with ITC Included				
52 kW PV Only	921,000	1,170,000	N/A	>25
52 kW PV + 79 kWh BESS	1,010,000	1,270,000	N/A	>25

26.2.1 Electric Vehicle

The Justice Center Parking Garage was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 26-1. A total of seventeen (17) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 122.4 kW.

Electrical equipment necessary for EV chargers may require additional footprint and reduce available parking spots on the top level. Consideration for increased parking spot lengths due to the addition of curb stops to protect wall mounted Level 2 EV chargers may impact drive isle spacing and require additional review. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, see the self-assessment (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

26.3 Electrical Infrastructure Demand Feasibility Summary

26.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard cannot accommodate both the PV and BESS systems. To incorporate both would require a new feeder panel off the main distribution panel. New circuit breakers will be required for each system.

27 Justice Resource Center ("JRC")

Durham County | JRC | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	326 E Main St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Office	**Cooling Generation**	Packaged DX
Year Built	1926	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	40,623	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	3	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Various		
Wall Type	Masonry	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 27-1. JRC





27.1 Existing Building Performance & Condition

27.1.1 Past Conservation Projects and Successes

No historical data available.

27.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age. At the time of the site visit, plug-in "air purifiers" were present in several classrooms. This indicates that there may be indoor air quality deficiencies perceived by the occupants. Indoor air quality issues could be due to reduced or insufficient outdoor air intake, or related to the prevalence of smokers that attend meetings in the facility. A retro-commissioning effort should include an occupant IAQ survey and testing of outside air intake of the HVAC equipment.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 27-1. JRC Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Retro-commissioning IAQ Survey
Fix.1	

27.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 27-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

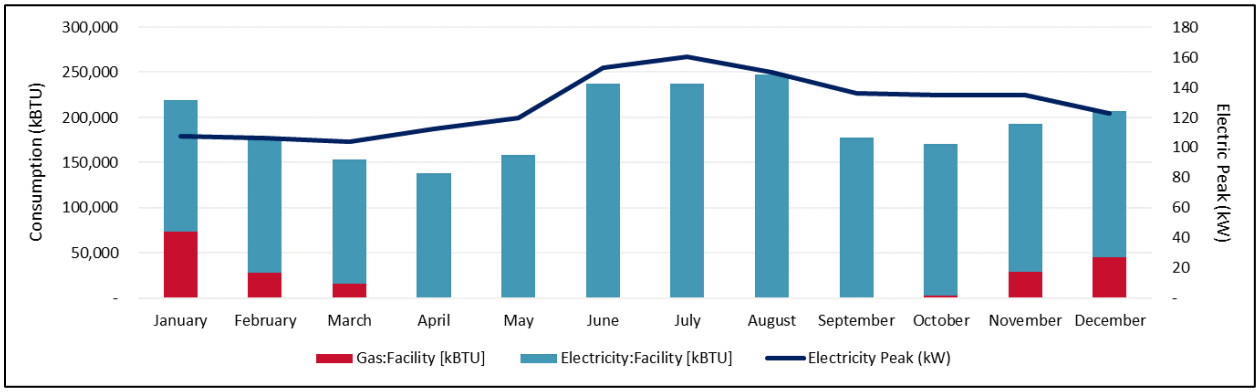
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 27-2. JRC Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	42,532	739	219	107.5	$3,133	$833	$3,966	12,075	3,925	16,000
February	44,035	278	178	106.0	$3,278	$315	$3,593	12,502	1,477	13,978
March	40,449	155	154	104.1	$3,041	$179	$3,220	11,484	821	12,304
April	40,278	10	138	112.6	$3,139	$29	$3,168	11,435	53	11,488
May	46,203	5	158	119.7	$3,583	$21	$3,604	13,117	27	13,144
June	69,452	5	238	152.9	$5,998	$21	$6,020	19,718	27	19,744
July	69,430	0	237	160.4	$5,949	$14	$5,963	19,711	0	19,711
August	72,246	10	248	149.7	$6,168	$24	$6,192	20,511	53	20,564
September	52,049	0	178	136.3	$5,317	$19	$5,336	14,777	0	14,777
October	49,165	27	170	135.0	$4,332	$50	$4,382	13,958	141	14,099
November	47,983	293	193	135.0	$4,212	$399	$4,611	13,623	1,554	15,176
December	47,534	448	207	122.7	$4,107	$589	$4,696	13,495	2,380	15,875
ANNUAL	621,358	1,969	2,318	-	$52,257	$2,494	$54,751	176,405	10,456	186,861
PEAK	-	-	-	160.4	-	-	-	-	-	-

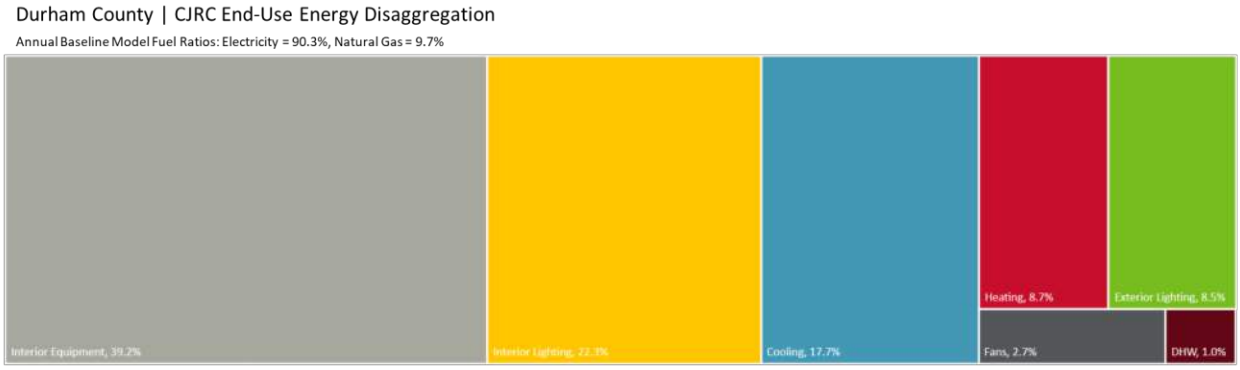
The data in Table 27-2 is represented in graphical format in Figure 27-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 27-2. JRC Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



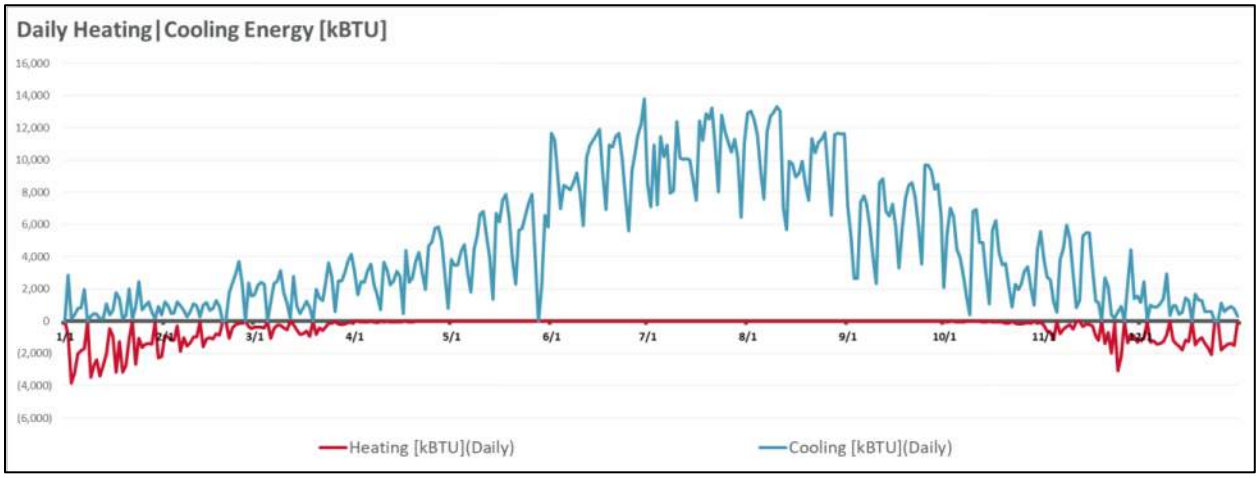
While Table 27-2 and Figure 27-2 encompasses "whole" building data, Figure 27-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 27-3. JRC Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 27-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 27-4. JRC Baseline Model Heating & Cooling Annual Load Profile



27.2 HVAC Refrigerants

The Durham County JRC utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 27-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 27-3. JRC HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
Split-System	Air-Cooled Condenser	Trane TWA090D3HRAA	7.5 tons	R-410A	Unavailable	Exterior
RTU 1	Rooftop Unit	Trane YCH300B3L0HB	25 tons	R-22	34 lbs	Exterior
RTU 2	Rooftop Unit	Trane YCH300B3L0HB	25 tons	R-22	34 lbs	Exterior
RTU 3	Rooftop Unit	Trane SFHLF40	40 tons	R-410A	61.25 lbs	Exterior
RTU 4	Rooftop Unit	Trane YCH210C3L0EA	17.5 tons	R-22	36 lbs	Exterior
MAU 3	Rooftop Unit	Aaon RM-004	4 tons	R-410A	14.5 lbs	Exterior
VRV	Air-Cooled Condenser	Mitsubishi P144TGM-A	12 tons	R-410A	26.1 lbs	Exterior
Mini-split	Air-Cooled Condenser	Mitsubishi MUY-A24NA-1	2 tons	R-410A	Unavailable	Exterior

27.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every

reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 27-4. JRC Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
JRC	Baseline	633,429.04	1,215.00	2,283.37	$58,266.90	186.29

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	52,785.75	101.25	190.28	$4,855.58	15.52	Potential Annual Energy Savings (%)	8.3%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,551.74	0.00	29.19	$765.32	2.43	NA	NA	
	Smart Thermostat	9,969.26	302.35	64.26	$1,285.20	4.44	Total Cooling Capacity Controled	1,338.00	kBTU/hr
	Air Conditioner Tune-up	12,601.15	0.00	43.01	$1,127.72	3.58	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$16.15	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	22,202.34	-147.34	61.04	$1,795.43	5.52	Applicable Area %	50.0%	%
	LED Exit Signs	953.96	-6.33	2.62	$77.14	0.24	Quantity of Exit Signs	9	#
	Daylight Dimming Control	6,660.70	-44.20	18.31	$538.63	1.66	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	2,743.80	0.00	9.36	$245.55	0.78	Quantity of Power Strips	102	#
Decarbonization Measure Savings Totals (predicted)		**116,468.70**	**218.15**	**419.32**	**$10,706.72**	**34.22**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**18.4%**	**18.0%**	**18.4%**	**18.4%**	**18.4%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

27.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 27-5. JRC Existing HVAC/DHW Systems

HVAC | Space Heating	Split-system AHU unknown kW electric resistance; Large RTU #3 natural gas furnace, 350 MBH input, 2-stage control; RTU #2 NG furnace 250 MBH input; RTU #1 NG furnace 250 MBH input; MAU-3 NG furnace 90 MBH input; RTU #4 NG furnace 250 MBH input; VRV-HP multi-
Domestic Hot Water	(1) Direct Vent Storage tank water heater (AO Smith #BPD-75 200), fuel- NG, 70 MBH input, 75 gallon storage, build date 8/3/2010.

Table 27-6. JRC HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace split-system condensing w/ heat pump, nominal 7.5-ton

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	0.0	(2,161.9)	44,029.8	NA	NA	665,387.5	106.7	56.2	2.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,347.5 MMBTU								2,281.6 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$63,076.14	$135.88	$1.56	-3.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$60,885.29 $US								$63,212.02 $US			
Carbon	176.4	12.0	4.64	0.0	(11.5)	12.5	NA	NA	188.9	0.6	4.66	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	188.5 MT CO2e								189.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 27-7. JRC HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace RTU#1 & RTU#2 with 25-ton heat-pump RTUs with 72kw electric heat, *Replace RTU#4 with 17.5-ton heat-pump RTU with 54kw electric heat, *Replace MAU-3 with heat-pump DOAS, AAON model # RQ-004 with 20kw electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	0.0	(2,161.9)	20,992.7	NA	NA	642,350.4	106.7	54.2	6.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,347.5 MMBTU								2,203.0 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$60,068.15	$135.88	$1.48	1.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$60,885.29 $US								$60,204.03 $US			
Carbon	176.4	12.0	4.64	0.0	(11.5)	6.0	NA	NA	182.4	0.6	4.50	2.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	188.5 MT CO2e								182.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 27-8. JRC DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 119 gallon, 13.5 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	NA	NA	NA	(106.7)	2,340.8	623,698.5	2,161.9	57.7	0.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,347.5 MMBTU								2,344.9 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$58,227.01	$2,752.63	$1.50	-0.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$60,885.29 $US								$60,979.64 $US			
Carbon	176.4	12.0	4.64	NA	NA	NA	(0.6)	0.7	177.1	11.5	4.64	-0.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	188.5 MT CO2e								188.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 27-9. JRC DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) air-source heat pump water heater (Lochinvar model AHP060, 13.5 kw input, 4.6 COP) + (1) 75 gallon storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	NA	NA	NA	(106.7)	476.5	621,834.2	2,161.9	57.6	0.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,347.5 MMBTU								2,338.5 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$58,043.10	$2,752.63	$1.50	0.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$60,885.29 $US								$60,795.72 $US			
Carbon	176.4	12.0	4.64	NA	NA	NA	(0.6)	0.1	176.5	11.5	4.63	0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	188.5 MT CO2e								188.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 27-10. JRC Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$53,658.00	($5,079.36)	$2,752.63	($2,326.73)	($115,044.63)	NA	NA	-0.5866	NA	NA	($51.89)
HVAC Pathway 2	$158,511.00	($2,071.37)	$2,752.63	$681.26	($193,262.93)	-6.1052%	-2.8175%	0.0977	NA	NA	$281.66
DHW Pathway 1	$5,964.00	($230.23)	$135.88	($94.35)	($9,726.23)	-8.9303%	NA	-0.2069	NA	NA	($4.98)
DHW Pathway 2	$58,607.00	($46.32)	$135.88	$89.57	($76,982.22)	-6.9711%	-5.8116%	0.0280	NA	NA	$22.01

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$331,751.00
DHW Existing Replacement:	$7,892.00

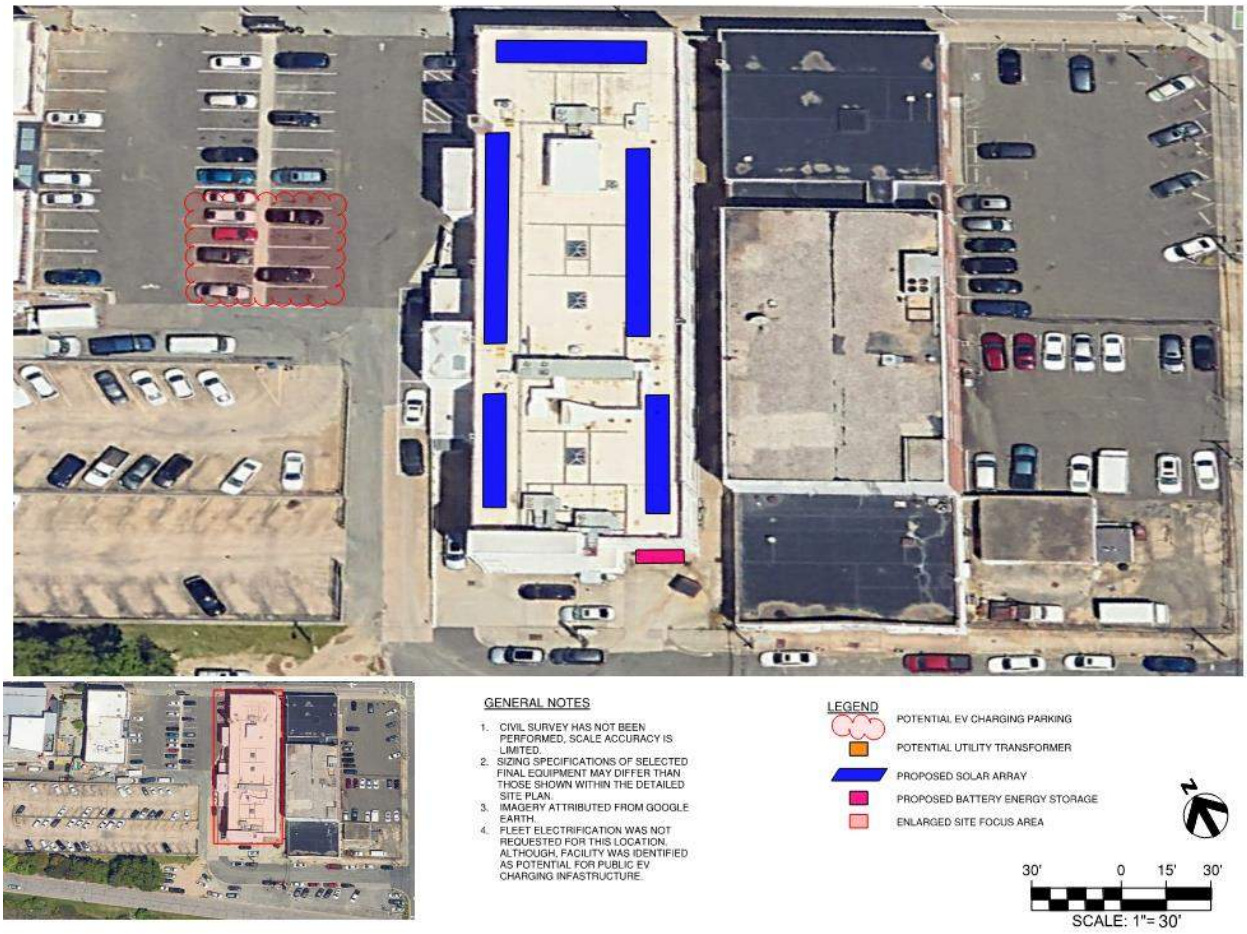
Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

27.5 Renewable Energy, Energy Storage, and Electric Vehicles

27.5.1 Solar and BESS Analysis

The Justice Resource Center (JRC) is a large rectangular building with main HVAC equipment located down the center of the flat unknown rooftop. The roof is scheduled for replacement in 2038. The roof has a parapet wall around the perimeter that has the potential for minimal shading on solar equipment. The available footprint for solar resulted in approximately 40 kW DC capacity. Potential BESS equipment can be located on the South wall of the building, as shown on Figure 27-5.

Figure 27-5. JRC Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 634,880 kWh with a peak July load of 156.3 kW. The estimated roof solar capacity is 40 kW DC and initial HOMER analysis indicates that a 40 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple PV and hybrid system configurations possess unfavorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS and small amount of excess PV generation. Both system configurations tend to have more favorable

payback periods when incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 27-11. Cost performance of the three system configurations is provided in Table 27-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only or PV+BESS system configurations do not possess a preferred results compared to the base. These system configurations should be re-evaluated once it is believed costs may be more preferable.

Table 27-11. JRC Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	634,880	N/A	N/A	N/A
40 kW PV Only	584,207	50,689	N/A	8
40 kW PV + 26.4 kWh BESS	584,375	50,689	840	7.6

27.6 Cost Summary

Table 27-12. JRC Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy MGS)	N/A	687,000	N/A	N/A
40 kW PV Only	95,500	756,000	N/A	>25
40 kW PV + 26.4 kWh BESS	139,000	789,000	N/A	>25
Cost Summary with ITC Included				
40 kW PV Only	67,000	727,000	1.7	20
40 kW PV + 26.4 kWh BESS	97,000	748,000	0.4	24

27.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, the facility was identified for long lay-overs and recommended for consideration of public charging.

27.7 Electrical Infrastructure Demand Feasibility Summary

Table 27-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	160.44 kW	160.44 kW
HVAC Electrification Pathway 1		222.42 kW
HVAC Electrification Pathway 2		160.44 kW
DHW Electrification Pathway 1		160.44 kW
DHW Electrification Pathway 2		160.44 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

27.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the required breaker size to supply power for the electric heater required by HVAC Electrification Pathway 1. The existing main distribution panelboard doesn't have enough space to accommodate the breakers required to supply power for the electric heat required by HVAC Electrification Pathway 2, therefore, a new branch panelboard will be required.

27.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards can accommodate the water heaters required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required.

27.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution system can accommodate the PV system but not the BESS system. Branch circuit panels have available space to provide a connection to house the required circuit breaker. The BESS system can only be installed in the main distribution panel; however, the panel has no available spaces therefore, a new main service panelboard will be required.

28 Justice Services Department ("JSD") Transitional Living Facility

Durham County | JSD Transitional Living Facility | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	1204 E Club Blvd, Durham, NC 27704	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Ductless Heat Pump
Building Type	Recovery Center	**Cooling Generation**	Split-System DX
Year Built	1963	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	2,050	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Wood Panel w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 28-1. JSD Transitional Living Facility



28.1 Existing Building Performance & Condition

28.1.1 Past Conservation Projects and Successes

- Roof replaced in 2015.
- Split system HVAC was installed in 2017.

28.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained. The laundry room domestic water heater's plastic drain pan has been damaged and is not functional. There were no other noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 28-1. JSD Transitional Living Facility Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	Replace domestic water heater drain pan.

28.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 28-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was NOT AVAILABLE in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was PREDICTED via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

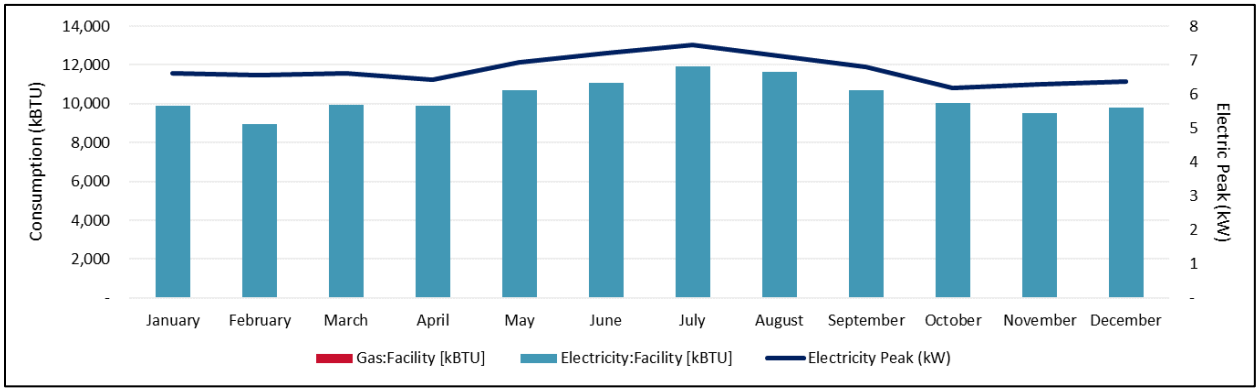
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 28-2. JSD Transitional Living Facility Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	2,907	0	10	6.6	$0	$0	$0	825	0	825
February	2,629	0	9	6.6	$0	$0	$0	746	0	746
March	2,911	0	10	6.6	$0	$0	$0	826	0	826
April	2,902	0	10	6.4	$0	$0	$0	824	0	824
May	3,129	0	11	6.9	$0	$0	$0	888	0	888
June	3,240	0	11	7.2	$0	$0	$0	920	0	920
July	3,489	0	12	7.5	$0	$0	$0	991	0	991
August	3,413	0	12	7.1	$0	$0	$0	969	0	969
September	3,134	0	11	6.8	$0	$0	$0	890	0	890
October	2,946	0	10	6.2	$0	$0	$0	836	0	836
November	2,795	0	10	6.3	$0	$0	$0	793	0	793
December	2,871	0	10	6.4	$0	$0	$0	815	0	815
ANNUAL	36,366	0	124	-	$0	$0	$0	10,324	0	10,324
PEAK	-	-	-	7.5	-	-	-	-	-	-

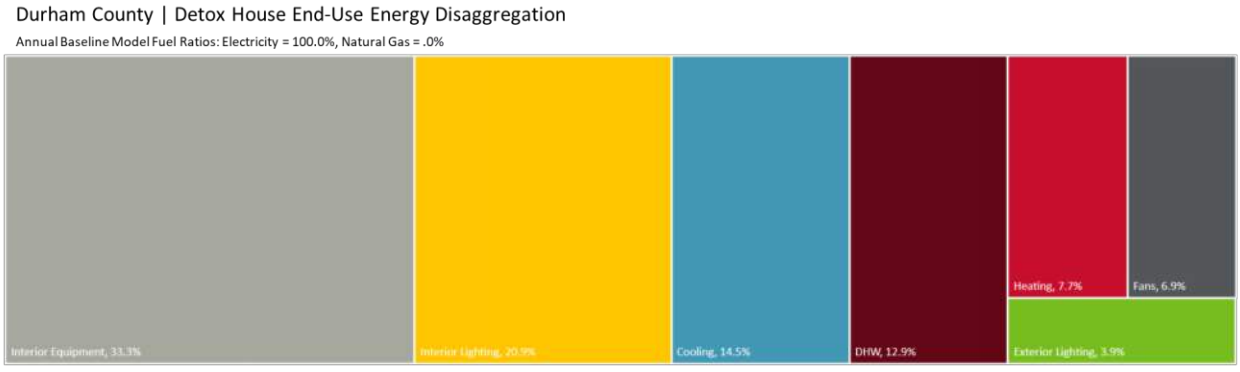
The data in Table 28-2 is represented in graphical format in Figure 28-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 28-2. JSD Transitional Living Facility Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



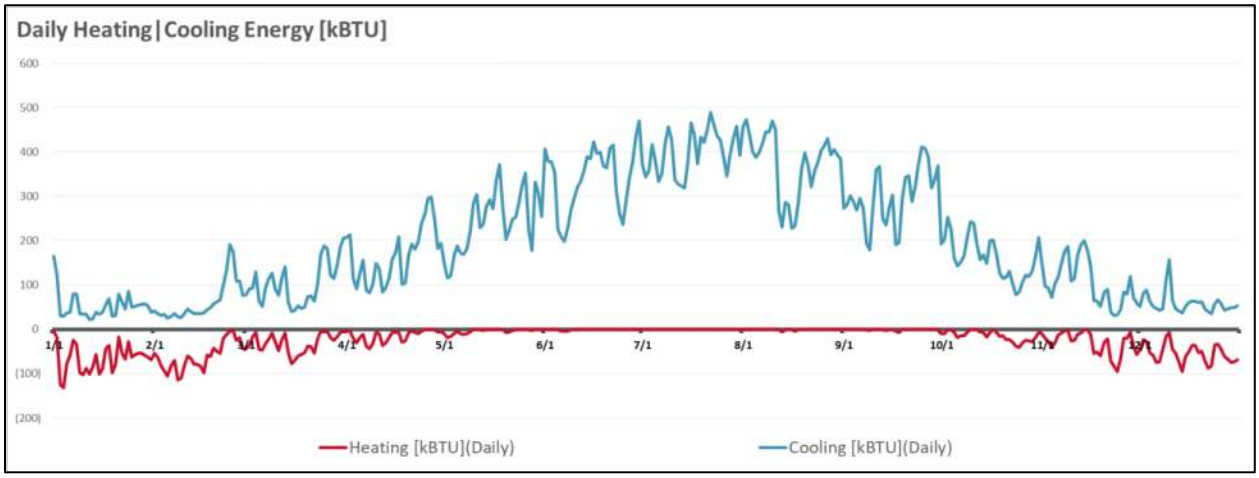
While Table 28-2 and Figure 28-2 encompasses "whole" building data, Figure 28-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 28-3. JSD Transitional Living Facility Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 28-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 28-4. JSD Transitional Living Facility Baseline Model Heating & Cooling Annual Load Profile



28.2 HVAC Refrigerants

The Durham County JSD Transitional Living Facility utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 28-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 28-3. JSD Transitional Living Facility HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(3) CU	Split-System Condensing Unit	Carrier 38MHRQ12A	1 Ton	R-410A	2.12 lbs	Exterior
(1) CU	Split-System Condensing Unit	Carrier 38MGRQ36D	3 Tons	R-410A	10.13 lbs	Exterior
(1) CU	Split-System Condensing Unit	Carrier 38GJQC18	1.5 Tons	R-410A	3.5 lbs	Exterior
	Refrigerator	Midea MRU21F2AWW		R-600A	2.47 oz	Interior

28.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 28-4. JSD Transitional Living Facility Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
JSD Transitional Living Facility	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	550.51	0.00	1.88	$57.20	0.16	NA	NA	
	Smart Thermostat	997.65	0.00	3.40	$103.66	0.28	Total Cooling Capacity Controled	90.00	kBTU/hr
	Air Conditioner Tune-up	1,261.03	0.00	4.30	$131.02	0.36	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	0.00	0.00	$0.00	0.00	NA	NA	
	Solar Thermal Domestic Hot Water	2,831.80	0.00	9.66	$294.22	0.80	# Solar Thermal Panels	5	#
Lighting	LED Retrofit	13,207.59	0.00	45.08	$1,372.27	3.75	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	1	#
	Daylight Dimming Control	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.91	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	0.00	0.00	0.00	$0.00	0.00	Quantity of Power Strips	0	#
Decarbonization Measure Savings Totals (predicted)		18,953.59	0.00	64.69	$1,969.28	5.38			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		0.0%	0.0%	0.0%	-	-			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

28.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 28-5. JSD Transitional Living Facility Existing HVAC/DHW Systems

HVAC | Space Heating	(5) Ductless heat pump systems; (Mult.) Electric baseboard heaters
Domestic Hot Water	(1) Electric storage water heater, 50 gal, 4.5 kw, State model EN6-50-DORS110, mfg 2019; (1) Electric storage water heater, 40 gal, 4.5 kw, State model EN6-40-DORT110, mfg 2019;

Table 28-6. JSD Transitional Living Facility HVAC Electrification Pathway 1

Pathway 1 | Electrification	N/A - already heat pumps

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**36,365.7**	**0.0**	**60.5**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**36,365.7**	**0.0**	**60.5**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	124.1 MMBTU								124.1 MMBTU			
Energy Cost	**$5,118.35**	**$0.00**	**$2.50**						**$5,118.35**	**$0.00**	**$2.50**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,118.35 $US								$5,118.35 $US			
Carbon	**10.3**	**0.0**	**5.04**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**10.3**	**0.0**	**5.04**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	10.3 MT CO2e								10.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 28-7. JSD Transitional Living Facility HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**36,365.7**	**0.0**	**60.5**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**36,365.7**	**0.0**	**60.5**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	124.1 MMBTU								124.1 MMBTU			
Energy Cost	**$5,118.35**	**$0.00**	**$2.50**						**$5,118.35**	**$0.00**	**$2.50**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,118.35 $US								$5,118.35 $US			
Carbon	**10.3**	**0.0**	**5.04**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**10.3**	**0.0**	**5.04**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	10.3 MT CO2e								10.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 28-8. JSD Transitional Living Facility DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**36,365.7**	**0.0**	**60.5**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**36,365.7**	**0.0**	**60.5**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	124.1 MMBTU								124.1 MMBTU			
Energy Cost	**$5,118.35**	**$0.00**	**$2.50**						**$5,118.35**	**$0.00**	**$2.50**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,118.35 $US								$5,118.35 $US			
Carbon	**10.3**	**0.0**	**5.04**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**10.3**	**0.0**	**5.04**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	10.3 MT CO2e								10.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 28-9. JSD Transitional Living Facility DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) water heaters with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**36,365.7**	**0.0**	**60.5**	**NA**	**NA**	**NA**	**0.0**	**(3,219.4)**	**33,146.4**	**0.0**	**55.2**	**8.9%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	124.1 MMBTU								113.1 MMBTU			
Energy Cost	**$5,118.35**	**$0.00**	**$2.50**						**$4,713.01**	**$0.00**	**$2.30**	**7.9%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$5,118.35 $US								$4,713.01 $US			
Carbon	**10.3**	**0.0**	**5.04**	**NA**	**NA**	**NA**	**0.0**	**(0.9)**	**9.4**	**0.0**	**4.59**	**8.9%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	10.3 MT CO2e								9.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 28-10. JSD Transitional Living Facility Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
HVAC Pathway 2	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$14,617.00	$405.34	$0.00	$405.34	($11,199.15)	-2.8325%	0.8671%	0.4330	NA	NA	$46.61

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$29,816.00
DHW Existing Replacement:	$6,816.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

28.5 Electrical Infrastructure Demand Feasibility Summary

Table 28-11. JSD Transitional Living Facility Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	7.45 kW	7.45 kW
HVAC Electrification Pathway 1		7.45 kW
HVAC Electrification Pathway 2		7.45 kW
DHW Electrification Pathway 1		7.45 kW
DHW Electrification Pathway 2		6.75 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

28.5.1 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the Heat Pump Storage Water Heaters for DHW Electrification Pathway 2. New circuit breakers will be required.

29 Leesville VFD

Durham County | Leesville VFD | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	7305 Leesville Rd, Durham, NC 27703	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Gas Unit Heater
Building Type	Emergency Services	**Cooling Generation**	Split-System DX
Year Built	1988	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	1,017	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent/LED	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 29-1. Leesville VFD



29.1 Existing Building Performance & Condition

29.1.1 Past Conservation Projects and Successes

- Addition in 2023 to accommodate RV storage.
- HVAC was changed in 2018 to (4) split system units.
- Roof was re-coated in 2022.

29.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age. The domestic water heater was manufactured in 1985 and is beyond it expected service life. The water heater is installed in a pan, however the pan does not have a drain.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 29-1. Leesville VFD Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace water heater and provide drain pan.
Fix.1	

29.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 29-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was NOT AVAILABLE in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was PREDICTED via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

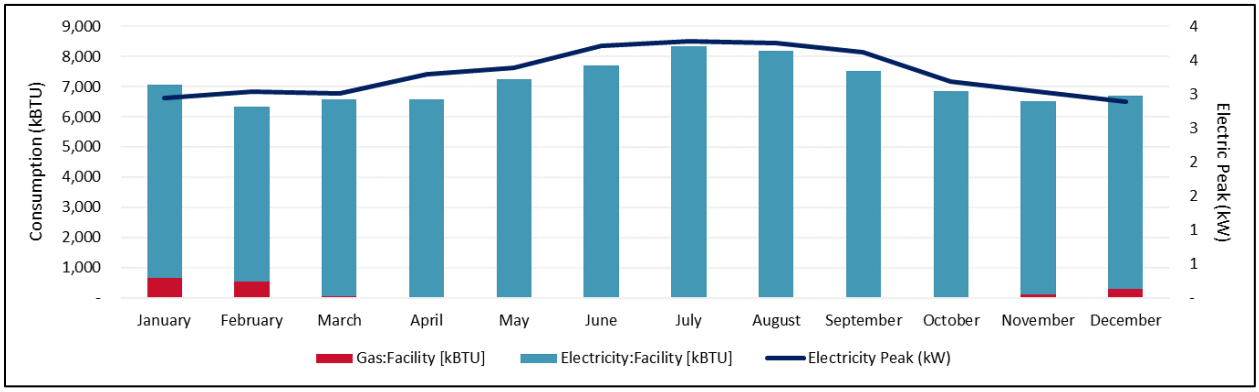
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 29-2. Leesville VFD Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	1,877	7	7	2.9	$0	$7	$7	533	35	568
February	1,697	5	6	3.0	$0	$5	$5	482	29	510
March	1,906	1	7	3.0	$0	$1	$1	541	4	545
April	1,929	0	7	3.3	$0	$0	$0	548	0	548
May	2,126	0	7	3.4	$0	$0	$0	604	0	604
June	2,258	0	8	3.7	$0	$0	$0	641	0	641
July	2,442	0	8	3.8	$0	$0	$0	693	0	693
August	2,401	0	8	3.8	$0	$0	$0	682	0	682
September	2,203	0	8	3.6	$0	$0	$0	625	0	625
October	2,007	0	7	3.2	$0	$0	$0	570	0	570
November	1,867	1	7	3.0	$0	$1	$1	530	7	537
December	1,878	3	7	2.9	$0	$3	$3	533	16	549
ANNUAL	24,590	17	86	-	$0	$17	$17	6,981	90	7,071
PEAK	-	-	-	3.8	-	-	-	-	-	-

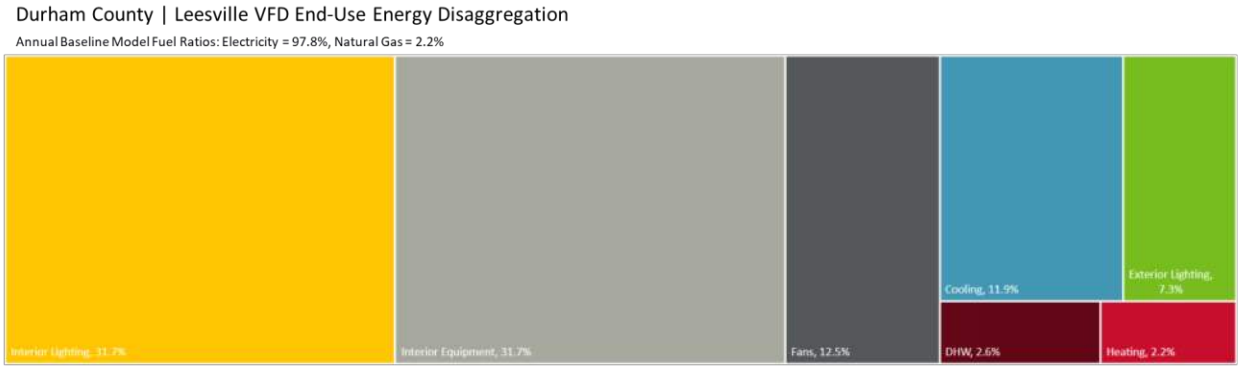
The data in Table 29-2 is represented in graphical format in Figure 29-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 29-2. Leesville VFD Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



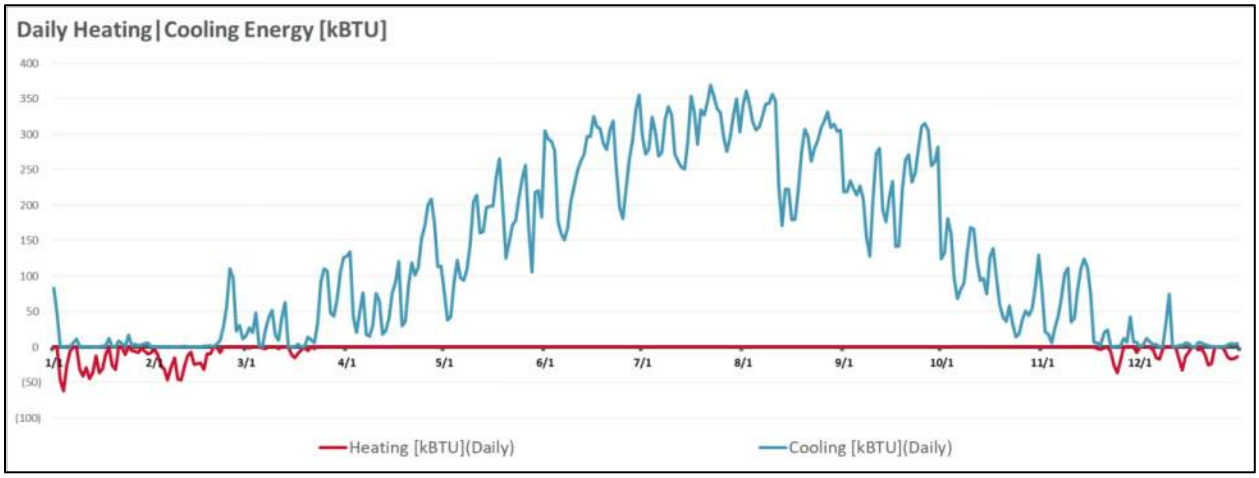
While Table 29-2 and Figure 29-2 encompasses “whole” building data, Figure 29-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 29-3. Leesville VFD Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 29-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 29-4. Leesville VFD Baseline Model Heating & Cooling Annual Load Profile



29.2 HVAC Refrigerants

The Durham County Leesville VFD utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 29-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 29-3. Leesville VFD HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) CU	Split-System Condensing Unit	Carrier 25HCE430A300	2.5 Tons	R-410A	6.4 lbs	Exterior
(2) CU	Split-System Condensing Unit	Carrier 38MGRQ48E	4 Tons	R-410A	10.13 lbs	Exterior

29.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 29-4. Leesville VFD Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Leesville VFD	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	70.61	0.00	0.24	$7.34	0.02	NA	NA	
	Smart Thermostat	1,222.83	0.00	4.17	$127.05	0.35	Total Cooling Capacity Controled	126.00	kBTU/hr
	Air Conditioner Tune-up	1,545.66	0.00	5.28	$160.59	0.44	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.44	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	6,889.27	-45.72	18.94	$670.25	1.71	Applicable Area %	95.0%	%
	Lighting Occupancy Sensor	178.36	-1.18	0.49	$17.35	0.04	Applicable Area %	5.0%	%
	LED Exit Signs	106.00	-0.70	0.29	$10.31	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	178.36	-1.18	0.49	$17.35	0.04	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$21.82	0.06	$0.00	2	#
	Tier 1 Advanced Power Strip	80.70	0.00	0.28	$8.38	0.02	Quantity of Power Strips	3	#
Decarbonization Measure Savings Totals (predicted)		**10,630.41**	**-48.79**	**31.40**	**$1,055.90**	**2.76**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**0.0%**	**0.0%**	**0.0%**	**-**	**-**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

29.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 29-5. Leesville VFD Existing HVAC/DHW Systems

HVAC | Space Heating	(1) gas-fired unit heater, Reznor "V3 Tcore 2", assumed 180 mbh input; (1) Heat pump 2.5-ton AHU, Carrier model FB4CNF030, 7.4 kw;
Domestic Hot Water	(1) Electric storage water heater, 40 gal, 4.5 kw, AO Smith model EES-40-912, mfg 1985;

Table 29-6. Leesville VFD HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas unit heater with (2) electric 30kw unit heater, Modine PTE300 (60kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	24,589.7	19.1	84.4	0.0	(19.1)	399.3	NA	NA	24,989.0	0.0	83.9	0.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	85.8 MMBTU								85.3 MMBTU			
Energy Cost	$3,516.78	$19.28	$3.48						$3,573.88	$0.00	$3.51	-1.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,536.06 $US								$3,573.88 $US			
Carbon	7.0	0.1	6.96	0.0	(0.1)	0.1	NA	NA	7.1	0.0	6.98	-0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.1 MT CO2e								7.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 29-7. Leesville VFD HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems & heat pumps

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**24,589.7**	**19.1**	**84.4**	**0.0**	**(19.1)**	**399.3**	**NA**	**NA**	**24,989.0**	**0.0**	**83.9**	**0.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	85.8 MMBTU								85.3 MMBTU			
Energy Cost	**$3,516.78**	**$19.28**	**$3.48**						**$3,573.88**	**$0.00**	**$3.51**	**-1.1%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,536.06 $US								$3,573.88 $US			
Carbon	**7.0**	**0.1**	**6.96**	**0.0**	**(0.1)**	**0.1**	**NA**	**NA**	**7.1**	**0.0**	**6.98**	**-0.2%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.1 MT CO2e								7.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 29-8. Leesville VFD DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**24,589.7**	**19.1**	**84.4**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**24,589.7**	**19.1**	**84.4**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	85.8 MMBTU								85.8 MMBTU			
Energy Cost	**$3,516.78**	**$19.28**	**$3.48**						**$3,516.78**	**$19.28**	**$3.48**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,536.06 $US								$3,536.06 $US			
Carbon	**7.0**	**0.1**	**6.96**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**7.0**	**0.1**	**6.96**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.1 MT CO2e								7.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 29-9. Leesville VFD DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**24,589.7**	**19.1**	**84.4**	**NA**	**NA**	**NA**	**0.0**	**(438.0)**	**24,151.7**	**19.1**	**82.9**	**1.7%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	85.8 MMBTU								84.3 MMBTU			
Energy Cost	**$3,516.78**	**$19.28**	**$3.48**						**$3,454.13**	**$19.28**	**$3.42**	**1.8%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$3,536.06 $US								$3,473.41 $US			
Carbon	**7.0**	**0.1**	**6.96**	**NA**	**NA**	**NA**	**0.0**	**(0.1)**	**6.9**	**0.1**	**6.84**	**1.8%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	7.1 MT CO2e								7.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 29-10. Leesville VFD Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$252,266.00	($57.11)	$19.28	($37.83)	($341,640.31)	-7.2942%	NA	-0.0022	NA	NA	($0.60)
HVAC Pathway 2	$252,266.00	($57.11)	$19.28	($37.83)	($341,640.31)	-7.2942%	NA	-0.0022	NA	NA	($0.60)
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$8,852.00	$62.64	$0.00	$62.64	($10,639.95)	-6.1834%	-2.5187%	0.1105	NA	NA	$6.34

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$9,947.00
DHW Existing Replacement:	$1,525.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

29.5 Renewable Energy, Energy Storage, and Electric Vehicles

29.5.1 Solar and BESS Analysis

The Leesville VFD has metal gabled roof with small flush skylights spread throughout both sides of the rood footprint. Solar footprint assumes equipment racking can be placed above skylights on rooftop. The age of the roof was not confirmed, and the replacement cycle was not identified. As shown in Figure 29-5, the estimated total capacity is 35 kW DC with the potential for BESS equipment placement adjacent to existing utility equipment on the southeastern corner of the building.

Figure 29-5. Leesville VFD Conceptual Renewables and EV Visual Aid



No load data was provided for the Leesville VFD building; thus, it was assumed the load is similar to the EMS #6 building. The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The assumed annual building consumption for the past year is approximately 60,402 kWh with a peak July load of 15.7 kW. The estimated roof solar capacity is 35 kW DC and initial HOMER analysis indicates that a 35 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and

BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV and hybrid system both tend to have more favorable periods if ITCs are factored into the system cost. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 29-11. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Based on the data below, a standalone PV system is recommended due to BESS providing a marginal increase renewable fraction and a longer payback period.

Table 29-11. Leesville VFD Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	60,402	N/A	N/A	N/A
35 kW PV Only	37,437	47,621	N/A	56
35 kW PV + 13.2 kWh BESS	33,638	47,621	4,330	58.1

29.6 Cost Summary

Cost performance for the three systems is provided in Table 29-12.

Table 29-12. Leesville VFD Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	72,000	N/A	N/A
35 kW PV Only	71,000	114,000	0.7	23
35 kW PV + 13.2 kWh BESS	92,000	137,000	N/A	>25
Cost Summary with ITC Included				
35 kW PV Only	50,000	93,000	3.8	16
35 kW PV + 13.2 kWh BESS	65,000	110,000	0.4	24

29.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

29.7 Electrical Infrastructure Demand Feasibility Summary

Table 29-13. Leesville VFD Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	3.78 kW	3.78 kW
HVAC Electrification Pathway 1		4.36 kW
HVAC Electrification Pathway 2		4.36 kW
DHW Electrification Pathway 1		3.78 kW
DHW Electrification Pathway 2		3.73 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

29.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power for the electric unit heaters required by HVAC Electrification Pathways 1. A new utility transformer and main distribution panelboard will be required along with associated circuit breaker for each new piece of equipment.

29.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power for the heat-pump storage water heater and heat pump storage water heater for DHW Electrification Pathway 2. A new utility transformer and main distribution panelboard will be required along with associated circuit breaker for each new piece of equipment.

29.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power to the PV and BESS systems. A new utility transformer and main distribution panelboard will be required along with associated circuit breaker for each new piece of equipment.

30 Main Library

Durham County | Main Library | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	300 N Roxboro St, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Direct Vent Condensing Boiler
Building Type	Library	**Cooling Generation**	Water-Cooled Chiller
Year Built	2019	**Domestic Hot Water Generation**	Direct Vent Gas Instantaneous Water Heater
Floor Area (ft2)	95,000	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	4	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Metal Panel	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED	**Weekday Operating Hours**	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

Figure 30-1. Main Library



30.1 Existing Building Performance & Condition

30.1.1 Past Conservation Projects and Successes

- Total rebuild in 2019. Everything was replaced, originally built in the 1970's.

30.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained with no noted deficiencies for most equipment beyond normal wear for the equipment age.

The heating water boilers are condensing-type natural gas boilers and the HVAC system was designed for a 160°F hot water supply temperature. According to the boiler control display at the time of the site visit, the boilers were being controlled to a 180°F supply temperature set point and the return to the boiler was 155°F. At these conditions, the boilers would not be condensing and would be operating at a reduced efficiency and output capacity.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 30-1. Main Library Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

30.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 30-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

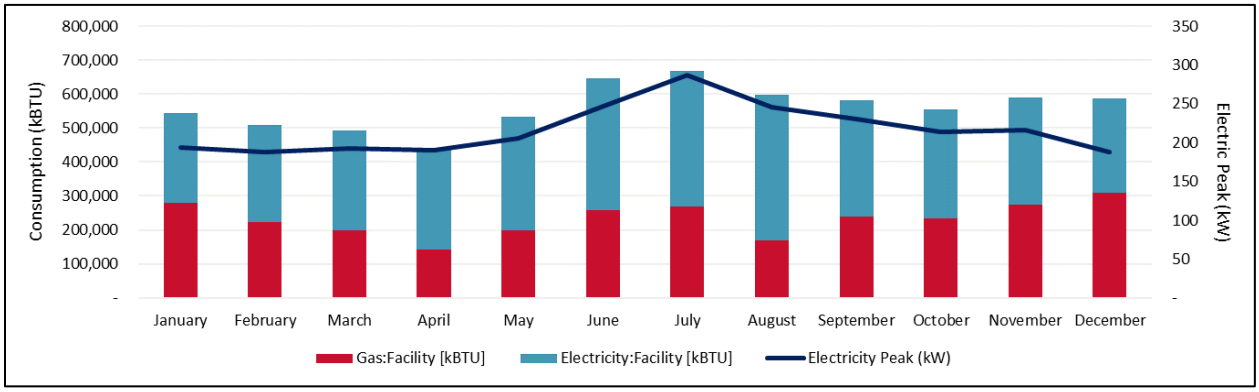
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 30-2. Main Library Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	77,650	2,791	544	193.8	$6,955	$2,982	$9,937	22,045	14,822	36,867
February	84,188	2,223	510	188.2	$7,389	$2,161	$9,550	23,901	11,807	35,709
March	86,648	1,979	494	192.2	$7,499	$1,867	$9,366	24,600	10,509	35,108
April	86,276	1,423	437	190.4	$7,508	$1,349	$8,857	24,494	7,556	32,050
May	97,930	1,993	534	206.0	$8,273	$1,843	$10,117	27,803	10,586	38,389
June	114,304	2,572	647	246.4	$9,451	$2,375	$11,826	32,451	13,658	46,110
July	116,858	2,684	667	286.4	$9,814	$2,505	$12,318	33,176	14,253	47,430
August	125,429	1,703	598	245.4	$10,331	$1,698	$12,030	35,610	9,045	44,655
September	100,753	2,391	583	230.0	$9,563	$2,347	$11,910	28,604	12,697	41,301
October	94,207	2,332	555	214.2	$9,053	$2,430	$11,483	26,746	12,386	39,132
November	92,030	2,749	589	216.4	$8,862	$2,820	$11,682	26,128	14,599	40,726
December	81,510	3,092	587	188.0	$8,065	$3,210	$11,275	23,141	16,420	39,561
ANNUAL	1,157,783	27,928	6,744	-	$102,763	$27,586	$130,349	328,698	148,339	477,037
PEAK	-	-	-	286.4	-	-	-	-	-	-

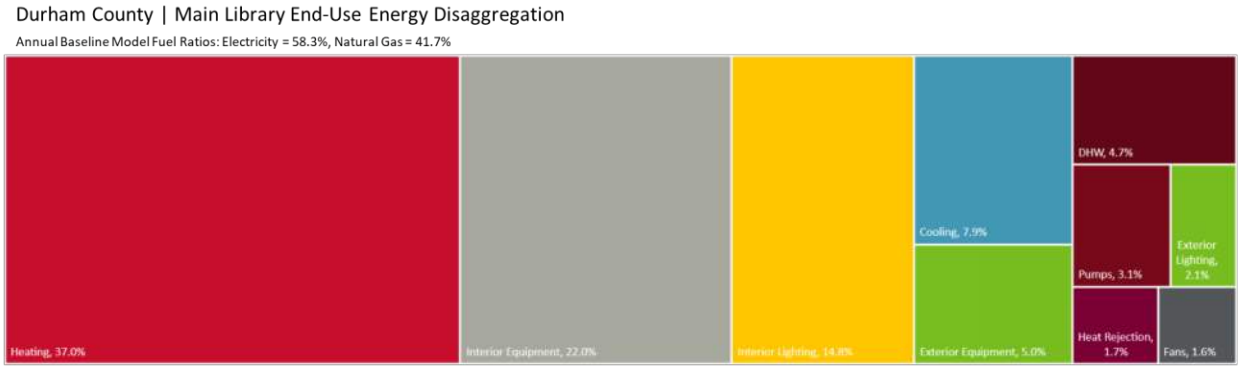
The data in Table 30-2 is represented in graphical format in Figure 30-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 30-2. Main Library Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



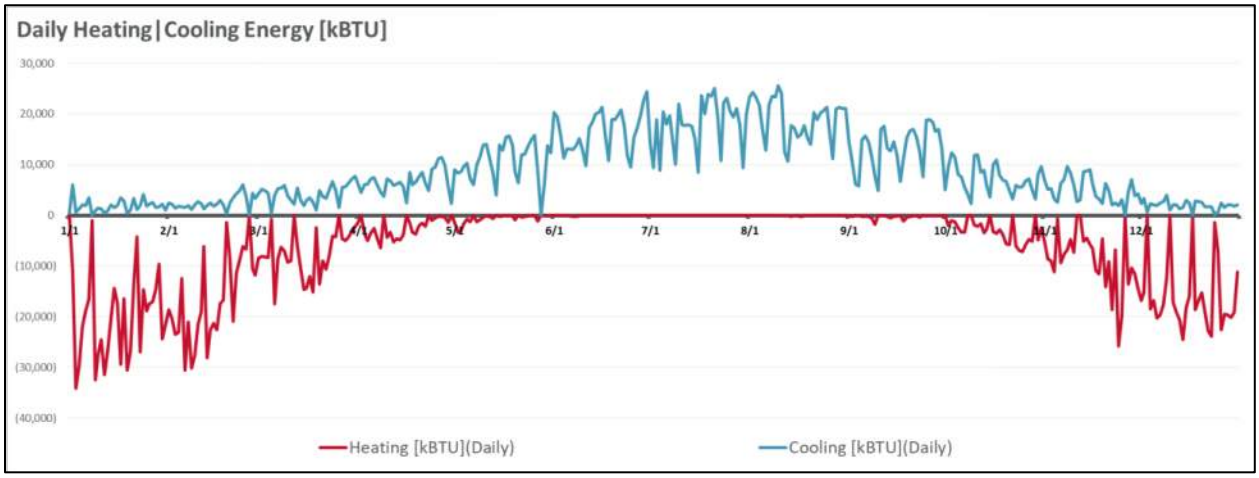
While Table 30-2 and Figure 30-2 encompasses “whole” building data, Figure 30-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 30-3. Main Library Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 30-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 30-4. Main Library Baseline Model Heating & Cooling Annual Load Profile



30.2 HVAC Refrigerants

The Durham County Main Library utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 30-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 30-3. Main Library HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Water-Cooled Chiller	Daikin WMC048DDSNA		R-134A	916 lbs	Interior

30.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 30-4. Main Library Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Main Library	Baseline	1,208,018.00	28,058.00	6,928.73	$136,385.52	491.99

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	140,935.43	3,273.43	808.35	$15,911.64	57.40	Potential Annual Energy Savings (%)	11.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	13,202.85	0.00	45.06	$1,227.88	3.75	NA	NA	
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00	kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	479.65	47.96	$410.94	2.55	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$10.65	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$759.87	5.10	# Solar Thermal Panels	20	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	Lighting Occupancy Sensor	39,780.14	-264.00	109.37	$3,473.41	9.89	Applicable Area %	50.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	19	#
	Daylight Dimming Control	31,824.11	-211.20	87.50	$2,778.73	7.91	Applicable Area %	40.0%	%
	LED Outdoor Pole/Arm	3,892.32	0.00	13.28	$361.99	1.11	Quantity of Outdoor Fixtures	15	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	8,892.10	0.00	30.35	$826.97	2.52	Transformer Size	675.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.77	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$50.03	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		**237,836.41**	**4,321.99**	**1,243.93**	**$25,821.88**	**90.48**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**19.7%**	**15.4%**	**18.0%**	**18.9%**	**18.4%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

30.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 30-5. Main Library Existing HVAC/DHW Systems

HVAC | Space Heating	Hot water reheat at VAV terminal units, single-duct and parallel fan-powered; (2) Gas-fired direct-vent condensing boilers, Lochinvar "Crest" model FBN1751, 1750 mbh input, 1680 mbh output, mfg 2018, 180F LWT setpoint, 160F EWT; per design terminal unit schedule supply water temp 160F w/ 135F return; VV primary-only pumps w/ VFDs
Domestic Hot Water	(3) direct-vent gas-fired instantaneous water heaters, AO Smith model ATIO-910-100, mfg 2018, 380 mbh input, 8 gpm;

Table 30-6. Main Library HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace (2) gas boilers with (2) electric boilers, 492kw each (984 kw total), 8-step control, Lochinvar BWX3-491C

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	0.0	(24,401.2)	724,160.3	NA	NA	1,881,943.6	3,835.8	71.6	-0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,775.2 MMBTU								6,806.6 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$198,933.60	$3,788.83	$2.13	-51.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$133,639.47 $US								$202,722.43 $US			
Carbon	328.7	150.0	5.04	0.0	(129.6)	205.6	NA	NA	534.3	20.4	5.84	-15.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	478.7 MT CO2e								554.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 30-7. Main Library HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace heating water boilers with (6) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 360 FLA @ 460V/3ph);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	0.0	(24,401.2)	324,210.3	NA	NA	1,481,993.6	3,835.8	57.3	19.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,775.2 MMBTU								5,441.6 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$153,717.32	$3,788.83	$1.66	-17.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$133,639.47 $US								$157,506.15 $US			
Carbon	328.7	150.0	5.04	0.0	(129.6)	92.0	NA	NA	420.7	20.4	4.64	7.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	478.7 MT CO2e								441.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 30-8. Main Library DHW Electrification Pathway 1

Pathway 1 | Electrification	Replace gas instaneous water heaters with (3) electric instantaneous heaters, 96kw input each (288 kw total), Eemax "SpecAdvantage" model AP096480

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	NA	NA	NA	(3,835.8)	87,601.7	1,245,385.1	24,401.2	70.4	1.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,775.2 MMBTU								6,690.6 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$113,838.57	$24,102.50	$1.45	-3.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$133,639.47 $US								$137,941.07 $US			
Carbon	328.7	150.0	5.04	NA	NA	NA	(20.4)	24.9	353.6	129.6	5.09	-0.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	478.7 MT CO2e								483.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 30-9. Main Library DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WHs with (3) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) 120 gallon HW storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**1,157,783.3**	**28,237.0**	**71.3**	**NA**	**NA**	**NA**	**(3,835.8)**	**16,510.7**	**1,174,294.1**	**24,401.2**	**67.9**	**4.8%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,775.2 MMBTU								6,448.0 MMBTU			
Energy Cost	**$105,748.14**	**$27,891.33**	**$1.41**						**$107,227.84**	**$24,102.50**	**$1.38**	**1.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$133,639.47 $US								$131,330.35 $US			
Carbon	**328.7**	**150.0**	**5.04**	**NA**	**NA**	**NA**	**(20.4)**	**4.7**	**333.4**	**129.6**	**4.87**	**3.3%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	478.7 MT CO2e								463.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 30-10. Main Library Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$532,596.75	($93,185.46)	$24,102.50	($69,082.95)	($2,119,952.52)	NA	NA	-1.9456	NA	NA	($3,875.23)
HVAC Pathway 2	$1,149,708.75	($47,969.19)	$24,102.50	($23,866.68)	($1,999,774.34)	-9.6972%	NA	-0.2872	NA	NA	$1,915.68
DHW Pathway 1	$30,948.00	($8,090.43)	$3,788.83	($4,301.60)	($123,558.10)	NA	NA	-1.9545	NA	NA	($229.33)
DHW Pathway 2	$737,050.00	($1,479.70)	$3,788.83	$2,309.13	($938,227.30)	-6.6414%	-4.0776%	0.0580	NA	NA	$800.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$105,636.00
DHW Existing Replacement:	$40,168.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

30.5 Renewable Energy, Energy Storage, and Electric Vehicles

30.5.1 Solar and BESS Analysis

The Main Library was recognized as having an unknown roof surface with no shading from adjacent buildings or trees. The large roof is divided into two (2) main levels with varying material. The lower rooftop level has a parapet wall surrounding the perimeter with a thin slanted aisle running to the shorter roof level. The lower roof level has various HVAC equipment and a large skylight, reducing the available footprint for solar equipment due to shading concerns. The roof is scheduled to be replaced in 2040. As shown on Figure 30-5, the total estimated available solar capacity is 95 kW DC with placement of the BESS equipment proposed on the Western side of the building.

Figure 30-5. Main Library Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 1,196,100 kWh with a peak August load of 245.2 kW. The estimated roof solar capacity is 95 kW DC and initial HOMER analysis indicates that only a 90 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BES hybrid systems tend to possess

unfavorable payback periods and IRR due to the high capital cost of BESS and low amounts of excess PV generation. Standalone PV systems tend to have more favorable payback periods when incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 30-1. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the low renewable fraction and relatively high simple payback period for both configurations, it is recommended to wait until the energy density of PV and BESS technology improves.

Table 30-11. Main Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	1,196,100	N/A	N/A	N/A
90 kW PV Only	1,074,278	121,836	N/A	10.2
90 kW PV + 132 kWh BESS	1,074,896	121,836	2,880	10.1

30.6 Cost Summary

Cost performance for the three systems is provided in Table 30-2.

Table 30-12. Main Library Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	1,230,000	N/A	N/A
90 kW PV Only	168,000	1,300,000	1.4	21
90 kW PV + 132 kWh BESS	384,000	1,510,000	N/A	>25
Cost Summary with ITC Included				
90 kW PV Only	117,000	1,250,000	4.6	14.7
90 kW PV + 132 kWh BESS	269,000	1,400,000	N/A	>25

30.6.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location, this facility was identified for long lay-over periods and recommended for consideration of public charging. Six (6) charging locations are shown in Figure 30-5 should chargers be considered in the future.

30.7 Electrical Infrastructure Demand Feasibility Summary

Table 30-13. Main Library Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	286.40 kW	286.40 kW
HVAC Electrification Pathway 1		1,420.12 kW
HVAC Electrification Pathway 2		1,210.07 kW
DHW Electrification Pathway 1		300.47 kW
DHW Electrification Pathway 2		288.87 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

30.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the breaker size needed to supply power to the electric boilers required by HVAC Electrification Pathway 1 or air-to-water modular heat pump chillers for Electrification Pathway 2. New circuit breakers will be required.

30.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboards can accommodate the equipment required by DHW Electrification Pathway 1 or for DHW Electrification Pathway 2. New circuit breakers will be required.

30.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

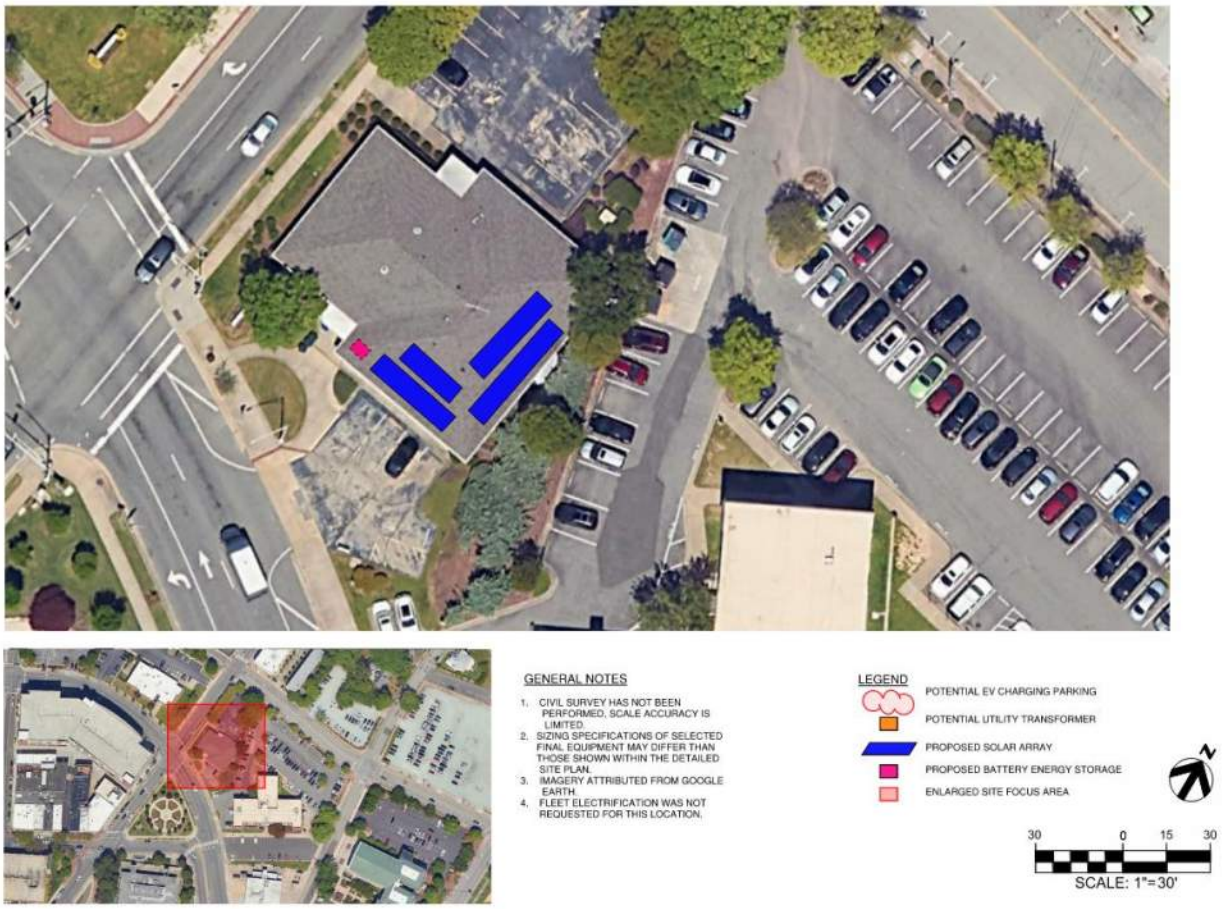
31 Main Library Annex / Family Justice Resource Center

31.1 Renewable Energy, Energy Storage, and Electric Vehicles

31.1.1 Solar and BESS Analysis

The Main Library Annex/Family Justice Resource Center roof is composed of shingles and shaded by adjacent trees on the East side of the facility. The roof is divided into various subsections due to the angles of the architecture. The age of the roof was not confirmed, and the replacement cycle was not identified. The architecture of the roof, as shown in Figure 31-1, has focused solar footprint to only the southern facing region for an estimated total capacity is 12 kW DC. Due to the high foot traffic by the general public surrounding the facility, it is recommended for BESS equipment to be placed in a secure location internal to the building.

Figure 31-1. Main Library Annex/Family Justice Resource Center Conceptual Renewables and EV Visual Aid



*BESS system to be located in a secure interior location. Durham County to determine installation location.

No load data was provided for this building; thus, it was assumed that the load is similar to the Southwest Regional Library but scaled to account for the smaller building area. The current

building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 127,750 kWh with a peak July load of 34 kW. The estimated roof solar capacity is 12 kW DC and initial HOMER analysis indicates that a 12 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV systems tend to have significantly more favorable payback periods and rate of return if ITCs are factored into the system cost. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 31-1. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Based on the data below, a standalone PV system would be recommended due to the favorable payback period and BESS not providing an increase in renewable fraction.

Table 31-1. Main Library Annex/Family Justice Resource Center Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	127,750	N/A	N/A	N/A
12 kW PV Only	111,430	16,327	N/A	12.8
12 kW PV + 13.2 kWh BESS	111,586	16,327	742	12.7

31.2 Cost Summary

Cost performance for the three systems is provided in Table 31-2.

Table 31-2. Main Library Annex/Family Justice Resource Center Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	155,000	N/A	N/A
12 kW PV Only	36,000	177,000	2.8	18
12 kW PV + 13.2 kWh BESS	57,000	200,000	N/A	>25
Cost Summary with ITC Included				
12 kW PV Only	25,000	167,000	3.6	12
12 kW PV + 13.2 kWh BESS	42,000	185,000	N/A	>25

31.2.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location. This facility was identified for long lay-over periods and recommended for consideration of public charging. Three (3) charging locations are shown in Figure 31-1 should chargers be considered in the future.

31.3 Electrical Infrastructure Demand Feasibility Summary

31.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

32 North Regional Library

Durham County | North Regional Library | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	221 Milton Rd, Durham, NC 27712	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Natural Draft Boiler
Building Type	Library	**Cooling Generation**	Air-Cooled Chiller
Year Built	2006	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	26,649	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

Figure 32-1. North Regional Library





32.1 Existing Building Performance & Condition

32.1.1 Past Conservation Projects and Successes

None.

32.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 32-1. North Regional Library Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

32.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 32-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

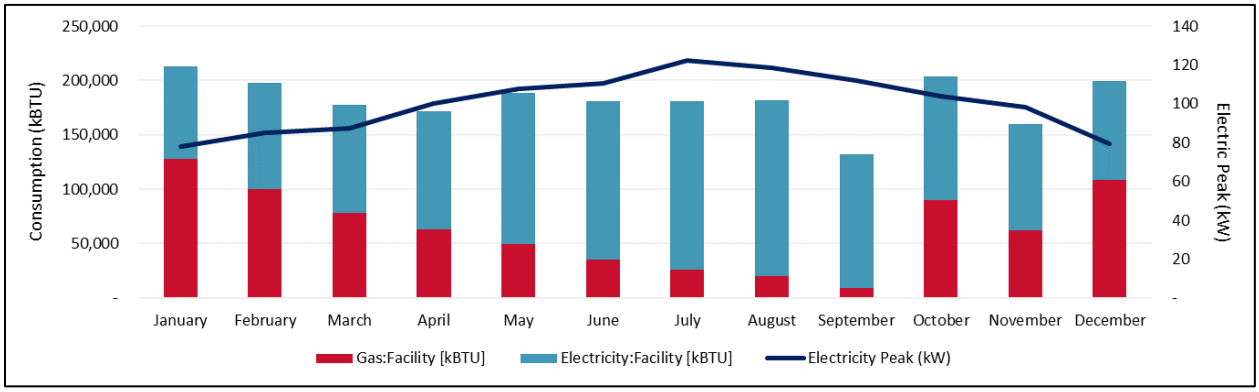
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 32-2. North Regional Library Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	24,910	1,281	213	77.8	$1,983	$1,541	$3,524	7,072	6,801	13,873
February	28,510	1,004	198	85.2	$2,249	$1,104	$3,352	8,094	5,330	13,424
March	29,149	782	178	87.2	$2,274	$821	$3,095	8,275	4,151	12,426
April	31,950	630	172	100.4	$2,491	$653	$3,144	9,071	3,344	12,414
May	40,823	494	189	107.7	$3,143	$517	$3,660	11,590	2,621	14,211
June	42,709	355	181	110.7	$4,182	$380	$4,561	12,125	1,883	14,008
July	45,552	259	181	122.4	$4,465	$278	$4,743	12,932	1,373	14,305
August	47,344	198	181	118.4	$4,684	$221	$4,905	13,441	1,052	14,493
September	36,018	94	132	112.0	$3,925	$112	$4,037	10,226	499	10,725
October	33,310	899	204	103.8	$2,839	$456	$3,295	9,457	4,775	14,232
November	28,586	622	160	98.4	$2,570	$658	$3,228	8,116	3,301	11,417
December	26,620	1,086	199	79.6	$2,341	$1,302	$3,643	7,557	5,766	13,323
ANNUAL	415,481	7,700	2,188	-	$37,145	$8,042	$45,187	117,956	40,896	158,852
PEAK	-	-	-	122.4	-	-	-	-	-	-

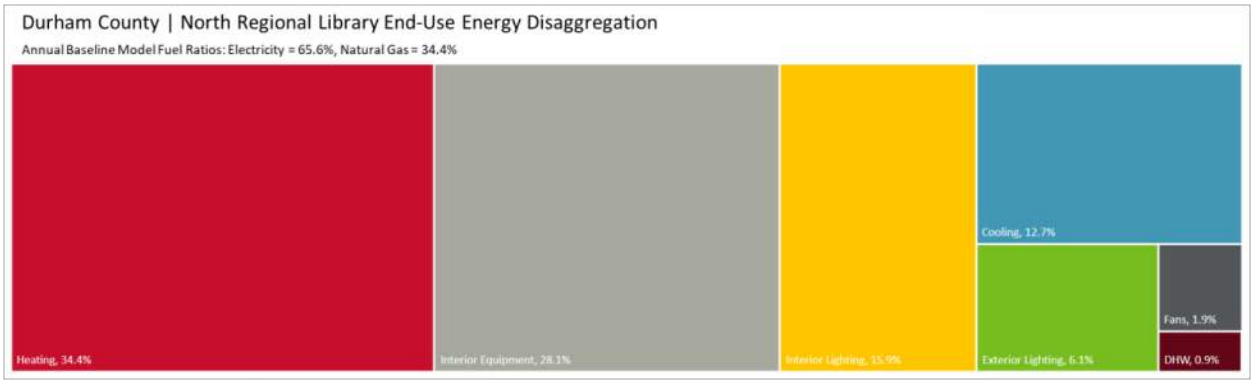
The data in Table 32-2 is represented in graphical format in Figure 32-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 32-2. North Regional Library Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



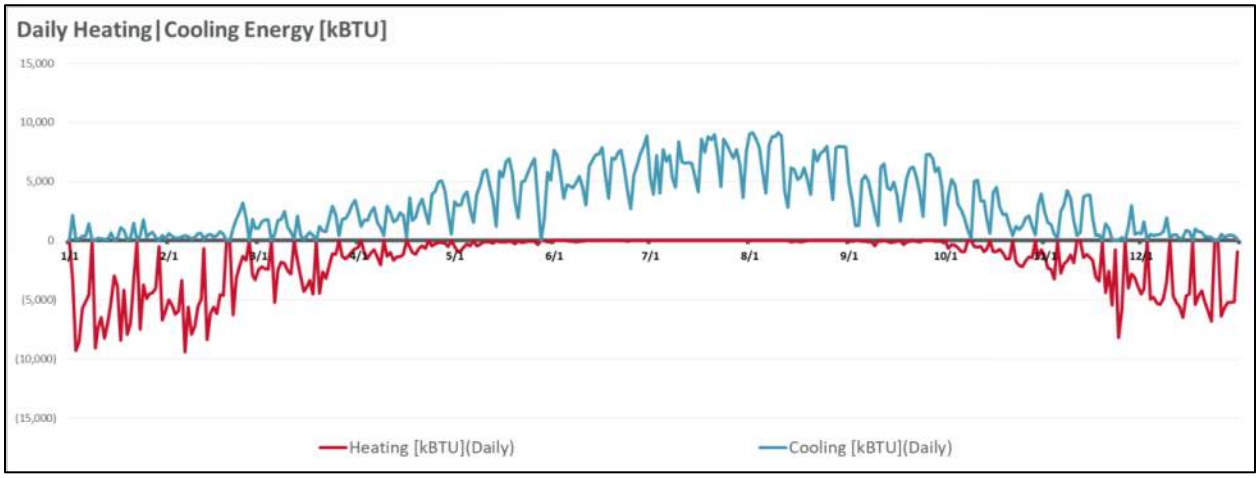
While Table 32-2 and Figure 32-2 encompasses “whole” building data, Figure 32-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 32-3. North Regional Library Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 32-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 32-4. North Regional Library Baseline Model Heating & Cooling Annual Load Profile



32.2 HVAC Refrigerants

The Durham County North Regional Library utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 32-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 32-3. North Regional Library HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Air-Cooled Chiller	Carrier 30GXN083-E-661FZ	80 tons	R-134A	Circuit 1: 128 lbs, Circuit 2: 123 lbs	Exterior
CU-3	Air-Cooled Condenser	LG LSU243HLV3	24 MBH	R-410A	4 lbs, 13.6 oz	Roof

32.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 32-4. North Regional Library Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
North Regional Library	Baseline	429,563.20	8,612.00	2,327.29	$49,553.47	167.70

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	45,342.78	909.04	245.66	$5,230.64	17.70	Potential Annual Energy Savings (%)	10.6%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	6,133.25	0.00	20.93	$574.89	1.74	NA	NA	
	Smart Thermostat	1,112.76	0.00	3.80	$104.30	0.32	Total Cooling Capacity Controled	93.40	kBTU/hr
	Air Conditioner Tune-up	898.11	0.00	3.07	$84.18	0.25	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	223.48	22.35	$241.06	1.19	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$27.86	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$221.95	0.67	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	45,135.20	-299.53	124.09	$3,907.57	11.22	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	17,477.89	-115.99	48.05	$1,513.14	4.35	Applicable Area %	50.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	6	#
	Daylight Dimming Control	13,982.31	-92.79	38.44	$1,210.51	3.48	Applicable Area %	40.0%	%
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$243.23	0.74	Quantity of Outdoor Fixtures	10	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$453.89	1.37	Transformer Size	500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.84	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$50.43	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		**140,827.66**	**624.21**	**543.06**	**$13,873.50**	**43.30**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**32.8%**	**7.2%**	**23.3%**	**28.0%**	**25.8%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

32.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 32-5. North Regional Library Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 1530 MBH, Output: 1265 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 160 deg F, LWT: 180 deg F, Controls: Heat-Timer SQ Elite 8T Sequencing Controller (for multi-stage control)
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE8220RTA), fuel: electric resistance, capacity: 4000W 1PH/3PH Interlock & 8000W 1PH-3PH Simultaneous, Volume: 80 gal rated, Location: Janitor's Closet off of Lobby

Table 32-6. North Regional Library HVAC Electrification Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	0.0	(7,431.3)	194,352.5	NA	NA	609,833.2	0.0	78.1	3.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,161.2 MMBTU								2,081.3 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$64,709.81	$0.00	$2.43	-34.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$48,303.67 $US								$64,709.81 $US			
Carbon	118.0	39.5	5.91	0.0	(39.5)	55.2	NA	NA	173.1	0.0	6.50	-10.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	157.4 MT CO2e								173.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 32-7. North Regional Library HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	0.0	(7,431.3)	87,938.2	NA	NA	503,418.9	0.0	64.5	20.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,161.2 MMBTU								1,718.2 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$52,560.57	$0.00	$1.97	-8.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$48,303.67 $US								$52,560.57 $US			
Carbon	118.0	39.5	5.91	0.0	(39.5)	25.0	NA	NA	142.9	0.0	5.36	9.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	157.4 MT CO2e								142.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 32-8. North Regional Library DHW Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	NA	NA	NA	0.0	0.0	415,480.7	7,431.3	81.1	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,161.2 MMBTU								2,161.2 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$40,060.42	$8,243.25	$1.81	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$48,303.67 $US								$48,303.67 $US			
Carbon	118.0	39.5	5.91	NA	NA	NA	0.0	0.0	118.0	39.5	5.91	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	157.4 MT CO2e								157.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 32-9. North Regional Library DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Commercial Storage Tank Water Heater, fuel: electric heat pump, capacity: 4000W, Volume: 80 gal rated, Efficiency: 3.50 COP, Location: Janitor's Closet off of Lobby

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	NA	NA	NA	0.0	(3,386.7)	412,094.0	7,431.3	80.7	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,161.2 MMBTU								2,149.6 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$39,735.95	$8,243.25	$1.80	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$48,303.67 $US								$47,979.20 $US			
Carbon	118.0	39.5	5.91	NA	NA	NA	0.0	(1.0)	117.0	39.5	5.87	0.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	157.4 MT CO2e								156.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 32-10. North Regional Library Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$135,130.00	($24,649.40)	$8,243.25	($16,406.15)	($509,137.57)	NA	NA	-1.7882	NA	NA	($801.01)
HVAC Pathway 2	$657,269.00	($12,500.15)	$8,243.25	($4,256.90)	($958,351.46)	-7.8705%	NA	-0.0790	NA	NA	$739.77
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$8,278.00	$324.46	$0.00	$324.46	($4,339.75)	-0.8814%	1.7435%	0.6120	NA	NA	$49.04

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$38,740.00
DHW Existing Replacement:	$4,611.00

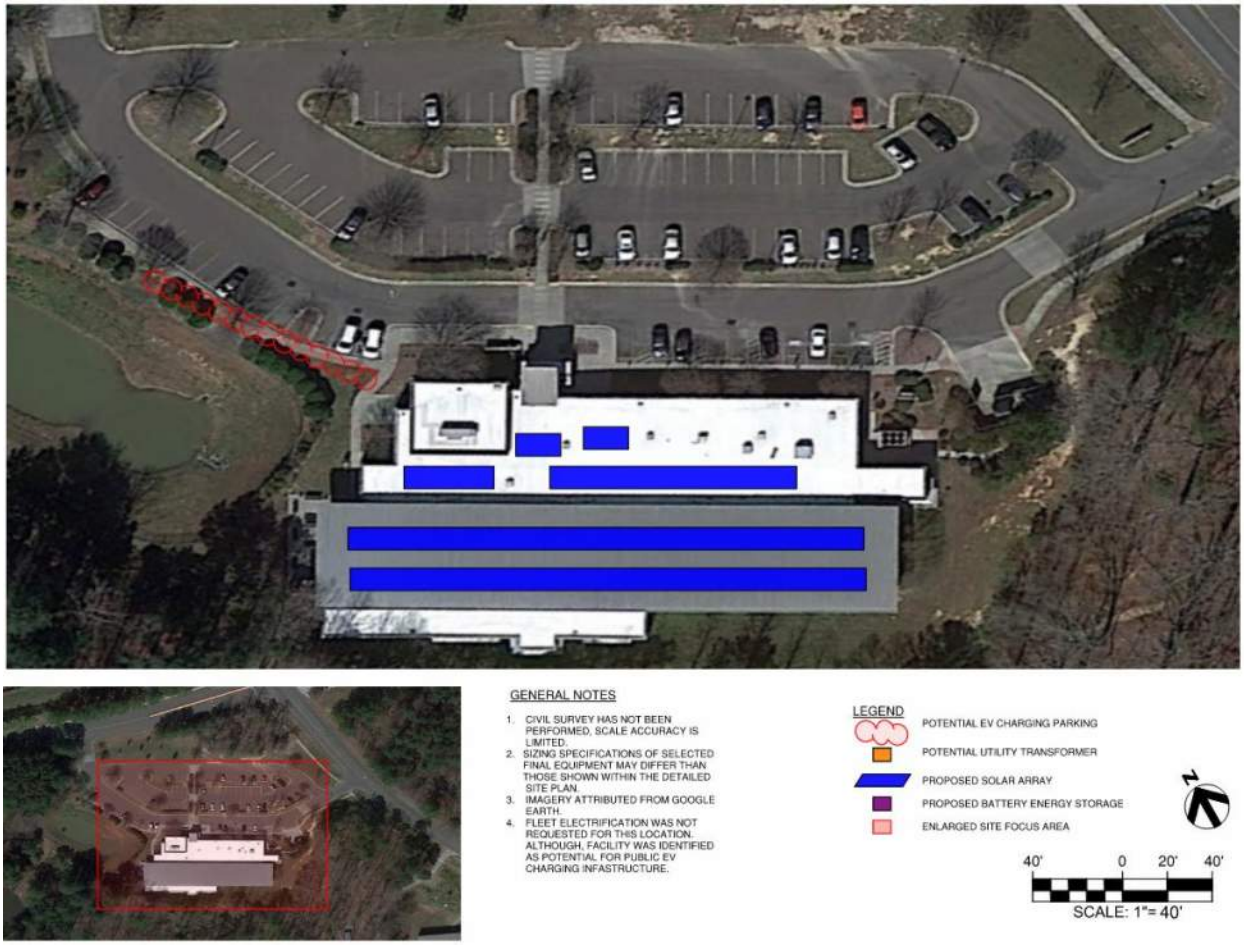
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

32.5 Renewable Energy, Energy Storage, and Electric Vehicles

32.5.1 Solar and BESS Analysis

The North Regional Library has a large sized roof shaded by adjacent trees. The roof is divided into two (2) main levels with varying material. The lowest rooftop level has a parapet height of approximately 12 inches and various pieces of equipment, impacting the total capacity of rooftop solar strings placed on this level. The upper metal roof is sloped. As shown in Figure 32-5, the large main roof has an estimated capacity of 94 kW DC, and the small lower roof level capacity is approximately 34 kW DC. Placement of BESS equipment is proposed on the Eastern side of the facility. The roof is scheduled to be replaced in 2025.

Figure 32-5. North Regional Library Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 430,837 kWh with a peak summer load (August and September) of 120.5 kW. The estimated roof solar capacity is 128 kW DC; however, initial HOMER analysis indicates that 120 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable renewable fractions, but tend to have unfavorable payback periods and IRR.

PV and BESS hybrid systems tend to have unfavorable payback period and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV systems tend to have more favorable payback periods if incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 32-11. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the high renewable fraction and relatively low simple payback period, the standalone PV system configuration has preferred results compared to the PV + BESS system configuration.

Table 32-11. North Regional Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	430,837	N/A	N/A	0.0
128 kW PV	271,219	176,877	N/A	39.5
128 kW PV + 119 kWh BESS	259,892	176,877	13,673	40.1

32.6 Cost Summary

Cost performance for the three systems is provided in Table 32-12.

Table 32-12. North Regional Library Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	490,000	N/A	N/A
130 kW PV	237,000	618,000	N/A	>25
130 kW PV + 119 kWh BESS	431,000	802,000	N/A	>25
Cost Summary with Incentives Included				
130 kW PV	166,000	547,000	2.7	17.9
130 kW PV + 119 kWh BESS	302,000	672,000	N/A	>25

32.6.1 Electric Vehicle

The North Regional library location was not identified for fleet electrification. The location is ideal for public charging. Four (4) charging locations, in addition to the two (2) previously installed chargers, are shown in Figure 32-5 should chargers be considered in the future.

32.7 Electrical Infrastructure Demand Feasibility Summary

Table 32-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	122.24 kW	122.24 kW
HVAC Electrification Pathway 1		390.27 kW
HVAC Electrification Pathway 2		348.08 kW
DHW Electrification Pathway 1		122.44 kW
DHW Electrification Pathway 2		121.80 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

32.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the required breaker size to supply power for the electric heat required by HVAC Electrification Pathway 1 or for Electrification Pathway 2. Therefore, a new main service panelboard will be required.

32.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the water heaters required for DHW Electrification Pathway 2. A new main distribution panel will be required.

32.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the required breaker size to interconnect the PV system. A new main circuit breaker will be required.

33 Parkwood VFD #1

Durham County | Parkwood VFD #1 | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	1409 Seaton Rd, Durham, NC 27713	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Emergency Services	**Cooling Generation**	Split-System DX
Year Built	1976	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	9,829	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 33-1. Parkwood VFD #1



33.1 Existing Building Performance & Condition

33.1.1 Past Conservation Projects and Successes

None.

33.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear to be in fair condition, with no noted deficiencies for most equipment beyond normal wear for the equipment age. The electric domestic water heater was manufactured in 2008 and is beyond it expected service life. The water heater is not installed in a drain pan.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 33-1. Parkwood VFD #1 Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace water heater and provide drain pan.
Fix.1	

33.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 33-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was NOT AVAILABLE in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was PREDICTED via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

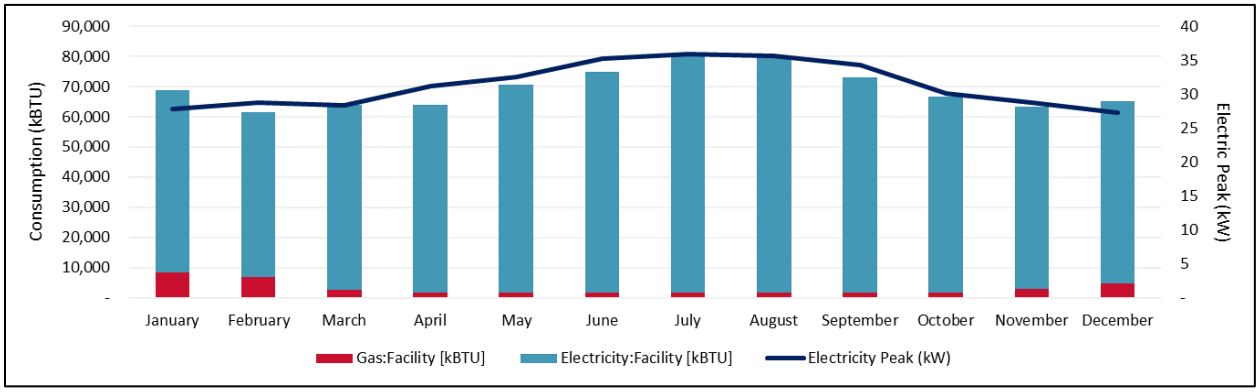
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 33-2. Parkwood VFD #1 Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	17,673	83	69	27.8	$0	$84	$84	5,018	443	5,460
February	15,973	70	62	28.7	$0	$71	$71	4,535	372	4,907
March	17,952	26	64	28.4	$0	$26	$26	5,097	139	5,236
April	18,200	19	64	31.2	$0	$19	$19	5,167	99	5,266
May	20,112	19	71	32.5	$0	$19	$19	5,710	99	5,809
June	21,413	17	75	35.2	$0	$17	$17	6,079	92	6,171
July	23,188	17	81	35.8	$0	$18	$18	6,583	93	6,676
August	22,802	17	80	35.6	$0	$17	$17	6,474	92	6,566
September	20,893	17	73	34.3	$0	$17	$17	5,932	90	6,022
October	18,967	18	67	30.1	$0	$18	$18	5,385	97	5,481
November	17,619	31	63	28.7	$0	$31	$31	5,002	163	5,165
December	17,690	48	65	27.3	$0	$49	$49	5,022	257	5,280
ANNUAL	232,483	384	832	-	$0	$386	$386	66,003	2,037	68,040
PEAK	-	-	-	35.8	-	-	-	-	-	-

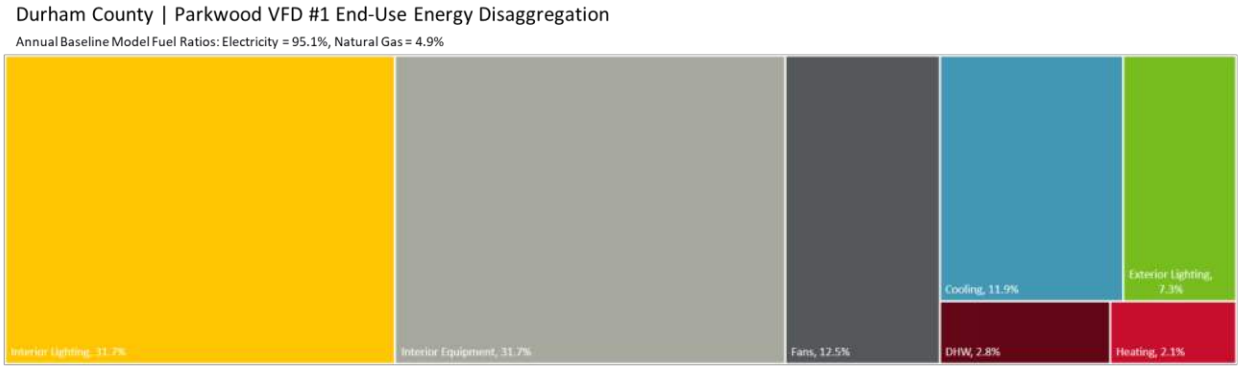
The data in Table 33-2 is represented in graphical format in Figure 33-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 33-2. Parkwood VFD #1 Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



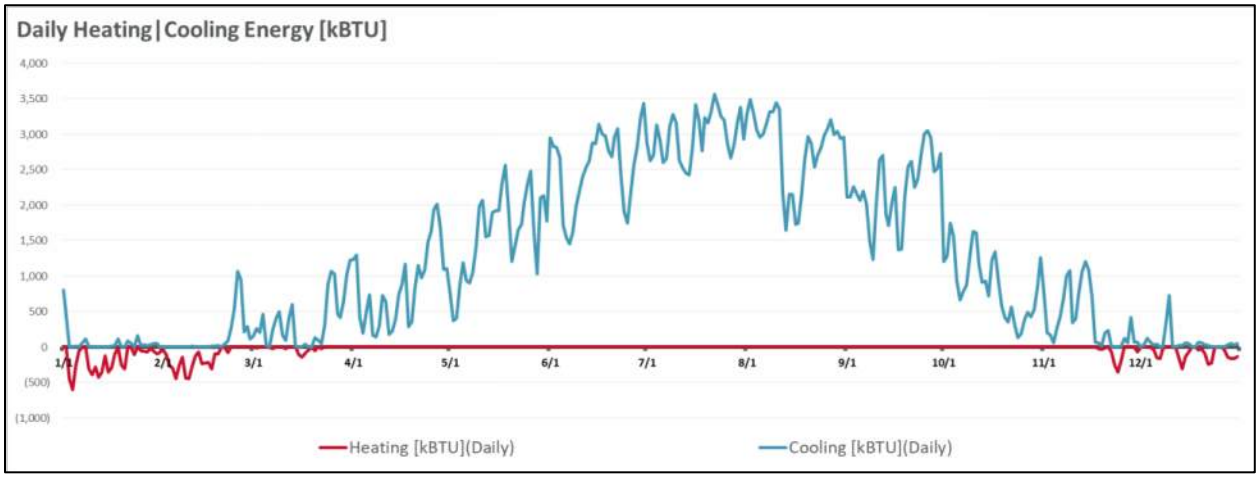
While Table 33-2 and Figure 33-2 encompasses “whole” building data, Figure 33-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 33-3. Parkwood VFD #1 Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 33-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 33-4. Parkwood VFD #1 Baseline Model Heating & Cooling Annual Load Profile



33.2 HVAC Refrigerants

The Durham County Parkwood VFD #1 utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 33-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 33-3. Parkwood VFD #1 HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(3) RTU	Rooftop Unit	Trane 4YCC4024	2 Tons	R-410A	5.3 lbs	Exterior
Freezer	Household Chest Freezer	Hotpoint FH27CJ	-	R-12	13.8 oz	Interior
AC	Split-System Condensing Unit	Trane 4TTR4036L1	3 Tons	R-410A	6.1 lbs	Exterior

33.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 33-4. Parkwood VFD #1 Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Parkwood VFD #1 (Station 18)	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	682.44	0.00	2.33	$70.91	0.19	NA	NA	
	Smart Thermostat	1,165.03	10.52	5.03	$131.52	0.39	Total Cooling Capacity Controled	120.00	kBTU/hr
	Air Conditioner Tune-up	1,472.60	0.00	5.03	$153.00	0.42	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.19	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	-1,333.55	220.47	17.50	$81.05	0.79	# Solar Thermal Panels	5	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	1,723.76	-11.44	4.74	$167.70	0.43	Applicable Area %	5.0%	%
	LED Exit Signs	211.99	-1.41	0.58	$20.62	0.05	Quantity of Exit Signs	2	#
	Daylight Dimming Control	1,723.76	-11.44	4.74	$167.70	0.43	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	518.98	0.00	1.77	$53.92	0.15	Quantity of Outdoor Fixtures	2	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$21.82	0.06	$0.00	2	#
	Tier 1 Advanced Power Strip	161.40	0.00	0.55	$16.77	0.05	Quantity of Power Strips	6	#
Decarbonization Measure Savings Totals (predicted)		**6,536.41**	**212.91**	**43.60**	**$891.21**	**2.99**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**0.0%**	**0.0%**	**0.0%**	**-**	**-**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

33.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 33-5. Parkwood VFD #1 Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Direct-vent gas furnace, Trane model S9B1B060U4PSA, 60 mbh input, 55 mbh output, mfg 2015; (4?) Gas-fired radiant tube heaters, Space-Ray, approx. 15' double tube, approx 50 mbh; (3) RTU gas furnaces, no namplate data gathered;
Domestic Hot Water	(1) Gas-fired storage water heater, natural draft, 40 gal, 40 mbh input, 41 gph recovery, State model GS6-40-BCS 400, mfg 2016; (1) Electric storage water heater, 50 gal, 4.5 kw, Rheem model 82MV52-2, mfg. 2008;

Table 33-6. Parkwood VFD #1 HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace (1) split-system with (1) 3-ton split-system heat pump condensing unit and AHU with 20 kw heater; *Replace (3) RTUs with (3) 3-ton heat pump RTU, w/ economizer, 18 kw elec heat, Trane model WHC036 (54 kw total); *Replace (4) gas radiant heaters with (4) electric unit heaters, Modine HER150, 15 kw (60 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	0.0	(185.0)	2,811.8	NA	NA	235,294.9	220.8	83.9	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	834.0 MMBTU								825.1 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$20,906.59	$222.44	$2.15	-0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$21,004.84 $US								$21,129.03 $US			
Carbon	66.0	2.2	6.93	0.0	(1.0)	0.8	NA	NA	66.8	1.2	6.92	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	68.2 MT CO2e								68.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 33-7. Parkwood VFD #1 HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	0.0	(185.0)	2,811.8	NA	NA	235,294.9	220.8	83.9	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	834.0 MMBTU								825.1 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$20,906.59	$222.44	$2.15	-0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$21,004.84 $US								$21,129.03 $US			
Carbon	66.0	2.2	6.93	0.0	(1.0)	0.8	NA	NA	66.8	1.2	6.92	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	68.2 MT CO2e								68.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 33-8. Parkwood VFD #1 DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 50 gallon, 6kw input, Bradford White model LE350S3-3 (total 6 kw);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	NA	NA	NA	(220.8)	5,219.9	237,703.0	185.0	84.4	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	834.0 MMBTU								829.8 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$21,004.60	$186.35	$2.16	-0.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$21,004.84 $US								$21,190.95 $US			
Carbon	66.0	2.2	6.93	NA	NA	NA	(1.2)	1.5	67.5	1.0	6.97	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	68.2 MT CO2e								68.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 33-9. Parkwood VFD #1 DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) water heaters with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	NA	NA	NA	(220.8)	986.7	233,469.8	185.0	83.0	2.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	834.0 MMBTU								815.3 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$20,674.02	$186.35	$2.12	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$21,004.84 $US								$20,860.36 $US			
Carbon	66.0	2.2	6.93	NA	NA	NA	(1.2)	0.3	66.3	1.0	6.84	1.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	68.2 MT CO2e								67.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 33-10. Parkwood VFD #1 Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$106,372.00	($310.54)	$186.35	($124.19)	($145,917.46)	-7.3983%	NA	-0.0151	NA	NA	$9.40
HVAC Pathway 2	$106,372.00	($310.54)	$186.35	($124.19)	($145,917.46)	-7.3983%	NA	-0.0151	NA	NA	$9.40
DHW Pathway 1	-$213.00	($408.55)	$222.44	($186.11)	($3,109.17)	NA	NA	NA	NA	NA	($15.76)
DHW Pathway 2	$9,901.00	($77.97)	$222.44	$144.47	($9,800.80)	-4.3591%	-0.3405%	0.2675	NA	NA	$45.53

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$42,861.00
DHW Existing Replacement:	$9,853.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

33.5 Renewable Energy, Energy Storage, and Electric Vehicles

33.5.1 Solar and BESS Analysis

Solar and BESS review was not requested for this location.

Figure 33-5. Parkwood VFD #1 Conceptual Renewables and EV Visual Aid



33.5.2 Electric Vehicle

The Parkwood VFD #1 was identified for fleet electrification. Ideal locations for EV chargers, if not permitted interior to the structure, are indicated in Figure 33-5. A total of six (6) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 43.2 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

33.6 Electrical Infrastructure Demand Feasibility Summary

Table 33-11. Parkwood VFD #1 Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	35.84 kW	35.84 kW
HVAC Electrification Pathway 1		37.45 kW
HVAC Electrification Pathway 2		37.45 kW
DHW Electrification Pathway 1		36.39 kW
DHW Electrification Pathway 2		35.95 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

33.6.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power for the air handling unit, roof top units, and electric unit heaters required by HVAC Electrification Pathways 1. A new main distribution panelboard will be required along with associated circuit breaker for each new piece of equipment.

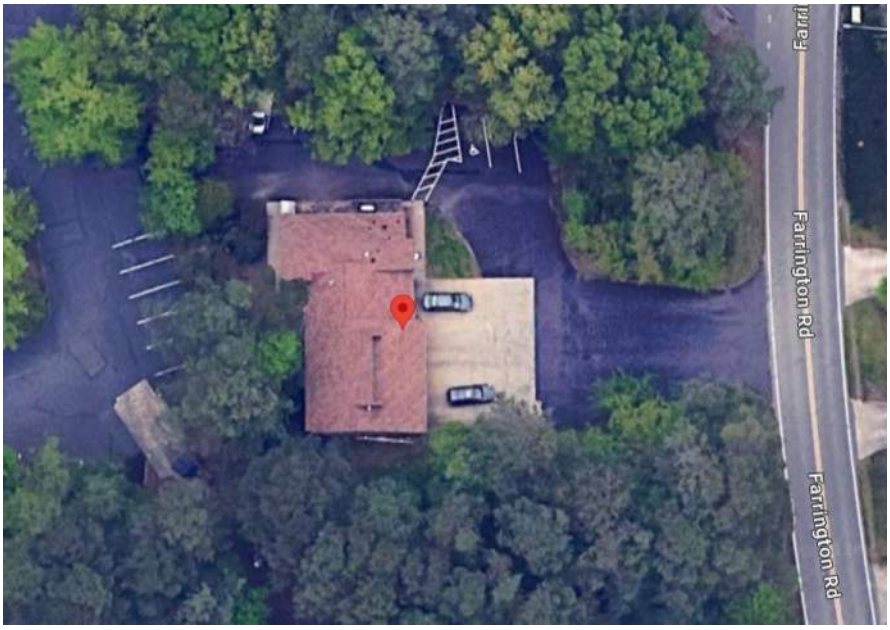
33.6.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power for the electric storage water heater for DHW Electrification Pathway 1 and heat pump storage water heater for DHW Electrification Pathway 2. A new main distribution panelboard will be required along with associated circuit breaker for each new piece of equipment.

34 Parkwood VFD #2

Durham County | Parkwood VFD #2 | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	4200 Farrington Rd, Durham, NC 27707	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Emergency Services	**Cooling Generation**	Split-System DX
Year Built	1984	**Domestic Hot Water Generation**	Gas Instantaneous Water Heater
Floor Area (ft2)	2,467	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent/LED	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 34-1. Parkwood VFD #2



34.1 Existing Building Performance & Condition

34.1.1 Past Conservation Projects and Successes

None.

34.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 34-1. Parkwood VFD #2 Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

34.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 34-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was NOT AVAILABLE in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was PREDICTED via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

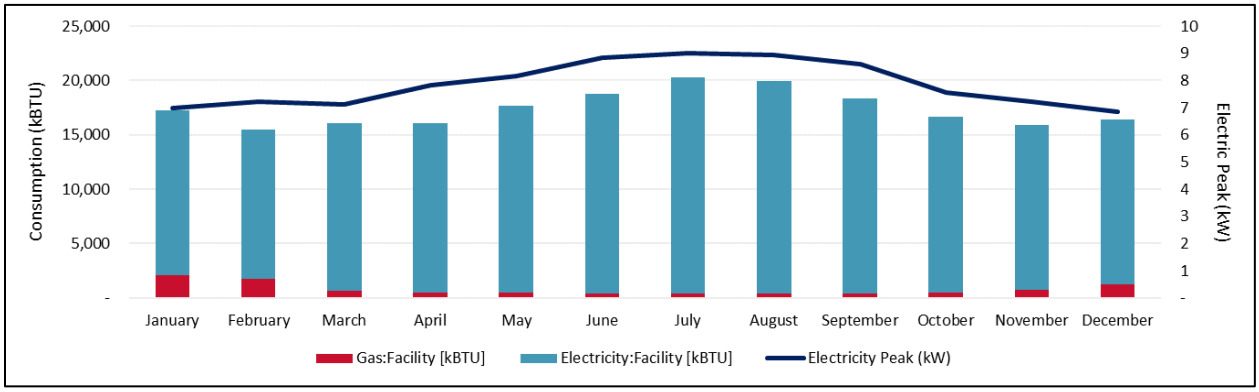
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 34-2. Parkwood VFD #2 Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	4,436	21	17	7.0	$0	$21	$21	1,259	111	1,371
February	4,009	18	15	7.2	$0	$18	$18	1,138	93	1,232
March	4,506	7	16	7.1	$0	$7	$7	1,279	35	1,314
April	4,568	5	16	7.8	$0	$5	$5	1,297	25	1,322
May	5,048	5	18	8.2	$0	$5	$5	1,433	25	1,458
June	5,374	4	19	8.8	$0	$4	$4	1,526	23	1,549
July	5,820	4	20	9.0	$0	$4	$4	1,652	23	1,676
August	5,723	4	20	8.9	$0	$4	$4	1,625	23	1,648
September	5,244	4	18	8.6	$0	$4	$4	1,489	23	1,511
October	4,761	5	17	7.6	$0	$5	$5	1,352	24	1,376
November	4,422	8	16	7.2	$0	$8	$8	1,255	41	1,296
December	4,440	12	16	6.9	$0	$12	$12	1,261	65	1,325
ANNUAL	58,351	96	209	-	$0	$97	$97	16,566	511	17,077
PEAK	-	-	-	9.0	-	-	-	-	-	-

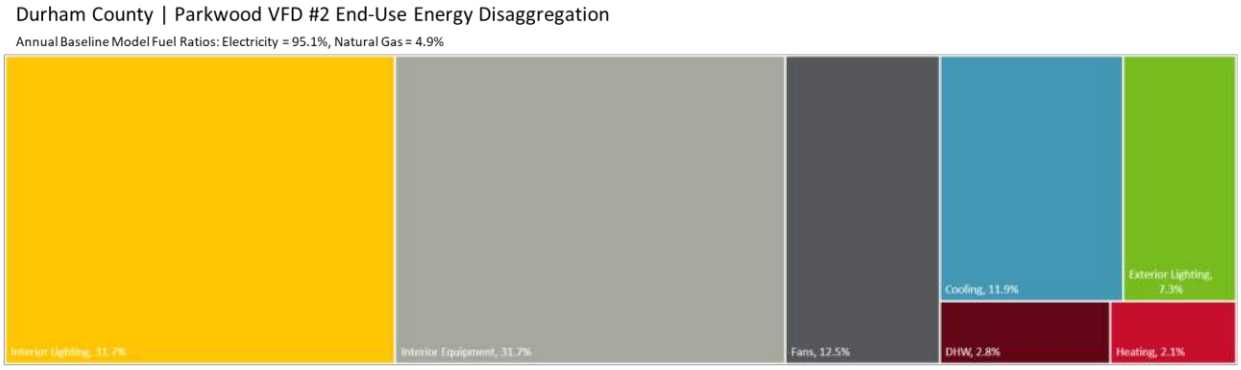
The data in Table 34-2 is represented in graphical format in Figure 34-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 34-2. Parkwood VFD #2 Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



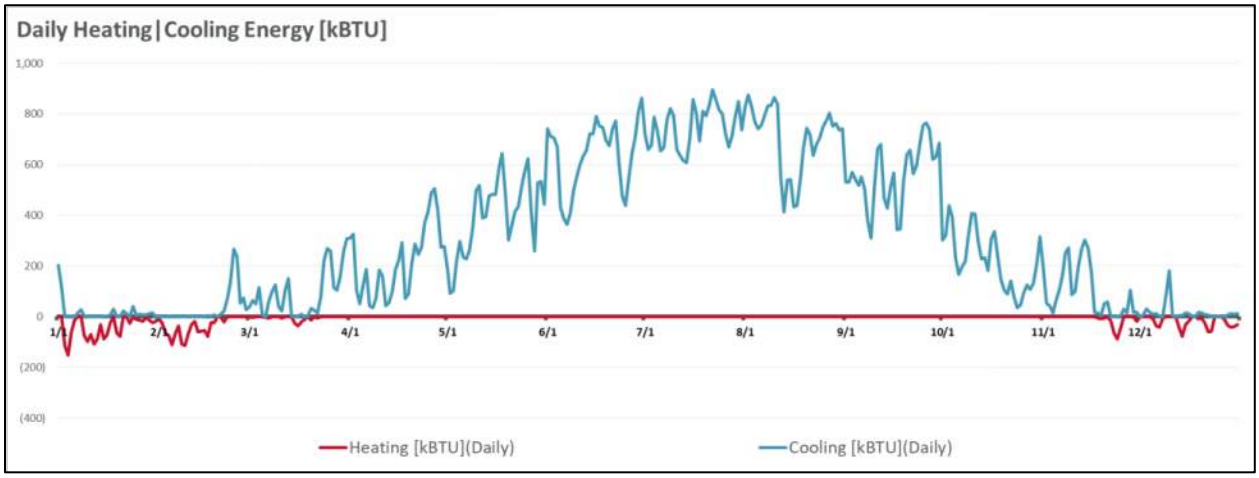
While Table 34-2 and Figure 34-2 encompasses “whole” building data, Figure 34-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 34-3. Parkwood VFD #2 Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 34-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 34-4. Parkwood VFD #2 Baseline Model Heating & Cooling Annual Load Profile



34.2 HVAC Refrigerants

The Durham County Parkwood VFD #2 utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 34-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section of this report.

Table 34-3. Parkwood VFD #2 HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(1) C**U**	Split-System Condensing Unit	York YCJD36S41S1A	3 Tons	R-410A	4.6 lbs	Exterior

34.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 34-4. Parkwood VFD #2 Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Parkwood VFD #2	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	171.29	0.00	0.58	$17.80	0.05	NA	NA	
	Smart Thermostat	376.39	14.03	2.69	$53.08	0.18	Total Cooling Capacity Controled	36.00	kBTU/hr
	Air Conditioner Tune-up	475.76	0.00	1.62	$49.43	0.14	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.19	0.03	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	15,832.16	-105.07	43.53	$1,540.30	3.94	Applicable Area %	90.0%	%
	Lighting Occupancy Sensor	432.65	-2.87	1.19	$42.09	0.11	Applicable Area %	5.0%	%
	LED Exit Signs	106.00	-0.70	0.29	$10.31	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	432.65	-2.87	1.19	$42.09	0.11	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$21.82	0.06	$0.00	2	#
	Tier 1 Advanced Power Strip	80.70	0.00	0.28	$8.38	0.02	Quantity of Power Strips	3	#
Decarbonization Measure Savings Totals (predicted)		**18,117.60**	**-91.28**	**52.71**	**$1,791.50**	**4.66**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**0.0%**	**0.0%**	**0.0%**	**-**	**-**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

34.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 34-5. Parkwood VFD #2 Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Direct-vent gas furnace, York model TG9S080B12, 80 mbh input, 76 mbh output, mfg 2009; (2) Gas radiant tube heater, Roberts-Gordon model CTH2-80, 80 mbh input;
Domestic Hot Water	(1) gas-fired instantaneous water heater, Noritz model N-0751M-DVC, 199.8 mbh input, 168 mbh output, 202 gph recovery, mfg 2009;

Table 34-6. Parkwood VFD #2 HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace (1) split-system with (1) 3-ton split-system heat pump condensing unit and AHU with 20 kw heater; *Replace (2) gas radiant heaters with (3) electric unit heaters, Modine HER150, 15 kw (45 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**58,351.4**	**101.9**	**84.9**	**0.0**	**(46.4)**	**968.6**	**NA**	**NA**	**59,320.0**	**55.4**	**84.3**	**0.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	209.3 MMBTU								208.0 MMBTU			
Energy Cost	**$7,042.73**	**$102.60**	**$2.90**						**$7,125.23**	**$55.83**	**$2.91**	**-0.5%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,145.34 $US								$7,181.07 $US			
Carbon	**16.6**	**0.5**	**6.93**	**0.0**	**(0.2)**	**0.3**	**NA**	**NA**	**16.8**	**0.3**	**6.95**	**-0.2%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.1 MT CO2e								17.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 34-7. Parkwood VFD #2 HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	58,351.4	101.9	84.9	0.0	(46.4)	968.6	NA	NA	59,320.0	55.4	84.3	0.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	209.3 MMBTU								208.0 MMBTU			
Energy Cost	$7,042.73	$102.60	$2.90						$7,125.23	$55.83	$2.91	-0.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,145.34 $US								$7,181.07 $US			
Carbon	16.6	0.5	6.93	0.0	(0.2)	0.3	NA	NA	16.8	0.3	6.95	-0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.1 MT CO2e								17.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 34-8. Parkwood VFD #2 DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 50 gallon, 27kw input, Bradford White model CEHD50(A)27 3*CF (total 27 kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	58,351.4	101.9	84.9	NA	NA	NA	(55.4)	1,310.2	59,661.5	46.4	84.4	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	209.3 MMBTU								208.3 MMBTU			
Energy Cost	$7,042.73	$102.60	$2.90						$7,154.21	$46.77	$2.92	-0.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,145.34 $US								$7,200.98 $US			
Carbon	16.6	0.5	6.93	NA	NA	NA	(0.3)	0.4	16.9	0.2	6.97	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.1 MT CO2e								17.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 34-9. Parkwood VFD #2 DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace (1) gas water heater with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT (total 12 kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**58,351.4**	**101.9**	**84.9**	**NA**	**NA**	**NA**	**(55.4)**	**247.7**	**58,599.0**	**46.4**	**83.0**	**2.2%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	209.3 MMBTU								204.6 MMBTU			
Energy Cost	**$7,042.73**	**$102.60**	**$2.90**						**$7,063.92**	**$46.77**	**$2.88**	**0.5%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$7,145.34 $US								$7,110.70 $US			
Carbon	**16.6**	**0.5**	**6.93**	**NA**	**NA**	**NA**	**(0.3)**	**0.1**	**16.6**	**0.2**	**6.84**	**1.3%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	17.1 MT CO2e								16.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 34-10. Parkwood VFD #2 Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$55,756.23	($82.50)	$46.77	($35.73)	($75,986.08)	-7.3459%	NA	-0.0085	NA	NA	($1.45)
HVAC Pathway 2	$55,756.23	($82.50)	$46.77	($35.73)	($75,986.08)	-7.3459%	NA	-0.0085	NA	NA	($1.45)
DHW Pathway 1	$8,440.00	($111.47)	$55.83	($55.64)	($12,446.08)	-8.0662%	NA	-0.0913	NA	NA	($3.96)
DHW Pathway 2	$15,566.00	($21.19)	$55.83	$34.64	($20,170.46)	-6.8267%	-4.9010%	0.0411	NA	NA	$11.43

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$16,945.00
DHW Existing Replacement:	$5,174.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

34.5 Renewable Energy, Energy Storage, and Electric Vehicles

34.5.1 Solar and BESS Analysis

Solar and BESS review was not requested for this location.

Figure 34-5. Parkwood VFD #2 Conceptual Renewables and EV Visual Aid



34.5.2 Electric Vehicle

The Parkwood VFD #2 was identified for fleet electrification. Ideal locations for EV chargers, if not permitted interior to the structure, are indicated in Solar and BESS review was not requested for this location.

Figure 33-5. A total of six (6) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 43.2 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

34.6 Electrical Infrastructure Demand Feasibility Summary

Table 34-11. Parkwood VFD #2 Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	9.00 kW	9.00 kW
HVAC Electrification Pathway 1		10.41 kW
HVAC Electrification Pathway 2		10.41 kW
DHW Electrification Pathway 1		9.13 kW
DHW Electrification Pathway 2		9.02 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

34.6.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the circuit breakers required to supply power for the air handling unit and electric unit heaters required by HVAC Electrification Pathways 1. New circuit breakers will be required.

34.6.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the circuit breakers required to supply power for the electric storage water heater for DHW Electrification Pathway 1 and heat pump storage water heaters for DHW Electrification Pathway 2. New circuit breakers will be required.

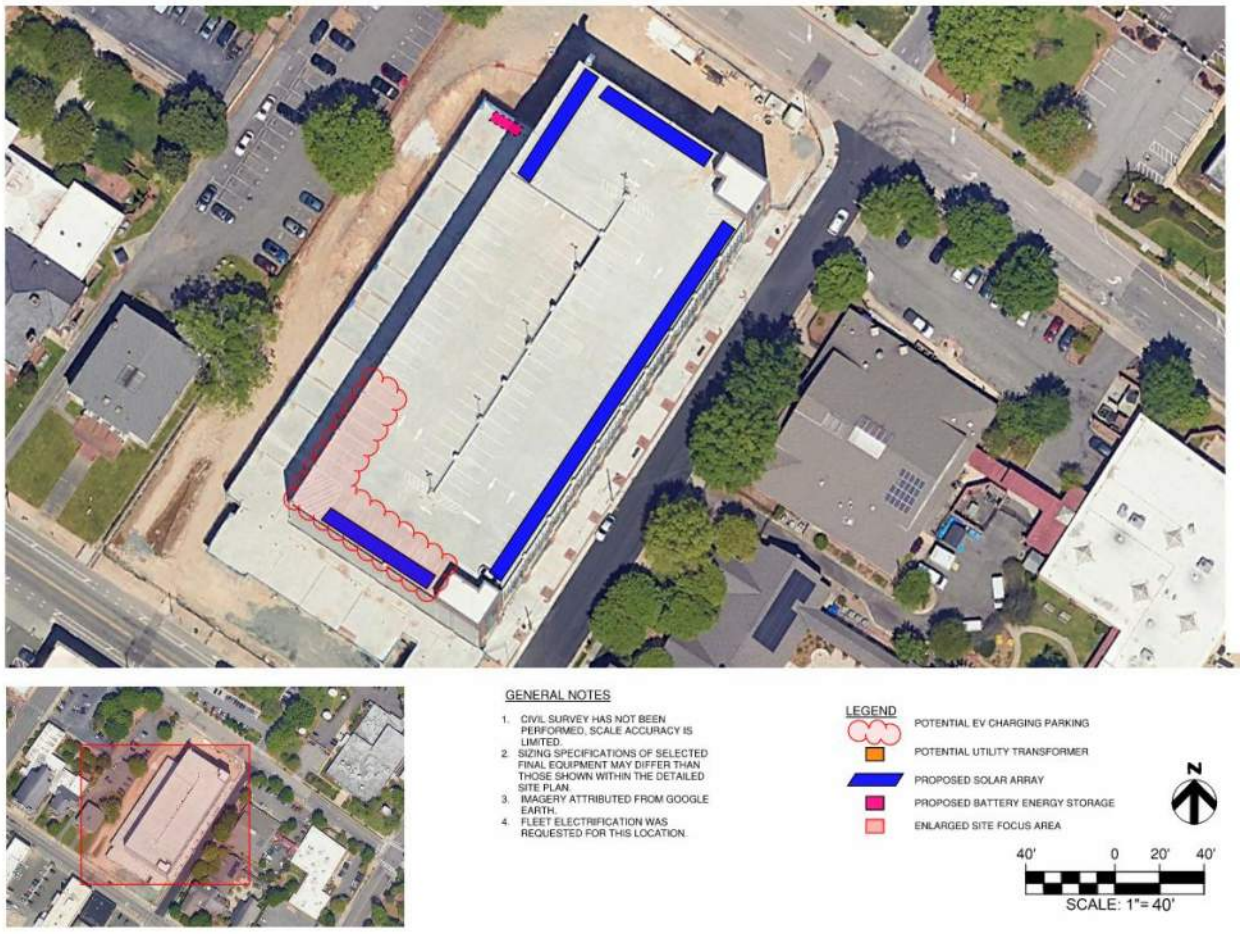
35 Queen Street Parking Deck

35.1 Renewable Energy, Energy Storage, and Electric Vehicles

35.1.1 Solar and BESS Analysis

The Queen Street Parking Deck solar canopies were reviewed for the main parking stalls of the top level for an estimated available solar footprint of 35 kW DC.

Figure 35-1. Queen Street Parking Deck Conceptual Renewables and EV Visual Aid



*BESS system to be located in a secure interior location. Durham County to determine installation location.

The current parking garage load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. Only annual energy consumption data was provided for this building; thus, it was assumed that the load profile is similar to the Justice Center Parking Deck but scaled to match the annual consumption data. The annual building consumption for the past year is approximately 17,166 kWh with a peak February load of 3.1 kW. The estimated roof solar capacity is 35 kW DC and initial HOMER analysis indicates that only a 11 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV and BESS possess favorable payback periods, IRR, and renewable

fractions. The base case and PV system configuration with the fastest payback period are provided in Table 35-1. It should be noted that the PV capital cost for this building is increased to account for a more expensive mounting structure. It is also important to note that this estimation does not include the potential increased structural analysis costs associated with implementation of solar canopies on the top level of a parking garage. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Due to the significantly higher renewable fraction, the PV + BESS system configuration has preferred results compared to the standalone PV configuration.

Table 35-1. Queen Street Parking Deck Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	17,166	N/A	N/A	N/A
11 kW PV Only	10,097	15,794	N/A	61
11 kW PV + 39.6 kWh BESS	3,802	15,794	7,023	78.6

35.2 Cost Summary

Cost performance for the three systems is provided in Table 35-2.

Table 35-2. Queen Street Parking Deck Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	24,000	N/A	N/A
11 kW PV Only	295,000	293,000	N/A	>25
11 kW PV + 39.6 kWh BESS	360,000	368,000	N/A	>25
Cost Summary with ITC Included				
11 kW PV Only	195,000	209,000	N/A	>25
11 kW PV + 39.6 kWh BESS	240,000	265,000	N/A	>25

35.2.1 Electric Vehicle

The Queen Steet Parking Deck was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 35-1. A total of fifteen (15) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 122.4 kW. Electrical equipment necessary for EV chargers may require additional footprint and reduce available

parking spots on the top level. Consideration for increased parking spot lengths due to the addition of curb stops to protect wall mounted Level 2 EV chargers may impact drive isle spacing and require additional review. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, see the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

35.3 Electrical Infrastructure Demand Feasibility Summary

35.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required for each system.

36 Rainbow Assisted Living

Durham County | Rainbow Assisted Living | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	706 Rigsbee Ave, Durham, NC 27701	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Packaged Furnace
Building Type	Adult Daycare	**Cooling Generation**	Split-Systme DX
Year Built	1997	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	5,376	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 36-1. Rainbow Assisted Living



36.1 Existing Building Performance & Condition

36.1.1 Past Conservation Projects and Successes

None.

36.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear to be in fair condition. The outdoor condensing units are covered by an overgrown vine or shrub. A 30+ year old R-22 condensing unit is still in place but appears to be abandoned. The electric domestic water heater was manufactured in 1995 and is beyond it expected service life. The water heater is not installed in a drain pan and does not have an expansion tank.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 36-1. Rainbow Assisted Living Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace water heater and provide drain pan and expansion tank.
Fix.1	Clear landscaping overgrowth from condensing units.
Fix.2	If abandoned, recover R-22 refrigerant from condensing unit and demolish unit.

36.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 36-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was NOT AVAILABLE in the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities, and thus was PREDICTED via the analytical model.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

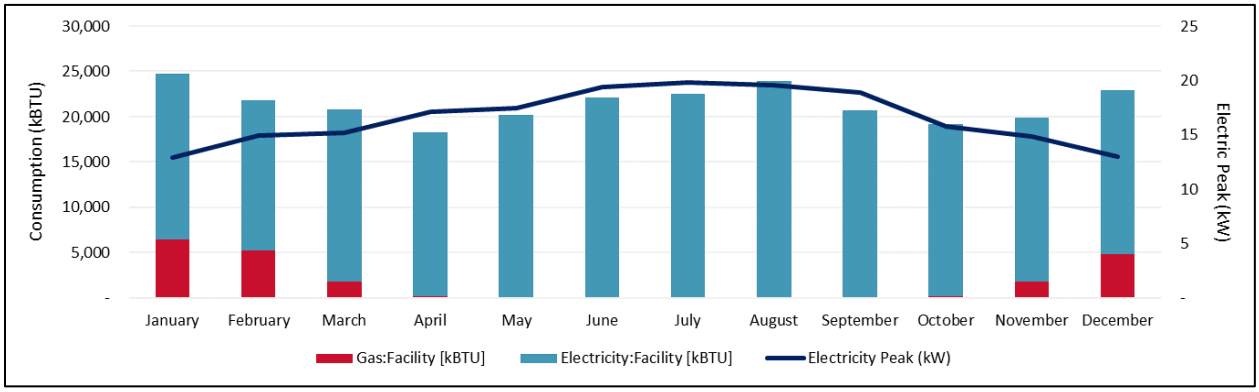
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 36-2. Rainbow Assisted Living Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	5,375	64	25	12.9	$0	$65	$65	1,526	343	1,868
February	4,850	52	22	14.9	$0	$53	$53	1,377	278	1,655
March	5,575	17	21	15.2	$0	$18	$18	1,583	93	1,675
April	5,285	2	18	17.1	$0	$2	$2	1,500	12	1,512
May	5,905	0	20	17.5	$0	$0	$0	1,676	1	1,678
June	6,480	0	22	19.4	$0	$0	$0	1,840	0	1,840
July	6,612	0	23	19.8	$0	$0	$0	1,877	0	1,877
August	7,010	0	24	19.6	$0	$0	$0	1,990	0	1,990
September	6,063	0	21	18.9	$0	$0	$0	1,721	0	1,722
October	5,543	2	19	15.8	$0	$2	$2	1,574	12	1,585
November	5,319	17	20	14.9	$0	$18	$18	1,510	93	1,603
December	5,296	48	23	13.0	$0	$49	$49	1,504	257	1,761
ANNUAL	69,311	205	257	-	$0	$206	$206	19,678	1,088	20,766
PEAK	-	-	-	19.8	-	-	-	-	-	-

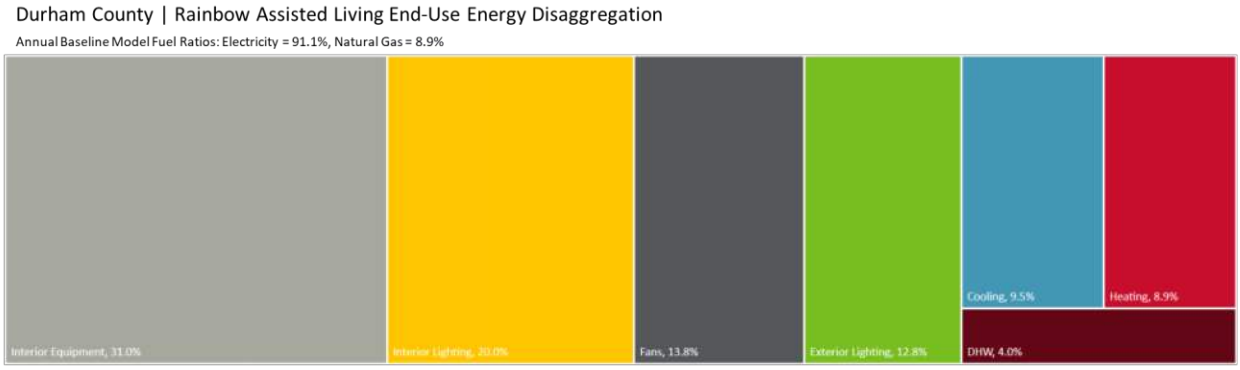
The data in Table 36-2 is represented in graphical format in Figure 36-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 36-2. Rainbow Assisted Living Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



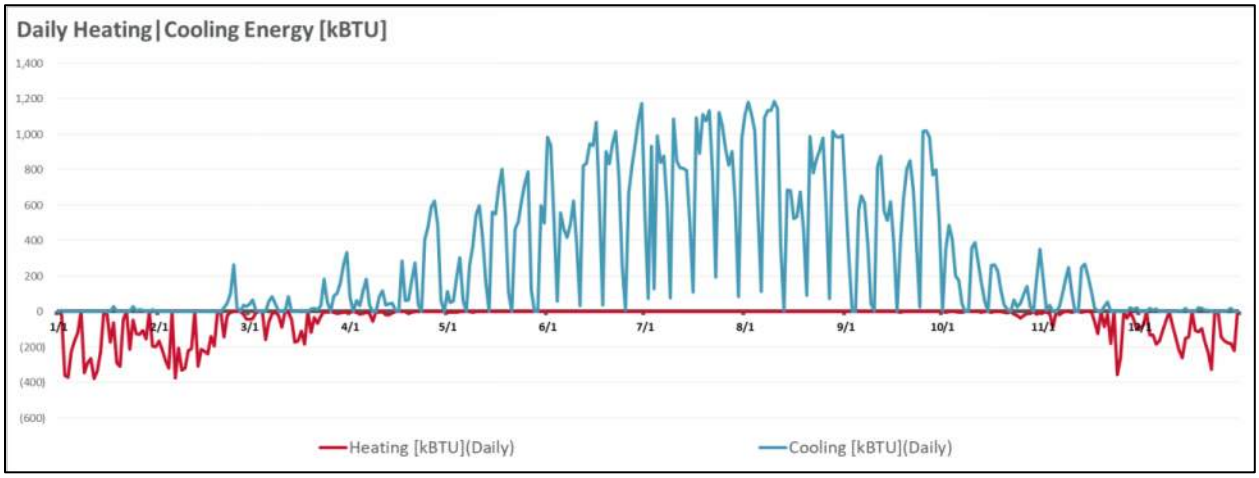
While Table 36-2 and Figure 36-2 encompasses “whole” building data, Figure 36-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 36-3. Rainbow Assisted Living Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 36-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 36-4. Rainbow Assisted Living Baseline Model Heating & Cooling Annual Load Profile



36.2 HVAC Refrigerants

The Durham County Rainbow Assisted Living utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 36-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 36-3. Rainbow Assisted Living HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
(3) CU	Split-System Condensing Unit	Trane 2TTA0060A	5 Tons	R-22	7.5 lbs	Exterior
(1) CU	Split-System Condensing Unit	Carrier 38EN036500	3 Tons	R-22	5.8 lbs	Exterior

36.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 36-4. Rainbow Assisted Living Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Rainbow Assisted Living	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	37.23	0.00	0.13	$3.87	0.01	NA	NA	
	Smart Thermostat	750.78	0.00	2.56	$78.01	0.21	Total Cooling Capacity Controled	156.00	kBTU/hr
	Air Conditioner Tune-up	948.99	0.00	3.24	$98.60	0.27	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.44	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	15,313.86	-101.63	42.10	$1,489.88	3.81	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	413.29	-2.74	1.14	$40.21	0.10	Applicable Area %	5.0%	%
	LED Exit Signs	211.99	-1.41	0.58	$20.62	0.05	Quantity of Exit Signs	2	#
	Daylight Dimming Control	413.29	-2.74	1.14	$40.21	0.10	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,024.92	0.00	3.50	$106.49	0.29	Transformer Size	45.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.91	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$13.97	0.04	Quantity of Power Strips	5	#
Decarbonization Measure Savings Totals (predicted)		**19,502.48**	**-108.52**	**55.71**	**$1,918.21**	**4.96**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**0.0%**	**0.0%**	**0.0%**	**-**	**-**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

36.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 36-5. Rainbow Assisted Living Existing HVAC/DHW Systems

HVAC | Space Heating	(1) "Unit 1" 5-ton AHU condensing gas furnace, Trane "XB90", mfg 2003; (2) "Unit 2" & "Unit 3" 5-ton AHU non-condensing gas furnace, Trane "XR80", mfg 2006;
Domestic Hot Water	(1) electric storage water heater, 40 gal, 4.5 kw, State model PV-40-20RS0NC, mfg 1995;

Table 36-6. Rainbow Assisted Living HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace (3) split-systems with (3) 5-ton split-system heat pump condensing units and (3) AHU with 25 kw heaters (75 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	69,311.0	230.1	48.3	0.0	(230.1)	4,849.5	NA	NA	74,160.5	0.0	47.1	2.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	259.6 MMBTU								253.1 MMBTU			
Energy Cost	$8,174.94	$231.76	$1.56						$8,581.56	$0.00	$1.60	-2.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,406.70 $US								$8,581.56 $US			
Carbon	19.7	1.2	3.89	0.0	(1.2)	1.4	NA	NA	21.1	0.0	3.92	-0.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	20.9 MT CO2e								21.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 36-7. Rainbow Assisted Living HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	*Replace (3) split-systems with (1) 15-ton VRF system inverter heat pump condensing unit + (3) indoor AHUs [condensing unit 80 MCA, 125 MOP @ 208V/3ph, AHUs each 6 MCA, 15 MOP @ 208V/1ph] {Vendor estimate for system equip cost - $160k}

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	69,311.0	230.1	48.3	0.0	(230.1)	2,177.1	NA	NA	71,488.1	0.0	45.4	6.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	259.6 MMBTU								244.0 MMBTU			
Energy Cost	$8,174.94	$231.76	$1.56						$8,363.33	$0.00	$1.56	0.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,406.70 $US								$8,363.33 $US			
Carbon	19.7	1.2	3.89	0.0	(1.2)	0.6	NA	NA	20.3	0.0	3.78	2.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	20.9 MT CO2e								20.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 36-8. Rainbow Assisted Living DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	69,311.0	230.1	48.3	NA	NA	NA	0.0	0.0	69,311.0	230.1	48.3	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	259.6 MMBTU								259.6 MMBTU			
Energy Cost	$8,174.94	$231.76	$1.56						$8,174.94	$231.76	$1.56	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,406.70 $US								$8,406.70 $US			
Carbon	19.7	1.2	3.89	NA	NA	NA	0.0	0.0	19.7	1.2	3.89	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	20.9 MT CO2e								20.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 36-9. Rainbow Assisted Living DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**69,311.0**	**230.1**	**48.3**	**NA**	**NA**	**NA**	**0.0**	**(1,989.1)**	**67,321.9**	**230.1**	**47.0**	**2.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	259.6 MMBTU								252.8 MMBTU			
Energy Cost	**$8,174.94**	**$231.76**	**$1.56**						**$8,007.90**	**$231.76**	**$1.53**	**2.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$8,406.70 $US								$8,239.67 $US			
Carbon	**19.7**	**1.2**	**3.89**	**NA**	**NA**	**NA**	**0.0**	**(0.6)**	**19.1**	**1.2**	**3.78**	**2.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	20.9 MT CO2e								20.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 36-10. Rainbow Assisted Living Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$78,763.00	($406.63)	$231.76	($174.87)	($109,570.30)	-7.5217%	NA	-0.0295	NA	NA	($7.89)
HVAC Pathway 2	$518,406.00	($188.39)	$231.76	$43.37	($699,056.90)	-7.2475%	-11.7196%	0.0021	NA	NA	$30.80
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$11,827.00	$167.03	$0.00	$167.03	($12,457.40)	-5.0692%	-0.8200%	0.2205	NA	NA	$28.80

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$35,337.00
DHW Existing Replacement:	$1,512.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

36.5 Electrical Infrastructure Demand Feasibility Summary

Table 36-11. Rainbow Assisted Living Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	19.83 kW	19.83 kW
HVAC Electrification Pathway 1		26.98 kW
HVAC Electrification Pathway 2		19.83 kW
DHW Electrification Pathway 1		19.83 kW
DHW Electrification Pathway 2		19.55 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

36.5.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power for the air handling units required by HVAC Electrification Pathways 1 or air handling units and inverter heat pump condensing unit of HVAC Electrification Pathways 2. A new main distribution panelboard and feeder panelboard will be required along with associated circuit breaker for each new piece of equipment.

36.5.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the circuit breakers required to supply power for the heat pump storage water heaters for DHW Electrification Pathway 2. A new main distribution panelboard and feeder panelboard will be required along with associated circuit breaker for each new piece of equipment.

37 South Regional Library

Durham County | South Regional Library | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	4505 S. Alston Avenue, Durham, NC 27713	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Natural Draft Boiler
Building Type	Library	**Cooling Generation**	Air-Cooled Chiller
Year Built	2009	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	27,320	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

Figure 37-1. South Regional Library





37.1 Existing Building Performance & Condition

37.1.1 Past Conservation Projects and Successes

The South Regional Library was built in 2009. Based on available information, HDR found no past energy conservation projects and/or analysis reports conducted since its opening.

37.1.2 Condition Assessment Summary

The HVAC and plumbing equipment are all original construction and are in good serviceable condition. No signs of leakage or disrepair were evident. Based on the 2010 installation date, the equipment still has expected service life remaining, except for the domestic water heater. A storage-type water heater tank has an expected life of around 10 years. The existing domestic water heater is at risk of developing a tank leak and does not currently have a drain pan but is located in a ground floor mechanical room. The water damage risk in the case of a leak should be assessed , and the water heater replacement should be planned.

All indoor air handling units had outside air flow measuring stations installed and are operational. However, all outside air stations were reading airflows between 30-100 cfm which indicates the building is not ventilated at its design airflow rates or the airflow stations need recalibration. If the outside air flow intake is insufficient for makeup exhaust, then the building would be negatively pressurized. This condition should be investigated by the facility maintenance staff as soon as possible.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 37-1. South Regional Library Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace Domestic Water Heater that is >10 years old and has no drain pan
Fix.1	Re-calibrate Air Flow Measuring Stations (AFMS)

37.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 37-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

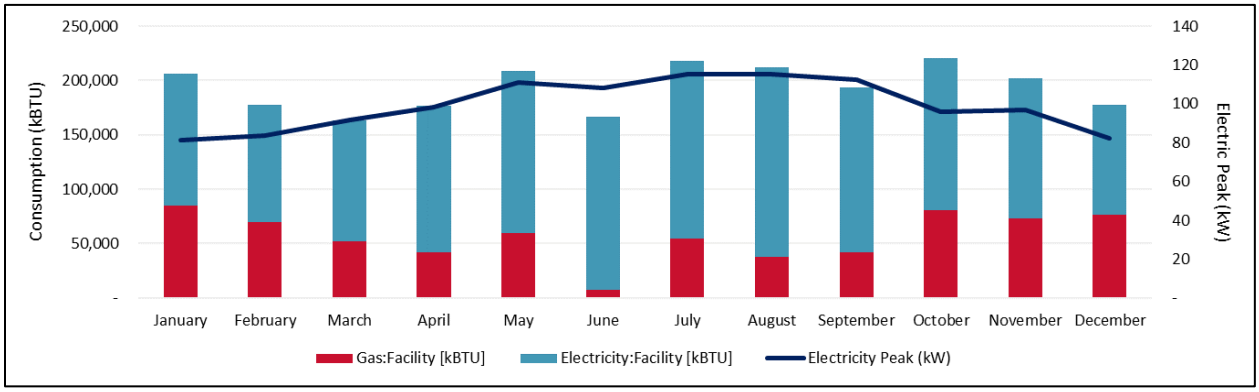
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 37-2. South Regional Library Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	35,413	852	206	81.4	$3,344	$1,033	$4,377	10,054	4,525	14,579
February	31,511	698	177	83.5	$3,087	$754	$3,841	8,946	3,707	12,653
March	32,645	521	163	91.5	$3,164	$545	$3,709	9,268	2,765	12,033
April	39,507	419	177	98.2	$3,613	$425	$4,038	11,216	2,223	13,439
May	43,563	600	209	111.0	$3,871	$636	$4,507	12,368	3,187	15,555
June	46,710	73	167	108.2	$4,066	$97	$4,163	13,261	385	13,646
July	47,984	543	218	115.2	$4,155	$332	$4,486	13,623	2,884	16,507
August	51,182	377	212	115.1	$4,416	$446	$4,862	14,531	2,000	16,531
September	44,418	418	193	112.3	$4,393	$499	$4,892	12,610	2,220	14,831
October	40,969	804	220	96.0	$4,182	$1,097	$5,279	11,631	4,270	15,902
November	37,812	733	202	96.7	$3,892	$993	$4,885	10,735	3,893	14,628
December	29,819	761	178	82.2	$3,317	$970	$4,287	8,466	4,042	12,508
ANNUAL	481,533	6,797	2,323	-	$45,499	$7,826	$53,326	136,709	36,102	172,811
PEAK	-	-	-	115.2	-	-	-	-	-	-

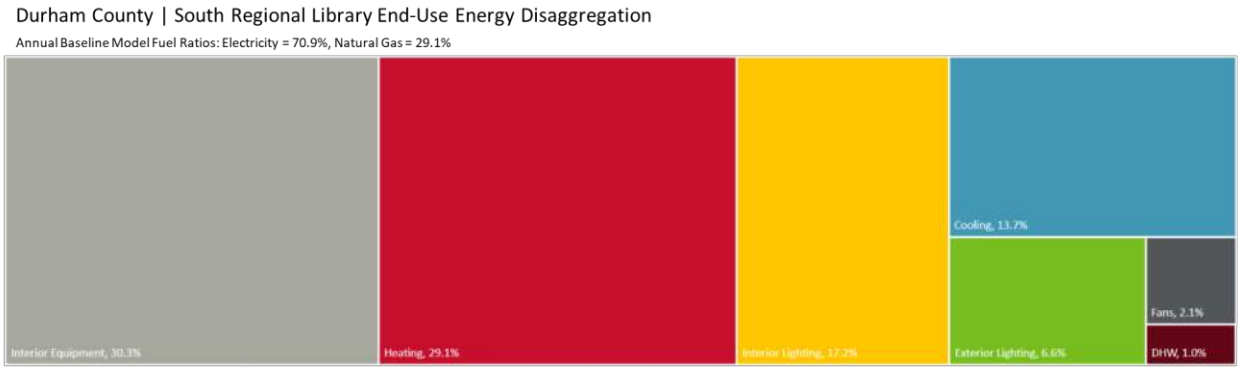
The data in Table 37-2 is represented in graphical format in Figure 37-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 37-2. South Regional Library Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



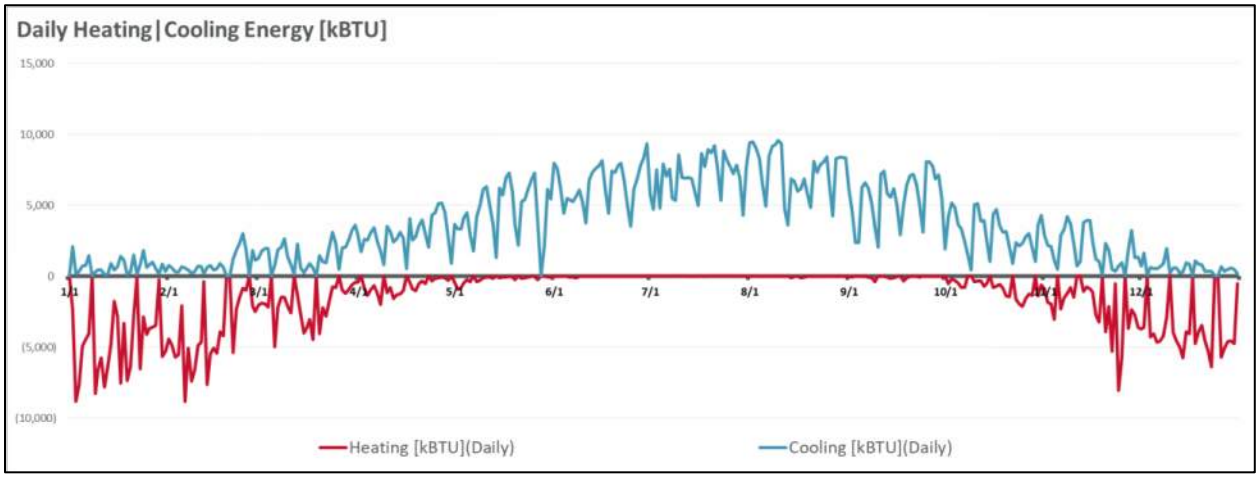
While Table 37-2 and Figure 37-2 encompasses “whole” building data, Figure 37-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 37-3. South Regional Library Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 37-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 37-4. South Regional Library Baseline Model Heating & Cooling Annual Load Profile



37.2 HVAC Refrigerants

The Durham County South Regional Library utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 37-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 37-3. South Regional Library HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Air-Cooled Chiller	Carrier 30XAA0806T-08J7C	80 tons	R-134A	Circuit 1: 98 lbs, Circuit 2: 98 lbs	Exterior
HP-3	Air-Cooled Condenser	Mitsubishi PUHY-P72TGMU-A	72 MBH	R-410A	15 lbs, 7 oz	Exterior
HP-4	Air-Cooled Condenser	Mitsubishi PUHY-P72TGMU-A	72 MBH	R-410A	15 lbs, 7 oz	Exterior
CU-5	Air-Cooled Condenser	Liebert PFH020A	18 MBH	R-407C	8 lbs, 6 oz	Exterior

37.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 37-4. South Regional Library Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
South Regional Library	Baseline	456,882.00	5,051.00	2,064.42	$52,233.76	156.54

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	50,764.67	561.22	229.38	$5,803.75	17.39	Potential Annual Energy Savings (%)	11.1%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,839.86	0.00	30.17	$902.76	2.51	NA	NA	
	Smart Thermostat	2,229.30	0.00	7.61	$227.66	0.63	Total Cooling Capacity Controled	162.00	kBTU/hr
	Air Conditioner Tune-up	1,577.54	0.00	5.38	$161.10	0.45	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	224.56	22.46	$247.88	1.19	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$30.36	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$241.81	0.67	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	34,457.62	-228.67	94.74	$3,266.51	8.57	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	16,264.00	-107.93	44.72	$1,541.79	4.04	Applicable Area %	50.0%	%
	LED Exit Signs	635.98	-4.22	1.75	$60.29	0.16	Quantity of Exit Signs	6	#
	Daylight Dimming Control	13,011.20	-86.35	35.77	$1,233.43	3.24	Applicable Area %	40.0%	%
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$265.00	0.74	Quantity of Outdoor Fixtures	10	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$494.52	1.37	Transformer Size	500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.72	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$54.94	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		**138,525.53**	**358.61**	**508.64**	**$14,542.53**	**41.23**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**30.3%**	**7.1%**	**24.6%**	**27.8%**	**26.3%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

37.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 37-5. South Regional Library Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 1530 MBH, Output: 1265 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 160 deg F, LWT: 180 deg F, Controls: Heat-Timer SQ Elite 8T Sequencing Controller (for multi-stage control)
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE8220RTA), fuel: electric resistance, capacity: 4000W 1PH/3PH Interlock & 8000W 1PH-3PH Simultaneous, Volume: 80 gal rated, Location: Janitor's Closet off of Lobby

Table 37-6. South Regional Library HVAC Electrification Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	481,533.3	6,730.4	84.8	0.0	(6,730.4)	169,905.2	NA	NA	651,438.5	0.0	81.4	4.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,316.5 MMBTU								2,223.3 MMBTU			
Energy Cost	$45,004.94	$8,072.20	$1.94						$68,817.48	$0.00	$2.52	-29.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$53,077.14 $US								$68,817.48 $US			
Carbon	136.7	35.7	6.31	0.0	(35.7)	48.2	NA	NA	184.9	0.0	6.77	-7.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	172.5 MT CO2e								184.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 37-7. South Regional Library HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	481,533.3	6,730.4	84.8	0.0	(6,730.4)	78,051.4	NA	NA	559,584.7	0.0	69.9	17.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,316.5 MMBTU								1,909.8 MMBTU			
Energy Cost	$45,004.94	$8,072.20	$1.94						$57,595.81	$0.00	$2.11	-8.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$53,077.14 $US								$57,595.81 $US			
Carbon	136.7	35.7	6.31	0.0	(35.7)	22.2	NA	NA	158.9	0.0	5.82	7.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	172.5 MT CO2e								158.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 37-8. South Regional Library DHW Electrification Pathway 1

Pathway 1 | Electrification	NA, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	481,533.3	6,730.4	84.8	NA	NA	NA	0.0	0.0	481,533.3	6,730.4	84.8	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,316.5 MMBTU								2,316.5 MMBTU			
Energy Cost	$45,004.94	$8,072.20	$1.94						$45,004.94	$8,072.20	$1.94	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$53,077.14 $US								$53,077.14 $US			
Carbon	136.7	35.7	6.31	NA	NA	NA	0.0	0.0	136.7	35.7	6.31	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	172.5 MT CO2e								172.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 37-9. South Regional Library DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Commercial Storage Tank Water Heater, fuel: electric heat pump, capacity: 4000W, Volume: 80 gal rated, Efficiency: 3.50 COP, Location: Janitor's Closet off of Lobby

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**481,533.3**	**6,730.4**	**84.8**	**NA**	**NA**	**NA**	**0.0**	**(4,003.4)**	**477,529.9**	**6,730.4**	**84.3**	**0.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	2,316.5 MMBTU								2,302.8 MMBTU			
Energy Cost	**$45,004.94**	**$8,072.20**	**$1.94**						**$44,634.47**	**$8,072.20**	**$1.93**	**0.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$53,077.14 $US								$52,706.67 $US			
Carbon	**136.7**	**35.7**	**6.31**	**NA**	**NA**	**NA**	**0.0**	**(1.1)**	**135.6**	**35.7**	**6.27**	**0.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	172.5 MT CO2e								171.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the "life" of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 37-10. South Regional Library Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$698,398.00	($23,812.54)	$8,072.20	($15,740.34)	($1,256,642.65)	-10.2445%	NA	-0.3315	NA	NA	($636.91)
HVAC Pathway 2	$692,270.00	($12,590.86)	$8,072.20	($4,518.66)	($1,011,579.31)	-7.9044%	NA	-0.0814	NA	NA	$693.05
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$366.00	$370.47	$0.00	$370.47	$7,322.54	5486.0570%	10.3589%	15.8057	2.00	2.00	$57.97

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$42,924.00
DHW Existing Replacement:	$11,431.00

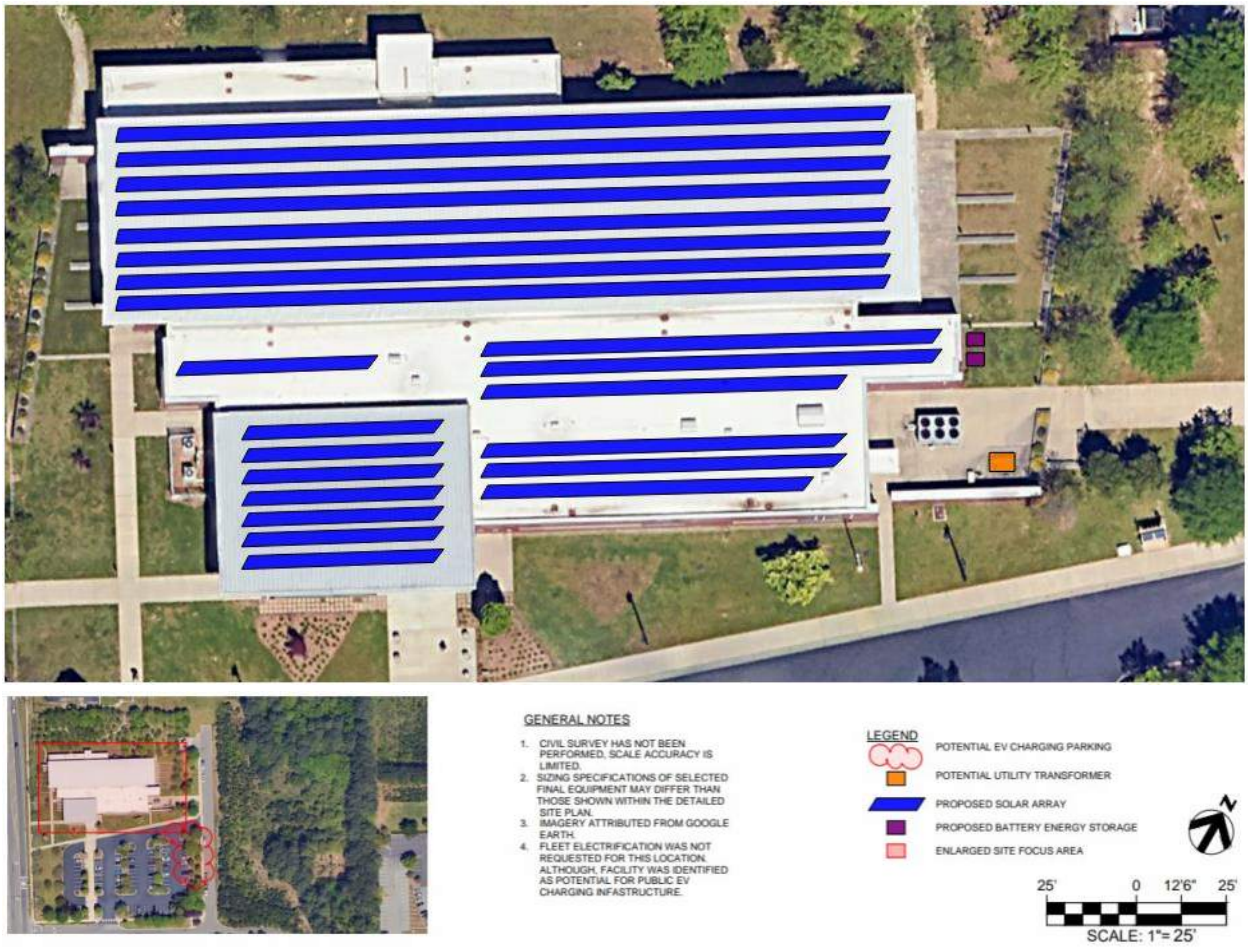
Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

37.5 Renewable Energy, Energy Storage, and Electric Vehicles

37.5.1 Solar and BESS Analysis

The South Regional Library was recognized as having a large roof with multiple slopes and minimal shading from adjacent buildings or trees. The large roof is divided into three (3) main levels with varying material. The lowest rooftop level has a parapet height of 12 inches and various pieces of equipment, providing minimal impact to rooftop solar strings placed on this level. The other two roof levels are sloped and elevated above the middle roof. They are composed of metal and do not have additional equipment placed within the footprint to reduce available solar capacity. The roof is scheduled for replacement in 2025. As shown on Figure 37-5, the largest and main roof level has an estimated available capacity of 155 kW DC, the middle flat level capacity is 61 kW DC, and the smallest third tier is 30 kW DC. The roof is 16 years old and will need to be replaced in the near future. Placement of the BESS equipment is proposed on the Eastern side of the building.

Figure 37-5. South Regional Library Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately

441,300 kWh with a peak September load of 121.9 kW. While the estimated roof solar capacity is 246 kW DC, the initial HOMER analysis indicates that only a 200 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple PV and hybrid system configurations possess favorable renewable fractions but unfavorable payback periods, IRR. PV and BESS hybrid systems tend to have unfavorable payback periods and IRR due to the high capital cost of BESS and small amount of excess PV generation. Standalone PV systems tend to have more favorable payback periods when incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 37-11. Cost performance of the three system configurations is provided in Table 37-12. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 37-11. South Regional Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	414,150	N/A	N/A	0.0
200 kW PV	258,322	278,755	N/A	50.6
200 kW PV + 119 kWh BESS	227,935	278,755	35,034	53.4

37.6 Cost Summary

Table 37-12. South Regional Library Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	439,000	N/A	N/A
200 kW PV	356,000	641,000	N/A	>25
200 kW PV + 119 kWh BESS	563,000	822,000	N/A	>25
Cost Summary with ITC Included				
200 kW PV	249,000	534,000	2.2	19
200 kW PV + 119 kWh BESS	394,000	653,000	N/A	>25

37.6.1 Electric Vehicle

The South Regional library fleet was not identified for further review of fleet electrification. During the site visit it was found that public EV charging is already provided, region clouded in Figure 37-5. The location is an ideal charging location, and expansion is recommended.

37.7 Electrical Infrastructure Demand Feasibility Summary

Table 37-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	115.16 kW (excludes PL lighting)	115.16 kW
HVAC Electrification Pathway 1		416.68 kW
HVAC Electrification Pathway 2		371.99 kW
DHW Electrification Pathway 1		115.16 kW
DHW Electrification Pathway 2		114.55 kW
Electric Vehicle (EV) Charging		TBD
Rooftop Solar		200 kW
BESS		119 kWh

37.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the required breaker size to supply power for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. Therefore, a new main service panelboard will be required.

37.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard has enough space for the water heaters required for DHW Electrification Pathway 2. New circuit breakers will be required.

37.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

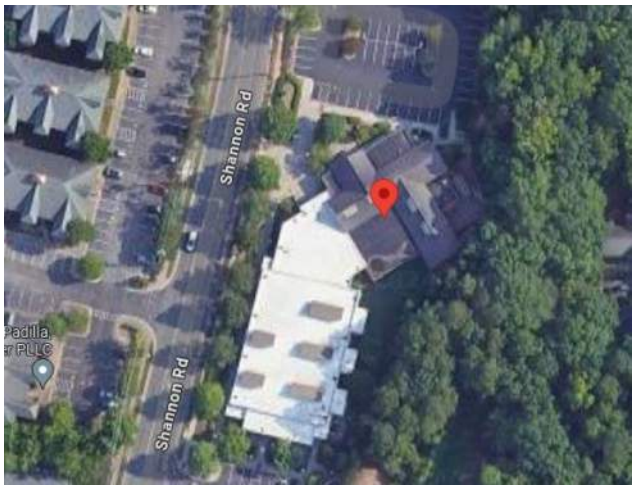
The existing main distribution panelboard cannot accommodate the size breaker required to interconnect the PV system. Therefore, a new main service panelboard will be required. The BESS system can be added to the existing main distribution panel. New circuit breakers will be required.

38 Southwest Regional Library

Durham County | Southwest Regional Library | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	3605 Shannon Rd, Durham, NC 27707	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Natural Draft Boiler
Building Type	Library	**Cooling Generation**	Air-Cooled Chiller
Year Built	2009	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	25,684	**Heating / Cooling / Vent Distribution**	Multi-Zone Air-Handlers
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

Figure 38-1. Southwest Regional Library





38.1 Existing Building Performance & Condition

38.1.1 Past Conservation Projects and Successes

No historical data available.

38.1.2 FCondition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age. The chiller and boiler, and their associated pumps appear to be grossly overside for the size and type of building. The chiller is 170-tons and boiler is 1739 MBH output to serve 25,684 square feet. For comparison, the South Regional Library has an 80-tons chiller and 1265 MBH output to serve 27,320 square feet. This oversizing can lead to short cycling of the equipment and increased energy consumption.

The oversizing of the HVAC plant was confirmed during a June 20, 2024 site visit. According to the chiller control panel, only one of two compressors was operating. The electrical load on the compressor at the time of observation was 66 amps out of 133 rated amps. This indicates that the chiller was only operating at about 25% capacity at an outdoor temperature of 84°F.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on the preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 38-1. Southwest Regional Library Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	Replace chiller, boiler, and associated pumps with correctly sized equipment.
Fix.1	

38.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 38-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of the Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

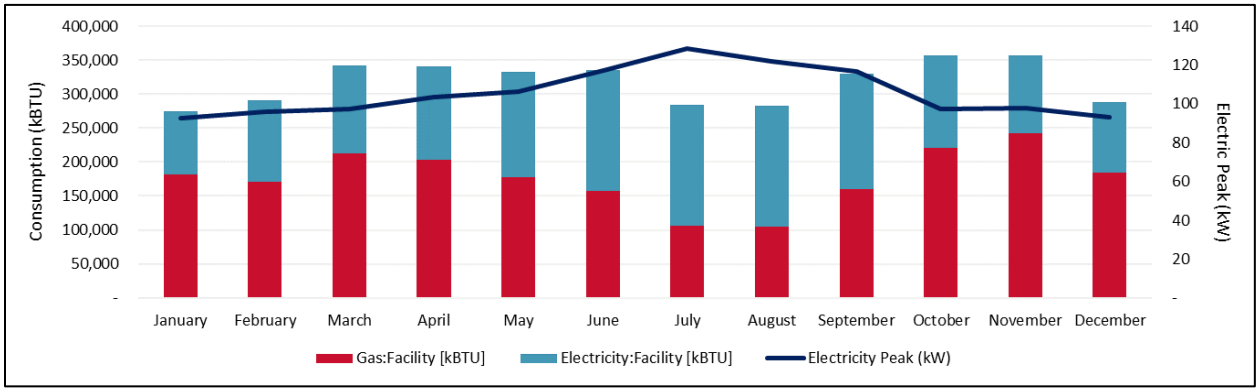
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 38-2. Southwest Regional Library Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	27,396	1,817	275	92.6	$2,488	$2,058	$4,546	7,778	9,651	17,429
February	35,011	1,714	291	95.9	$2,972	$1,753	$4,726	9,940	9,101	19,041
March	37,606	2,132	341	97.2	$3,113	$2,053	$5,166	10,676	11,321	21,998
April	40,493	2,028	341	103.4	$3,333	$1,904	$5,236	11,496	10,772	22,268
May	45,490	1,770	332	106.4	$3,667	$1,670	$5,337	12,915	9,401	22,316
June	52,065	1,571	335	116.9	$4,200	$1,569	$5,768	14,781	8,342	23,123
July	52,142	1,056	284	128.5	$4,266	$1,102	$5,368	14,803	5,606	20,410
August	51,909	1,052	282	121.8	$4,256	$1,101	$5,356	14,737	5,588	20,325
September	49,943	1,602	331	116.8	$4,540	$1,667	$6,207	14,179	8,506	22,685
October	39,774	2,206	356	97.4	$3,664	$2,660	$6,324	11,292	11,714	23,006
November	33,596	2,423	357	97.9	$3,222	$2,957	$6,179	9,538	12,867	22,405
December	30,149	1,846	287	93.3	$2,954	$2,245	$5,199	8,559	9,805	18,364
ANNUAL	495,572	21,214	3,813	-	$42,675	$22,738	$65,413	140,694	112,675	253,370
PEAK	-	-	-	128.5	-	-	-	-	-	-

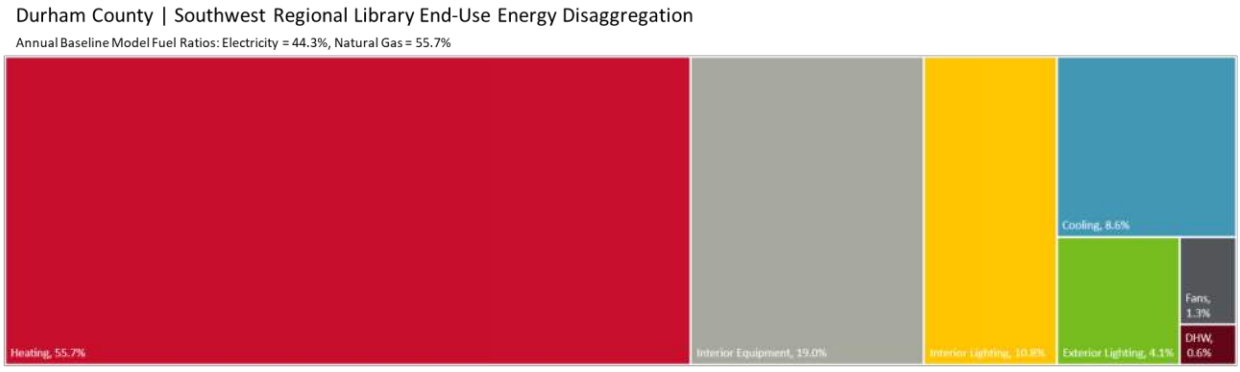
The data in Table 38-2 is represented in graphical format in Figure 38-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 38-2. Southwest Regional Library Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



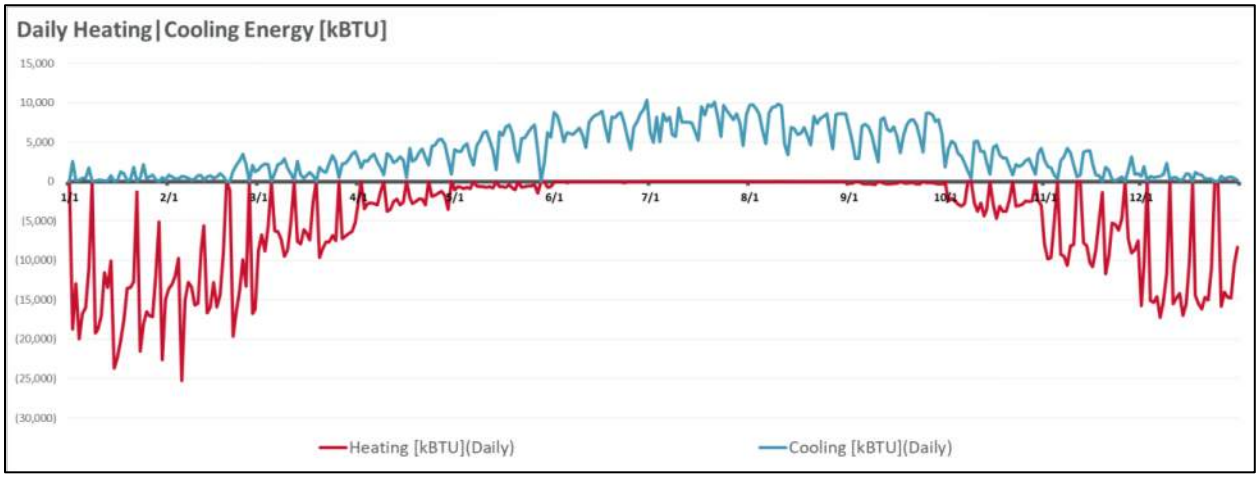
While Table 38-2 and Figure 38-2 encompasses “whole” building data, Figure 38-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models as described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 38-3. Southwest Regional Library Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 38-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 38-4. Southwest Regional Library Baseline Model Heating & Cooling Annual Load Profile



38.2 HVAC Refrigerants

The Durham County Southwest Regional Library utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 38-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 38-3. Southwest Regional Library HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CH-1	Air-Cooled Chiller	Trane RTAC 1704 UR0H	170 tons	R-134A	Circuit 1: 215 lbs, Circuit 2: 215 lbs	Exterior
Mini-split	Air-Cooled Condenser	Mitsubishi MU-A12WA	1 ton	R-410A	3.1 lbs	Exterior

38.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 38-4. Southwest Regional Library Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Southwest Regional Library	Baseline	510,826.28	18,955.00	3,638.93	$65,648.88	245.70

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	56,758.48	2,106.11	404.33	$7,294.32	27.30	Potential Annual Energy Savings (%)	11.1%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,293.01	0.00	28.30	$757.00	2.35	NA	NA	
	Smart Thermostat	91.51	0.00	0.31	$8.35	0.03	Total Cooling Capacity Controled	12.00	kBTU/hr
	Air Conditioner Tune-up	115.66	0.00	0.39	$10.56	0.03	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	799.45	79.94	$802.17	4.25	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$27.14	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$216.14	0.67	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	32,394.20	-214.98	89.06	$2,741.30	8.05	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	15,290.06	-101.47	42.04	$1,293.89	3.80	Applicable Area %	50.0%	%
	LED Exit Signs	635.98	-4.22	1.75	$53.82	0.16	Quantity of Exit Signs	6	#
	Daylight Dimming Control	12,232.05	-81.18	33.63	$1,035.12	3.04	Applicable Area %	40.0%	%
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$236.87	0.74	Quantity of Outdoor Fixtures	10	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	3,272.30	0.00	11.17	$298.70	0.93	Transformer Size	225.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.58	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$49.11	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		**134,986.26**	**2,503.71**	**711.08**	**$14,834.08**	**51.62**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**26.4%**	**13.2%**	**19.5%**	**22.6%**	**21.0%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings result will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

38.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 38-5. Southwest Regional Library Existing HVAC/DHW Systems

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 2070 MBH, Output: 1739 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 120 deg F, LWT: 160 deg F, Controls: VFD on secondary HWP
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE4020LSA), fuel: electric resistance, capacity: 5000W 1PH/3PH Interlock & 10000W 1PH-3PH Simultaneous, Volume: 40 gal rated;

Table 38-6. Southwest Regional Library HVAC Electrification Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	495,571.8	21,242.4	148.6	0.0	(21,242.4)	530,258.1	NA	NA	1,025,829.9	0.0	136.3	8.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,815.6 MMBTU								3,501.1 MMBTU			
Energy Cost	$46,585.01	$22,768.85	$2.70						$98,539.55	$0.00	$3.84	-42.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$69,353.85 $US								$98,539.55 $US			
Carbon	140.7	112.8	9.87	0.0	(112.8)	150.5	NA	NA	291.2	0.0	11.34	-14.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	253.5 MT CO2e								291.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 38-7. Southwest Regional Library HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**495,571.8**	**21,242.4**	**148.6**	**0.0**	**(21,242.4)**	**251,057.7**	**NA**	**NA**	**746,629.5**	**0.0**	**99.2**	**33.2%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,815.6 MMBTU								2,548.2 MMBTU			
Energy Cost	**$46,585.01**	**$22,768.85**	**$2.70**						**$71,775.53**	**$0.00**	**$2.79**	**-3.5%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$69,353.85 $US								$71,775.53 $US			
Carbon	**140.7**	**112.8**	**9.87**	**0.0**	**(112.8)**	**71.3**	**NA**	**NA**	**212.0**	**0.0**	**8.25**	**16.4%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	253.5 MT CO2e								212.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 38-8. Southwest Regional Library DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**495,571.8**	**21,242.4**	**148.6**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**495,571.8**	**21,242.4**	**148.6**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,815.6 MMBTU								3,815.6 MMBTU			
Energy Cost	**$46,585.01**	**$22,768.85**	**$2.70**						**$46,585.01**	**$22,768.85**	**$2.70**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$69,353.85 $US								$69,353.85 $US			
Carbon	**140.7**	**112.8**	**9.87**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**140.7**	**112.8**	**9.87**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	253.5 MT CO2e								253.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 38-9. Southwest Regional Library DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 66 gallon, 6 kw input, 3.7 COP, State model HPSX-66-DHPT;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	495,571.8	21,242.4	148.6	NA	NA	NA	0.0	(4,118.4)	491,453.4	21,242.4	148.0	0.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,815.6 MMBTU								3,801.6 MMBTU			
Energy Cost	$46,585.01	$22,768.85	$2.70						$46,195.87	$22,768.85	$2.69	0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$69,353.85 $US								$68,964.72 $US			
Carbon	140.7	112.8	9.87	NA	NA	NA	0.0	(1.2)	139.5	112.8	9.83	0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	253.5 MT CO2e								252.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 38-10. Southwest Regional Library Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$657,684.00	($51,954.55)	$22,768.85	($29,185.70)	($1,450,310.74)	NA	NA	-0.6319	NA	NA	($1,923.39)
HVAC Pathway 2	$657,243.00	($25,190.52)	$22,768.85	($2,421.68)	($884,981.61)	-6.8080%	-10.5469%	0.0036	NA	NA	$2,119.17
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$6,210.00	$389.13	$0.00	$389.13	($180.68)	3.0795%	2.9440%	0.9785	18.00	25.00	$59.63

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$65,607.00
DHW Existing Replacement:	$9,887.00

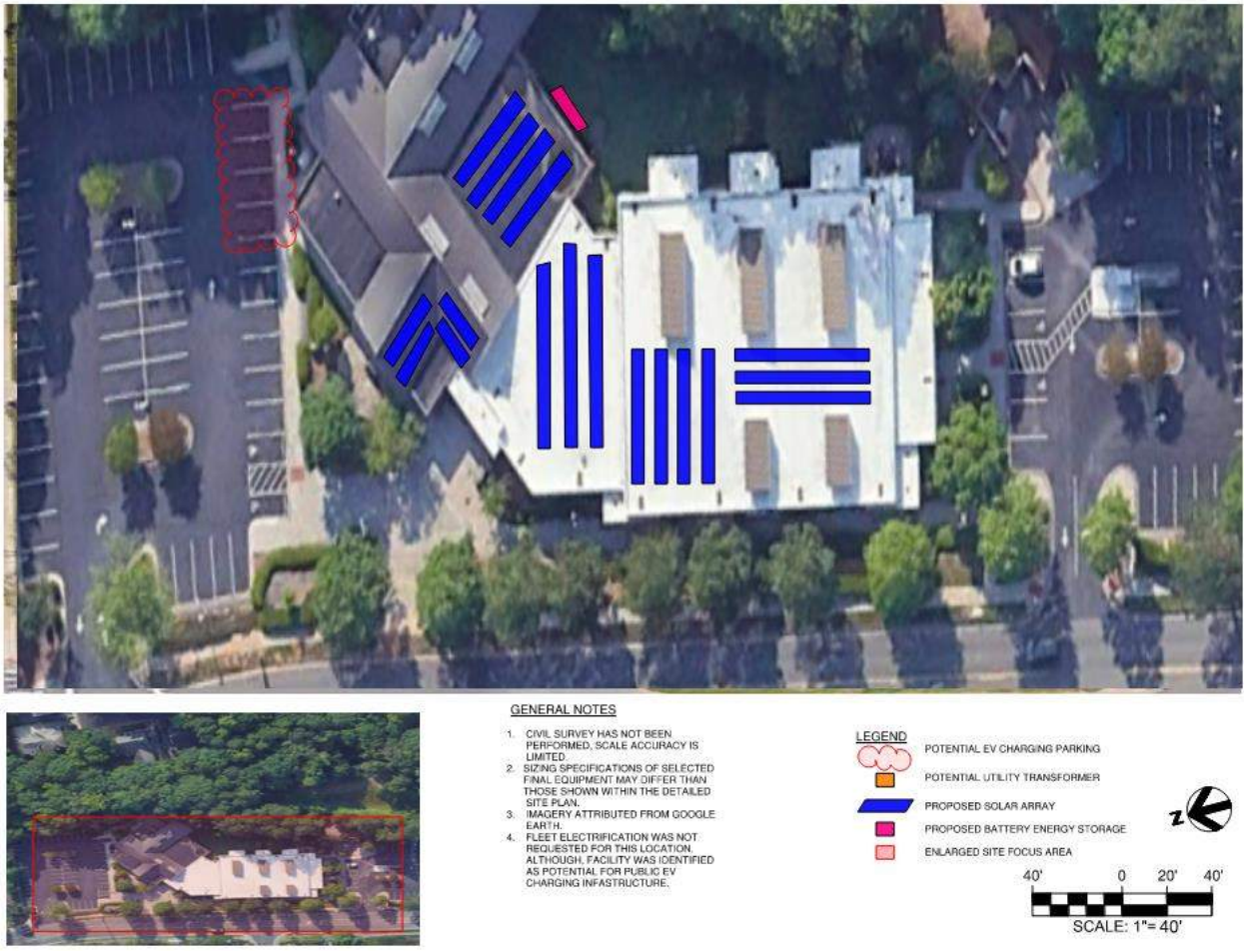
Note on Building Electrification Results: Each electrification pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

38.5 Renewable Energy, Energy Storage, and Electric Vehicles

38.5.1 Solar and BESS Analysis

The Southwest Regional Library has three (3) main roof levels varying in materials and slope. The tallest roof level is composed of shingles and sloped in various directions. The roof is scheduled for replacement in 2030. The remaining two (2) levels are flat with parapet walls surrounding the perimeter and various structures for additional equipment. The facility has large surrounding trees that may provide shading throughout the day. The total estimated capacity for solar equipment for the various roof levels is 115 kW DC with potential for BESS equipment to be placed on the Northern corner of the facility, Figure 38-5.

Figure 38-5. Southwest Regional Library Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The current annual building consumption for the past year is approximately 512,391 kWh with a peak July load of 136 kW. The estimated roof solar capacity is 115 kW DC and initial HOMER analysis indicates that a 115 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple PV system configurations possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to

have unfavorable payback periods and IRR due to the high capital cost of BESS and small amount of excess PV generation. Standalone PV and hybrid systems tend to have more favorable payback periods if incentives are considered in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 3911. Cost performance of the three system configurations is provided in Table 3912. Costs of technology will continue to decrease, and while the ROI is not currently favorable for some system configurations, the County should continue to evaluate the PV and BESS costs prior to constructing new projects. Based on the simple payback period and renewable fraction, the PV only system configuration possesses preferred results compared to the PV + BESS system configuration.

Table 38-11. Southwest Regional Library Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	512,391	N/A	N/A	N/A
115 kW PV Only	358,279	156,468	N/A	30.2
115 kW PV + 66 kWh BESS	358,279	156,468	4,907	30.3

38.6 Cost Summary

Table 38-12. Southwest Regional Library Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	564,000	N/A	N/A
115 kW PV Only	212,000	672,000	0.3	24
115 kW PV + 66 kWh BESS	320,000	757,000	N/A	>25
Cost Summary with ITC Included				
115 kW PV Only	148,000	609,000	3.3	17
115 kW PV + 66 kWh BESS	224,000	661,000	1.5	21

38.6.1 Electric Vehicle

The Southwest Regional Library was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 38-5. A total of four (4) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 28.8 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers, please

see the self-assessment tool (Figure 1-9) in section 1.3.3.4. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

38.7 Electrical Infrastructure Demand Feasibility Summary

Table 38-13. Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	128.50 kW	128.50 kW
HVAC Electrification Pathway 1		473.87 kW
HVAC Electrification Pathway 2		372.29 kW
DHW Electrification Pathway 1		128.50 kW
DHW Electrification Pathway 2		127.81 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

38.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard does not have enough space for the electric heat required by HVAC Electrification Pathway 1 or for HVAC Electrification Pathway 2. A new main distribution panelboard will be required.

38.7.2 Building DHW Electrification Implementation Feasibility

The existing main distribution panelboard has enough space for the water heaters required by DHW Electrification Pathway 2. New circuit breakers will be required.

38.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard cannot accommodate the required breaker size to interconnect the PV system. Therefore, a new main service panelboard will be required. The BESS system can be added to the existing main distribution panel. New circuit breakers will be required.

39 Triangle Waste-Water Treatment Plant, Administrative Building

Durham County | TWWTP Administrative Building | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	5926 NC-55, Durham, NC 27713	**Heating Primary Fuel**	Electricity
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	**Heating Generation**	Water Source Heat Pumps
Building Type	Office	**Cooling Generation**	Water Source Heat Pumps
Year Built	2001	**Domestic Hot Water Generation**	Gas Storage-type Water Heater
Floor Area (ft2)	10,580	**Heating / Cooling / Vent Distribution**	Water Source Heat Pumps
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

Figure 39-1. TWWTP Administrative Building



39.1 Existing Building Performance & Condition

39.1.1 Past Conservation Projects and Successes

None.

39.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 39-1. TWWTP Administrative Building Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

39.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 39-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

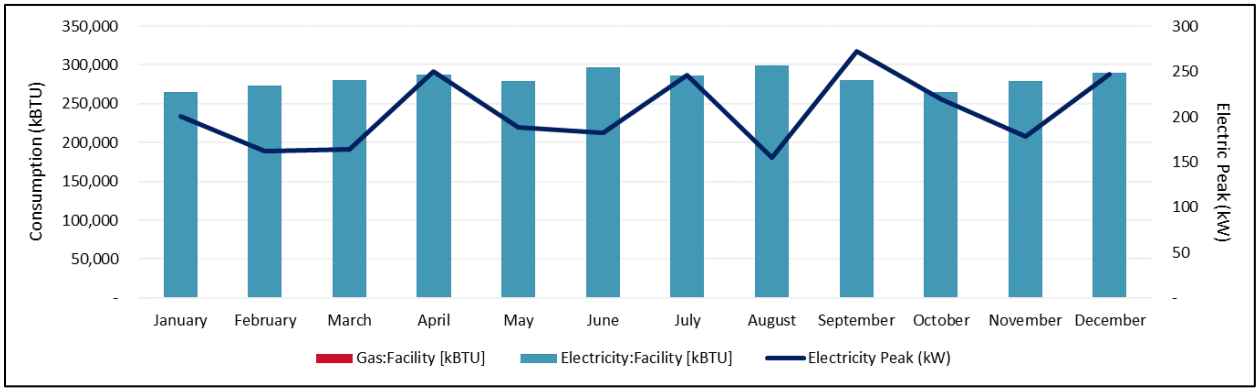
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 39-2. TWWTP Administrative Building Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	77,668	6	266	200.4	$5,499	$6	$5,505	22,050	32	22,082
February	80,109	6	274	162.5	$5,367	$6	$5,372	22,743	30	22,773
March	82,048	6	281	163.7	$5,595	$6	$5,601	23,294	33	23,327
April	84,088	5	288	250.2	$5,985	$6	$5,991	23,873	29	23,902
May	81,755	5	280	188.6	$5,532	$5	$5,538	23,210	28	23,239
June	86,936	5	297	182.1	$7,287	$5	$7,292	24,681	25	24,707
July	83,601	4	286	246.3	$8,205	$4	$8,210	23,735	23	23,758
August	87,557	5	299	154.5	$7,323	$5	$7,328	24,858	24	24,882
September	82,119	4	281	272.4	$7,912	$4	$7,916	23,314	23	23,337
October	77,694	5	266	219.5	$6,048	$5	$6,053	22,057	26	22,083
November	81,542	5	279	178.4	$6,155	$5	$6,160	23,150	28	23,178
December	84,876	6	290	246.6	$6,778	$6	$6,783	24,097	30	24,127
ANNUAL	989,991	63	3,385	-	$77,686	$63	$77,749	281,062	333	281,394
PEAK	-	-	-	272.4	-	-	-	-	-	-

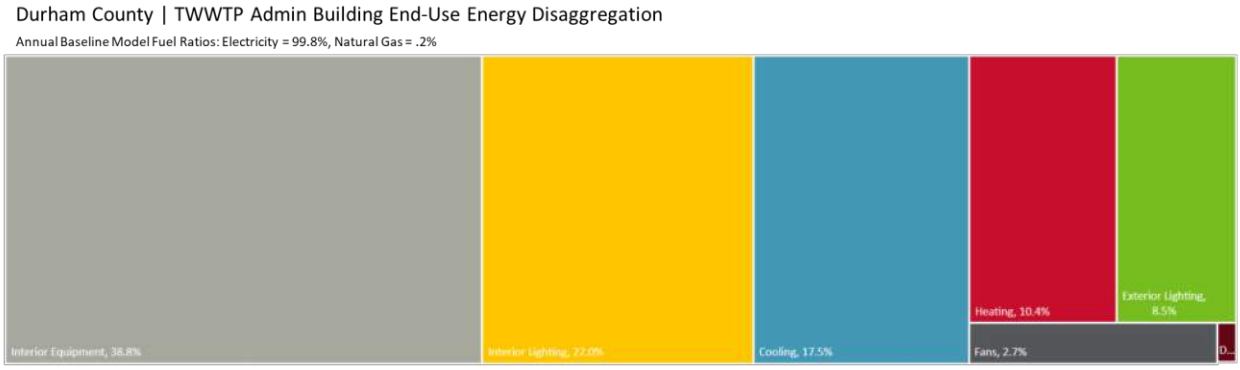
The data in Table 39-2 is represented in graphical format in Figure 39-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 39-2. TWWTP Administrative Building Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



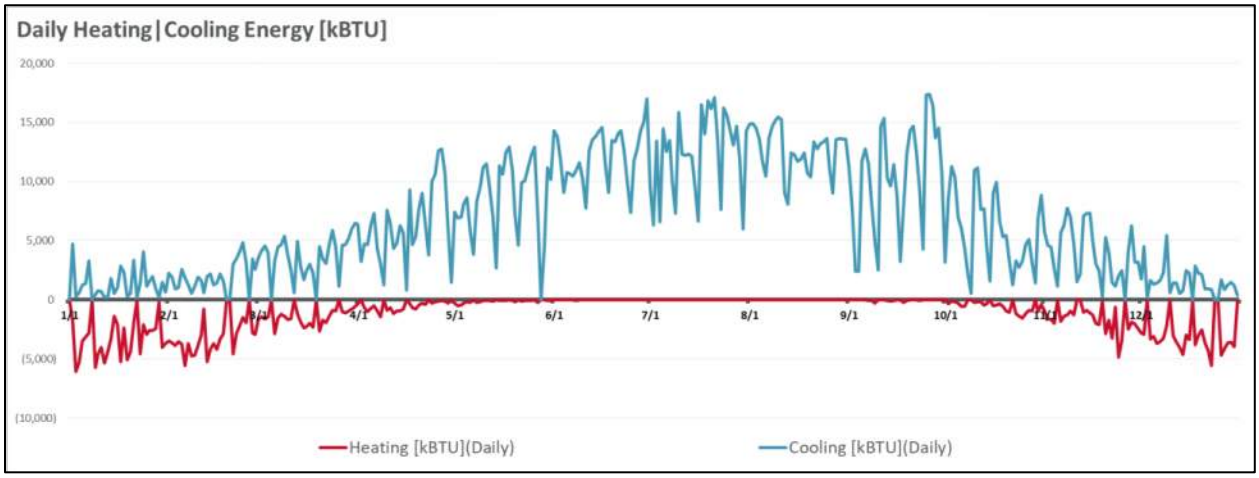
While Table 39-2 and Figure 39-2 encompasses “whole” building data, Figure 39-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 39-3. TWWTP Administrative Building Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 39-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 39-4. TWWTP Administrative Building Baseline Model Heating & Cooling Annual Load Profile



39.2 HVAC Refrigerants

The Durham County TWWTP Administrative Building utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 39-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 39-3. TWWTP Administrative Building HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
WSHP-3	Water Source Heat Pump	Carrier 50RVC048	4 Tons	R-22	4.13 lbs	Interior
WSHP-1, 2, 4	Water Source Heat Pump	Carrier 50PCV070	6 Tons	R-410A	4.6 lbs	Interior
CU	Mini-Split A/C	Mitsubishi MUY-D30NA	2.5 Tons	R-410A	4.0 lbs	Exterior
	Lab Refrig.	Thermo Fisher TFFU2065FWA		R-134A	4.2 oz	Interior

39.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 39-4. TWWTP Administrative Building Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Triangle Waste Water Treatment Plant (admin)	Baseline	977,377.30	0.00	3,335.76	$81,626.74	277.48

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	76,018.23	0.00	259.45	$6,348.75	21.58	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	15,701.27	0.00	53.59	$1,311.31	4.46	NA	NA	
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00	kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$12.38	0.07	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	14,844.44	0.00	50.66	$1,239.75	4.21	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	859.95	0.00	2.93	$71.82	0.24	Applicable Area %	10.0%	%
	LED Exit Signs	317.99	0.00	1.09	$26.56	0.09	Quantity of Exit Signs	3	#
	Daylight Dimming Control	1,289.93	0.00	4.40	$107.73	0.37	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	1,816.42	0.00	6.20	$151.70	0.52	Quantity of Outdoor Fixtures	7	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	849.02	0.00	2.90	$70.91	0.24	Transformer Size	30.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$8.77	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	188.30	0.00	0.64	$15.73	0.05	Quantity of Power Strips	7	#
Decarbonization Measure Savings Totals (predicted)		**111,990.56**	**12.43**	**383.46**	**$9,365.39**	**31.86**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**11.5%**	**0.0%**	**11.5%**	**11.5%**	**11.5%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

39.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 39-5. TWWTP Administrative Building Existing HVAC/DHW Systems

HVAC | Space Heating	(mult) Water source heat pumps, no elec resistance backup, reclaim water is condenser source; (6) Gas infrared radiant heaters, propane fired, assumed 50 mbh input;
Domestic Hot Water	(1) Gas-fired direct-vent storage water heater, State model SDV7570PE, 75 gal, 65 mbh input propane, 67 gph recovery, mfg 2004, recirc pump;

Table 39-6. TWWTP Administrative Building HVAC Electrification Pathway 1

Pathway 1 | Electrification	Replace gas radiant heaters with (6) electric unit heaters, Modine HER150, 15 kw (90 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	0.0	0.0	2,543.4	NA	NA	992,534.6	65.6	320.8	-0.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,385.4 MMBTU								3,394.0 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,378.26	$66.07	$8.74	-0.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$92,150.28 $US								$92,444.33 $US			
Carbon	281.1	0.3	26.60	0.0	0.0	0.7	NA	NA	281.8	0.3	26.67	-0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	281.4 MT CO2e								282.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 39-7. TWWTP Administrative Building HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - already heat pumps

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	0.0	0.0	2,543.4	NA	NA	992,534.6	65.6	320.8	-0.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,385.4 MMBTU								3,394.0 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,378.26	$66.07	$8.74	-0.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$92,150.28 $US								$92,444.33 $US			
Carbon	281.1	0.3	26.60	0.0	0.0	0.7	NA	NA	281.8	0.3	26.67	-0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	281.4 MT CO2e								282.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 39-8. TWWTP Administrative Building DHW Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 80 gallon, 18kw input, Bradford White model CEHD80(A)18 3*CF (total 18kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	NA	NA	NA	(65.6)	1,482.1	991,473.3	0.0	319.8	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,385.4 MMBTU								3,383.9 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,226.77	$0.00	$8.72	-0.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$92,150.28 $US								$92,226.77 $US			
Carbon	281.1	0.3	26.60	NA	NA	NA	(0.3)	0.4	281.5	0.0	26.61	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	281.4 MT CO2e								281.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 39-9. TWWTP Administrative Building DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WH with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**989,991.2**	**65.6**	**320.0**	**NA**	**NA**	**NA**	**(65.6)**	**329.0**	**990,320.2**	**0.0**	**319.5**	**0.2%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	3,385.4 MMBTU								3,379.9 MMBTU			
Energy Cost	**$92,084.21**	**$66.07**	**$8.71**						**$92,115.11**	**$0.00**	**$8.71**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$92,150.28 $US								$92,115.11 $US			
Carbon	**281.1**	**0.3**	**26.60**	**NA**	**NA**	**NA**	**(0.3)**	**0.1**	**281.2**	**0.0**	**26.57**	**0.1%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	281.4 MT CO2e								281.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 39-10. TWWTP Administrative Building Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$89,031.00	($294.05)	$0.00	($294.05)	($126,512.56)	-7.7739%	NA	-0.0516	NA	NA	($36.83)
HVAC Pathway 2	$89,031.00	($294.05)	$0.00	($294.05)	($126,512.56)	-7.7739%	NA	-0.0516	NA	NA	($36.83)
DHW Pathway 1	$1,509.00	($142.56)	$66.07	($76.49)	($3,495.58)	NA	NA	-0.7143	NA	NA	($3.69)
DHW Pathway 2	$8,372.00	($30.90)	$66.07	$35.17	($10,413.59)	-6.3962%	-3.3175%	0.0795	NA	NA	$13.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$17,932.00
DHW Existing Replacement:	$9,851.00

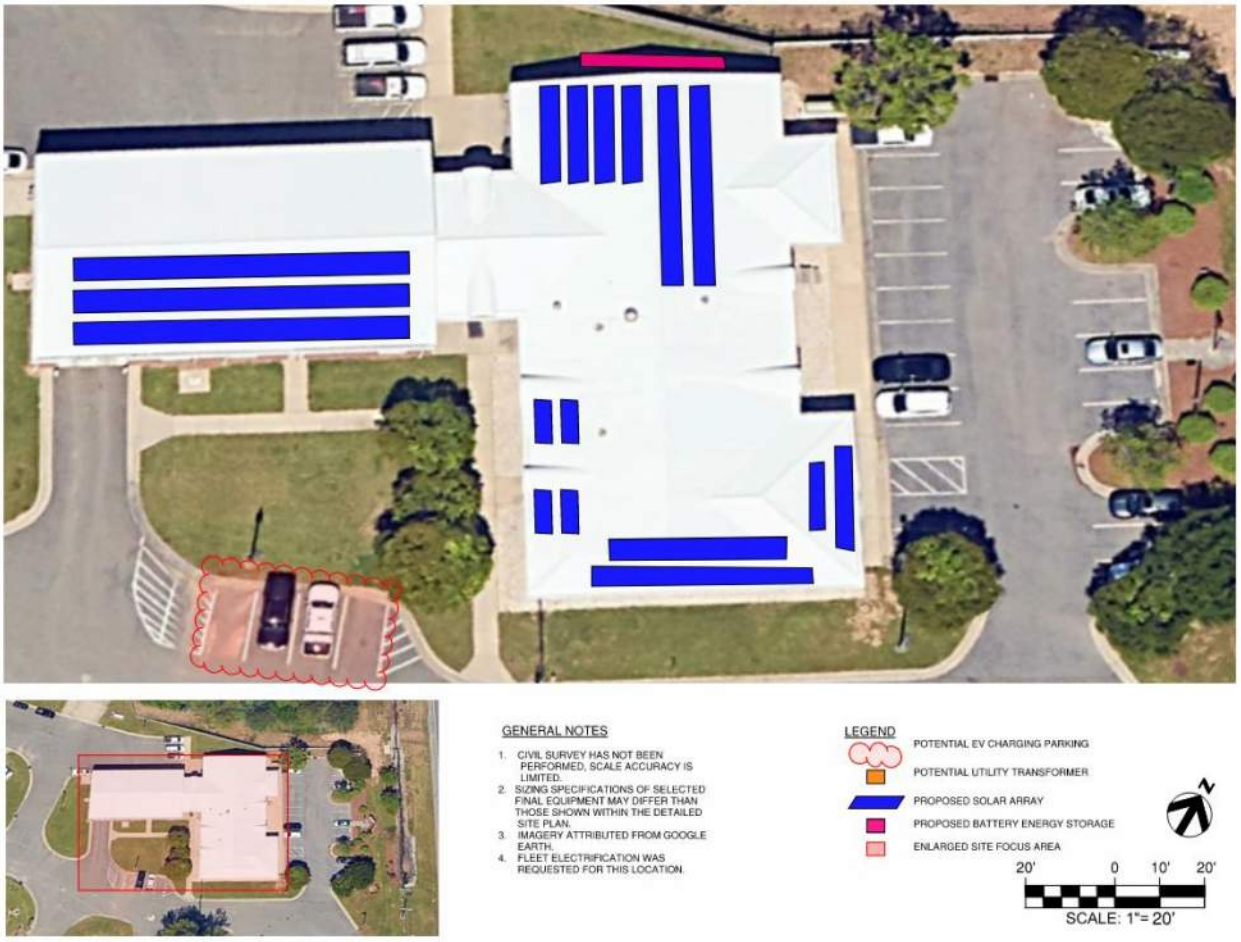
Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

39.5 Renewable Energy, Energy Storage, and Electric Vehicles

39.5.1 Solar and BESS Analysis

The TWWTP Administrative Building has a large sized gabled roof across an L shaped facility. Shading concerns to the various angles and heights to the roof have restricted the placement of the solar equipment to primarily South facing roof sides. The facility roof was replaced in 2002 thus a future PV system could be considered during a future roof replacement. As shown in Figure 39-5, the estimated total capacity is 35 kW DC with the potential for BESS equipment placement adjacent to existing utility equipment on the northern side of the building.

Figure 39-5. TWWTP Administrative Building Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 981,386 kWh with a peak December load of 317.7 kW. The estimated roof solar capacity is 35 kW DC and initial HOMER analysis indicates that a 35 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of

excess PV generation. Standalone PV systems tend to have more favorable payback period and rate of return if ITCs are factored into the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 39-11. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. In general, renewable systems tend to provide low renewable fractions at this building but a standalone PV system could be utilized given the low payback period.

Table 39-11. TWWTP Administrative Building Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	981,386	N/A	N/A	N/A
35kW PV Only	934,062	47,621	N/A	4.9
35kW PV + 66 kWh BESS	933,962	47,621	771	4.8

39.6 Cost Summary

Cost performance for the three systems is provided in Table 39-12.

Table 39-12. TWWTP Administrative Building Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	1,010,000	N/A	N/A
35kW PV Only	71,000	1,030,000	2.6	18
35kW PV + 66 kWh BESS	178,000	1,150,000	N/A	>25
Cost Summary with ITC Included				
35kW PV Only	48,000	1,010,000	3.8	13
35kW PV + 66 kWh BESS	125,000	1,090,000	N/A	>25

39.6.1 Electric Vehicle

The TWWTP Administrative Building was identified for fleet electrification and for public charging. Ideal locations for EV chargers are indicated in Figure 39-5. A total of four (4) Level 2, 7.2 kW EV chargers were identified for fleet charging usage for a total load of 28.4 kW. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

39.7 Electrical Infrastructure Demand Feasibility Summary

Table 39-13. TWWTP Administrative Building Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	272.40 kW	272.40 kW
HVAC Electrification Pathway 1		272.40 kW
HVAC Electrification Pathway 2		272.40 kW
DHW Electrification Pathway 1		272.71 kW
DHW Electrification Pathway 2		272.46 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

39.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard cannot accommodate the number of circuit breakers required to supply power for the electric unit heaters required by HVAC Electrification Pathway 1. Therefore, a new main service panelboard will be required. New circuit breakers will be required.

39.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the Electric Storage Water Heater required by DHW Electrification Pathway 1 or the Heat Pump Storage Water Heater for DHW Electrification Pathway 2. New circuit breakers will be required.

39.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

40 Triangle Waste-Water Treatment Plant Building 1, Filter Building

40.1 Renewable Energy, Energy Storage, and Electric Vehicles

40.1.1 Solar and BESS Analysis

The main TWWTP Filter Building has a metal gabled roof facing East to West. Adjacent to the main structure is a smaller metal gabled roof with a Southern face. The roof was replaced in 2002 and the future replacement schedule was not identified. Future roof replacement should be considered if a PV system is pursued at this location. As shown in Figure 40-1, the estimated total capacity for equipment placed on both the main and adjacent structure are 44 kW DC with the potential for BESS equipment placement adjacent to existing utility equipment on the eastern side of the building.

Figure 40-1. TWWTP Filter Building Conceptual Renewables and EV Visual Aid



Only monthly energy data was provided for this building; thus, the load profile was assumed to be similar to a scaled version of the TWWTP Sludge Building. The current building load data,

utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 3,744,754 kWh with a peak July load of 962 kW. The estimated roof solar capacity is 44 kW DC and initial HOMER analysis indicates that only a 44 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV systems tend to have more favorable payback periods if ITCs are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 40-1. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Renewable energy systems tend to provide low renewable fraction at this building and would likely not be recommended. A standalone PV system could be pursued due to the short payback period if a renewable system is desired at this location.

Table 40-1. TWWTP Filter Building Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	3,744,754	N/A	N/A	N/A
44 kW PV	3,685,192	59,866	N/A	1.6
44 kW PV + 132 kWh BESS	3,685,257	59,866	1,681	1.6

40.2 Cost Summary

Cost performance for the three systems is provided in Table 40-2.

Table 40-2. TWWTP Filter Building Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	3,996,000	N/A	N/A
44 kW PV	84,000	3,980,000	1.1	22
44 kW PV + 132 kWh BESS	300,000	4,200,000	N/A	>25
Cost Summary with ITC Included				
44 kW PV	59,000	3,950,000	4.3	15
44 kW PV + 132 kWh BESS	210,000	4,110,000	N/A	>25

40.2.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

40.3 Electrical Infrastructure Demand Feasibility Summary

40.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard cannot accommodate the PV or BESS systems. The main circuit breaker for the panelboard feeding the systems will need to be updated and replaced.

41 Triangle Waste-Water Treatment Plant, Sludge Building

Durham County | TWWTP Sludge Building | Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	5926 NC-55, Durham, NC 27713	**Heating Primary Fuel**	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	**Heating Generation**	Gas Unit Heaters
Building Type	Wastewater Treatment Plant	**Cooling Generation**	Split-System DX
Year Built	2013	**Domestic Hot Water Generation**	Electric Storage-type Water Heater
Floor Area (ft2)	4,930	**Heating / Cooling / Vent Distribution**	Split System Units
Stories	1	**Electric Rate Structure**	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	NA		
Wall Type	Metal Building	**Natural Gas Rate Structure**	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	**Weekday Operating Hours**	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

Figure 41-1. TWWTP Sludge Building



41.1 Existing Building Performance & Condition

41.1.1 Past Conservation Projects and Successes

None.

41.1.2 Condition Assessment Summary

The mechanical and plumbing systems appear well maintained, with no noted deficiencies for most equipment beyond normal wear for the equipment age.

Per the above summary, the opportunities have been identified but do not qualify as quantifiable measures based on preliminary information. The measures are either capital in nature or are O&M observed anomalies and require additional investigation by the building owner to proceed. The Durham County team is encouraged to pursue these opportunities via additional investigation, using trended data collection to validate and quantify the measures identified.

Table 41-1. TWWTP Sludge Building Non-Quantifiable Savings Measures

ID	Energy Reduction Measure Description
Capital.1	
Fix.1	

41.1.3 Existing Building Energy, Energy Cost, & Carbon Data

Table 41-2 summarizes the annual energy consumption, electric demand, energy cost and energy emissions on a monthly basis. Energy data was obtained by the Enpira platform which manages the utility data at the portfolio-level for the majority of Durham County facilities.

Electric energy costs were calculated per the specific Duke Energy tariff that is allocated to the specific building. Natural gas energy costs were obtained by the Enpira platform.

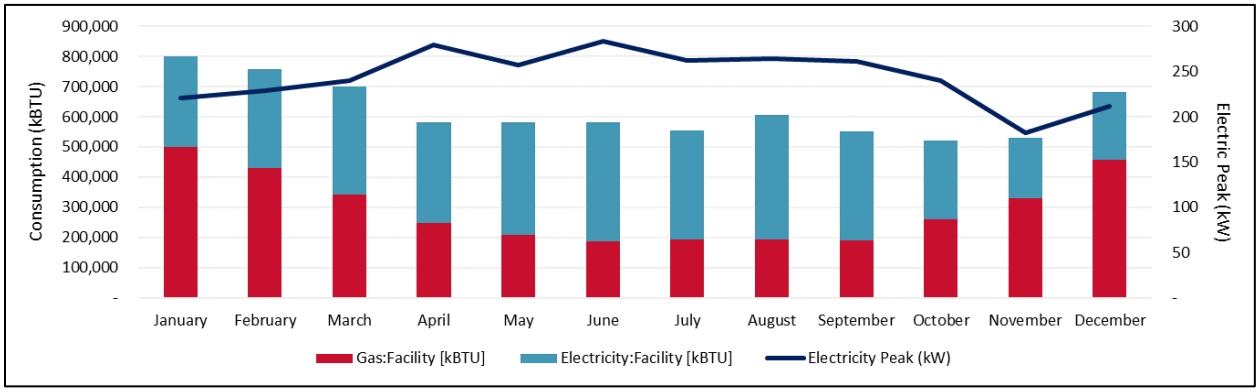
Electric Emissions were calculated using the carbon emission factor for FY2022 provided by the eGRID database for region SRVC. This carbon emission factor of 625.90 lbs CO_2e/MWH (63.12 kg CO_2e/MMBTU) represents the grid generation mix specific to the Virginia and Carolinas region. Natural gas emissions were calculated using the carbon emission factor provided by the EPA. This carbon emission factor of 53.115 kg CO_2e/MMBTU includes the emissions from CO_2, CH_4 and N_20 and are weighted per the individual components' GWP metrics.

Table 41-2. TWWTP Sludge Building Existing Building Performance Summary

	Electricity Facility [kWh]	Gas Facility [Therms]	Total Energy Facility [MMBTU]	Electricity Facility [kW](Monthly Peak)	Electricity Cost Facility [$US]	Gas Cost Facility [$US]	Total Energy Cost Facility [$US]	Electricity Emissions Facility [kg CO2e]	Gas Emissions Facility [kg CO2e]	Total Emissions Facility [kg CO2e]
January	88,018	4,999	800	220.6	$6,312	$5,036	$11,348	24,989	26,553	51,541
February	96,193	4,307	759	229.0	$6,630	$4,338	$10,968	27,310	22,874	50,184
March	104,336	3,435	700	240.1	$7,378	$3,460	$10,838	29,621	18,247	47,868
April	98,126	2,472	582	279.4	$7,301	$2,490	$9,791	27,858	13,130	40,988
May	109,352	2,093	582	257.5	$7,837	$2,108	$9,945	31,045	11,116	42,161
June	115,003	1,886	581	283.6	$10,383	$1,900	$12,282	32,650	10,016	42,666
July	106,312	1,926	555	261.9	$9,444	$1,940	$11,385	30,182	10,231	40,413
August	120,774	1,945	607	263.7	$10,604	$1,960	$12,563	34,288	10,333	44,621
September	106,040	1,898	552	261.3	$10,292	$1,911	$12,203	30,105	10,079	40,184
October	76,716	2,593	521	239.4	$6,577	$2,612	$9,189	21,780	13,771	35,551
November	58,953	3,301	531	182.3	$5,553	$3,325	$8,878	16,737	17,533	34,270
December	65,688	4,579	682	211.1	$5,985	$4,613	$10,597	18,649	24,322	42,971
ANNUAL	1,145,510	35,433	7,453	-	$94,295	$35,692	$129,987	325,214	188,203	513,417
PEAK	-	-	-	283.6	-	-	-	-	-	-

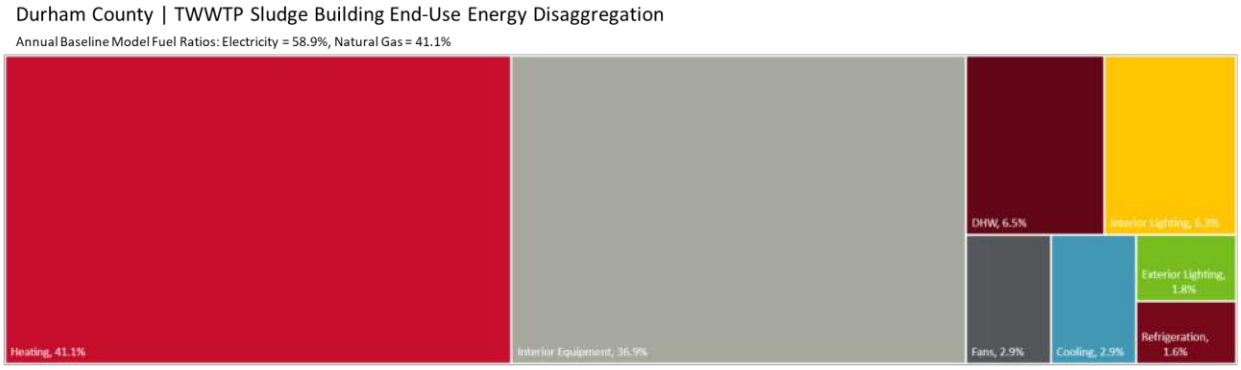
The data in Table 41-2 is represented in graphical format in Figure 41-2 with all monthly energy consumption values (primary axis) converted to common energy units, kBTU and all monthly electric peak values (secondary axis) in kW.

Figure 41-2. TWWTP Sludge Building Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



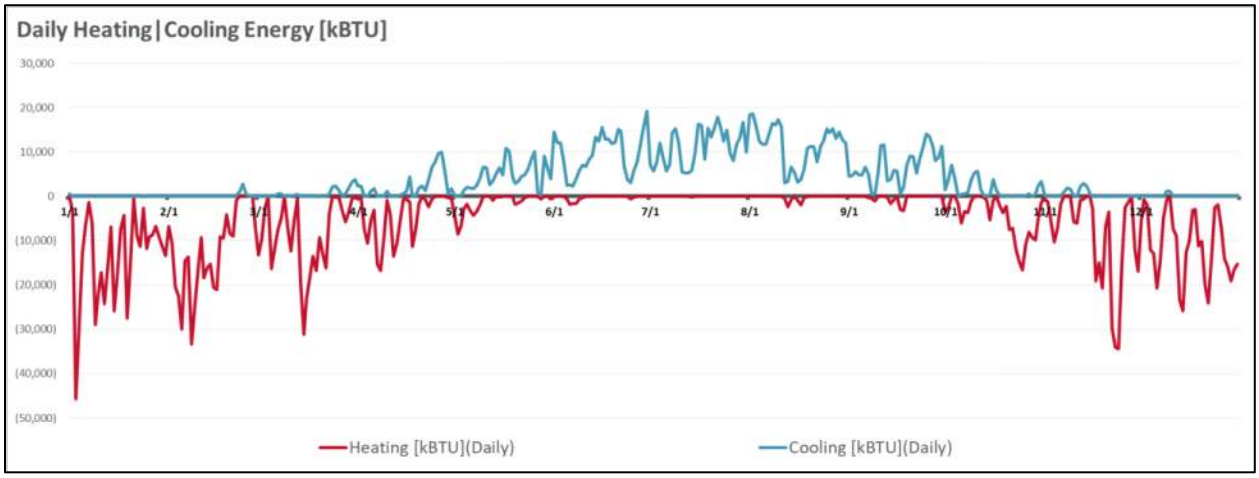
While Table 41-2 and Figure 41-2 encompasses “whole” building data, Figure 41-3 disaggregates the whole building data into the individual end-uses to show where the most energy is predicted to be consumed in the building, and thus where the primary area of focus should be when identifying decarbonization measures. The facility does not have end-use sub-metering which would allow the true end-use disaggregation, thus the location adjusted prototype energy analysis models described in Section 1.3 are utilized to develop engineering validated assumptions on the breakdown of energy use specific to each fuel-specific end-use. The existing building annual electricity versus natural gas consumption data is utilized to adjust the end-use disaggregation even further to assure that the disaggregation presented below aligns with the true fuel ratios as seen during current operation of the building today.

Figure 41-3. TWWTP Sludge Building Baseline Model End-Use Energy Disaggregation



As part of the location and gross area adjusted prototype energy analysis described in Section 1.3, heating and cooling hourly load values for all hours of the year (8,760 hours) are output and used in both the decarbonization and electrification analysis. Figure 41-4 summarizes these load outputs for this facility with the cooling loads on the positive Y axis and the heating loads on the negative Y axis.

Figure 41-4. TWWTP Sludge Building Baseline Model Heating & Cooling Annual Load Profile



41.2 HVAC Refrigerants

The Durham County TWWTP Sludge Building utilizes a variety of HFCs specific to refrigeration and air conditioning system operation. Should the County adapt a phase-out initiative of currently used HFCs, Table 41-3 summarizes the findings from the Comprehensive Facilities Assessment with respect to the various HFCs currently used in the building. Alternate Refrigerant options for all Durham County owned facilities are identified in Section 1.3.1 of this report.

Table 41-3. TWWTP Sludge Building HVAC Refrigerant Summary

Equipment Tag	Equipment Description	Make/Model	Capacity	Refrigerant Type	Refrigerant Charge	Location
CU-1	Split-System Heat Pump	Trane 4TWX6036	3 Tons	R-410A	10.5 lbs	Exterior
CU-2	Split-System Heat Pump	Trane 4TWX6024	2 Tons	R-410A	10.5 lbs	Exterior

41.3 Building Decarbonization Analysis

All recommendations included in this report are based on observations made during the assessment, information provided by Durham County personnel, and the experience of the HDR team. As such, the energy saving estimates provided are first-order estimates and are not intended to be used to justify capital investment without further consideration. While every reasonable effort was made in the time allotted to collect accurate data, all assumptions should be verified.

Table 41-4. TWWTP Sludge Building Building Decarbonization Recommendations

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
TWWTP Bldg 2 (Sludge)	Baseline	1,191,472.36	0.00	4,066.46	$102,640.40	338.26

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	79,431.49	0.00	271.10	$6,842.69	22.55	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	0.69	0.00	0.00	$0.06	0.00	NA	NA	
	Smart Thermostat	248.04	0.00	0.85	$21.37	0.07	Total Cooling Capacity Controled	72.00	kBTU/hr
	Air Conditioner Tune-up	313.52	0.00	1.07	$27.01	0.09	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	0.00	0.00	$0.00	0.00	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	9,976.15	-66.21	27.43	$793.46	2.48	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	1	#
	Daylight Dimming Control	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	0.00	0.00	0.00	$0.00	0.00	Quantity of Power Strips	0	#
Decarbonization Measure Savings Totals (predicted)		**89,969.89**	**-66.21**	**300.44**	**$7,684.59**	**25.19**			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		**7.6%**	**0.0%**	**7.4%**	**7.5%**	**7.4%**			

Note: Each Decarbonization measure savings results are presented independently as non-coincident measures. If measures are combined and become coincident measures, the savings results will be impacted. For example, if both LED Retrofit and Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be less as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

41.4 Building Electrification Analysis

As part of the location and gross area adjusted prototype energy analysis described in Section 1.3.2, electrification pathways were analyzed for both space heating and DHW systems.

Table 41-5. TWWTP Sludge Building Existing HVAC/DHW Systems

HVAC | Space Heating	(2) Gas unit heater, Trane, propane fired, unknown capacity (100 mbh assumed); (1) AHU-2 w/ elec heat, Trane model 4TEE3F31, cap not marked; (1) AHU-1 w/ elec heat, Trane model 4TEE3F37, cap not marked;
Domestic Hot Water	(1) Electric storage water heater, 65 gal, 4.5 kw, Rheem model ELD-66B, mfg 2012;

Table 41-6. TWWTP Sludge Building HVAC Electrification Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (2) electric 30kw unit heater, Modine PTE300 (60kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	0.0	(27,312.4)	579,861.9	NA	NA	1,725,372.2	0.0	1,194.5	11.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,640.8 MMBTU								5,888.6 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$191,598.66	$0.00	$38.86	-42.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$134,834.34 $US								$191,598.66 $US			
Carbon	325.2	145.1	95.39	0.0	(145.1)	164.6	NA	NA	489.8	0.0	99.36	-4.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	470.3 MT CO2e								489.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 41-7. TWWTP Sludge Building HVAC Electrification Pathway 2

Pathway 2 | High Performance Electrification	N/A - already electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	0.0	(27,312.4)	579,861.9	NA	NA	1,725,372.2	0.0	1,194.5	11.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,640.8 MMBTU								5,888.6 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$191,598.66	$0.00	$38.86	-42.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$134,834.34 $US								$191,598.66 $US			
Carbon	325.2	145.1	95.39	0.0	(145.1)	164.6	NA	NA	489.8	0.0	99.36	-4.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	470.3 MT CO2e								489.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 41-8. TWWTP Sludge Building DHW Electrification Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	NA	NA	NA	0.0	0.0	1,145,510.3	27,312.4	1,347.0	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,640.8 MMBTU								6,640.8 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$107,322.51	$27,511.82	$27.35	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$134,834.34 $US								$134,834.34 $US			
Carbon	325.2	145.1	95.39	NA	NA	NA	0.0	0.0	325.2	145.1	95.39	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	470.3 MT CO2e								470.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Table 41-9. TWWTP Sludge Building DHW Electrification Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			D%
	Electricity	Natural Gas	/ ft2	D Cooling Electricity	D Heating Natural Gas	D Heating Electricity	D Water Heating Natural Gas	D Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	NA	NA	NA	0.0	(145,821.5)	999,688.8	27,312.4	1,246.1	7.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	D%
	6,640.8 MMBTU								6,143.2 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$93,702.18	$27,511.82	$24.59	10.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	D%
	$134,834.34 $US								$121,214.00 $US			
Carbon	325.2	145.1	95.39	NA	NA	NA	0.0	(41.4)	283.8	145.1	86.99	8.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	D%
	470.3 MT CO2e								428.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Financial Evaluation was completed on all recommended Electrification pathways, for both space heating and DHW systems. While the primary metric of NPV via a LCCA calculation is recommended to be used during the decision-making process as they represent the benefits across the “life” of the measure, additional financial metrics including IRR, SIR and Simple/Discounted Payback Periods are also provided for additional consideration.

Table 41-10. TWWTP Sludge Building Electrification Pathway Financial Analysis Summary

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$7,141.75	($84,276.14)	$27,511.82	($56,764.32)	($1,141,850.66)	NA	NA	-117.3181	NA	NA	($997.31)
HVAC Pathway 2	$7,141.75	($84,276.14)	$27,511.82	($56,764.32)	($1,141,850.66)	NA	NA	-117.3181	NA	NA	($997.31)
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	-$633.00	$13,620.34	$0.00	$13,620.34	$288,250.79	NA	NA	NA	NA	NA	$2,111.36

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$31,457.00
DHW Existing Replacement:	$10,542.00

Note on Building Electrification Results: Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to all financial impact metrics currently presented.

41.5 Renewable Energy, Energy Storage, and Electric Vehicles

41.5.1 Solar and BESS Analysis

The TWWTP Sludge Building has a large sized metal gabled roof facing North to South with no shading concerns. The roof at this facility was replaced in 2013 and future replacement schedule was not identified. As shown in Figure 41-5, the estimated total capacity is 150 kW DC with the potential for BESS equipment placement on the north side of the building.

Figure 41-5. TWWTP Sludge Building Conceptual Renewables and EV Visual Aid



The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 1,192,596 kWh with a peak July load of 306.6 kW. The estimated roof solar capacity is 150 kW DC and initial HOMER analysis indicates that only a 75 kW DC nameplate PV system would be optimal. Potential PV systems should utilize south facing azimuth angles when possible. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV systems tend to have more favorable payback periods if

ITCs are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 41-11. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. Renewable systems would likely not be recommended at this facility due to the low renewable fraction of the system. A standalone PV system could be pursued due to the reasonable payback period if a renewable system is desired at this location.

Table 41-11. TWWTP Sludge Building Renewables HOMER modeling summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	1,192,596	N/A	N/A	N/A
75 kW PV	1,091,322	102,045	N/A	8.6
75 kW PV + 132 kWh BESS	1,091,164	102,045	2,788	8.5

41.6 Cost Summary

Cost performance for the three systems is provided in Table 41-12.

Table 41-12. TWWTP Sludge Building Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	1,280,000	N/A	N/A
75 kW PV	140,000	1,340,000	1.7	20
75 kW PV + 132 kWh BESS	356,000	1,570,000	N/A	>25
Cost Summary with ITC Included				
75 kW PV	98,000	1,300,000	2.8	16
75 kW PV + 132 kWh BESS	249,000	1,470,000	N/A	>25

41.6.1 Electric Vehicle

The TWWTP Sludge Building was identified for fleet electrification. Due to the lack of surrounding facility parking, it is recommended for all fleet vehicles to be charged at the facilities recommended at the administrative building in Section 1.15.1. Fleet data for the facility was not provided to determine recommended quantity of fleet EV chargers. See the self-assessment tool (Figure 1-9) in Fleet Electrification and Public Charging Analysis Methodology for additional evaluation. The potential additional load for fleet and/or public EV Chargers was not considered in the building load review or cost estimation.

41.7 Electrical Infrastructure Demand Feasibility Summary

Table 41-13. TWWTP Sludge Building Electrical Infrastructure Demand Feasibility Summary

Analysis Iteration	Per Duke Energy (Enpira Data)	Per Baseline Model Analysis + TMY3 Raleigh Durham Weather File
Existing Demand	283.56 kW	283.56 kW
HVAC Electrification Pathway 1		1,196.11 kW
HVAC Electrification Pathway 2		1,196.11 kW
DHW Electrification Pathway 1		283.56 kW
DHW Electrification Pathway 2		256.71 kW
Electric Vehicle (EV) Charging		
Rooftop Solar		
BESS		

41.7.1 Building HVAC Electrification Implementation Feasibility

The existing main distribution panelboard can accommodate the circuit breakers required to supply power for the electric unit heaters required by HVAC Electrification Pathway 1. New circuit breakers will be required.

41.7.2 Building DHW Electrification Implementation Feasibility

The existing distribution panelboard can accommodate the Heat Pump Storage Water Heater for DHW Electrification Pathway 2. New circuit breakers will be required.

41.7.3 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

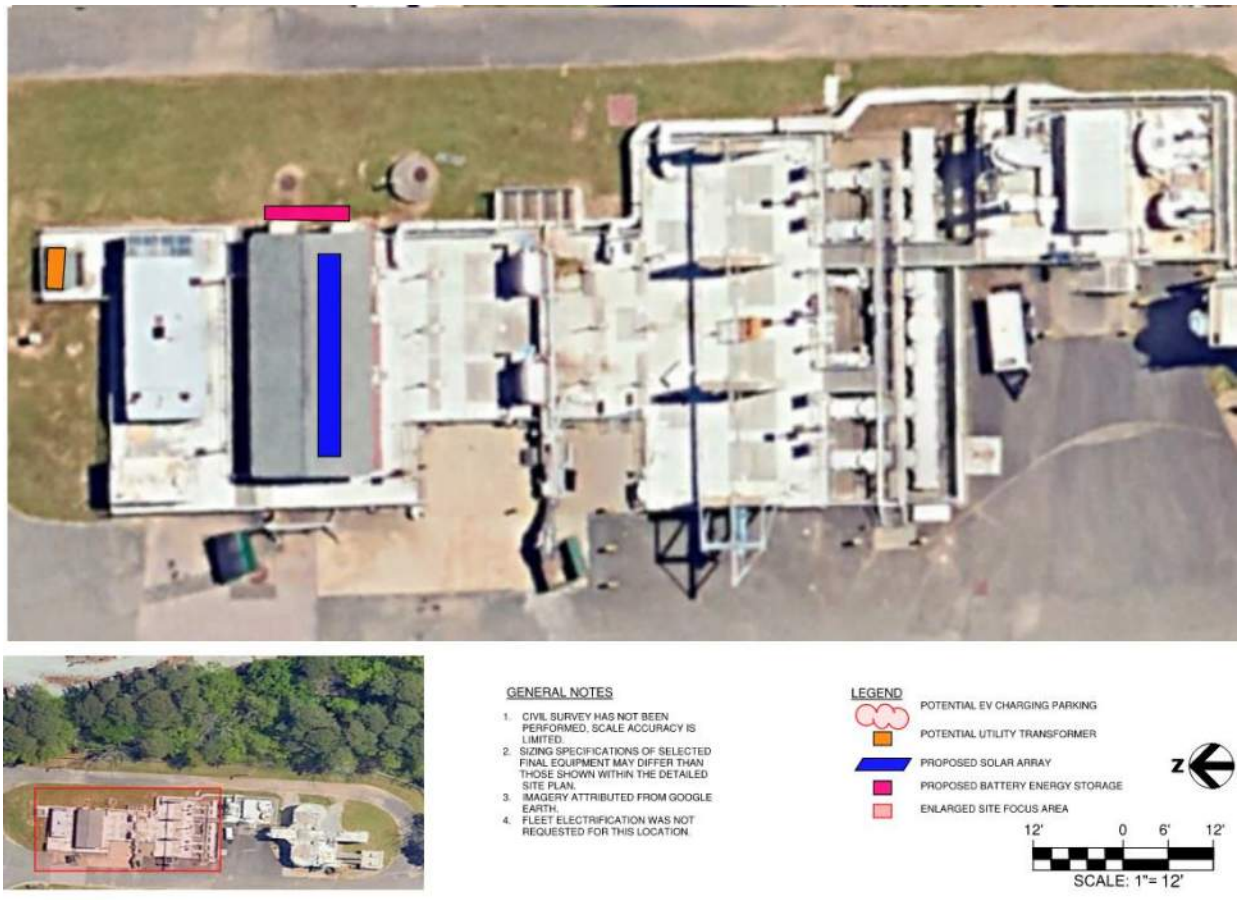
42 Triangle Waste-Water Treatment Plant, Sludge Building Cover

42.1 Renewable Energy, Energy Storage, and Electric Vehicles

42.1.1 Solar and BESS Analysis

The TWWTP Sludge Building Cover roof is a small gabled roof facing North and South. Solar equipment was placed on the south-facing roof, as shown in Figure 42-1, the estimated total capacity is 2.5 kW DC with the potential for BESS equipment placement on the eastern face of the main building. The roof at this facility was replaced in 2013 but a schedule for replacement was not identified.

Figure 42-1. TWWTP Sludge Building Cover Conceptual Renewables and EV Visual Aid



No load data was provided for the Sludge Cover building; thus, a scaled load profile similar to Durham County Warehouse was utilized. The current building load data, utility rate, and estimated PV system size was analyzed through the HOMER modeling software. Refer to Solar Analysis Methodology for further information regarding HOMER. The annual building consumption for the past year is approximately 139,353 kWh with a peak July load of 16 kW. The estimated roof solar capacity is 2.5 kW DC and initial HOMER analysis indicates that only a

2.5 kW DC nameplate PV system would be optimal. HOMER model results indicate that multiple combinations of PV possess favorable payback periods, IRR, and renewable fractions. PV and BESS hybrid systems tend to possess unfavorable payback periods and IRR due to the high capital cost of BESS and low amount of excess PV generation. Standalone PV systems tend to have more favorable payback periods if ITCs are included in the cost analysis. The base case, PV only, and PV+BESS system configurations with the fastest payback period are provided in Table 42-2. Costs of technology will continue to decrease, and while the ROI is not current favorable for some system configurations, the County should continue to evaluate the solar and battery costs prior to constructing new projects. A renewable system would likely not be recommended at this location due to the low renewable fraction for the system. If a renewable system is desired, a standalone PV system would be recommended due to the reasonable payback period.

Table 42-1. TWWTP Sludge Building Cover Renewables HOMER Modeling Summary

System Configuration	Annual Energy Purchased (kWh)	Annual PV Generation (kWh)	Annual BESS Throughput (kWh)	Renewable Fraction (%)
Base Case (Duke Energy SGS TOU)	139,353	N/A	N/A	N/A
2.5 kW PV	135,954	3,401	N/A	2.4
9 kW PV + 13.2 kWh BESS	136,024	3,401	328	2.4

42.2 Cost Summary

Cost performance for the three systems is provided in Table 42-2.

Table 42-2. TWWTP Sludge Building Cover Renewables Cost Summary

System Configuration	Capital Cost ($)	Net Present Cost ($)	IRR (%)	Simple Payback Period (yr)
Base Case (Duke Energy SGS TOU)	N/A	167,000	N/A	N/A
2.5 kW PV	21,000	185,000	3.1	14
2.5kW PV + 13.2 kWh BESS	42,000	206,000	N/A	>25
Cost Summary with ITC Included				
2.5 kW PV	15,000	178,000	9	10
2.5kW PV + 13.2 kWh BESS	30,000	193,000	N/A	>25

42.2.1 Electric Vehicle

Public and fleet EV charging was not included in the scope for this location.

42.3 Electrical Infrastructure Demand Feasibility Summary

42.3.1 Building Renewables Electrical Infrastructure Implementation Feasibility

The existing main distribution panelboard can accommodate the PV or BESS systems. New circuit breakers will be required.

43 Overarching Portfolio-Wide Energy Efficiency Conclusions / Recommendations

43.1 Summary

To summarize the building data, HDR used a Pareto chart to show a statistical representation of the results that combines a bar chart and a line graph. Key data points were chosen from the Decarbonization, Electrification and HOMER data to build the scores for each building.

- The bars in the Pareto chart represent building scores. These are arranged in descending order based on their score impact. The highest scores appear at the left end of the chart.
- The line graph shows the cumulative sum of the scores. It represents the total contribution of each score as you move from left to right. In general, bars to the left of the intersection of the line should be prioritized at a higher level.

43.1.1 Summary Chart Criteria

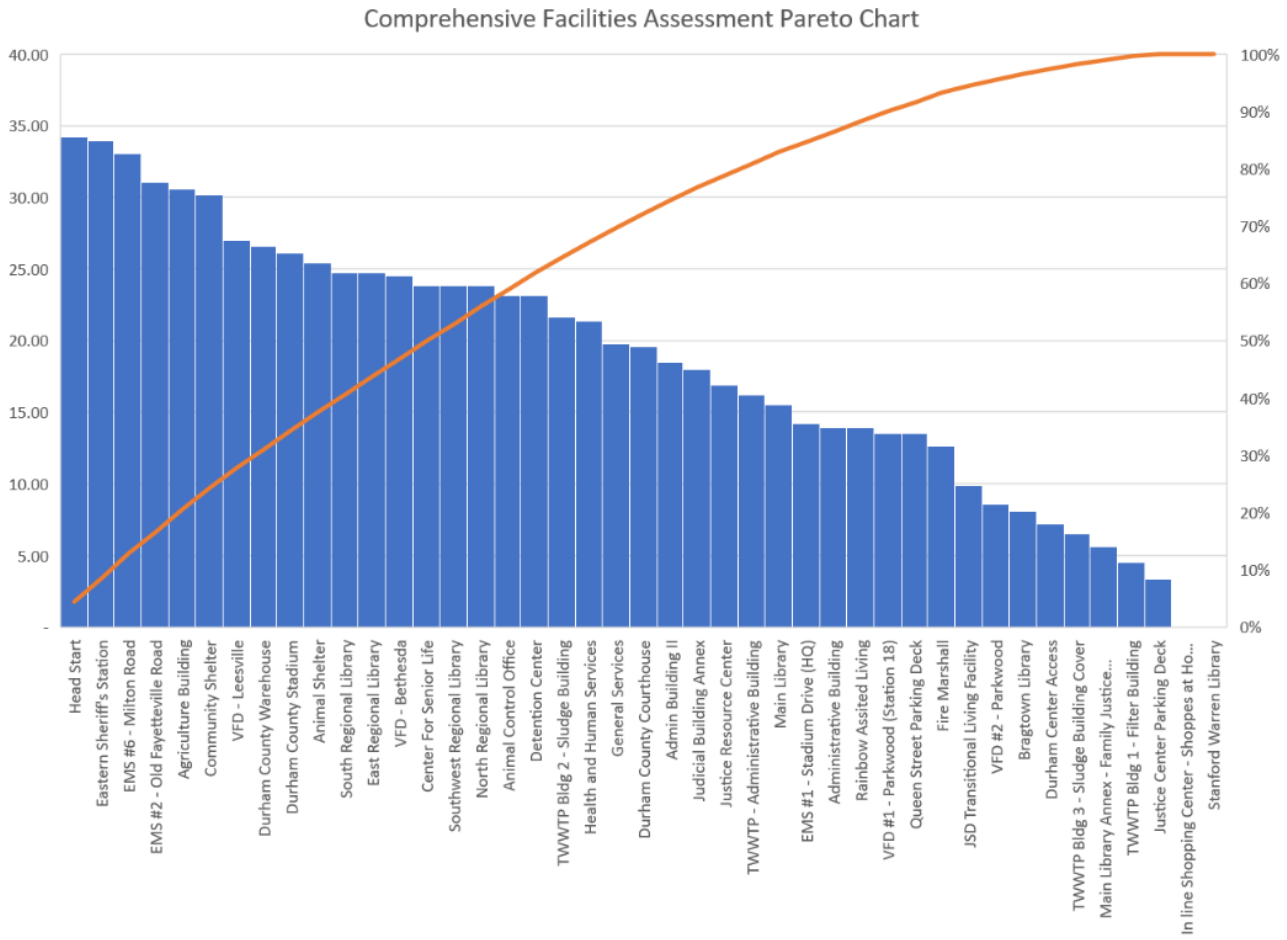
Total Energy Cost Savings	10.0%	**Decarbonization Weighting**
Total Energy GHG Reduction	60.0%	
Total Condition / Priority	30.0%	**30.0%**
Null	0.0%	
Null	0.0%	
Null	0.0%	

DHW Energy Usage Savings	30.0%	**Electrification Weighting**
DHW 40-Year NPV	5.0%	
DHW Condition / Priority	15.0%	**20.0%**
HVAC Energy Usage Savings	30.0%	
HVAC 40-Year NPV	5.0%	
HVAC Condition / Priority	15.0%	

PV Payback Period	10.0%	**Renewables Weighting**
PV Renewable Fraction	45.0%	
PV Estimated CapEx	5.0%	**50.0%**
PV + BESS Payback Period	5.0%	
PV + BESS Renewable Fraction	30.0%	
PV + BESS Estimated CapEx	5.0%	

Comprehensive Facilities Assessment Weighting
100.0%

43.1.2 Summary Chart



A

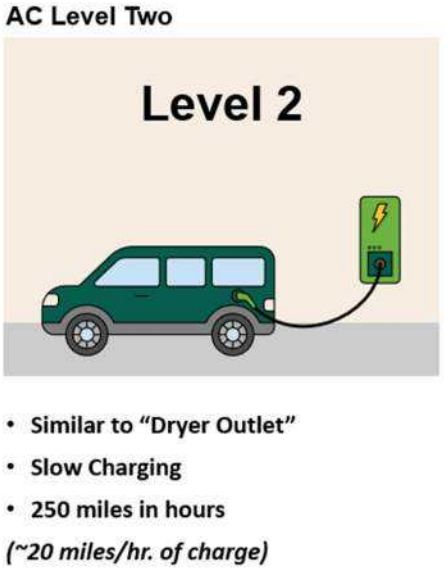
Appendix A – Supplemental Building Data

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Renewables Definitions and Abbreviations

Alternating Current Level 2 (LVL2) Charging - A method that uses dedicated alternating current (AC) EV / plug-in hybrid electric vehicle (PHEV) supply equipment. The vehicle shall be fitted with an onboard charger capable of accepting energy from single phase AC electric vehicle supply equipment. Level 2 charging occurs using a 208- or 240-volt (V) supply to the EVSE. For the purpose of this report, light-duty (LD) vehicle charging is anticipated to be operated at 7.2 kilowatts (kW) using Level 2 chargers while medium-duty (MD) and heavy-duty (HD) vehicle charging will operate at 19.2 kW, Level 2.



Ampere (Amp) (A) – The base unit of electric current in the International System of Units that is defined by setting the fixed numerical value of elementary charge to $1.602176634 \times 10^{-19}$ ampere seconds.

ABA/ADA (Architectural Barriers Act/Americans with Disabilities Act) - Legislation that requires accommodations to provide equal access and opportunities for people with disabilities. ABA typically refers to government facilities while ADA typically refers to public sector facilities.

Canopy Solar - Solar array mounted on an elevated structure, typically a parking overhang or gantry system.

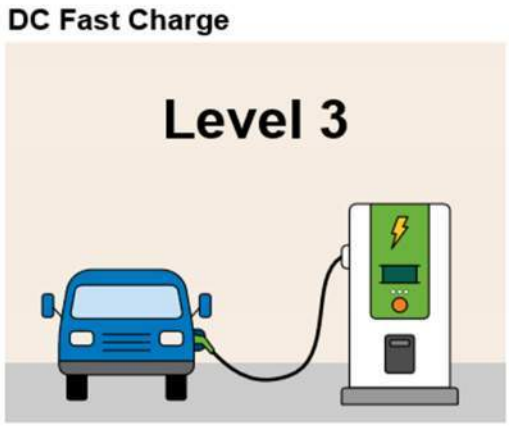
Connector - A conductive device that, by insertion into a vehicle inlet, establishes an electrical connection to the electric vehicle for the purpose of transferring energy and exchanging information.

Direct Current Fast Charging (DCFC) or Level (L3) Charging - A method that uses dedicated direct current (DC) EV/PHEV supply equipment to provide energy from an appropriate off-board charger to the EV/PHEV. DC charging occurs using a 480V supply to the EVSE. DCFC was not covered under the current scope of work.

Electric Vehicle (EV) - An automotive type vehicle, intended for highway use, primarily powered by an electric motor that draws from a rechargeable energy storage device. This is a general term, including both battery and plug-in hybrid electric vehicles.

EV Charger – An electrical device that converts AC energy to regulated direct current (DC) for replenishing the energy of a rechargeable energy storage device (i.e., battery) and that may also provide energy for operating other vehicle electrical systems. For the purpose of this study, a Level 2 charger location indicates the presence of two connectors, and a single charger can charge two vehicles simultaneously.

Electric Vehicle Supply Equipment (EVSE) - The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle.



Ground Coverage Ratio (GCR) – Considered as the ratio of module area to overall land area for a solar array. This spacing is influenced by inter-row shading.

Kilowatt-hour (kWh) - A unit of energy consumed or produced over time, equal to one kilowatt of power used for one hour.

Pad Mount EVSE - A type of EVSE that is installed on the ground and designed to look like a small pillar, post, or bollard.

Parking Space - Designated areas within a parking lot or garage where electric vehicles can be parked to utilize charging. Synonymous with stall.

Plug-in Hybrid Electric Vehicle (PHEV) - A hybrid vehicle with the ability to store and use off-board electrical energy in a rechargeable energy storage device. A PHEV combines a traditional gasoline engine with an electric motor and a rechargeable battery.

Renewable Fraction – The fraction of energy delivered to the load that originates from renewable power sources.

Small Service Vehicle – Equipment movers or vehicles smaller than a passenger car.

Special Service Vehicle – Vehicles that provide services such as waste transportation and are considered medium to heavy duty in size.

Solar Panel - A device that is capable of producing DC electricity through converting sunlight into usable energy.

Vehicle Duty – Classifications used to categorize electric vehicles (EVs) based on their intended use and capacity. For the purpose of this report, classifications are based off Federal Highway Administration classifications for Class 2 through Class 8 vehicles. FHWA definitions are based on vehicle characteristics that can be easily identified visually but that cannot be perfectly computed based on the number, weight, and spacing of axles. For this reason, some classifications under other definitions may vary.

> *Light-Duty (LD) Vehicle – Class 2 (Passenger Car) vehicles*. These vehicles are currently available as EVs within the existing market. Class 2 vehicles have 2 axles and can support 1- or 2-axle trailers. Small pickup trucks are included within the LD classification. Motorcycles (Class 1) vehicles were not considered within this scope of work.

Medium-Duty (MD) Vehicle – Class 3 (Pickups, Panels, and Vans), Class 4 (buses), and Class 5 (Single Unit 2-Axle Trucks) vehicles. Class 3 vehicles are similar to Class 2 in that they have 2 axles and 4 tires and can have 1- or 2-axle trailers. Class 4 vehicles are 2 or 3 axle, full length buses. Class 5 vehicles have 2 axles, six tires (dual rear tires).

Heavy-Duty (HD) Vehicle – Class 6 (3 axle, single unit), Class 7 (Single unit, 4 or more axles), and Class 8 and larger (Truck and trailer(s)) vehicles. For the purpose of this report, vehicles with a heavy-duty vehicles are present as non-tactical at some Army installations, but they are not a common part of this study.

Volt-Ampere (VA) - A unit of apparent power in an AC (alternating current) electrical circuit. VA refers to the product of the voltage and current in an AC circuit, without accounting for the phase angle between them.

W (Watt) - A unit of real power, which measures the rate of energy transfer per unit time.

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Appendix B – Electrification Systems Additional Information

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LCCA | Renewables-X

Building Engineering Services | North America | Sustainability - Solar Thermal Analysis - Summary

Manufacturer/Model: SunMaxx Solar ALDH 29-V3

Form Revision Level: 02/13/2024 © HDR

Project Information

Project Name:	Durham County Decarb
Project Number:	
Prepared By:	Greenfield
Revision Date:	3.11.24
Solar/Weather Data:	USA_WA_PULLMAN MOSCOW RGNL_727857_TMY3
Zenith/Azimuth Data:	NREL Solar Position Algorithm (SPA)

Building Gross Square Footage:	100,000	GSF
Project Latitude {N+/S-}:	35.9967	
Project Longitude {E+/W-}:	-78.8966	
Project Zip Code:	27701	
Project Time Zone (UTC Delta):	-8	

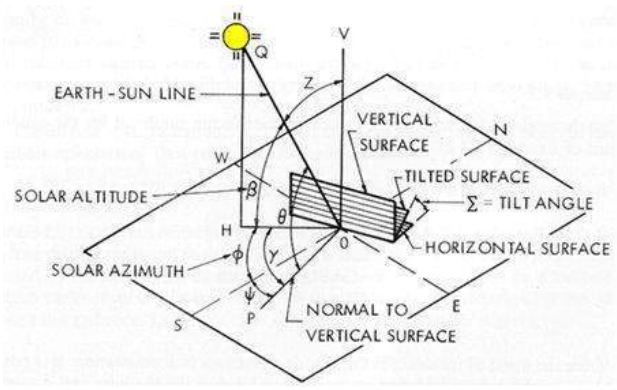
Solar Thermal System Design Data

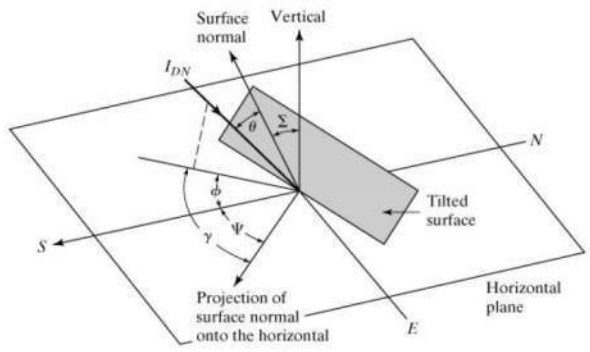
Gross Roof Area Available:		GSF
Gross Non-Roof Area Available:		GSF
Total Gross Area Available:	0	GSF

Panel Quantity Specification Methodology*:	Manual
If Manual, # Panels:	5

Solar Thermal Collector Design Data

Panel Design Manufacturer/Model:	SunMaxx Solar ALDH 29-V3	
Collector Type:	Glazed Flat Plate	
SRCC Certified:	Yes, #10002034	
# Panels:	5	
Panel Tilt, degrees:	21.0	
Panel Azimuth, degrees:	180.0	
Single Panel Horizontal Footprint:	Length (ft.):	7.74
	Width (ft.):	3.77
Module Type:	Standard	
Heat Exchanger Effectiveness (%):	95.0%	
Supply Side Pump hp:	1 1/2	
Pump Load Factor (%):	70.0%	
Pump Motor Efficiency (%):	86.5%	





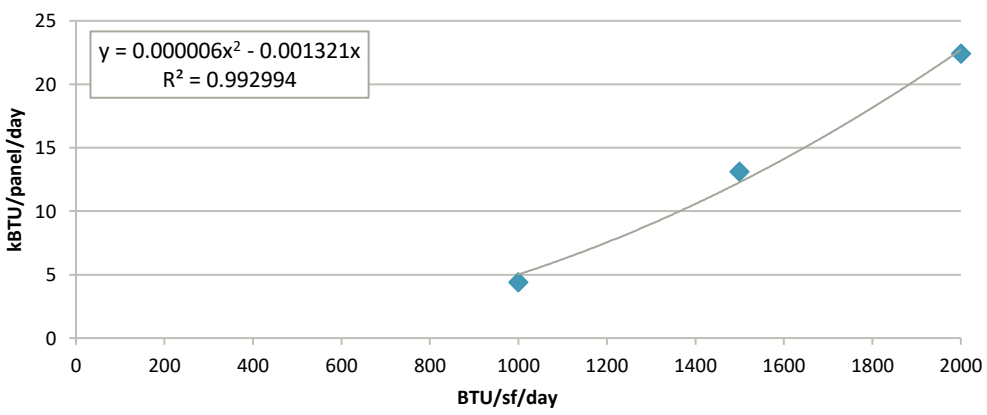
Manufacturer Solar Thermal Performance Data

Climate Category	Thousands of BTU Per Panel Per Day		
	High Radiation (2000 BTU/sf/day)	Med Radiation (1500 BTU/sf/day)	Low Radiation (1000 BTU/sf/day)
A - Pool Heating (Warm Climate)	44.1	32.5	22.4
B - Pool Heating (Cool Climate)	39.2	29.1	18.9
C - Water Heating (Warm Climate)	33.5	23.6	13.7
D - Space & Water Heating (Cool Climate)	22.4	13.1	4.4
E - Commercial Hot Water & Cooling	11.7	4.1	0.0

Category:	D - Space & Water Heating (Cool Climate)
Climate	kBTU/panel/day
High Radiation (2000 BTU/sf/day):	22.4
Med Radiation (1500 BTU/sf/day):	13.1
Low Radiation (1000 BTU/sf/day):	4.4

BTU/sf/day	kBTU/day/panel	kBTU/day
2000	22.4	112.0
1500	13.1	65.5
1000	4.4	22.0

y =	Ax +	Bx^2	
A, B:	A	B	R^2
	-0.001321	0.000006	0.992994



Solar Thermal Energy/Energy-Cost Savings Data

Baseline Heating Type:	Ideal Loads
Baseline Heating Fuel Type:	Natural Gas
Baseline Heating COP w/o Solar Thermal:	1.00

Virtual Rate | Electric Cost ($/kWh):	$0.0900
Virtual Rate | Natural Gas Cost ($/therm):	$1.0000
Virtual Rate | District HW/Steam Cost ($/MMBTU):	

LCCA | Renewables-X

Building Engineering Services | North America | Sustainability - Solar Thermal Analysis - Summary

Manufacturer/Model: SunMaxx Solar ALDH 29-V3

Form Revision Level: 02/13/2024 © HDR

Solar Thermal Analysis

Peak Day Analysis

Peak Gallons/Day:		Gallons/Day
Incoming Water Temp:	40	deg F
Leaving Water Setpoint:	140	deg F
Qaux Only [Output]:	-	kBTU/Day
Qaux Only [Input]:	-	kBTU/Day
Solar Thermal Qdelivered [Output]:	-	kBTU/Day
Qaux [Output]:	-	kBTU/Day
Qaux [Input]:	-	kBTU/Day
Pump Power [Input]:	-	kW
Pump Power [Input]:	-	kBTU
Q Saved [Input]:	-	kBTU
Solar Fraction:	**0.00%**	%

Annual Analysis

Month	Days per Month	Avg Solar Radiation	Solar Output	Avoided Input	Avoided Input	Cost Credit	Pump Energy	Cost Penalty	Cost Savings	Energy Model Qaux Only
		BTU/SF/day	kBTU/month	kBTU/month	MMBTU/month	$	kWh/month	$	$	kBTU/month
January	31	494.85	203.47	203.47	0.20	$2.03	42.40	$3.82	($1.78)	
February	28	979.43	764.88	764.88	0.76	$7.65	75.79	$6.82	$0.83	
March	31	1,258.26	1,425.14	1,425.14	1.43	$14.25	107.80	$9.70	$4.55	
April	30	1,545.94	2,066.76	2,066.76	2.07	$20.67	128.17	$11.54	$9.13	
May	31	1,829.80	2,821.55	2,821.55	2.82	$28.22	156.77	$14.11	$14.11	
June	30	1,997.75	3,264.23	3,264.23	3.26	$32.64	165.64	$14.91	$17.74	
July	31	2,132.09	3,742.96	3,742.96	3.74	$37.43	182.67	$16.44	$20.99	
August	31	1,901.00	2,955.39	2,955.39	2.96	$29.55	162.87	$14.66	$14.90	
September	30	1,462.47	1,775.78	1,775.78	1.78	$17.76	121.26	$10.91	$6.84	
October	31	1,062.21	1,040.84	1,040.84	1.04	$10.41	91.00	$8.19	$2.22	
November	30	644.48	338.77	338.77	0.34	$3.39	53.43	$4.81	($1.42)	
December	31	534.06	233.76	233.76	0.23	$2.34	45.76	$4.12	($1.78)	
TOTAL:	**365**	**1,321.98**	**20,633.54**	**20,633.54**	**20.63**	**$206.34**	**1,333.55**	**$120.02**	**$86.32**	**0.00**
				206.34						
				Therms			kWh			

Solar Thermal Annual Analysis Results

Max Solar Thermal Generation:	**20,255.32**	BTU/hr	Max Solar Thermal Generation Theoretical:	**46,261.93**	BTU/hr		
Annual Solar Thermal Generation:	**20,633.54**	kBTU/yr					
Annual Energy Consumption Avoided:	**20,633.54**	kBTU/yr (gen)	**-1,333.55**	kWh/yr (pump)	**16,082.18**	kBTU/yr (net)	- kWh/yr (net)
Annual Energy Cost Avoided:	**$86.32**	$/yr					
Renewable Production Intensity (RPI):	**0.161**	kBTU/ft2/yr	Annual DHW Requirements:	-	kBTU/yr (per Energy Model)		
Capacity Factor:	**5.09%**	%	Reduction in DHW Requirements:	-	% (generation)		

Solar Thermal System Design Area Data

Horizontal Panel Tilt, degrees (∑):	0.0	
Panel Horizontal Footprint:	Length (ft.):	7.74
	Width (ft.):	3.77
Panel Horizontal Footprint Area (sf):	29.19	
Total Panels Horizontal Footprint Area (sf):	**145.94**	

If Fixed Panel Tilt, MIN degrees (∑):	21.0	
Panel Footprint @ MIN Fixed Tilt Angle:	Length (ft.):	7.23
	Width (ft.):	3.77
Panel Footprint Area @ MIN Fixed Tilt Angle (sf):	27.25	
Total Panels Footprint Area @ MIN Fixed Tilt Angle (sf):	**136.24**	

Building Engineering Services | North America | Sustainability - Solar Thermal Analysis - Summary

Manufacturer/Model: SunMaxx Solar ALDH 29-V3

Form Revision Level: 02/13/2024 © HDR

Solar Thermal System Self Shading Design Data

Simplified Self Shading Analysis for Fixed Tilt and Seasonal Adjustment Tilt Systems:	**ON**

Inter-Row Spacing Specification Methodology:	Automatic	
If Manual, Inter-Row Spacing Width (ft.):		ft

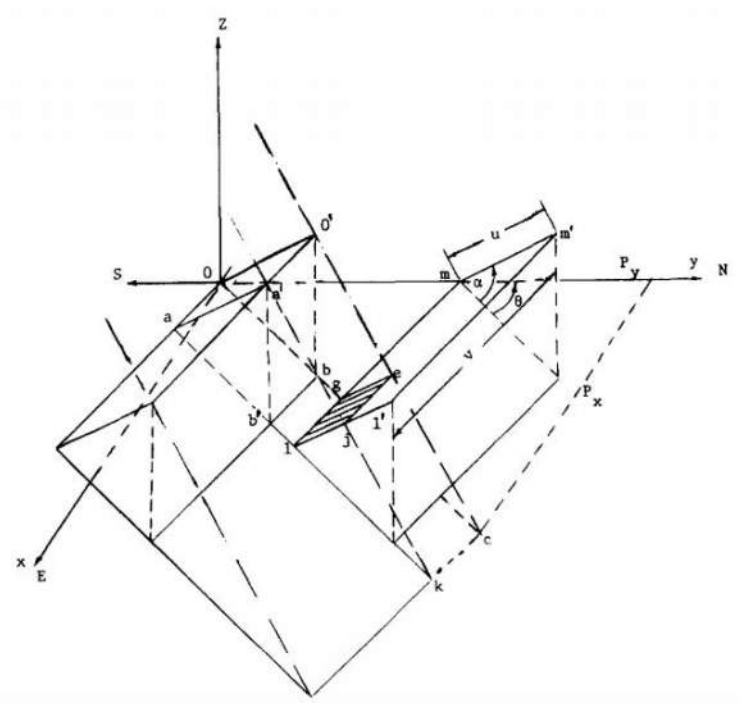
# Rows in Array (N):	1

Winter Solstice Parameter	Solar Altitude Angle	Solar Azimuth Angle Correction	Panel Tilt
December 21st @ 9am (shortest day of year):	30.05	3.68	21.00
December 21st @ 3pm (shortest day of year):	-8.46	66.79	21.00
December 21st Average (shortest day of year):	10.79	35.23	21.00

December 21st Panel Self-Shading Shadow Length:	14.55	ft
December 21st Minimum Inter-Row Spacing:	11.89	ft

Inter-Row Spacing Width (ft.):	11.89	ft
Ground Cover Ratio (GCR):	0.378	

Self-Shading Plane of Array (POA) Irradiance Reduction (%):	0.000%
System Footprint Area @ MIN Fixed Tilt Angle WITH Inter-Row Spacing Area Included (sf):	360.31



Greenhouse Gas Emission Factor Inputs

eGrid Region	SRVC	**eGrid Region**	SERC Virginia/Carolina

SERC Virginia/Carolina eGRID 2021 Electric Generation Resource Mix Percentages

Coal-Fired	Oil-Fired	NG Fired	Nuclear	Hydro	Biomass	Wind	Solar	Geothermal	Other Fossil	Other
13.40%	0.20%	38.10%	38.80%	1.90%	2.30%	0.40%	4.70%	0.00%	0.20%	0.10%

Region Electric GHG Emission Factor	85.443	kg/MMBTU
Over-Ride Value		kg/MMBTU
Electric GHG Emission Factor	85.443	kg/MMBTU
Grid Gross Loss (%)	4.50%	%

Natural Gas GHG Emission Factor	53.115	kg/MMBTU
Over-Ride Value		kg/MMBTU
Natural Gas GHG Emission Factor	53.115	kg/MMBTU

District HW/Steam GHG Emission Factor	66.400	kg/MMBTU
Over-Ride Value		kg/MMBTU
District HW/Steam GHG Emission Factor	66.400	kg/MMBTU

Reduction in Heating Energy GHG Emissions (kg CO2e):	1,096
Additional Electric Energy GHG Emissions Penalty (kg CO2e):	-389
Additional Grid Transmission/Distribution (T&D) Losses GHG Emissions Penalty (kg CO2e):	-18
Net GHG Emission Reduction (kg CO2e):	**689**

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C

Appendix C – Supplemental Decarbonization Analysis Calculations

Confidential

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Durham County | Administrative Building | Decarbonization Pathways

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Building Characteristics

Durham County |Administrative Building Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	200 E Main St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Administration	Cooling Generation	Water-Cooled Chiller
Year Built	1926	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	109,036	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	5		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	1,787,921.36	48,839.00	10,986.02	$182,748.49	767.00

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	218,523.72	5,969.21	1,342.74	$22,335.93	93.74	Potential Annual Energy Savings (%)	12.2% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	20,604.31	0.00	70.32	$1,638.45	5.85	NA	NA
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00 kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	867.15	86.72	$720.39	4.61	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	27.96	2.80	$23.23	0.15	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	44,531.17	-295.53	122.43	$3,295.61	11.07	Applicable Area %	20.0% %
	Lighting Occupancy Sensor	11,918.64	-79.10	32.77	$882.06	2.96	Applicable Area %	10.0% %
	LED Exit Signs	2,331.91	-15.48	6.41	$172.58	0.58	Quantity of Exit Signs	22 #
	Daylight Dimming Control	17,877.96	-118.64	49.15	$1,323.09	4.45	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	2,075.90	0.00	7.08	$165.08	0.59	Quantity of Outdoor Fixtures	8 #
Power	Variable Speed Drive Screw Air Compressors	995.67	0.00	3.40	$79.18	0.28	HP total of Air Compressors	2.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	6,519.28	0.00	22.25	$518.41	1.85	Transformer Size	2500.0 kVA
	Vending Machine Controller | Beverage	3,224.00	0.00	11.00	$256.37	0.92	Quantity of Beverage Vending Machines	2 #
	Vending Machine Controller | Snack	574.00	0.00	1.96	$45.64	0.16	Quantity of Snack Vending Machines	2 #
	EnergyStar Refrigerator Upgrade	525.00	0.00	1.79	$41.75	0.15	$0.00	5 #
	Tier 1 Advanced Power Strip	3,685.30	0.00	12.58	$293.05	1.05	Quantity of Power Strips	137 #

Decarbonization Measure Savings Totals (predicted)	**333,386.86**	**6,355.58**	**1,773.40**	**$31,790.82**	**128.41**
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings % from Baseline (predicted)	**18.6%**	**13.0%**	**16.1%**	**17.4%**	**16.7%**

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Admin Building II Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	201 E Main St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Condensing Boilers
Building Type	Administration	Cooling Generation	Water-Cooled Chiller
Year Built	1977	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	140,987	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	6		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	1,920,169.60	49,769.00	11,530.38	$223,653.66	809.49

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	245,355.00	6,359.37	1,473.33	$28,577.97	103.43	Potential Annual Energy Savings (%)	12.8% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	17,851.53	0.00	60.93	$1,689.58	5.07	NA	NA
	Smart Thermostat	14,635.89	0.00	49.95	$1,385.23	4.16	Total Cooling Capacity Controled	1,608.00 kBTU/hr
	Air Conditioner Tune-up	14,620.02	0.00	49.90	$1,383.73	4.15	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	457.99	45.80	$385.73	2.43	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	27.96	2.80	$23.55	0.15	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$742.69	5.10	# Solar Thermal Panels	20 #
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0% %
	Lighting Occupancy Sensor	37,935.20	-251.75	104.30	$3,378.39	9.43	Applicable Area %	50.0% %
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	29 #
	Daylight Dimming Control	11,380.56	-75.53	31.29	$1,013.52	2.83	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	1,556.93	0.00	5.31	$147.36	0.44	Quantity of Outdoor Fixtures	6 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	3,761.89	0.00	12.84	$356.05	1.07	Transformer Size	232.5 kVA
	Vending Machine Controller | Beverage	3,224.00	0.00	11.00	$305.14	0.92	Quantity of Beverage Vending Machines	2 #
	Vending Machine Controller | Snack	574.00	0.00	1.96	$54.33	0.16	Quantity of Snack Vending Machines	2 #
	EnergyStar Refrigerator Upgrade	630.00	0.00	2.15	$59.63	0.18	$0.00	6 #
	Tier 1 Advanced Power Strip	4,761.30	0.00	16.25	$450.64	1.35	Quantity of Power Strips	177 #
Decarbonization Measure Savings Totals (predicted)		354,952.78	7,549.72	1,966.41	$39,953.53	140.87		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		18.5%	15.2%	17.1%	17.9%	17.4%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Agriculture Building Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	721 Foster St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Furnaces
Building Type	Administration	Cooling Generation	DX RTUs
Year Built	1970	Domestic Hot Water Generation	CV Air-Handlers
Floor Area (ft2)	16,772	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	2		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	122,599.28	3,140.00	732.43	$16,696.90	51.48

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	8,854.39	226.78	52.90	$1,205.89	3.72	Potential Annual Energy Savings (%)	7.2% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	955.81	0.00	3.26	$99.52	0.27	NA	NA
	Smart Thermostat	2,680.96	209.02	30.05	$540.87	1.87	Total Cooling Capacity Controled	498.00 kBTU/hr
	Air Conditioner Tune-up	3,388.74	0.00	11.57	$352.83	0.96	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.48	0.04	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	34,249.09	-227.29	94.16	$3,281.40	8.52	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	9,166.67	-60.83	25.20	$878.26	2.28	Applicable Area %	50.0% %
	LED Exit Signs	423.98	-2.81	1.17	$40.62	0.11	Quantity of Exit Signs	4 #
	Daylight Dimming Control	2,750.00	-18.25	7.56	$263.48	0.68	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.93	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	564.90	0.00	1.93	$58.82	0.16	Quantity of Power Strips	21 #
Decarbonization Measure Savings Totals (predicted)		63,288.19	126.61	228.66	$6,748.09	18.64		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		51.6%	4.0%	31.2%	40.4%	36.2%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Animal Control Office Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	3005 Glenn Rd	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Split-System Heat Pump
Building Type	Administration	Cooling Generation	Split-System DX
Year Built	2009	Domestic Hot Water Generation	CV Air-Handlers
Floor Area (ft2)	3,488	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	58,895.28	0.00	201.01	$6,824.73	16.72

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	4,253.55	0.00	14.52	$492.90	1.21	Potential Annual Energy Savings (%)	7.2% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	25.24	0.00	0.09	$2.92	0.01	NA	NA
	Smart Thermostat	673.34	0.00	2.30	$78.03	0.19	Total Cooling Capacity Controled	138.00 kBTU/hr
	Air Conditioner Tune-up	711.50	0.00	2.43	$82.45	0.20	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$17.22	0.04	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	2,362.57	0.00	8.06	$273.77	0.67	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	1,063.16	0.00	3.63	$123.20	0.30	Applicable Area %	50.0% %
	LED Exit Signs	106.00	0.00	0.36	$12.28	0.03	Quantity of Exit Signs	1 #
	Daylight Dimming Control	318.95	0.00	1.09	$36.96	0.09	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	1,037.95	0.00	3.54	$120.28	0.29	Quantity of Outdoor Fixtures	4 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,254.96	0.00	4.28	$145.42	0.36	Transformer Size	75.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$12.17	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$15.59	0.04	Quantity of Power Strips	5 #
Decarbonization Measure Savings Totals (predicted)		12,195.34	0.00	41.62	$1,413.19	3.46		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		20.7%	0.0%	20.7%	20.7%	20.7%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Animal Shelter Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	2117 E Club Blvd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Animal shelter	Cooling Generation	Packaged DX
Year Built	1970	Domestic Hot Water Generation	Single-Zone Air-Handlers
Floor Area (ft2)	22,968	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

Category	Existing Conditions	Energy			Energy Cost	Carbon
		FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	194,045.16	18,474.00	2,509.67	$38,513.48	153.21

Category	Decarbonization Measure	Energy			Energy Cost	Carbon
		Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	15,092.40	1,436.87	195.20	$2,995.49	11.92
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	1,926.38	0.00	6.57	$197.59	0.55
	Smart Thermostat	1,317.35	77.44	12.24	$213.13	0.79
	Air Conditioner Tune-up	1,665.13	0.00	5.68	$170.80	0.47
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.26	0.03
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$902.47	5.10
Lighting	LED Retrofit	50,903.52	-337.81	139.95	$4,881.01	12.66
	Lighting Occupancy Sensor	9,915.12	-65.80	27.26	$950.74	2.47
	LED Exit Signs	529.98	-3.52	1.46	$50.82	0.13
	Daylight Dimming Control	9,915.12	-65.80	27.26	$950.74	2.47
	LED Outdoor Pole/Arm	1,556.93	0.00	5.31	$159.70	0.44
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.77	0.03
	Tier 1 Advanced Power Strip	780.10	0.00	2.66	$80.02	0.22

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	7.8%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	216.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	20	#
Applicable Area %	100.0%	%
Applicable Area %	10.0%	%
Quantity of Exit Signs	5	#
Applicable Area %	10.0%	%
Quantity of Outdoor Fixtures	6	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	1	#
Quantity of Power Strips	29	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	92,373.48	2,079.26	523.19	$11,569.53	37.27
Decarbonization Measure Savings % from Baseline (predicted)	47.6%	11.3%	20.8%	30.0%	24.3%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Bethesda VFD Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	1724 S Miami Blvd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Direct Vent Gas Furnaces
Building Type	Emergency Services	Cooling Generation	Split-System DX
Year Built	1983	Domestic Hot Water Generation	Single-Zone Air-Handlers
Floor Area (ft2)	10,800	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	2		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	261,130.01	179.10	909.14	$23,182.89	75.09

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	17,408.67	11.94	60.61	$1,545.53	5.01	Potential Annual Energy Savings (%)	6.7% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	749.85	0.00	2.56	$65.85	0.21	NA	NA
	Smart Thermostat	2,070.17	78.01	14.87	$290.66	1.00	Total Cooling Capacity Controled	198.00 kBTU/hr
	Air Conditioner Tune-up	2,616.69	0.00	8.93	$229.80	0.74	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$13.05	0.04	NA	NA
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$207.95	0.67	# Solar Thermal Panels	3 #
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	3,788.10	-25.14	10.41	$297.60	0.94	Applicable Area %	10.0% %
	LED Exit Signs	317.99	-2.11	0.87	$24.98	0.08	Quantity of Exit Signs	3 #
	Daylight Dimming Control	5,682.16	-37.71	15.62	$446.41	1.41	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.22	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$23.62	0.08	Quantity of Power Strips	10 #
Decarbonization Measure Savings Totals (predicted)		35,524.12	25.00	123.74	$3,154.68	10.22		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		13.6%	14.0%	13.6%	13.6%	13.6%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Bragtown Library Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	3200 Dearborn Dr	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Heat Pumps
Building Type	Library	Cooling Generation	DX Mini-Splits
Year Built	1964	Domestic Hot Water Generation	Mini-Splits
Floor Area (ft2)	1,092	Heating / Cooling / Vent Distribution	Electric Instantaneous Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	12,943.53	0.00	44.18	$2,259.68	3.67

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	862.90	0.00	2.95	$150.65	0.24	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	9.94	0.00	0.03	$1.74	0.00	NA	NA	
	Smart Thermostat	223.41	0.00	0.76	$39.00	0.06	Total Cooling Capacity Controled	42.00	kBTU/hr
	Air Conditioner Tune-up	237.04	0.00	0.81	$41.38	0.07	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	0.00	0.00	$0.00	0.00	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	368.35	0.00	1.26	$64.31	0.10	Applicable Area %	50.0%	%
	LED Exit Signs	106.00	0.00	0.36	$18.50	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	36.83	0.00	0.13	$6.43	0.01	Applicable Area %	5.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	53.80	0.00	0.18	$9.39	0.02	Quantity of Power Strips	2	#
Decarbonization Measure Savings Totals (predicted)		1,898.27	0.00	6.48	$331.40	0.54			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		14.7%	0.0%	14.7%	14.7%	14.7%			

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Durham County | Center For Senior Life | Decarbonization Pathways

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Building Characteristics

Durham County |Center For Senior Life Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	406 Rigsbee Ave	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Electric Resistance
Building Type	Community Center	Cooling Generation	Split-System DX
Year Built	2006	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	35,180	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	2		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	533,114.28	1,823.27	2,001.83	$58,142.76	161.04

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	38,502.70	131.68	144.58	$4,199.20	11.63
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	574.25	0.00	1.96	$61.55	0.16
	Smart Thermostat	8,140.08	0.00	27.78	$872.55	2.31
	Air Conditioner Tune-up	8,247.42	0.00	28.15	$884.05	2.34
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$6.80	0.07
	Solar Thermal Domestic Hot Water	-1,333.55	515.84	47.03	$139.30	2.36
Lighting	LED Retrofit	1,945.22	0.00	6.64	$208.51	0.55
	Lighting Occupancy Sensor	939.54	0.00	3.21	$100.71	0.27
	LED Exit Signs	847.97	0.00	2.89	$90.89	0.24
	Daylight Dimming Control	2,818.62	0.00	9.62	$302.13	0.80
	LED Outdoor Pole/Arm	3,113.86	0.00	10.63	$333.78	0.88
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$11.26	0.03
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$14.42	0.04

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	7.2%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	1,680.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	10	#
Applicable Area %	100.0%	%
Applicable Area %	5.0%	%
Quantity of Exit Signs	8	#
Applicable Area %	15.0%	%
Quantity of Outdoor Fixtures	12	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	1	#
Quantity of Power Strips	5	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	64,035.61	659.94	284.55	$7,225.14	21.69
Decarbonization Measure Savings % from Baseline (predicted)	12.0%	36.2%	14.2%	12.4%	13.5%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Community Shelter Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	412 Liberty St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Gas Furnaces
Building Type	Shelter	Cooling Generation	DX RTUs
Year Built	2002	Domestic Hot Water Generation	CV Air-Handlers
Floor Area (ft2)	17,816	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	193,415.84	4,323.00	1,092.42	$22,383.19	77.87

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	15,043.45	336.23	84.97	$1,740.91	6.06	Potential Annual Energy Savings (%)	7.8% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	4,011.86	0.00	13.69	$365.40	1.14	NA	NA
	Smart Thermostat	1,903.71	81.86	14.68	$263.66	0.98	Total Cooling Capacity Controled	276.00 kBTU/hr
	Air Conditioner Tune-up	2,406.29	0.00	8.21	$219.16	0.68	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$13.70	0.07	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	972.74	92.72	$951.20	4.79	# Solar Thermal Panels	20 #
Lighting	LED Retrofit	39,485.24	-262.04	108.56	$3,307.32	9.82	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	4,806.90	-31.90	13.22	$402.63	1.20	Applicable Area %	10.0% %
	LED Exit Signs	423.98	-2.81	1.17	$35.51	0.11	Quantity of Exit Signs	4 #
	Daylight Dimming Control	7,210.35	-47.85	19.82	$603.95	1.79	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	420.00	0.00	1.43	$38.25	0.12	$0.00	4 #
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$12.25	0.04	Quantity of Power Strips	5 #

Decarbonization Measure Savings Totals (predicted)	**74,512.74**	**1,058.65**	**360.17**	**$7,953.94**	**26.78**
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings % from Baseline (predicted)	**38.5%**	**24.5%**	**33.0%**	**35.5%**	**34.4%**

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Detention Center Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	219 S Mangum St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Steam Boiler
Building Type	Justice	Cooling Generation	Water-Cooled Chiller
Year Built	1996	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	290,919	Heating / Cooling / Vent Distribution	Steam Conversion Water Heater
Stories	8		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

Category	Existing Conditions	Energy			Energy Cost	Carbon
		FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	4,051,640.88	123,530.00	26,181.12	$367,338.53	1,806.40

Category	Decarbonization Measure	Energy			Energy Cost	Carbon
		Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	427,673.20	13,039.28	2,763.56	$38,774.62	190.68
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	93,890.12	0.00	320.44	$7,349.39	26.66
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00
	Space Heating Fossil Fuel Boiler Tune-up	0.00	18,982.37	1,898.24	$7,712.53	100.82
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$5.05	0.07
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$314.78	5.10
Lighting	LED Retrofit	1,541,812.52	-10,232.03	4,238.96	$116,530.44	383.38
	Lighting Occupancy Sensor	47,095.36	-312.54	129.48	$3,559.48	11.71
	LED Exit Signs	6,253.76	-41.50	17.19	$472.66	1.56
	Daylight Dimming Control	47,095.36	-312.54	129.48	$3,559.48	11.71
	LED Outdoor Pole/Arm	5,189.76	0.00	17.71	$406.24	1.47
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$16.44	0.06
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$42.11	0.15

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	10.6%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	0.00	kBTU/hr
Electric Cooling Savings %	0.00%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	20	#
Applicable Area %	100.0%	%
Applicable Area %	5.0%	%
Quantity of Exit Signs	59	#
Applicable Area %	5.0%	%
Quantity of Outdoor Fixtures	20	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	2	#
Quantity of Power Strips	20	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	2,168,424.54	22,167.14	9,617.48	$178,743.22	733.36
Decarbonization Measure Savings % from Baseline (predicted)	53.5%	17.9%	36.7%	48.7%	40.6%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Durham County Courthouse Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	510 S Dillard St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Fire-Tube Boiler
Building Type	Justice	Cooling Generation	Water-Cooled Chiller
Year Built	2013	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	318,533	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	10		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	5,730,530.40	153,180.00	34,876.12	$548,184.36	2,440.53

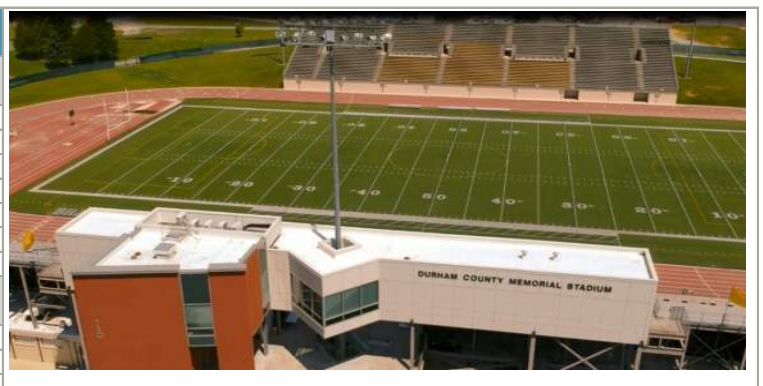
		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	732,234.44	19,573.00	4,456.39	$70,045.78	311.85	Potential Annual Energy Savings (%)	12.8% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	59,089.79	0.00	201.67	$5,082.22	16.78	NA	NA
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00 kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	4,252.11	425.21	$1,535.37	22.58	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	27.96	2.80	$10.09	0.15	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$257.83	5.10	# Solar Thermal Panels	20 #
Lighting	LED Retrofit	248,704.20	-1,650.49	683.77	$20,794.67	61.84	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	135,256.82	-897.61	371.87	$11,309.10	33.63	Applicable Area %	50.0% %
	LED Exit Signs	6,783.74	-45.02	18.65	$567.20	1.69	Quantity of Exit Signs	64 #
	Daylight Dimming Control	40,577.05	-269.28	111.56	$3,392.73	10.09	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	3,892.32	0.00	13.28	$334.77	1.11	Quantity of Outdoor Fixtures	15 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,482.02	0.00	5.06	$127.47	0.42	Transformer Size	112.5 kVA
	Vending Machine Controller | Beverage	3,224.00	0.00	11.00	$277.29	0.92	Quantity of Beverage Vending Machines	2 #
	Vending Machine Controller | Snack	574.00	0.00	1.96	$49.37	0.16	Quantity of Snack Vending Machines	2 #
	EnergyStar Refrigerator Upgrade	1,050.00	0.00	3.58	$90.31	0.30	$0.00	10 #
	Tier 1 Advanced Power Strip	5,380.00	0.00	18.36	$462.72	1.53	Quantity of Power Strips	200 #
Decarbonization Measure Savings Totals (predicted)		1,236,914.82	22,022.33	6,423.79	$114,336.92	468.14		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		21.6%	14.4%	18.4%	20.9%	19.2%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Durham County Stadium Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	750 Stadium Dr	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Direct Fired MAU
Building Type	Recreation	Cooling Generation	Packaged DX
Year Built	1975	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	14,773	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	2		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	416,169.20	6,899.00	2,110.27	$63,998.14	154.80

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	34,680.77	574.92	175.86	$5,333.18	12.90
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	5,315.89	0.00	18.14	$722.58	1.51
	Smart Thermostat	1,297.69	1,007.92	105.22	$1,261.72	5.72
	Air Conditioner Tune-up	1,640.28	0.00	5.60	$222.96	0.47
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$13.38	0.07
	Solar Thermal Domestic Hot Water	-1,333.55	773.76	72.82	$651.91	3.73
Lighting	LED Retrofit	2,746.30	-18.23	7.55	$353.68	0.68
	Lighting Occupancy Sensor	5,997.92	-39.80	16.49	$772.43	1.49
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00
	Daylight Dimming Control	1,199.58	-7.96	3.30	$154.49	0.30
	LED Outdoor Pole/Arm	1,297.44	0.00	4.43	$176.36	0.37
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$658.21	1.37
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$36.56	0.08

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	8.3%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	210.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	15	#
Applicable Area %	100.0%	%
Applicable Area %	50.0%	%
Quantity of Exit Signs	3	#
Applicable Area %	10.0%	%
Quantity of Outdoor Fixtures	5	#
HP total of Air Compressors	0.0	HP
Transformer Size	500.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	0	#
Quantity of Power Strips	10	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	57,953.67	2,303.03	428.10	$10,357.46	28.69
Decarbonization Measure Savings % from Baseline (predicted)	13.9%	33.4%	20.3%	16.2%	18.5%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Durham County Warehouse Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	4527 Hillsborough Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Warehouse	Cooling Generation	Packaged DX
Year Built	2000	Domestic Hot Water Generation	RTUs
Floor Area (ft2)	53,520	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	300,333.60	14,537.00	2,478.73	$49,764.27	162.48

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	21,690.76	1,049.89	179.02	$3,594.09	11.73	Potential Annual Energy Savings (%)	7.2% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	0.00	0.00	0.00	$0.00	0.00	NA	NA
	Smart Thermostat	1,936.18	339.83	40.59	$592.50	2.35	Total Cooling Capacity Controled	810.00 kBTU/hr
	Air Conditioner Tune-up	2,447.33	0.00	8.35	$274.75	0.69	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.86	0.03	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	77,357.81	-513.37	212.68	$8,117.92	19.24	Applicable Area %	20.0% %
	Lighting Occupancy Sensor	8,664.07	-57.50	23.82	$909.21	2.15	Applicable Area %	5.0% %
	LED Exit Signs	1,165.96	-7.74	3.21	$122.36	0.29	Quantity of Exit Signs	11 #
	Daylight Dimming Control	8,664.07	-57.50	23.82	$909.21	2.15	Applicable Area %	5.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$11.79	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$30.20	0.08	Quantity of Power Strips	10 #
Decarbonization Measure Savings Totals (predicted)		122,300.18	759.83	493.39	$14,568.87	38.76		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		40.7%	5.2%	19.9%	29.3%	23.9%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |East Regional Library Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	211 Lick Creek Ln	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2005	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	26,649	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	489,883.16	10,047.00	2,676.66	$52,426.47	192.44

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	54,431.46	1,116.33	297.41	$5,825.16	21.38
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	8,137.67	0.00	27.77	$697.98	2.31
	Smart Thermostat	136.87	0.00	0.47	$11.74	0.04
	Air Conditioner Tune-up	173.00	0.00	0.59	$14.84	0.05
	Space Heating Fossil Fuel Boiler Tune-up	0.00	284.66	28.47	$294.89	1.51
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$25.50	0.08
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$203.10	0.67
Lighting	LED Retrofit	45,135.20	-299.53	124.09	$3,561.04	11.22
	Lighting Occupancy Sensor	17,477.89	-115.99	48.05	$1,378.95	4.35
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00
	Daylight Dimming Control	13,982.31	-92.79	38.44	$1,103.16	3.48
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$222.57	0.74
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$415.34	1.37
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.01	0.03
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$46.15	0.15

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	11.1%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	18.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	3	#
Applicable Area %	100.0%	%
Applicable Area %	50.0%	%
Quantity of Exit Signs	6	#
Applicable Area %	40.0%	%
Quantity of Outdoor Fixtures	10	#
HP total of Air Compressors	0.0	HP
Transformer Size	500.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	1	#
Quantity of Power Strips	20	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	150,219.76	892.67	601.96	$13,809.42	47.39
Decarbonization Measure Savings % from Baseline (predicted)	30.7%	8.9%	22.5%	26.3%	24.6%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Durham County | Eastern Sheriff's Station | Decarbonization Pathways

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Building Characteristics

Durham County |Eastern Sheriff's Station Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	5323 Wake Forest Hwy	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency Services	Cooling Generation	Packaged DX
Year Built	1991	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	3,038	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	26,422.08	741.00	164.28	$5,237.86	11.44

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	1,908.26	53.52	11.86	$378.29	0.83	Potential Annual Energy Savings (%)	7.2% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	120.60	0.00	0.41	$19.20	0.03	NA	NA
	Smart Thermostat	264.12	23.79	3.28	$75.15	0.20	Total Cooling Capacity Controled	60.00 kBTU/hr
	Air Conditioner Tune-up	333.85	0.00	1.14	$53.15	0.09	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$8.64	0.03	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	257.92	21.24	$146.57	0.99	# Solar Thermal Panels	5 #
Lighting	LED Retrofit	19,906.43	-132.11	54.73	$2,985.56	4.95	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	532.79	-3.54	1.46	$79.91	0.13	Applicable Area %	5.0% %
	LED Exit Signs	106.00	-0.70	0.29	$15.90	0.03	Quantity of Exit Signs	1 #
	Daylight Dimming Control	532.79	-3.54	1.46	$79.91	0.13	Applicable Area %	5.0% %
	LED Outdoor Pole/Arm	518.98	0.00	1.77	$82.63	0.15	Quantity of Outdoor Fixtures	2 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$16.72	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	53.80	0.00	0.18	$8.57	0.02	Quantity of Power Strips	2 #
Decarbonization Measure Savings Totals (predicted)		23,049.07	201.55	98.82	$3,950.20	7.61		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		87.2%	27.2%	60.2%	75.4%	66.6%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Durham County | EMS #2 - Old Fayetteville Road | Decarbonization Pathways

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Building Characteristics

Durham County |EMS #2 - Old Fayetteville Road Building Characteristics

Location Basics		Heating | Cooling | Ventilation	
Location	615 Old Fayetteville St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency services	Cooling Generation	Packaged DX
Year Built	2007	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	6,990	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	63,278.44	1,654.00	381.37	$8,481.53	26.75

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	4,570.11	119.46	27.54	$612.55	1.93	Potential Annual Energy Savings (%)	7.2% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	27.41	0.00	0.09	$2.79	0.01	NA	NA
	Smart Thermostat	628.79	56.09	7.75	$133.02	0.48	Total Cooling Capacity Controled	108.00 kBTU/hr
	Air Conditioner Tune-up	794.79	0.00	2.71	$80.99	0.23	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.15	0.04	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	19,856.44	-131.77	54.59	$1,861.47	4.94	Applicable Area %	67.0% %
	Lighting Occupancy Sensor	1,885.96	-12.52	5.19	$176.80	0.47	Applicable Area %	10.0% %
	LED Exit Signs	211.99	-1.41	0.58	$19.87	0.05	Quantity of Exit Signs	2 #
	Daylight Dimming Control	2,828.94	-18.77	7.78	$265.20	0.70	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,254.96	0.00	4.28	$127.89	0.36	Transformer Size	75.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.70	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	269.00	0.00	0.92	$27.41	0.08	Quantity of Power Strips	10 #

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	**32,582.02**	**11.07**	**112.31**	**$3,333.86**	**9.31**
Decarbonization Measure Savings % from Baseline (predicted)	**51.5%**	**0.7%**	**29.4%**	**39.3%**	**34.8%**

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |EMS #6 - Milton Road Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	226 Milton Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency services	Cooling Generation	Split-System DX
Year Built	1990	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	7,805	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	0		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	52,682.00	1,254.00	305.20	$7,909.27	21.62

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	3,512.13	83.60	20.35	$527.28	1.44
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	24.68	0.00	0.08	$2.92	0.01
	Smart Thermostat	551.23	31.40	5.02	$107.25	0.32
	Air Conditioner Tune-up	696.76	0.00	2.38	$82.38	0.20
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$8.33	0.03
	Solar Thermal Domestic Hot Water	-1,333.55	515.84	47.03	$533.70	2.36
Lighting	LED Retrofit	23,013.95	-152.73	63.27	$2,516.23	5.72
	Lighting Occupancy Sensor	1,368.80	-9.08	3.76	$149.66	0.34
	LED Exit Signs	211.99	-1.41	0.58	$23.18	0.05
	Daylight Dimming Control	1,368.80	-9.08	3.76	$149.66	0.34
	LED Outdoor Pole/Arm	518.98	0.00	1.77	$61.36	0.15
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$24.83	0.06
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$15.90	0.04

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	6.7%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	102.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	10	#
Applicable Area %	90.0%	%
Applicable Area %	5.0%	%
Quantity of Exit Signs	2	#
Applicable Area %	5.0%	%
Quantity of Outdoor Fixtures	2	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	2	#
Quantity of Power Strips	5	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	**30,278.27**	**464.75**	**149.81**	**$4,202.67**	**11.06**
Decarbonization Measure Savings % from Baseline (predicted)	**57.5%**	**37.1%**	**49.1%**	**53.1%**	**51.2%**

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Fire Marshall Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	120 E Parrish St	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Electric Resistance
Building Type	Administration	Cooling Generation	Split-System DX
Year Built	1985	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	3,872	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	0		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	25,429.62	0.00	86.79	$4,083.98	7.22

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	1,977.86	0.00	6.75	$317.64	0.56	Potential Annual Energy Savings (%)	7.8%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	16.95	0.00	0.06	$2.72	0.00	NA	NA	
	Smart Thermostat	1,482.01	0.00	5.06	$238.01	0.42	Total Cooling Capacity Controled	90.00	kBTU/hr
	Air Conditioner Tune-up	604.07	0.00	2.06	$97.01	0.17	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$23.87	0.04	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	6,369.34	0.00	21.74	$1,022.91	1.81	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	340.95	0.00	1.16	$54.76	0.10	Applicable Area %	10.0%	%
	LED Exit Signs	106.00	0.00	0.36	$17.02	0.03	Quantity of Exit Signs	1	#
	Daylight Dimming Control	340.95	0.00	1.16	$54.76	0.10	Applicable Area %	10.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$16.86	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	80.70	0.00	0.28	$12.96	0.02	Quantity of Power Strips	3	#
Decarbonization Measure Savings Totals (predicted)		11,572.46	0.00	39.50	$1,858.53	3.29			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		45.5%	0.0%	45.5%	45.5%	45.5%			

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |General Services Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	310 S Dillard	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Furnaces
Building Type	Administration	Cooling Generation	DX RTUs
Year Built	1994	Domestic Hot Water Generation	CV Air-Handlers
Floor Area (ft2)	10,387	Heating / Cooling / Vent Distribution	Electric Instantaneous Water Heater
Stories	2		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	120,917.92	3,526.00	765.29	$16,295.56	53.06

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	9,404.73	274.24	59.52	$1,267.43	4.13
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	97.95	0.00	0.33	$9.94	0.03
	Smart Thermostat	2,041.30	137.56	20.72	$364.04	1.31
	Air Conditioner Tune-up	2,580.21	0.00	8.81	$261.96	0.73
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$7.08	0.03
	Solar Thermal Domestic Hot Water	-1,333.55	154.75	10.92	$41.00	0.44
Lighting	LED Retrofit	21,210.67	-140.76	58.32	$1,993.01	5.27
	Lighting Occupancy Sensor	5,676.97	-37.67	15.61	$533.42	1.41
	LED Exit Signs	317.99	-2.11	0.87	$29.88	0.08
	Daylight Dimming Control	1,703.09	-11.30	4.68	$160.03	0.42
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$263.45	0.74
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.66	0.03
	Tier 1 Advanced Power Strip	349.70	0.00	1.19	$35.50	0.10

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	7.8%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	456.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	3	#
Applicable Area %	100.0%	%
Applicable Area %	50.0%	%
Quantity of Exit Signs	3	#
Applicable Area %	15.0%	%
Quantity of Outdoor Fixtures	10	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	1	#
Quantity of Power Strips	13	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	44,748.94	380.92	190.82	$4,977.42	14.73
Decarbonization Measure Savings % from Baseline (predicted)	37.0%	10.8%	24.9%	30.5%	27.8%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Head Start Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	215 W Seminary	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Daycare	Cooling Generation	Packaged DX
Year Built	2003	Domestic Hot Water Generation	Single-Zone Air-Handlers
Floor Area (ft2)	13,370	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	113,499.20	4,202.00	807.57	$16,734.69	54.54

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	8,827.72	326.82	62.81	$1,301.59	4.24	Potential Annual Energy Savings (%)	7.8% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	164.60	0.00	0.56	$17.46	0.05	NA	NA
	Smart Thermostat	1,538.39	328.90	38.14	$530.54	2.18	Total Cooling Capacity Controled	450.00 kBTU/hr
	Air Conditioner Tune-up	1,944.52	0.00	6.64	$206.31	0.55	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.94	0.03	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	533.60	48.81	$454.45	2.46	# Solar Thermal Panels	15 #
Lighting	LED Retrofit	22,942.92	-152.26	63.08	$2,264.10	5.70	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	1,541.76	-10.23	4.24	$152.15	0.38	Applicable Area %	10.0% %
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	3 #
	Daylight Dimming Control	2,312.65	-15.35	6.36	$228.22	0.58	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$513.75	1.37	Transformer Size	500.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0 #
	Tier 1 Advanced Power Strip	53.80	0.00	0.18	$5.71	0.02	Quantity of Power Strips	2 #
Decarbonization Measure Savings Totals (predicted)		42,835.16	1,017.70	247.96	$5,681.22	17.57		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		37.7%	24.2%	30.7%	33.9%	32.2%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Health and Human Services Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	414 E Main St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Condensing Boilers
Building Type	Health care/Social Services	Cooling Generation	Water-Cooled Chiller
Year Built	2010	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	293,507	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	3		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	4,771,019.20	151,660.00	31,449.34	$480,567.12	2,160.05

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	556,618.91	17,693.67	3,669.09	$56,066.16	252.01
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	113,976.85	0.00	389.00	$10,123.21	32.36
	Smart Thermostat	7,505.68	0.00	25.62	$666.64	2.13
	Air Conditioner Tune-up	9,487.17	0.00	32.38	$842.63	2.69
	Space Heating Fossil Fuel Boiler Tune-up	0.00	3,158.42	315.84	$1,183.20	16.78
DHW	Low Flow Faucet Aerators	668.88	0.00	2.28	$59.41	0.19
	Solar Thermal Domestic Hot Water	23,342.48	0.00	79.67	$2,073.23	6.63
Lighting	LED Retrofit	246,792.43	-1,637.80	678.51	$21,306.08	61.37
	Lighting Occupancy Sensor	111,056.59	-737.01	305.33	$9,587.74	27.61
	LED Exit Signs	6,253.76	-41.50	17.19	$539.90	1.56
	Daylight Dimming Control	33,316.98	-221.10	91.60	$2,876.32	8.28
	LED Outdoor Pole/Arm	5,189.76	0.00	17.71	$460.94	1.47
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	6,519.28	0.00	22.25	$579.03	1.85
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	525.00	0.00	1.79	$46.63	0.15
	Tier 1 Advanced Power Strip	9,872.30	0.00	33.69	$876.84	2.80

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	11.7%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	1,060.40	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	20	#
Applicable Area %	100.0%	%
Applicable Area %	50.0%	%
Quantity of Exit Signs	59	#
Applicable Area %	15.0%	%
Quantity of Outdoor Fixtures	20	#
HP total of Air Compressors	0.0	HP
Transformer Size	2500.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	5	#
Quantity of Power Strips	367	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	1,131,126.06	18,214.67	5,681.97	$107,287.97	417.88
Decarbonization Measure Savings % from Baseline (predicted)	23.7%	12.0%	18.1%	22.3%	19.3%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Judicial Building Annex Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	201 N Roxboro St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Condensing Boilers
Building Type	Justice	Cooling Generation	Packaged DX
Year Built	1974	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	25,692	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	3		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	776,369.84	14,633.00	4,113.03	$78,297.03	298.14

		Energy			Energy Cost	Carbon			
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter	
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	86,263.32	1,625.89	457.00	$8,699.67	33.13	Potential Annual Energy Savings (%)	11.1%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,747.46	0.00	29.85	$715.69	2.48	NA	NA	
	Smart Thermostat	10,367.04	0.00	35.38	$848.20	2.94	Total Cooling Capacity Controled	900.00	kBTU/hr
	Air Conditioner Tune-up	6,840.22	0.00	23.35	$559.64	1.94	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	281.50	28.15	$284.27	1.50	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$24.32	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	4,835.46	0.00	16.50	$395.62	1.37	# Solar Thermal Panels	5	#
Lighting	LED Retrofit	37,612.12	-249.61	103.41	$2,825.24	9.35	Applicable Area %	75.0%	%
	Lighting Occupancy Sensor	15,122.00	-100.36	41.58	$1,135.89	3.76	Applicable Area %	50.0%	%
	LED Exit Signs	635.98	-4.22	1.75	$47.77	0.16	Quantity of Exit Signs	6	#
	Daylight Dimming Control	4,536.60	-30.11	12.47	$340.77	1.13	Applicable Area %	15.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	3,703.38	0.00	12.64	$303.00	1.05	Transformer Size	300.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	315.00	0.00	1.08	$25.77	0.09	$0.00	3	#
	Tier 1 Advanced Power Strip	1,748.50	0.00	5.97	$143.06	0.50	Quantity of Power Strips	65	#
Decarbonization Measure Savings Totals (predicted)		181,024.36	1,523.10	770.14	$16,348.91	59.48			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		23.3%	10.4%	18.7%	20.9%	20.0%			

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |JRC Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	326 E Main St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Administration	Cooling Generation	Packaged DX
Year Built	1926	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	40,623	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	3		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	633,429.04	1,215.00	2,283.37	$58,266.90	186.29

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	52,785.75	101.25	190.28	$4,855.58	15.52	Potential Annual Energy Savings (%)	8.3% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	8,551.74	0.00	29.19	$765.32	2.43	NA	NA
	Smart Thermostat	9,969.26	302.35	64.26	$1,285.20	4.44	Total Cooling Capacity Controled	1,338.00 kBTU/hr
	Air Conditioner Tune-up	12,601.15	0.00	43.01	$1,127.72	3.58	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$16.15	0.07	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	22,202.34	-147.34	61.04	$1,795.43	5.52	Applicable Area %	50.0% %
	LED Exit Signs	953.96	-6.33	2.62	$77.14	0.24	Quantity of Exit Signs	9 #
	Daylight Dimming Control	6,660.70	-44.20	18.31	$538.63	1.66	Applicable Area %	15.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0 #
	Tier 1 Advanced Power Strip	2,743.80	0.00	9.36	$245.55	0.78	Quantity of Power Strips	102 #
Decarbonization Measure Savings Totals (predicted)		116,468.70	218.15	419.32	$10,706.72	34.22		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		18.4%	18.0%	18.4%	18.4%	18.4%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |JSD Transitional Living Facility Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	1204 E Club Blvd	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Ductless Heat Pump
Building Type	Shelter	Cooling Generation	Split-System DX
Year Built	1963	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	2,050	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	550.51	0.00	1.88	$57.20	0.16
	Smart Thermostat	997.65	0.00	3.40	$103.66	0.28
	Air Conditioner Tune-up	1,261.03	0.00	4.30	$131.02	0.36
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	0.00	0.00	$0.00	0.00
	Solar Thermal Domestic Hot Water	2,831.80	0.00	9.66	$294.22	0.80
Lighting	LED Retrofit	13,207.59	0.00	45.08	$1,372.27	3.75
	Lighting Occupancy Sensor	0.00	0.00	0.00	$0.00	0.00
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00
	Daylight Dimming Control	0.00	0.00	0.00	$0.00	0.00
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.91	0.03
	Tier 1 Advanced Power Strip	0.00	0.00	0.00	$0.00	0.00

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	6.7%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	90.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	5	#
Applicable Area %	100.0%	%
Applicable Area %	0.0%	%
Quantity of Exit Signs	1	#
Applicable Area %	0.0%	%
Quantity of Outdoor Fixtures	0	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	1	#
Quantity of Power Strips	0	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	18,953.59	0.00	64.69	$1,969.28	5.38
Decarbonization Measure Savings % from Baseline (predicted)	0.0%	0.0%	0.0%	0.0%	0.0%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Leesville VFD Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	7305 Leesville Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Unit Heater
Building Type	Emergency Services	Cooling Generation	Split-System DX
Year Built	1988	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	1,017	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	70.61	0.00	0.24	$7.34	0.02
	Smart Thermostat	1,222.83	0.00	4.17	$127.05	0.35
	Air Conditioner Tune-up	1,545.66	0.00	5.28	$160.59	0.44
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.44	0.04
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00
Lighting	LED Retrofit	6,889.27	-45.72	18.94	$670.25	1.71
	Lighting Occupancy Sensor	178.36	-1.18	0.49	$17.35	0.04
	LED Exit Signs	106.00	-0.70	0.29	$10.31	0.03
	Daylight Dimming Control	178.36	-1.18	0.49	$17.35	0.04
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$21.82	0.06
	Tier 1 Advanced Power Strip	80.70	0.00	0.28	$8.38	0.02

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	6.7%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	126.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	0	#
Applicable Area %	95.0%	%
Applicable Area %	5.0%	%
Quantity of Exit Signs	1	#
Applicable Area %	5.0%	%
Quantity of Outdoor Fixtures	0	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	2	#
Quantity of Power Strips	3	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	10,630.41	-48.79	31.40	$1,055.90	2.76
Decarbonization Measure Savings % from Baseline (predicted)	0.0%	0.0%	0.0%	0.0%	0.0%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Main Library Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	300 N Roxboro St	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Direct Vent Condensing Boilers
Building Type	Library	Cooling Generation	Water-Cooled Chiller
Year Built	2019	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	95,000	Heating / Cooling / Vent Distribution	Direct Vent Gas Instantaneous Water Heat
Stories	4		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	1,208,018.00	28,058.00	6,928.73	$136,385.52	491.99

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	140,935.43	3,273.43	808.35	$15,911.64	57.40	Potential Annual Energy Savings (%)	11.7% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	13,202.85	0.00	45.06	$1,227.88	3.75	NA	NA
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00	Total Cooling Capacity Controled	0.00 kBTU/hr
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00	Electric Cooling Savings %	0.00% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	479.65	47.96	$410.94	2.55	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$10.65	0.07	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	1,031.68	98.62	$759.87	5.10	# Solar Thermal Panels	20 #
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0% %
	Lighting Occupancy Sensor	39,780.14	-264.00	109.37	$3,473.41	9.89	Applicable Area %	50.0% %
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	19 #
	Daylight Dimming Control	31,824.11	-211.20	87.50	$2,778.73	7.91	Applicable Area %	40.0% %
	LED Outdoor Pole/Arm	3,892.32	0.00	13.28	$361.99	1.11	Quantity of Outdoor Fixtures	15 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	8,892.10	0.00	30.35	$826.97	2.52	Transformer Size	675.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.77	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$50.03	0.15	Quantity of Power Strips	20 #
Decarbonization Measure Savings Totals (predicted)		237,836.41	4,321.99	1,243.93	$25,821.88	90.48		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		19.7%	15.4%	18.0%	18.9%	18.4%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |North Regional Library Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	221 Milton Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2006	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	26,649	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	429,563.20	8,612.00	2,327.29	$49,553.47	167.70

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	45,342.78	909.04	245.66	$5,230.64	17.70	Potential Annual Energy Savings (%)	10.6% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	6,133.25	0.00	20.93	$574.89	1.74	NA	NA
	Smart Thermostat	1,181.75	0.00	4.03	$110.77	0.34	Total Cooling Capacity Controled	111.40 kBTU/hr
	Air Conditioner Tune-up	898.11	0.00	3.07	$84.18	0.25	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	223.48	22.35	$241.06	1.19	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$27.86	0.08	NA	NA
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$221.95	0.67	# Solar Thermal Panels	3 #
Lighting	LED Retrofit	45,135.20	-299.53	124.09	$3,907.57	11.22	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	17,477.89	-115.99	48.05	$1,513.14	4.35	Applicable Area %	50.0% %
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	6 #
	Daylight Dimming Control	13,982.31	-92.79	38.44	$1,210.51	3.48	Applicable Area %	40.0% %
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$243.23	0.74	Quantity of Outdoor Fixtures	10 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$453.89	1.37	Transformer Size	500.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.84	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$50.43	0.15	Quantity of Power Strips	20 #
Decarbonization Measure Savings Totals (predicted)		140,896.65	624.21	543.30	$13,879.96	43.32		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		32.8%	7.2%	23.3%	28.0%	25.8%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |Parkwood VFD #1 (Station 18) Building Characteristics

Location Basics		Heating | Cooling | Ventilation	
Location	1409 Seaton Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency services	Cooling Generation	Split-System DX
Year Built	1976	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	9,829	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	6.7% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	682.44	0.00	2.33	$70.91	0.19	NA	NA
	Smart Thermostat	1,165.03	10.52	5.03	$131.52	0.39	Total Cooling Capacity Controled	120.00 kBTU/hr
	Air Conditioner Tune-up	1,472.60	0.00	5.03	$153.00	0.42	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.19	0.03	NA	NA
	Solar Thermal Domestic Hot Water	-1,333.55	220.47	17.50	$81.05	0.79	# Solar Thermal Panels	5 #
Lighting	LED Retrofit	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	1,723.76	-11.44	4.74	$167.70	0.43	Applicable Area %	5.0% %
	LED Exit Signs	211.99	-1.41	0.58	$20.62	0.05	Quantity of Exit Signs	2 #
	Daylight Dimming Control	1,723.76	-11.44	4.74	$167.70	0.43	Applicable Area %	5.0% %
	LED Outdoor Pole/Arm	518.98	0.00	1.77	$53.92	0.15	Quantity of Outdoor Fixtures	2 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$21.82	0.06	$0.00	2 #
	Tier 1 Advanced Power Strip	161.40	0.00	0.55	$16.77	0.05	Quantity of Power Strips	6 #
Decarbonization Measure Savings Totals (predicted)		6,536.41	212.91	43.60	$891.21	2.99		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		0.0%	0.0%	0.0%	0.0%	0.0%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Parkwood VFD #2 Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	4200 Farrington Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency services	Cooling Generation	Split-System DX
Year Built	1984	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	2,467	Heating / Cooling / Vent Distribution	Gas Instantaneous Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	SGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

Category	Existing Conditions	Energy			Energy Cost	Carbon
		FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	0.00	0.00	0.00	$0.00	0.00

Category	Decarbonization Measure	Energy			Energy Cost	Carbon
		Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	171.29	0.00	0.58	$17.80	0.05
	Smart Thermostat	376.39	14.03	2.69	$53.08	0.18
	Air Conditioner Tune-up	475.76	0.00	1.62	$49.43	0.14
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	6.21	0.62	$6.19	0.03
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00
Lighting	LED Retrofit	15,832.16	-105.07	43.53	$1,540.30	3.94
	Lighting Occupancy Sensor	432.65	-2.87	1.19	$42.09	0.11
	LED Exit Signs	106.00	-0.70	0.29	$10.31	0.03
	Daylight Dimming Control	432.65	-2.87	1.19	$42.09	0.11
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	210.00	0.00	0.72	$21.82	0.06
	Tier 1 Advanced Power Strip	80.70	0.00	0.28	$8.38	0.02

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	6.7%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	36.00	kBTU/hr
Electric Cooling Savings %	6.32%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	0	#
Applicable Area %	90.0%	%
Applicable Area %	5.0%	%
Quantity of Exit Signs	1	#
Applicable Area %	5.0%	%
Quantity of Outdoor Fixtures	0	#
HP total of Air Compressors	0.0	HP
Transformer Size	0.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	2	#
Quantity of Power Strips	3	#

	Energy			Energy Cost	Carbon
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings Totals (predicted)	18,117.60	-91.28	52.71	$1,791.50	4.66
Decarbonization Measure Savings % from Baseline (predicted)	0.0%	0.0%	0.0%	0.0%	0.0%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Rainbow Assisted Living Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	706 Rigsbee Ave	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Disabled Adult Daycare	Cooling Generation	Split-System DX
Year Built	1997	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	5,376	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	0		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	0.00	0.00	0.00	$0.00	0.00

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	0.00	0.00	0.00	$0.00	0.00	Potential Annual Energy Savings (%)	7.8% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	37.23	0.00	0.13	$3.87	0.01	NA	NA
	Smart Thermostat	750.78	0.00	2.56	$78.01	0.21	Total Cooling Capacity Controled	156.00 kBTU/hr
	Air Conditioner Tune-up	948.99	0.00	3.24	$98.60	0.27	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	148.64	0.00	0.51	$15.44	0.04	NA	NA
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0 #
Lighting	LED Retrofit	15,313.86	-101.63	42.10	$1,489.88	3.81	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	413.29	-2.74	1.14	$40.21	0.10	Applicable Area %	5.0% %
	LED Exit Signs	211.99	-1.41	0.58	$20.62	0.05	Quantity of Exit Signs	2 #
	Daylight Dimming Control	413.29	-2.74	1.14	$40.21	0.10	Applicable Area %	5.0% %
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	1,024.92	0.00	3.50	$106.49	0.29	Transformer Size	45.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.91	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	134.50	0.00	0.46	$13.97	0.04	Quantity of Power Strips	5 #
Decarbonization Measure Savings Totals (predicted)		19,502.48	-108.52	55.71	$1,918.21	4.96		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		0.0%	0.0%	0.0%	0.0%	0.0%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

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Building Characteristics

Durham County |South Regional Library Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	4515 S Alston Ave	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2009	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	27,320	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	456,882.00	5,051.00	2,064.42	$52,233.76	156.54

		Energy			Energy Cost	Carbon	Key Parameter Description	Key Parameter	
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings			
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	50,764.67	561.22	229.38	$5,803.75	17.39	Potential Annual Energy Savings (%)	11.1%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	8,839.86	0.00	30.17	$902.76	2.51	NA	NA	
	Smart Thermostat	2,229.30	0.00	7.61	$227.66	0.63	Total Cooling Capacity Controled	162.00	kBTU/hr
	Air Conditioner Tune-up	1,577.54	0.00	5.38	$161.10	0.45	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	224.56	22.46	$247.88	1.19	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$30.36	0.08	NA	NA	
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$241.81	0.67	# Solar Thermal Panels	3	#
Lighting	LED Retrofit	34,457.62	-228.67	94.74	$3,266.51	8.57	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	16,264.00	-107.93	44.72	$1,541.79	4.04	Applicable Area %	50.0%	%
	LED Exit Signs	635.98	-4.22	1.75	$60.29	0.16	Quantity of Exit Signs	6	#
	Daylight Dimming Control	13,011.20	-86.35	35.77	$1,233.43	3.24	Applicable Area %	40.0%	%
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$265.00	0.74	Quantity of Outdoor Fixtures	10	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	4,842.35	0.00	16.53	$494.52	1.37	Transformer Size	500.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$10.72	0.03	$0.00	1	#
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$54.94	0.15	Quantity of Power Strips	20	#
Decarbonization Measure Savings Totals (predicted)		138,525.53	358.61	508.64	$14,542.53	41.23			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		30.3%	7.1%	24.6%	27.8%	26.3%			

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Building Characteristics

Durham County |Southwest Regional Library Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	3605 Shannon Rd	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2009	Domestic Hot Water Generation	Multi-Zone Air-Handlers
Floor Area (ft2)	25,684	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	510,826.28	18,955.00	3,638.93	$65,648.88	245.70

		Energy			Energy Cost	Carbon		
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings	Key Parameter Description	Key Parameter
		kWh	Therms	MMBTU	$US	MT CO2e		
Whole Building	Retro-Commissioning	56,758.48	2,106.11	404.33	$7,294.32	27.30	Potential Annual Energy Savings (%)	11.1% %
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00
HVAC	Air-Side Economizer	8,293.01	0.00	28.30	$757.00	2.35	NA	NA
	Smart Thermostat	91.51	0.00	0.31	$8.35	0.03	Total Cooling Capacity Controled	12.00 kBTU/hr
	Air Conditioner Tune-up	115.66	0.00	0.39	$10.56	0.03	Electric Cooling Savings %	6.32% %
	Space Heating Fossil Fuel Boiler Tune-up	0.00	799.45	79.94	$802.17	4.25	Natural Gas Heating Savings %	2.30% %
DHW	Low Flow Faucet Aerators	297.28	0.00	1.01	$27.14	0.08	NA	NA
	Solar Thermal Domestic Hot Water	2,367.86	0.00	8.08	$216.14	0.67	# Solar Thermal Panels	3 #
Lighting	LED Retrofit	32,394.20	-214.98	89.06	$2,741.30	8.05	Applicable Area %	100.0% %
	Lighting Occupancy Sensor	15,290.06	-101.47	42.04	$1,293.89	3.80	Applicable Area %	50.0% %
	LED Exit Signs	635.98	-4.22	1.75	$53.82	0.16	Quantity of Exit Signs	6 #
	Daylight Dimming Control	12,232.05	-81.18	33.63	$1,035.12	3.04	Applicable Area %	40.0% %
	LED Outdoor Pole/Arm	2,594.88	0.00	8.86	$236.87	0.74	Quantity of Outdoor Fixtures	10 #
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0 HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	3,272.30	0.00	11.17	$298.70	0.93	Transformer Size	225.0 kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0 #
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0 #
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$9.58	0.03	$0.00	1 #
	Tier 1 Advanced Power Strip	538.00	0.00	1.84	$49.11	0.15	Quantity of Power Strips	20 #
Decarbonization Measure Savings Totals (predicted)		134,986.26	2,503.71	711.08	$14,834.08	51.62		
		kWh	Therms	MMBTU	$US	MT CO2e		
Decarbonization Measure Savings % from Baseline (predicted)		26.4%	13.2%	19.5%	22.6%	21.0%		

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Durham County | Triangle Waste Water Treatment Plant (admin) | Decarbonization Pathways

Generated: 06/26/2024 © HDR

Building Characteristics

Durham County |Triangle Waste Water Treatment Plant (admin) Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	5926 NC-55	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Water Source Heat Pumps
Building Type	Office	Cooling Generation	Water Source Heat Pumps
Year Built	2001	Domestic Hot Water Generation	WSHPs
Floor Area (ft2)	10,580	Heating / Cooling / Vent Distribution	Gas Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	977,377.30	0.00	3,335.76	$81,626.74	277.48

		Energy			Energy Cost	Carbon
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Retro-Commissioning	76,018.23	0.00	259.45	$6,348.75	21.58
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00
HVAC	Air-Side Economizer	15,701.27	0.00	53.59	$1,311.31	4.46
	Smart Thermostat	0.00	0.00	0.00	$0.00	0.00
	Air Conditioner Tune-up	0.00	0.00	0.00	$0.00	0.00
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00
DHW	Low Flow Faucet Aerators	0.00	12.43	1.24	$12.38	0.07
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00
Lighting	LED Retrofit	14,844.44	0.00	50.66	$1,239.75	4.21
	Lighting Occupancy Sensor	859.95	0.00	2.93	$71.82	0.24
	LED Exit Signs	317.99	0.00	1.09	$26.56	0.09
	Daylight Dimming Control	1,289.93	0.00	4.40	$107.73	0.37
	LED Outdoor Pole/Arm	1,816.42	0.00	6.20	$151.70	0.52
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	849.02	0.00	2.90	$70.91	0.24
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00
	EnergyStar Refrigerator Upgrade	105.00	0.00	0.36	$8.77	0.03
	Tier 1 Advanced Power Strip	188.30	0.00	0.64	$15.73	0.05

Key Parameter Description	Key Parameter	
Potential Annual Energy Savings (%)	7.8%	%
	0.00	
NA	NA	
Total Cooling Capacity Controled	0.00	kBTU/hr
Electric Cooling Savings %	0.00%	%
Natural Gas Heating Savings %	2.30%	%
NA	NA	
# Solar Thermal Panels	0	#
Applicable Area %	100.0%	%
Applicable Area %	10.0%	%
Quantity of Exit Signs	3	#
Applicable Area %	15.0%	%
Quantity of Outdoor Fixtures	7	#
HP total of Air Compressors	0.0	HP
Transformer Size	30.0	kVA
Quantity of Beverage Vending Machines	0	#
Quantity of Snack Vending Machines	0	#
$0.00	1	#
Quantity of Power Strips	7	#

Decarbonization Measure Savings Totals (predicted)	111,990.56	12.43	383.46	$9,365.39	31.86
	kWh	Therms	MMBTU	$US	MT CO2e
Decarbonization Measure Savings % from Baseline (predicted)	11.5%	0.0%	11.5%	11.5%	11.5%

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

Durham County | TWWTP Bldg 2 (Sludge) | Decarbonization Pathways

Generated: 06/26/2024 © HDR

Building Characteristics

Durham County |TWWTP Bldg 2 (Sludge) Building Characteristics			
Location Basics		**Heating | Cooling | Ventilation**	
Location	5926 NC-55	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Unit Heater
Building Type	Warehouse	Cooling Generation	Split-System DX
Year Built	2013	Domestic Hot Water Generation	Split System Units
Floor Area (ft2)	4,930	Heating / Cooling / Vent Distribution	Electric Storage-type Water Heater
Stories	1		
Electric Utility		**Natural Gas Utility**	
Electric Provider	Duke Energy	Natural Gas Provider	Dominion Energy
Electric Rate Structure	LGS	Natural Gas Rate Structure	General



Decarbonization Measure Summary

		Energy			Energy Cost	Carbon
Category	Existing Conditions	FY23 Annual Electric Usage	FY23 Annual NG Usage	FY23 Total Annual Energy Usage	FY23 Annual Energy Cost	FY23 Annual GHG Emissions
		kWh	Therms	MMBTU	$US	MT CO2e
Whole Building	Baseline	1,191,472.36	0.00	4,066.46	$102,640.40	338.26

		Energy			Energy Cost	Carbon	Key Parameter Description	Key Parameter	
Category	Decarbonization Measure	Annual Electric Savings	Annual NG Savings	Annual Energy Savings	Energy Cost Savings	GHG Emissions Savings			
		kWh	Therms	MMBTU	$US	MT CO2e			
Whole Building	Retro-Commissioning	79,431.49	0.00	271.10	$6,842.69	22.55	Potential Annual Energy Savings (%)	6.7%	%
Envelope	Building Envelope EEM	0.00	0.00	0.00	$0.00	0.00		0.00	
HVAC	Air-Side Economizer	0.69	0.00	0.00	$0.06	0.00	NA	NA	
	Smart Thermostat	248.04	0.00	0.85	$21.37	0.07	Total Cooling Capacity Controled	72.00	kBTU/hr
	Air Conditioner Tune-up	313.52	0.00	1.07	$27.01	0.09	Electric Cooling Savings %	6.32%	%
	Space Heating Fossil Fuel Boiler Tune-up	0.00	0.00	0.00	$0.00	0.00	Natural Gas Heating Savings %	2.30%	%
DHW	Low Flow Faucet Aerators	0.00	0.00	0.00	$0.00	0.00	NA	NA	
	Solar Thermal Domestic Hot Water	0.00	0.00	0.00	$0.00	0.00	# Solar Thermal Panels	0	#
Lighting	LED Retrofit	9,976.15	-66.21	27.43	$793.46	2.48	Applicable Area %	100.0%	%
	Lighting Occupancy Sensor	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	LED Exit Signs	0.00	0.00	0.00	$0.00	0.00	Quantity of Exit Signs	1	#
	Daylight Dimming Control	0.00	0.00	0.00	$0.00	0.00	Applicable Area %	0.0%	%
	LED Outdoor Pole/Arm	0.00	0.00	0.00	$0.00	0.00	Quantity of Outdoor Fixtures	0	#
Power	Variable Speed Drive Screw Air Compressors	0.00	0.00	0.00	$0.00	0.00	HP total of Air Compressors	0.0	HP
	NEMA Premium Low Voltage Dry-Type Distribution Transformers	0.00	0.00	0.00	$0.00	0.00	Transformer Size	0.0	kVA
	Vending Machine Controller | Beverage	0.00	0.00	0.00	$0.00	0.00	Quantity of Beverage Vending Machines	0	#
	Vending Machine Controller | Snack	0.00	0.00	0.00	$0.00	0.00	Quantity of Snack Vending Machines	0	#
	EnergyStar Refrigerator Upgrade	0.00	0.00	0.00	$0.00	0.00	$0.00	0	#
	Tier 1 Advanced Power Strip	0.00	0.00	0.00	$0.00	0.00	Quantity of Power Strips	0	#
Decarbonization Measure Savings Totals (predicted)		89,969.89	-66.21	300.44	$7,684.59	25.19			
		kWh	Therms	MMBTU	$US	MT CO2e			
Decarbonization Measure Savings % from Baseline (predicted)		7.6%	0.0%	7.4%	7.5%	7.4%			

Note 1:
Each Decarbonization Measure Savings results are presented independently as Non-Coincident Measures. If Measures are combined and become Coincident Measures, the savings results will be impacted. For example, if both LED Retrofit AND Daylight Dimming Control are selected, the actual savings from implementing a Daylighting Dimming Control measure will be LESS as the Baseline Lighting Power Density will be lower as a result of the LED Retrofit.

Note 2:
Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)

D

Appendix D – Retro-Commissioning Savings Potential Summary

Confidential

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"X" Count	RCx Savings
6	5.00%
12	8.33%
18	11.67%
24	15.00%

X1 = RCx measure has been identified as a LOW-MEDIUM savings opportunity for this building based on trend data OR this RCx measure is generally applicable for this building
X2 = RCx measure has been identified as a HIGH savings opportunity for this building based on trend data
NA = RCx measure is NOT applicable for this building given the installed systems
No = RCx measure is applicable for this building but might not offer savings potential based on trend data

Building Engineering Services | North America | Sustainability - Retro-Commissioning Savings Potential Summary

Form Revision Level: 04/16/2024 © HDR

Bldg #	Group #	Facility	Assessment Type	Gross Area ft2	"X" Count	RCx Savings	#1: Scheduling equipment: AHUs, Fans, Pumps, Electrical Heat, VAV/FPBs, Lighting	#2: Duct static pressure reduce/reset	#3: Economizer and Outdoor Air Control	#4: Supply Air temperature reset	#5: Optimum Start for AHU	#6: Reduce simultaneous heating and cooling	#7: Reduce Ventilation Air	#8: Condenser water temperature reset	#9: Setback space temperature	#10: Reduce Supply Air	#11: Chilled Water temperature reset	#12: Demand Control Ventilation (DCV)	#13: Optimize supply fan performance	#14: Optimize chiller sequencing	#15: Reduce VAV Minimum Position	#16: Eliminate unnecessary fans	#17: Install efficient filters	#18: Balance airside
1	1	Administrative Building	EE	109,036	19	12.22%	X2	X1	X1	X1	X1	X2	X1	X1	X1	X1	X1	X1	NA	X1	X1	X1	X1	X1
2	1	JRC	EE, Solar	40,623	12	8.33%	X2	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
9	1	Judicial Building Annex	EE, Solar, EV	25,692	17	11.11%	X2	X1	X1	X1	X1	X2	X1	NA	X1	X1	NA	X1	X1	NA	X1	X1	X1	X1
10	1	South Regional Library	EE, Solar	27,320	17	11.11%	X2	X1	X1	X1	X1	X2	X1	NA	X1	X1	X1	X1	X1	NA	X1	NA	X1	X1
6	1	EMS #2 - Old Fayetteville Road	EE, Solar, EV	6,990	10	7.22%	X1	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
11	1	Southwest Regional Library	EE, Solar, EV	25,684	17	11.11%	X2	X1	X1	X1	X1	X2	X1	NA	X1	X1	X1	X1	X1	NA	X1	NA	X1	X1
3	1	Durham County Stadium	EE, solar, EV	14,773	12	8.33%	X1	NA	X1	NA	X1	X1	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
4	1	Durham County Warehouse	EE, Solar, EV	53,520	10	7.22%	X1	NA	X1	NA	No	X1	X1	NA	X1	X1	NA	NA	X1	NA	NA	X1	X1	X1
7	1	Head Start	EE, Solar	13,370	11	7.78%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
5	1	Eastern Sheriff's Station	EE, solar, EV	3,038	10	7.22%	X1	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
8	1	Health and Human Services	EE, Solar	293,507	18	11.67%	X2	X1	X1	X1	X1	No	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1
26	1	East Regional Library	EE, Solar	26,649	17	11.11%	X2	X1	X1	X1	X1	X2	X1	NA	X1	X1	X1	X1	X1	NA	X1	NA	X1	X1
16	2	Admin Building II	EE, Solar, EV	140,987	20	12.78%	X2	X1	X1	X1	X1	X2	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1
18	2	Animal Control Office	EE, Solar, EV	3,488	10	7.22%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	NA	X1	X1
20	2	Bragtown Library	EE, Solar	1,092	9	6.67%	X1	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	NA	X1	X1
31	3	Animal Shelter	All	22,968	11	7.78%	X2	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
22	2	Community Shelter	EE, Solar	17,816	11	7.78%	NA	NA	X1	NA	No	X2	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
29	2	Main Library	EE, Solar	95,000	18	11.67%	X2	X1	X1	X1	X1	X2	X1	X1	X1	X1	X1	X1	X1	NA	X1	NA	X1	X1
43	2	Queen Street Parking Deck	Solar canopy, EV	259,396	-	0.00%																		
25	2	Durham County Courthouse	EE, Solar	318,533	20	12.78%	X2	X1	X1	X1	X1	X2	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1
42	2	Justice Center Parking Deck	Solar canopy, EV	303,000	-	0.00%																		
23	2	Detention Center	EE, Solar	290,919	16	10.56%	NA	X1	X1	X1	No	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1	X1
17	2	Agriculture Building	EE, Solar, EV	16,772	10	7.22%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	NA	X1	X1
27	2	EMS #1 - Stadium Drive (HQ)	Solar	10,370	-	0.00%																		
28	2	General Services	EE, Solar, EV	10,387	11	7.78%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
30	2	North Regional Library	EE, Solar	26,649	16	10.56%	X1	X1	X1	X1	X1	X2	X1	NA	X1	X1	X1	X1	X1	NA	X1	NA	X1	X1
19	2	Bethesda VFD	EE, Solar, EV	10,800	9	6.67%	NA	NA	X1	NA	No	NA	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
21	2	Center For Senior Life	EE, Solar	35,180	10	7.22%	NA	NA	X1	NA	X1	NA	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
24	2	Durham Center Access	Solar	20,819	-	0.00%																		
32	3	JSD Transitional Living Facility	EE	2,050	9	6.67%	NA	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
34	3	Fire Marshall	EE, LED	3,872	11	7.78%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
35	3	In line Shopping Center - Shoppes at Hope Valley	LED only in breezeway , EV	-	-	0.00%																		
37	3	Main Library Annex - Family Justice Resource Center	Solar	5,650	-	0.00%																		
38	3	Parkwood VFD #1 (Station 18)	EE, EV	9,829	9	6.67%	NA	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
40	3	Rainbow Assisted Living	EE	5,376	11	7.78%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
33	3	EMS #6 - Milton Road	EE, Solar, EV	7,805	9	6.67%	NA	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
36	3	Leesville VFD	EE, Solar	1,017	9	6.67%	NA	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
39	3	Parkwood VFD #2	EE, EV	2,467	9	6.67%	NA	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
12	3	Triangle Waste Water Treatment Plant (admin)	EE, Solar, EV	10,580	11	7.78%	X1	NA	X1	NA	X1	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
13	3	TWWTP Bldg 1 (Filter Bldg)	LED/ Solar	16,115	-	0.00%																		
14	3	TWWTP Bldg 2 (Sludge)	EE, Solar, EV	4,930	9	6.67%	NA	NA	X1	NA	No	No	X1	NA	X1	X1	NA	X1	X1	NA	NA	X1	X1	X1
15	3	TWWTP Bldg 3 (cover over sludge bldg)	LED/ Solar	1,980	-	0.00%																		
41	99	Stanford Warren Library	EE, Solar	9,797	-	0.00%																		

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E

Appendix E – Supplemental Electrification Analysis Calculations

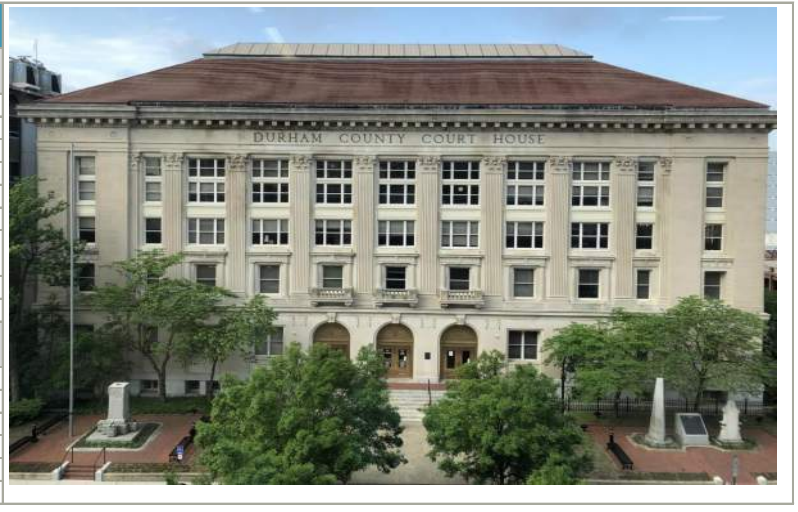
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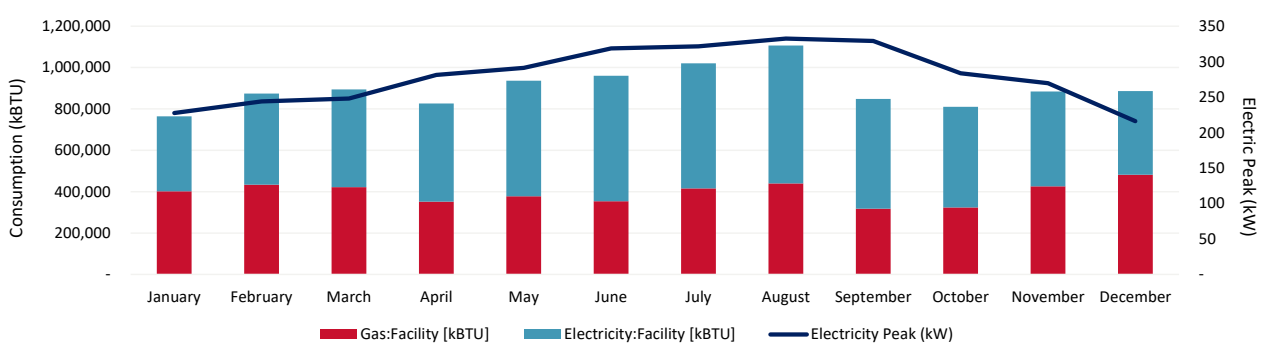
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Building Characteristics

Durham County | Administrative Building Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	200 E Main St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Office	Cooling Generation	Water-Cooled Chiller
Year Built	1926	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	109,036	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	4	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED (except 5th floor)	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

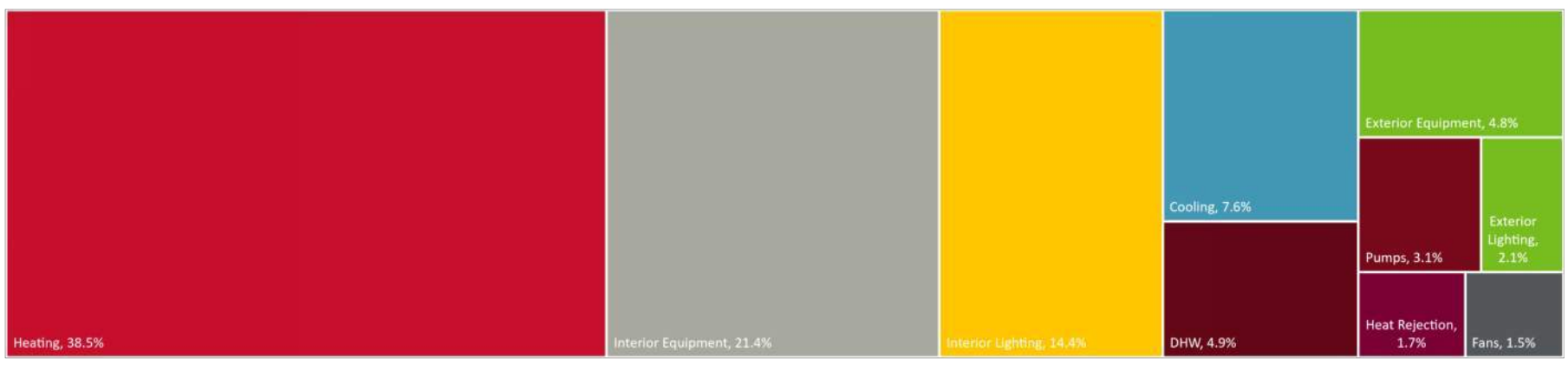


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

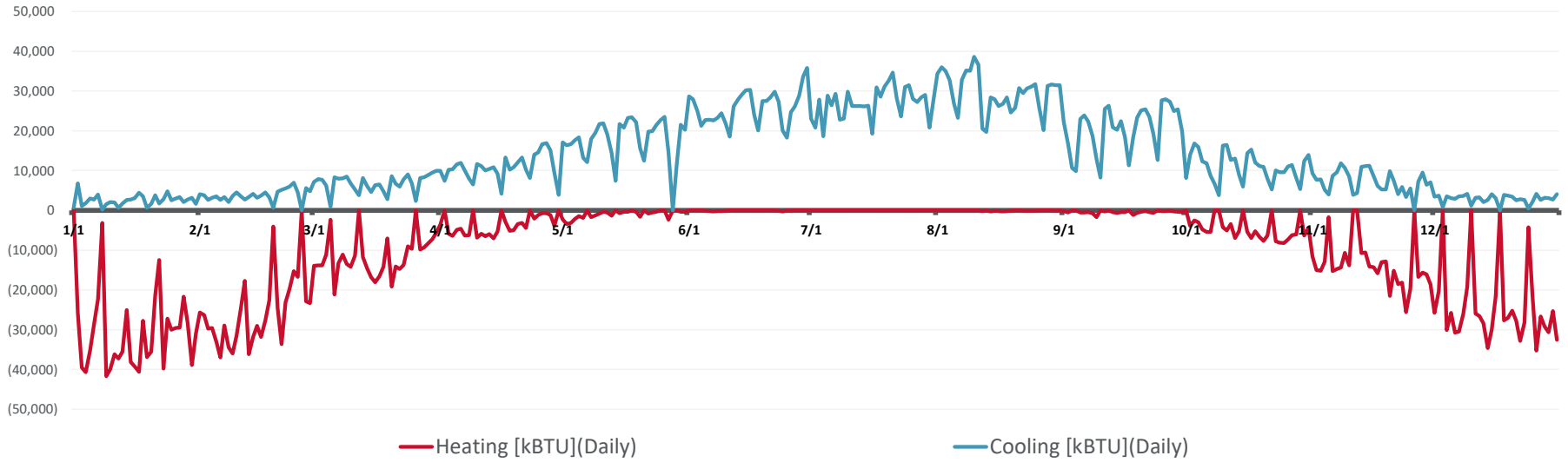


99.19 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	105,816.32	227.33	4,024.50
February	129,161.28	243.65	4,336.50
March	138,507.36	248.26	4,218.50
April	139,015.10	281.09	3,519.00
May	163,863.16	291.36	3,780.50
June	177,716.93	318.91	3,537.50
July	177,075.84	321.51	4,153.00
August	195,494.12	332.55	4,400.50
September	155,657.13	329.09	3,176.00
October	142,767.36	283.78	3,238.00
November	134,507.42	269.57	4,253.00
December	118,942.95	216.10	4,813.00
ANNUAL	1,778,524.97	-	47,450.00
PEAK	195,494.12	332.55	4,813.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	Natural gas heating water non-condensing boiler (2019 vintage); CV primary VV secondary pumping; terminal reheat coils selected for 165F EWT; (2) Lochinvar Copper-Fin 2 model CHN1262, mfg. 2019, 1260 Mbh input, 1071 Mbh output
Domestic Hot Water	Natural gas storage water heaters w/ recirc; approx. 540 MBH / 500 gph recovery total; (2) State "Titan" model GPG81270NEA, power draft, 81 gallon, 270 Mbh input, mfg. 4/2016; approx. 80% eff.

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace boilers with (2) 320 kw electric boilers, 4-step control, Lochinvar BWX3-320C

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	0.0	(40,928.5)	1,056,473.6	NA	NA	2,834,998.5	5,720.5	94.0	4.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,734.9 MMBTU								10,247.8 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$261,495.90	$5,364.87	$2.45	-32.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$200,964.56 $US								$266,860.77 $US			
Carbon	504.9	247.8	6.90	0.0	(217.4)	299.9	NA	NA	804.9	30.4	7.66	-11.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	752.7 MT CO2e								835.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Heat-recovery / heat-pump chiller system: *Replace chillers with Modular Water-Source Multipipe chillers - Trane "Thermafit" model MWS , (8) 40-ton modules, tandem scroll compressors; simultaneous heating/cooling, with dedicated condenser loop; *Replace cooling tower with hybrid fluid cooler - induced draft, closed circuit, (2) Marley DTW1212SAMB2L, 30 hp each, VFD fan; *Replace pumps with variable primary-only - two each for CHW, HW, CTW (total 6 pumps w/ VFDs) - (2) 10hp CTW pumps, (4) 15 hp CHW&HW pumps; *Add automatic glycol feed system for cooling tower loop *Add supplemental electric boilers (HVAC Pathway 1)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	6,717.4	(40,928.5)	335,443.3	NA	NA	2,120,685.7	5,720.5	71.6	27.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,734.9 MMBTU								7,809.9 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$198,132.74	$5,364.87	$1.87	-1.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$200,964.56 $US								$203,497.61 $US			
Carbon	504.9	247.8	6.90	1.9	(217.4)	95.2	NA	NA	602.1	30.4	5.80	16.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	752.7 MT CO2e								632.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	Replace WHs with (2) electric storage water heater, 119 gallon, 54 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	NA	NA	NA	(5,720.5)	133,813.8	1,912,338.7	40,928.5	97.4	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,734.9 MMBTU								10,619.6 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$168,691.95	$38,384.33	$1.90	-3.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$200,964.56 $US								$207,076.29 $US			
Carbon	504.9	247.8	6.90	NA	NA	NA	(30.4)	38.0	542.9	217.4	6.97	-1.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	752.7 MT CO2e								760.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WHs with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ x 119 gallon storage tank each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,778,525.0	46,648.9	98.5	NA	NA	NA	(5,720.5)	22,918.4	1,801,443.4	40,928.5	93.9	4.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,734.9 MMBTU								10,241.1 MMBTU			
Energy Cost	$157,215.35	$43,749.20	$1.84						$159,184.43	$38,384.33	$1.81	1.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$200,964.56 $US								$197,568.76 $US			
Carbon	504.9	247.8	6.90	NA	NA	NA	(30.4)	6.5	511.4	217.4	6.68	3.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	752.7 MT CO2e								728.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$469,101.00	($104,280.55)	$38,384.33	($65,896.21)	($1,932,878.99)	NA	NA	-2.0492	NA	NA	($4,209.82)
HVAC Pathway 2	$5,790,132.00	($40,917.39)	$38,384.33	($2,533.05)	($7,786,218.31)	-7.1416%	-9.8431%	0.0049	NA	NA	$6,132.76
DHW Pathway 1	-$16,086.00	($11,476.60)	$5,364.87	($6,111.73)	($94,440.23)	NA	NA	NA	NA	NA	($387.91)
DHW Pathway 2	$650,728.00	($1,969.07)	$5,364.87	$3,395.79	($794,895.62)	-6.2291%	-2.8603%	0.0960	NA	NA	$1,217.75

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$77,759.00
DHW Existing Replacement:	$51,008.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

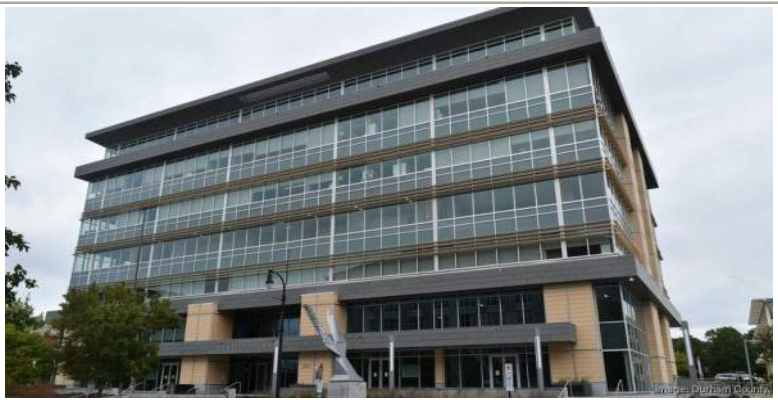
Durham County | Admin Building II | Electrification Pathways

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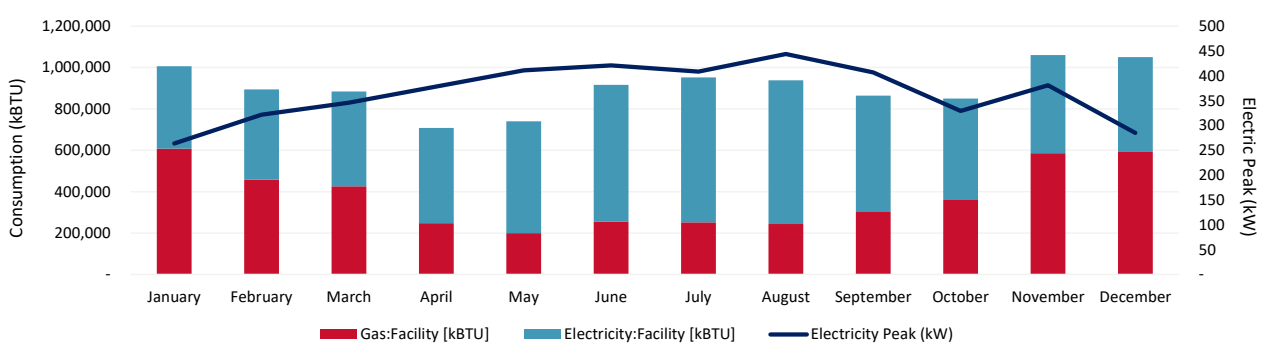
Building Characteristics

Durham County | Admin Building II Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	201 E Main St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Condensing Boilers
Building Type	Office	Cooling Generation	Water-Cooled Chiller
Year Built	1977 (2019 reno)	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	140,987	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	6	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Curtainwall	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

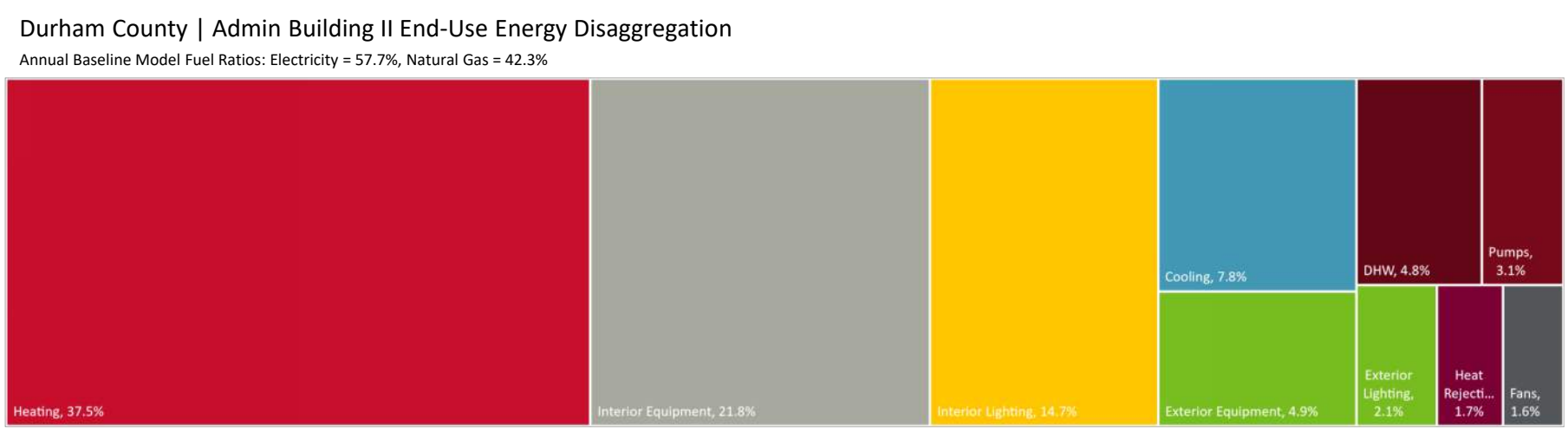


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

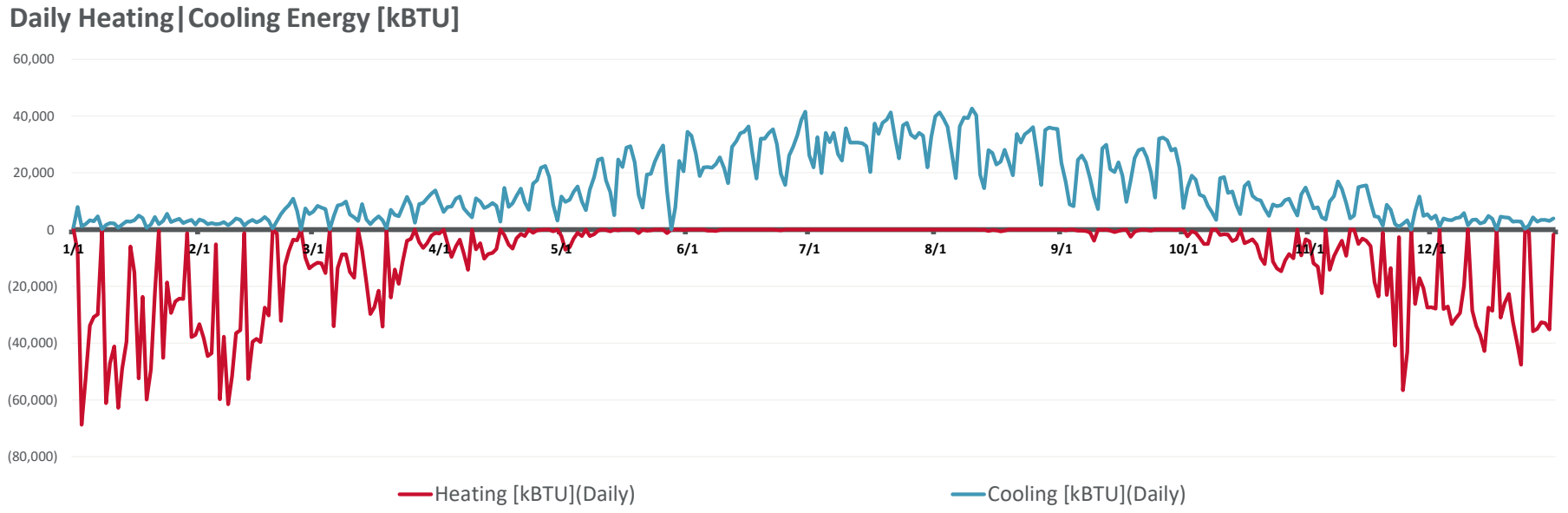


77.08 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	116,895.60	263.80	6,071.50
February	127,934.60	321.40	4,572.00
March	134,533.80	345.80	4,253.00
April	135,024.40	378.60	2,482.00
May	158,222.60	411.40	1,994.50
June	193,304.00	421.40	2,561.00
July	205,157.80	408.20	2,518.50
August	203,786.60	444.00	2,437.50
September	164,879.80	406.80	3,017.50
October	143,824.20	329.60	3,603.00
November	139,199.60	381.00	5,859.50
December	134,343.00	284.80	5,924.00
ANNUAL	1,857,106.00	-	45,294.00
PEAK	205,157.80	444.00	6,071.50

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(mult.) VRF heat pump systems, 1808 Mbh total capacity, no namplate data - per record dwgs; (2) Patterson-Kelley model C-2000H condensing boilers, 2000 mbh input, 1920 mbh output, 130F - 110F design water temps, CV primary - VV secondary pumps w/ VFD; (multi) single-duct and parallel FP terminal units, HW reheat; (4) HW unit heaters, 52.3 Mbh; (12) HW unit heaters, 26.1 Mbh;
Domestic Hot Water	Natural gas boiler and water storage tank w/ recirc; (1) AO Smith model HW-399, nat. draft, 399 Mbh input, 319 mbh output, mfg. 2017; approx. 80% eff.; (1) AO Smith TJVT 500 storage tank, 500 gallon

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace HW unit heaters with (12) 7.5 kw + (4) 15 kw electric unit heaters *Replace (2) gas boilers with (2) electric boilers, 445kw each (890 kw total), 8-step control, Lochinvar BWX3-445C

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	0.0	(40,109.2)	1,174,989.6	NA	NA	3,032,095.6	6,324.3	77.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,981.6 MMBTU								10,980.9 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$358,713.64	$5,937.47	$2.59	-69.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$214,698.94 $US								$364,651.11 $US			
Carbon	527.2	246.6	5.49	0.0	(213.0)	333.6	NA	NA	860.8	33.6	6.34	-15.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	773.9 MT CO2e								894.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) gas boilers with (8) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 480 FLA @ 460V/3ph)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	0.0	(40,109.2)	390,117.1	NA	NA	2,247,223.1	6,324.3	58.9	24.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,981.6 MMBTU								8,302.1 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$243,353.51	$5,937.47	$1.77	-16.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$214,698.94 $US								$249,290.98 $US			
Carbon	527.2	246.6	5.49	0.0	(213.0)	110.8	NA	NA	638.0	33.6	4.76	13.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	773.9 MT CO2e								671.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace gas boiler WH-1 with (1) electric boiler, 120 kw input, Bradford White "Brute" model BEB-120

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	NA	NA	NA	(6,324.3)	142,073.7	1,999,179.7	40,109.2	76.8	1.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,981.6 MMBTU								10,834.1 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$185,129.69	$37,655.93	$1.58	-3.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$214,698.94 $US								$222,785.62 $US			
Carbon	527.2	246.6	5.49	NA	NA	NA	(33.6)	40.3	567.6	213.0	5.54	-0.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	773.9 MT CO2e								780.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas boiler WH-1 with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) back-up electric boiler, 120 kw input, Bradford White "Brute" model BEB-120

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,857,106.0	46,433.5	77.9	NA	NA	NA	(6,324.3)	28,442.4	1,885,548.4	40,109.2	74.1	4.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	10,981.6 MMBTU								10,446.2 MMBTU			
Energy Cost	$171,105.54	$43,593.40	$1.52						$173,789.37	$37,655.93	$1.50	1.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$214,698.94 $US								$211,445.31 $US			
Carbon	527.2	246.6	5.49	NA	NA	NA	(33.6)	8.1	535.3	213.0	5.31	3.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	773.9 MT CO2e								748.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$744,102.84	($187,608.10)	$37,655.93	($149,952.17)	($4,079,845.16)	NA	NA	-3.0575	NA	NA	($6,147.75)
HVAC Pathway 2	$2,942,910.84	($72,247.97)	$37,655.93	($34,592.04)	($4,616,951.58)	-8.6411%	NA	-0.1610	NA	NA	$5,216.46
DHW Pathway 1	$113,945.00	($14,024.15)	$5,937.47	($8,086.69)	($310,459.76)	NA	NA	-1.0163	NA	NA	($343.94)
DHW Pathway 2	$300,121.00	($2,683.83)	$5,937.47	$3,253.63	($322,754.18)	-5.0238%	-1.0110%	0.2042	NA	NA	$1,301.34

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.
Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.
Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.
Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.
Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.
Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$191,976.00
DHW Existing Replacement:	$56,858.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

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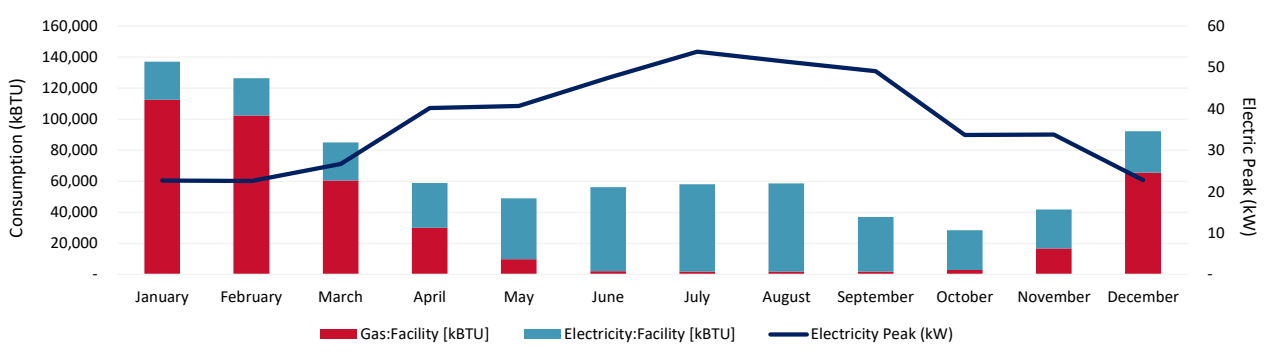
Building Characteristics

Durham County | Agriculture Building Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	721 Foster St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Furnaces
Building Type	Office	Cooling Generation	DX RTUs
Year Built	1970	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	16,772	Heating / Cooling / Vent Distribution	CV Air-Handlers
Stories	2	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

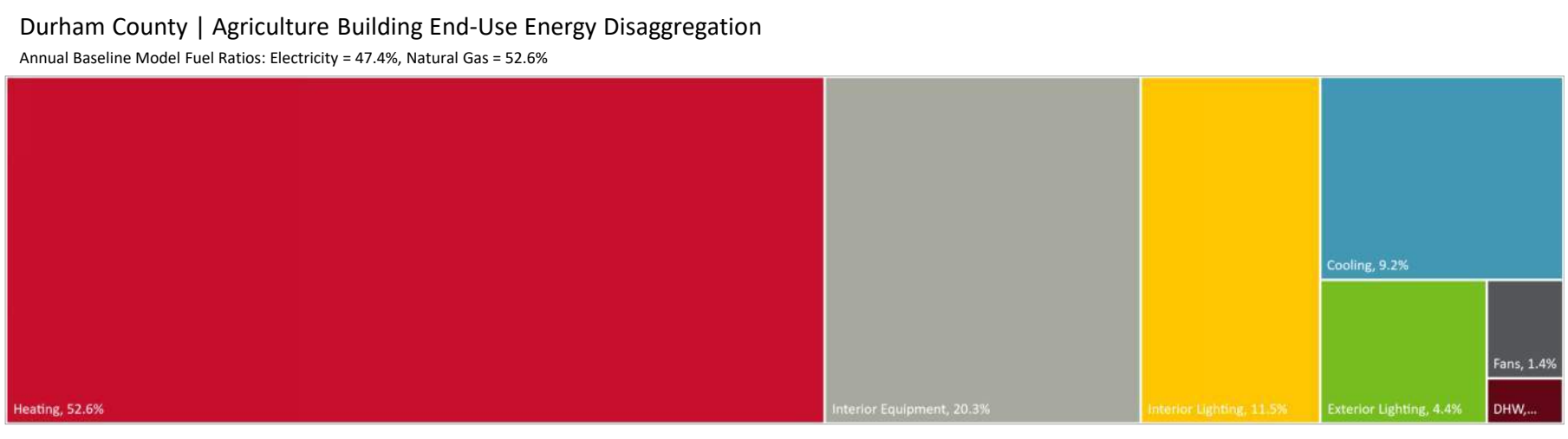


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

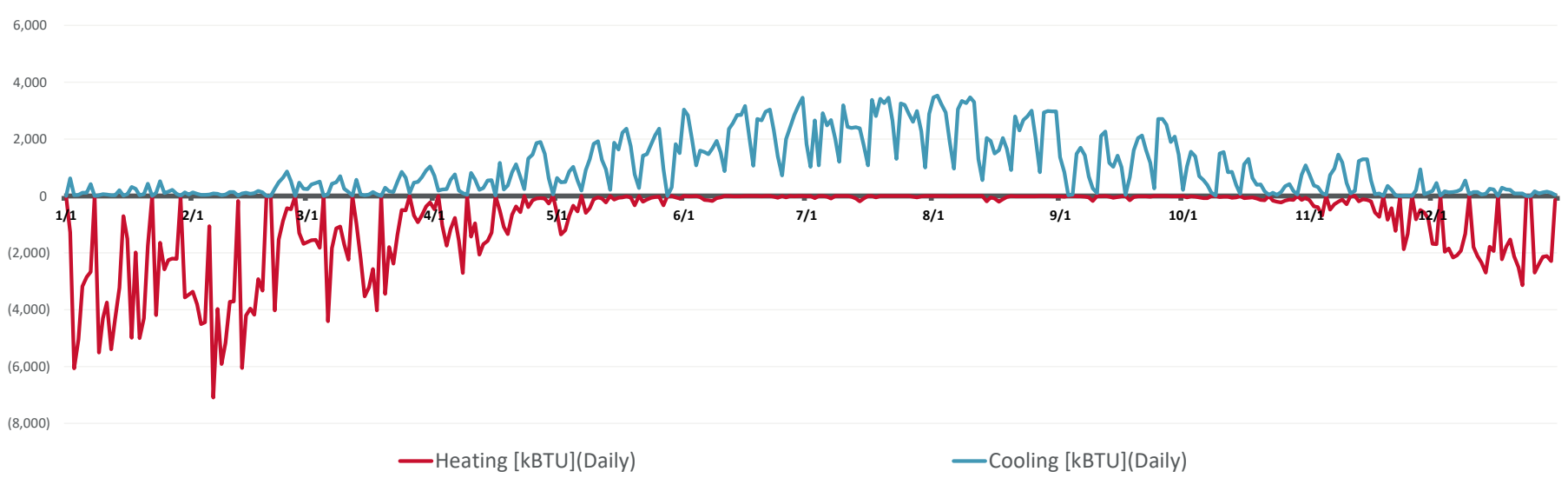


49.45 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	7,199.64	22.72	1,125.00
February	7,062.32	22.58	1,024.00
March	7,239.68	26.74	604.00
April	8,410.22	40.18	301.00
May	11,513.20	40.72	97.50
June	15,833.80	47.56	21.00
July	16,515.62	53.84	18.00
August	16,655.78	51.44	19.00
September	10,296.00	49.12	19.00
October	7,515.78	33.74	28.50
November	7,385.56	33.80	167.50
December	7,858.42	22.78	655.00
ANNUAL	123,486.02	-	4,079.50
PEAK	16,655.78	53.84	1,125.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU-6 gas furnace, 180 mbh input, 148 mbh output; (1) RTU-1 gas furnace, 115mbh input, 93 mbh output; (1) RTU-2 gas furnace, 125 mbh input, 103 mbh output; (1) RTU-4 gas furnace, 180 mbh input, 148 mbh output; (1) RTU-3 gas furnace, 72 mbh input, 59 mbh output; (1) RTU-5 gas furnace, 72 mbh input, 59 mbh output; (1) Abandoned? steam boiler, 2163 mbh input, 1310 mbh net
Domestic Hot Water	(1) Electric storage water heater, 50 gallon, 3380 W element, 208V/1ph, Rheem model PROE50, mfg 2012; HW recirc pump;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace rooftop units with electric resistance heaters

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	0.0	(4,670.4)	95,677.8	NA	NA	219,163.8	0.0	44.6	15.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	888.5 MMBTU								748.0 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$26,824.59	$0.00	$1.60	-45.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,469.65 $US								$26,824.59 $US			
Carbon	35.1	24.8	3.57	0.0	(24.8)	27.2	NA	NA	62.2	0.0	3.71	-3.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	59.9 MT CO2e								62.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Replace rooftop units with heat-pump units; (1) 5-ton heat-pump unit, w/ economizer, 18kw elec heat, Trane model WHC060; (2) 6-ton heat-pump unit, w/ economizer, 18kw elec heat, Trane model WHC074; (1) 7.5T heat pump RTU, economizer, 36kw elec heat, Trane WHC092; (2) 8.5T heat pump RTUs, economizer, 54kw elec heat, Trane WHC102;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	0.0	(4,670.4)	44,276.7	NA	NA	167,762.8	0.0	34.1	35.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	888.5 MMBTU								572.6 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$18,602.80	$0.00	$1.11	-0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,469.65 $US								$18,602.80 $US			
Carbon	35.1	24.8	3.57	0.0	(24.8)	12.6	NA	NA	47.6	0.0	2.84	20.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	59.9 MT CO2e								47.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	NA	NA	NA	0.0	0.0	123,486.0	4,670.4	53.0	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	888.5 MMBTU								888.5 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$12,903.39	$5,566.26	$1.10	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,469.65 $US								$18,469.65 $US			
Carbon	35.1	24.8	3.57	NA	NA	NA	0.0	0.0	35.1	24.8	3.57	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	59.9 MT CO2e								59.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	123,486.0	4,670.4	53.0	NA	NA	NA	0.0	(1,002.5)	122,483.5	4,670.4	52.8	0.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	888.5 MMBTU								885.1 MMBTU			
Energy Cost	$12,903.39	$5,566.26	$1.10						$12,810.68	$5,566.26	$1.10	0.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,469.65 $US								$18,376.94 $US			
Carbon	35.1	24.8	3.57	NA	NA	NA	0.0	(0.3)	34.8	24.8	3.55	0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	59.9 MT CO2e								59.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	-$35,838.00	($13,921.20)	$5,566.26	($8,354.94)	($114,602.17)	NA	NA	NA	NA	NA	($120.18)
HVAC Pathway 2	$29,319.00	($5,699.41)	$5,566.26	($133.15)	($29,165.55)	-3.0418%	-0.3744%	0.2638	NA	NA	$624.06
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$10,127.00	$92.71	$0.00	$92.71	($11,728.44)	-5.8579%	-1.8892%	0.1429	NA	NA	$14.52

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$268,487.00
DHW Existing Replacement:	$3,698.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

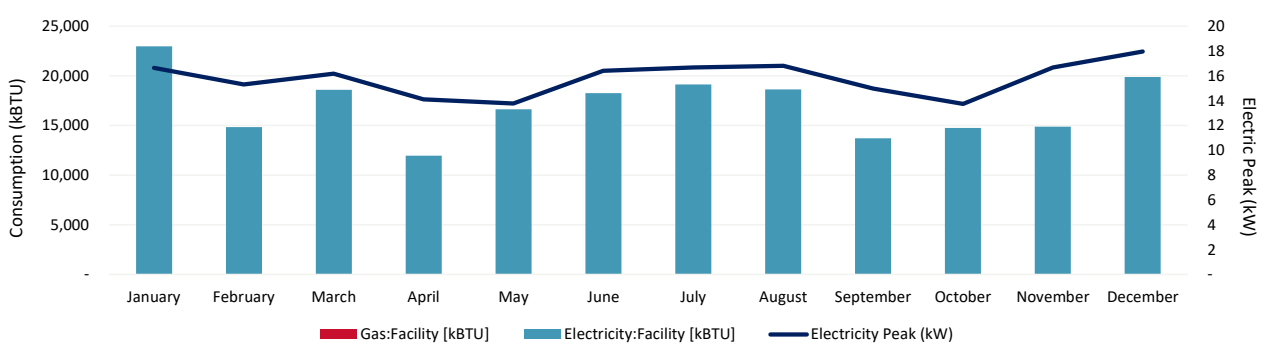
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Building Characteristics

Durham County | Animal Control Office Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	3005 Glenn Rd, Durham, NC 27704	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Split-System Heat Pump
Building Type	Office	Cooling Generation	Split-System DX
Year Built	2009	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	3,488	Heating / Cooling / Vent Distribution	CV Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

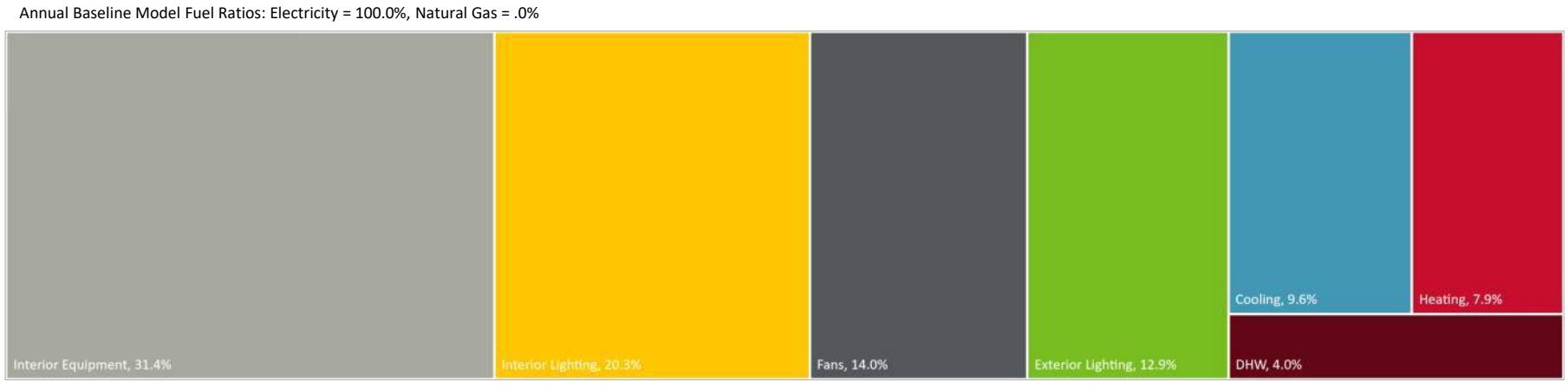


58.56 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	6,732.08	16.64	-
February	4,347.60	15.30	-
March	5,448.34	16.16	-
April	3,508.16	14.12	-
May	4,878.08	13.78	-
June	5,345.66	16.42	-
July	5,606.80	16.68	-
August	5,455.32	16.82	-
September	4,013.54	14.98	-
October	4,328.86	13.74	-
November	4,358.06	16.68	-
December	5,824.98	17.96	-
ANNUAL	59,847.48	-	-
PEAK	6,732.08	17.96	-

Annual Baseline Model Predicted End-Use Energy Disaggregation

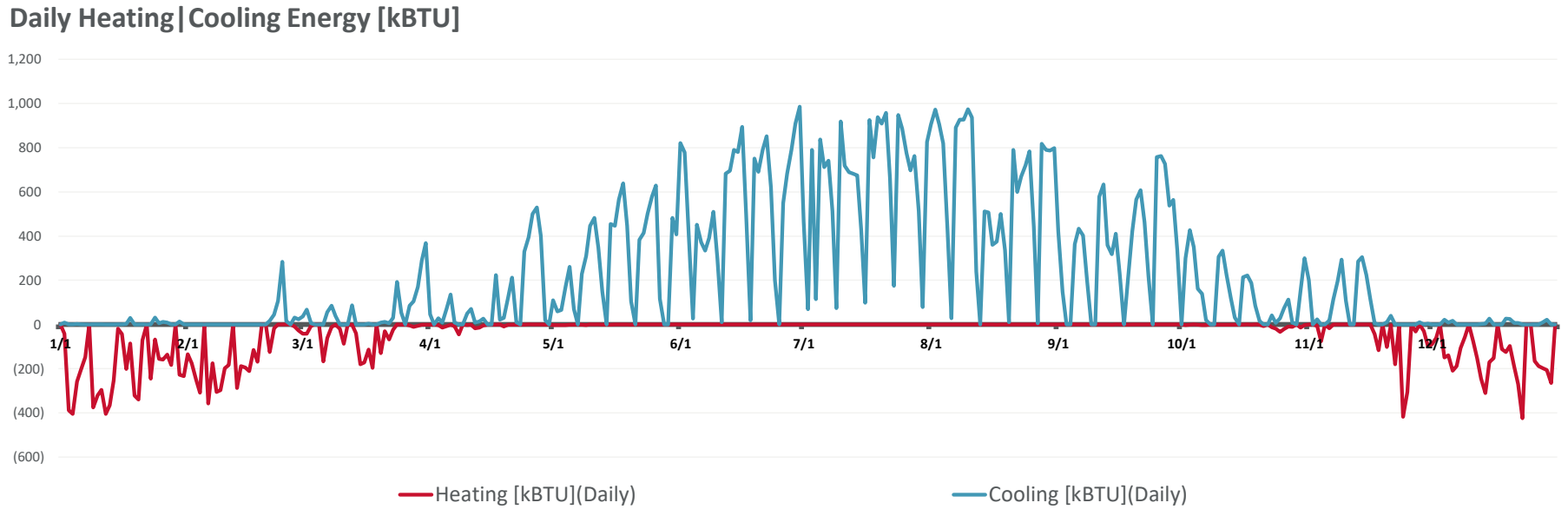
Durham County | Animal Control Office End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 100.0%, Natural Gas = .0%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	14 SEER Split-systems, CV AHUs; (1) 5-ton heat-pump, condensing unit, Trane 4TWA4060, mfg 2022; (2) 2.5-ton heat-pump, condensing unit, Trane 4TWR4030, mfg 2023; (1) 4-ton heat-pump, condensing unit, Trane 4TWA4048, mfg 2023;
Domestic Hot Water	(1) electric storage water heater, 34 gallon, Rheem ELDS40-C, mfg 2015

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,979.4	0.0	58.7	0.0	0.0	0.0	NA	NA	59,979.4	0.0	58.7	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	204.7 MMBTU								204.7 MMBTU			
Energy Cost	$7,179.52	$0.00	$2.06						$7,179.52	$0.00	$2.06	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,179.52 $US								$7,179.52 $US			
Carbon	17.0	0.0	4.88	0.0	0.0	0.0	NA	NA	17.0	0.0	4.88	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.0 MT CO2e								17.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - systems are already heat-pump (and all replaced late 2023)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,979.4	0.0	58.7	0.0	0.0	0.0	NA	NA	59,979.4	0.0	58.7	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	204.7 MMBTU								204.7 MMBTU			
Energy Cost	$7,179.52	$0.00	$2.06						$7,179.52	$0.00	$2.06	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,179.52 $US								$7,179.52 $US			
Carbon	17.0	0.0	4.88	0.0	0.0	0.0	NA	NA	17.0	0.0	4.88	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.0 MT CO2e								17.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,979.4	0.0	58.7	NA	NA	NA	0.0	0.0	59,979.4	0.0	58.7	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	204.7 MMBTU								204.7 MMBTU			
Energy Cost	$7,179.52	$0.00	$2.06						$7,179.52	$0.00	$2.06	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,179.52 $US								$7,179.52 $US			
Carbon	17.0	0.0	4.88	NA	NA	NA	0.0	0.0	17.0	0.0	4.88	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.0 MT CO2e								17.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,979.4	0.0	58.7	NA	NA	NA	0.0	(1,669.2)	58,310.2	0.0	57.1	2.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	204.7 MMBTU								199.0 MMBTU			
Energy Cost	$7,179.52	$0.00	$2.06						$7,039.22	$0.00	$2.02	2.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,179.52 $US								$7,039.22 $US			
Carbon	17.0	0.0	4.88	NA	NA	NA	0.0	(0.5)	16.6	0.0	4.75	2.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.0 MT CO2e								16.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$26,617.00	$0.00	$0.00	$0.00	($35,967.66)	NA	-100.0000%	0.0000	NA	NA	$0.00
HVAC Pathway 2	$26,617.00	$0.00	$0.00	$0.00	($35,967.66)	NA	-100.0000%	0.0000	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$2,772.00	$140.30	$0.00	$140.30	($785.39)	1.0706%	2.3959%	0.7903	22.00	NA	$24.17

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$6,092.00
DHW Existing Replacement:	$7,069.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Durham County | Animal Shelter | Electrification Pathways

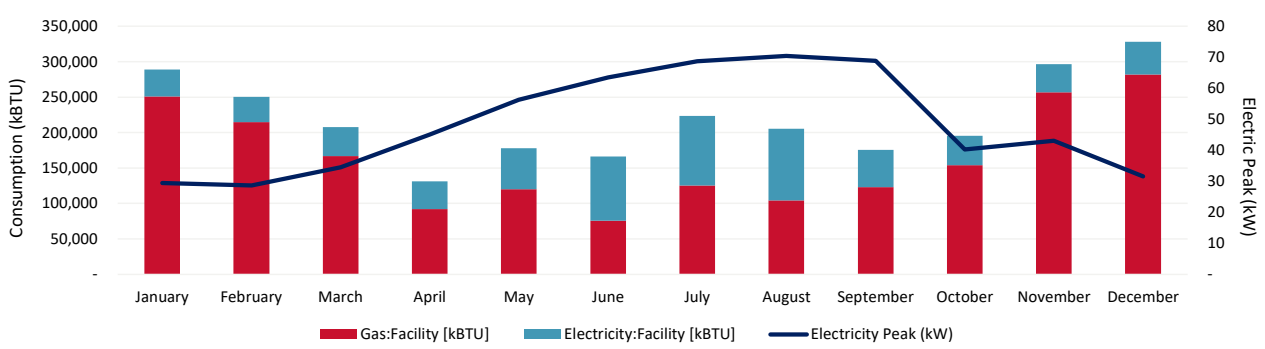
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Building Characteristics

Durham County | Animal Shelter Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	2117 E Club Blvd, Durham, NC 27704	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Animal Shelter	Cooling Generation	Packaged DX
Year Built	1970	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	22,968	Heating / Cooling / Vent Distribution	CV Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	6.5
		Weekday Opening Time	Monday-Friday, 10:30am
		Weekend Operating Hours	4
		Weekend Opening Time	Saturday, 10:00am; Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



115.26 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	11,127.68	29.48	2,509.00
February	10,516.16	28.68	2,146.50
March	11,958.82	34.52	1,670.00
April	11,459.56	45.12	919.50
May	17,044.08	56.30	1,199.00
June	26,545.14	63.46	755.00
July	28,849.96	68.74	1,251.50
August	29,553.56	70.42	1,043.50
September	15,477.36	68.80	1,228.00
October	12,057.92	40.24	1,542.50
November	11,642.28	43.02	2,570.00
December	13,553.48	31.64	2,820.00
ANNUAL	199,786.00	-	19,654.50
PEAK	29,553.56	70.42	2,820.00

Annual Baseline Model Predicted End-Use Energy Disaggregation

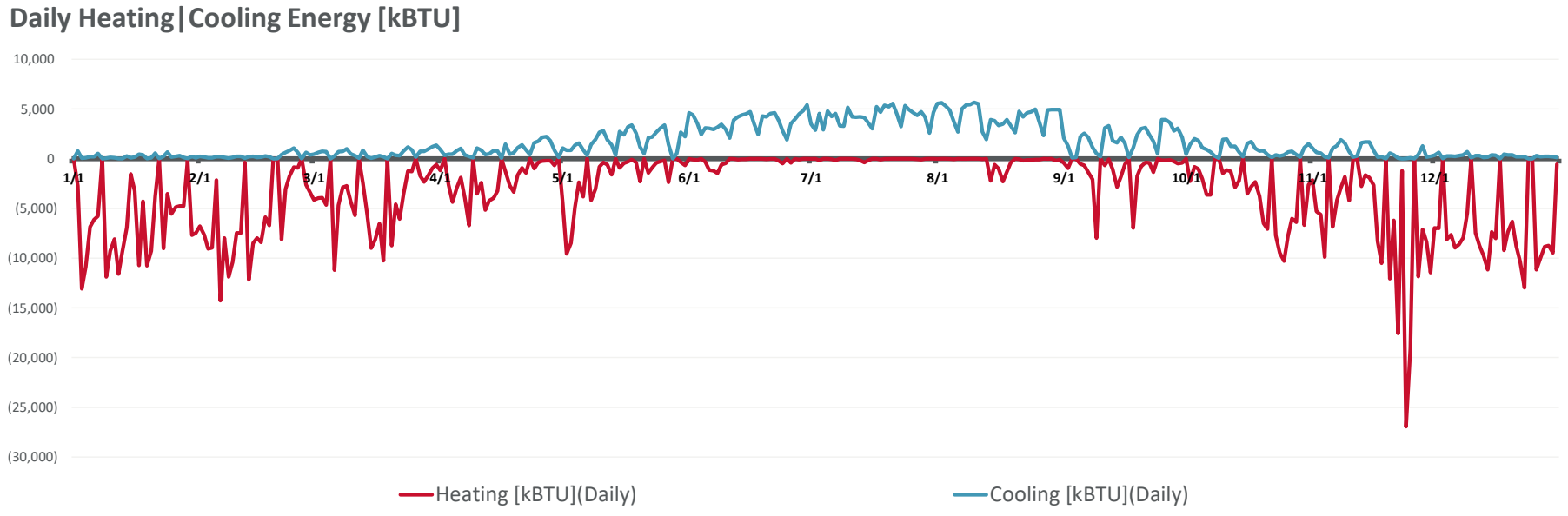
Durham County | Animal Shelter End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 23.1%, Natural Gas = 76.9%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU-? gas furnace, 120 mbh input, 96 mbh output; (1) RTU-1 gas furnace, 60 mbh input, 48 mbh output; (2) RTU-? gas furnace, 120 mbh input, 96 mbh output; (1) gas-fired large commercial clothes dryer;
Domestic Hot Water	(1) DHW storage tank, 119 gal, Lochinvar model RJS120; (1) DHW boiler, power-draft, Lochinvar model EWN250PM, 250 mbh input, 210 mbh output, 255 gph recovery, mfg 2003, recirc pump; (1) electric storage water heater, 50 gal, 9kw, State model PCE-52-2ORTA 110, mfg 2016; (1) Gas-fired storage water heater, natural draft, Rheem-Ruud model G100-200, 100 gal, 199.9 mbh input, 194 gph recovery, mfg 2010; (1) Electric storage water heater, 20 gal, 3 kw, AO Smith model DEL 20 102, mfg 2003;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace (4) RTUs with (1) 3-ton heat pump RTU, w/ economizer, 18 kw elec heat, Trane model WHC036; (3) 7.5-ton heat pump RTU, w/ economizer, 27 kw elec heat, Trane model WHC092; *Replace (1) gas clothes dryer with (1) lrg commercial electric dryer, 60kw;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	0.0	(17,148.6)	162,961.6	NA	NA	362,747.6	5,561.5	78.1	39.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,952.9 MMBTU								1,794.2 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$45,693.90	$5,999.79	$2.25	-18.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$43,809.31 $US								$51,693.70 $US			
Carbon	56.7	120.6	7.72	0.0	(91.1)	46.3	NA	NA	103.0	29.5	5.77	25.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	177.3 MT CO2e								132.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	0.0	(17,148.6)	162,961.6	NA	NA	362,747.6	5,561.5	78.1	39.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,952.9 MMBTU								1,794.2 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$45,693.90	$5,999.79	$2.25	-18.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$43,809.31 $US								$51,693.70 $US			
Carbon	56.7	120.6	7.72	0.0	(91.1)	46.3	NA	NA	103.0	29.5	5.77	25.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	177.3 MT CO2e								132.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace (1) gas DHW boiler with (1) electric boiler, 60 kw input, Bradford White "Brute" model BEB-60; *Replace (1) gas storage water heater with (1) electric storage water heater, 119 gallon, 30kw input, Bradford White model CEHD120(A)30 3*CF; (total 90kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	NA	NA	NA	(5,561.5)	121,394.2	321,180.2	17,148.6	122.4	4.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,952.9 MMBTU								2,811.0 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$30,535.88	$18,500.23	$2.13	-11.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$43,809.31 $US								$49,036.10 $US			
Carbon	56.7	120.6	7.72	NA	NA	NA	(29.5)	34.5	91.2	91.1	7.94	-2.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	177.3 MT CO2e								182.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas boiler with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) back-up electric boiler, 60 kw input, Bradford White "Brute" model BEB-60; *Replace (1) gas water heaters with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) electric storage water heater, 119 gallon, 30kw input, Bradford White model CEHD120(A)30 3*CF; (Total simultaneous 130kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	199,786.0	22,710.1	128.6	NA	NA	NA	(5,561.5)	26,875.0	226,661.0	17,148.6	108.3	15.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,952.9 MMBTU								2,488.4 MMBTU			
Energy Cost	$19,309.29	$24,500.02	$1.91						$21,688.12	$18,500.23	$1.75	8.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$43,809.31 $US								$40,188.34 $US			
Carbon	56.7	120.6	7.72	NA	NA	NA	(29.5)	7.6	64.3	91.1	6.77	12.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	177.3 MT CO2e								155.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$10,252.00	($26,384.61)	$18,500.23	($7,884.39)	($136,136.64)	NA	NA	-8.8268	NA	NA	$2,285.78
HVAC Pathway 2	$10,252.00	($26,384.61)	$18,500.23	($7,884.39)	($136,136.64)	NA	NA	-8.8268	NA	NA	$2,285.78
DHW Pathway 1	$63,613.00	($11,226.58)	$5,999.79	($5,226.79)	($181,952.36)	NA	NA	-1.1167	NA	NA	($251.16)
DHW Pathway 2	$619,472.00	($2,378.83)	$5,999.79	$3,620.97	($746,395.13)	-6.0902%	-2.5666%	0.1084	NA	NA	$1,117.39

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$133,110.00
DHW Existing Replacement:	$61,817.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

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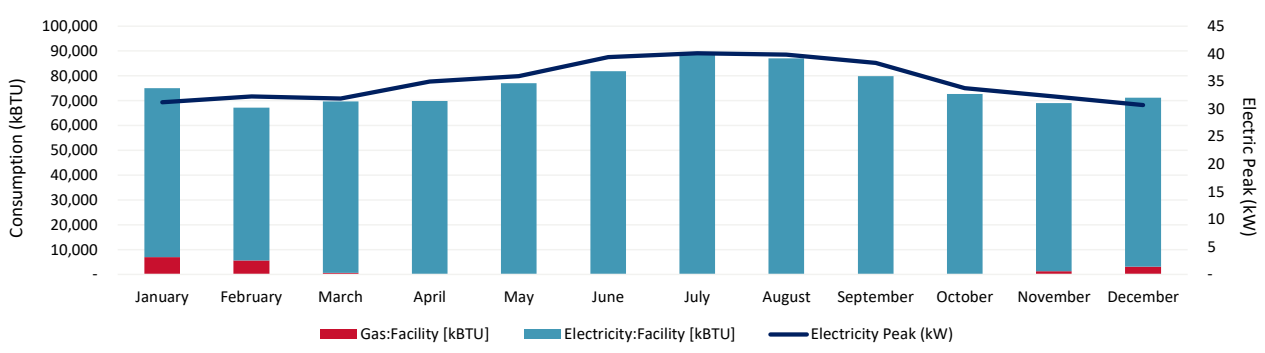
Building Characteristics

Durham County | Bethesda VFD Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	1724 S Miami Blvd, Durham, NC 27703	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Direct-Vent Gas Furnaces
Building Type	Emergency Services	Cooling Generation	Split-system DX
Year Built	1983	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	10,800	Heating / Cooling / Vent Distribution	Single Zone Units
Stories	2	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

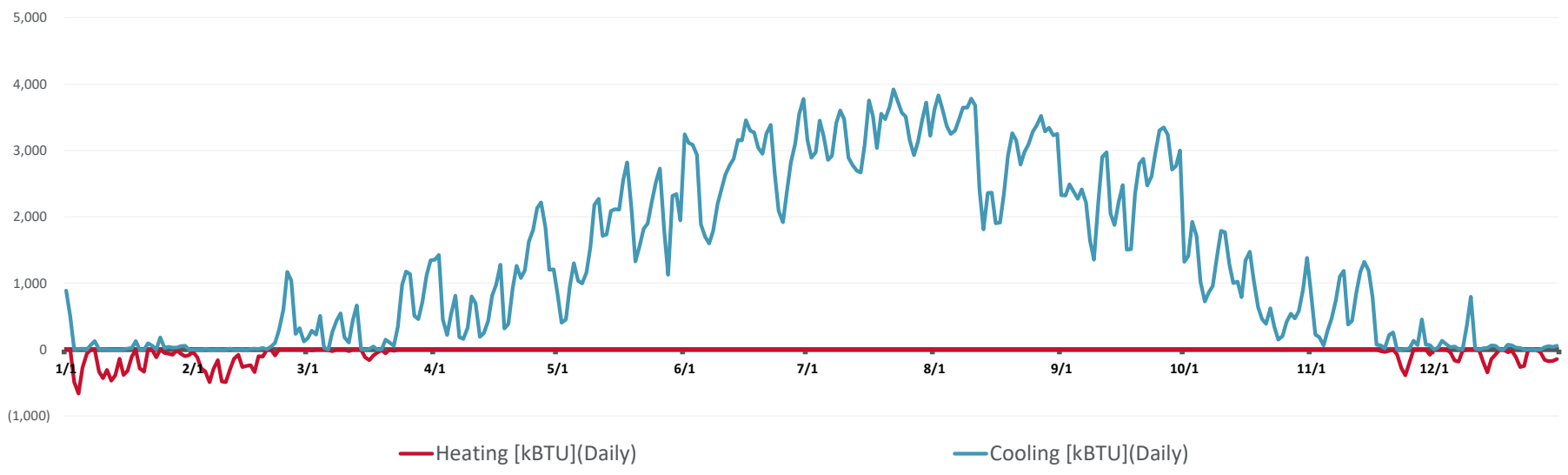


84.18 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	19,935.09	31.24	69.61
February	18,019.21	32.26	57.01
March	20,238.16	31.92	7.00
April	20,479.94	34.95	-
May	22,577.60	35.98	-
June	23,975.25	39.39	-
July	25,928.21	40.09	-
August	25,500.76	39.86	-
September	23,394.82	38.35	-
October	21,308.91	33.79	0.00
November	19,829.88	32.25	13.72
December	19,942.19	30.70	31.75
ANNUAL	261,130.01	-	179.10
PEAK	25,928.21	40.09	69.61

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(2?) Gas fired unit heater, 170 mbh input, 150.9 mbh output; (1) "AC-1" direct-vent gas furnace, Carrier model 59SC5A100S21, 100 mbh input, 97 mbh output, mfg 2017; (1) "Unit 2" direct-vent gas furnace, Lennox model G26Q4/5-125-6, 125 mbh input, mfg 1999; (1) "AHU-1" dirct-vent gas furnace, Carrier model 58MCB080, 80 mbh input, 74 mbh output, mfg 2006; (1) "AHU-2" direct-vent gas furnace, Carrier model 58MCB060, 60 mbh input, 56 mbh output, mfg 2006; (1) "AHU-3" direct vent gas furnace, Carrier model 58MCB080, 80 mbh input, 74 mbh output, mfg 2006; (1) 6-burner gas range in kitchen
Domestic Hot Water	(1) electric storage water heater, AO Smith model ELJF-40-913, 40 gallon, 4.5 kw, mfg. 1993; (1) gas instantaneous, Navien model NPE-240A2, 200 mbh input, approx 8 gpm;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification

*Replace gas unit heaters with (2) electric 40kw unit heater, Modine PTE400;
*Replace split-systems with heat pump systems w/ electric resistance backup (3) 5-ton HP condensing unit & AHU w/ 30kw heat, (1) 4 ton HP condensing unit & AHU w/20kw heat, (1) 2.5-ton HP condensing unit & AHU w/7.5kw heat;
*Replace gas range with electric 36" 6-burner induction range (240V, 22kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	0.0	(203.3)	3,059.1	NA	NA	264,189.1	0.0	83.5	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	911.6 MMBTU								901.7 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$23,334.12	$0.00	$2.16	-0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$23,182.89 $US								$23,334.12 $US			
Carbon	74.1	1.1	6.96	0.0	(1.1)	0.9	NA	NA	75.0	0.0	6.94	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	75.2 MT CO2e								75.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification

*Replace gas unit heaters with (2) electric 40kw unit heater, Modine PTE400;
*Replace split-systems with heat pump systems w/ electric resistance backup (3) 5-ton HP condensing unit & AHU w/ 30kw heat, (1) 4 ton HP condensing unit & AHU w/20kw heat, (1) 2.5-ton HP condensing unit & AHU w/7.5kw heat;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	0.0	(203.3)	3,059.1	NA	NA	264,189.1	0.0	83.5	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	911.6 MMBTU								901.7 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$23,334.12	$0.00	$2.16	-0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$23,182.89 $US								$23,334.12 $US			
Carbon	74.1	1.1	6.96	0.0	(1.1)	0.9	NA	NA	75.0	0.0	6.94	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	75.2 MT CO2e								75.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification

Replace (1) gas instantaneous WH with (1) electric storage water heater, 119 gallon, 54kw; +I17:N17

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	NA	NA	NA	0.0	0.0	261,130.0	203.3	84.4	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	911.6 MMBTU								911.6 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$22,933.00	$249.89	$2.15	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$23,182.89 $US								$23,182.89 $US			
Carbon	74.1	1.1	6.96	NA	NA	NA	0.0	0.0	74.1	1.1	6.96	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	75.2 MT CO2e								75.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification

*Replace (1) gas WHs with (1) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ x 119 gallon storage tank each;
*Replace (1) electric WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	261,130.0	203.3	84.4	NA	NA	NA	0.0	(4,651.4)	256,478.6	203.3	82.9	1.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	911.6 MMBTU								895.7 MMBTU			
Energy Cost	$22,933.00	$249.89	$2.15						$22,553.07	$249.89	$2.11	1.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$23,182.89 $US								$22,802.96 $US			
Carbon	74.1	1.1	6.96	NA	NA	NA	0.0	(1.3)	72.8	1.1	6.84	1.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	75.2 MT CO2e								73.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$136,459.00	($401.12)	$249.89	($151.24)	($186,993.36)	-7.3870%	NA	-0.0141	NA	NA	$10.77
HVAC Pathway 2	$136,459.00	($401.12)	$249.89	($151.24)	($186,993.36)	-7.3870%	NA	-0.0141	NA	NA	$10.77
DHW Pathway 1	$32,603.00	$0.00	$0.00	$0.00	($44,056.57)	NA	-100.0000%	0.0000	NA	NA	$0.00
DHW Pathway 2	$265,117.00	$379.93	$0.00	$379.93	($350,237.05)	-7.0550%	-6.3339%	0.0224	NA	NA	$67.35

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.
Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.
Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.
Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.
Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.
Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$56,448.00
DHW Existing Replacement:	$6,129.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

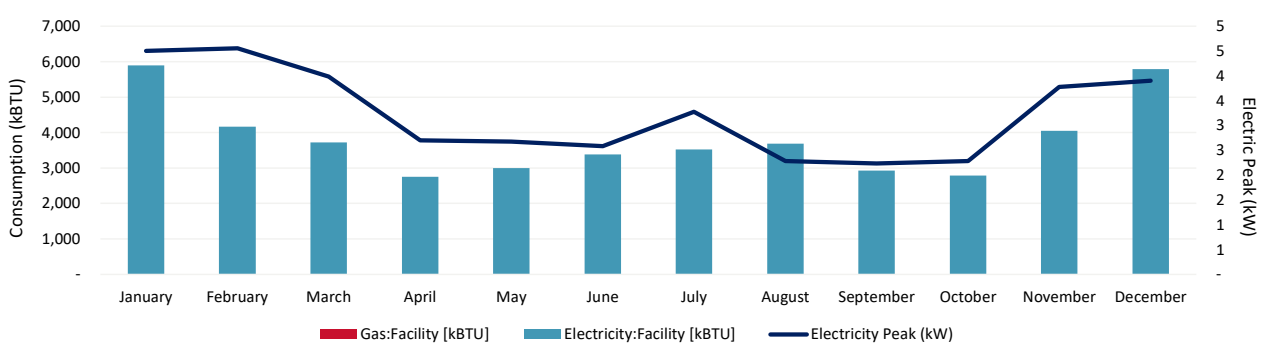
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Building Characteristics

Durham County | Bragtown Library Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	3200 Dearborn Dr, Durham, NC 27704	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Heat Pump
Building Type	Library	Cooling Generation	DX Mini-Split
Year Built	1964	Domestic Hot Water Generation	Electric Instanteneous Water Heater
Floor Area (ft2)	1,092	Heating / Cooling / Vent Distribution	Mini-Split
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

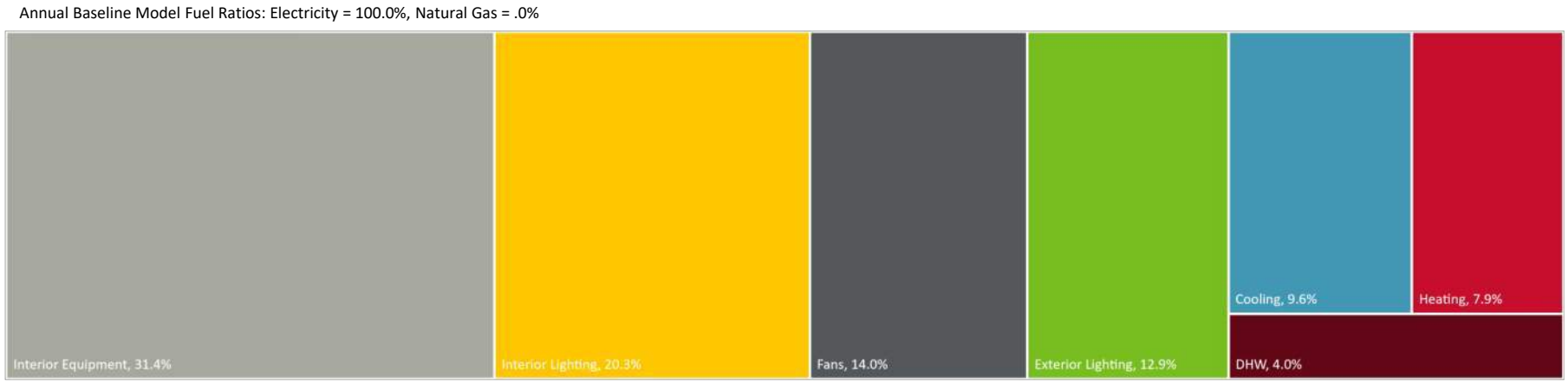


41.84 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	1,726.05	4.50	-
February	1,221.52	4.56	-
March	1,091.74	3.99	-
April	808.03	2.70	-
May	879.65	2.68	-
June	991.94	2.59	-
July	1,031.16	3.28	-
August	1,081.02	2.28	-
September	857.23	2.24	-
October	817.48	2.29	-
November	1,185.20	3.78	-
December	1,696.07	3.91	-
ANNUAL	13,387.06	-	-
PEAK	1,726.05	4.56	-

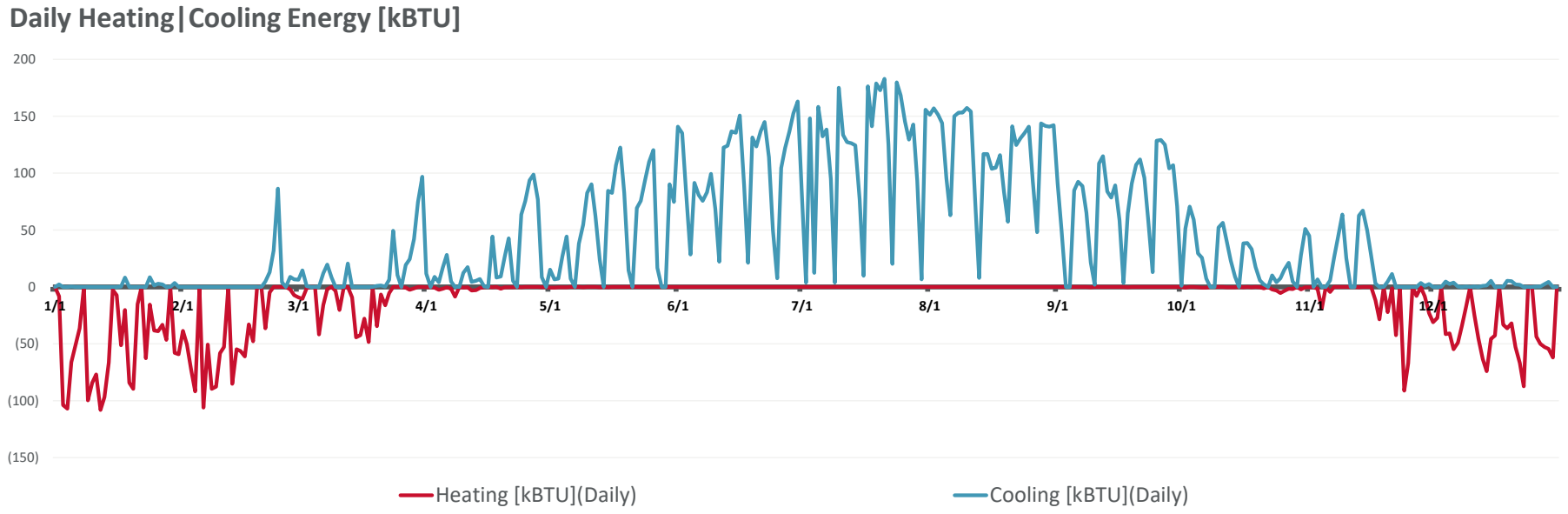
Annual Baseline Model Predicted End-Use Energy Disaggregation

Durham County | Bragtown Library End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 100.0%, Natural Gas = .0%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	Inverter drive heat pump, w/o electric resistance back-up
Domestic Hot Water	(1) instantaneous electric tankless water heater

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	13,414.8	0.0	41.9	0.0	0.0	0.0	NA	NA	13,414.8	0.0	41.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	$1,918.56	$0.00	$1.76						$1,918.56	$0.00	$1.76	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$1,918.56 $US								$1,918.56 $US			
Carbon	3.8	0.0	3.49	0.0	0.0	0.0	NA	NA	3.8	0.0	3.49	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	13,414.8	0.0	41.9	0.0	0.0	0.0	NA	NA	13,414.8	0.0	41.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	$1,918.56	$0.00	$1.76						$1,918.56	$0.00	$1.76	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$1,918.56 $US								$1,918.56 $US			
Carbon	3.8	0.0	3.49	0.0	0.0	0.0	NA	NA	3.8	0.0	3.49	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	13,414.8	0.0	41.9	NA	NA	NA	0.0	0.0	13,414.8	0.0	41.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	$1,918.56	$0.00	$1.76						$1,918.56	$0.00	$1.76	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$1,918.56 $US								$1,918.56 $US			
Carbon	3.8	0.0	3.49	NA	NA	NA	0.0	0.0	3.8	0.0	3.49	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	NA, already electric instantaneous

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	13,414.8	0.0	41.9	NA	NA	NA	0.0	0.0	13,414.8	0.0	41.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	45.8 MMBTU								45.8 MMBTU			
Energy Cost	$1,918.56	$0.00	$1.76						$1,918.56	$0.00	$1.76	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$1,918.56 $US								$1,918.56 $US			
Carbon	3.8	0.0	3.49	NA	NA	NA	0.0	0.0	3.8	0.0	3.49	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	3.8 MT CO2e								3.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
HVAC Pathway 2	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$14,492.00
DHW Existing Replacement:	$3,764.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Durham County | Center for Senior Life | Electrification Pathways

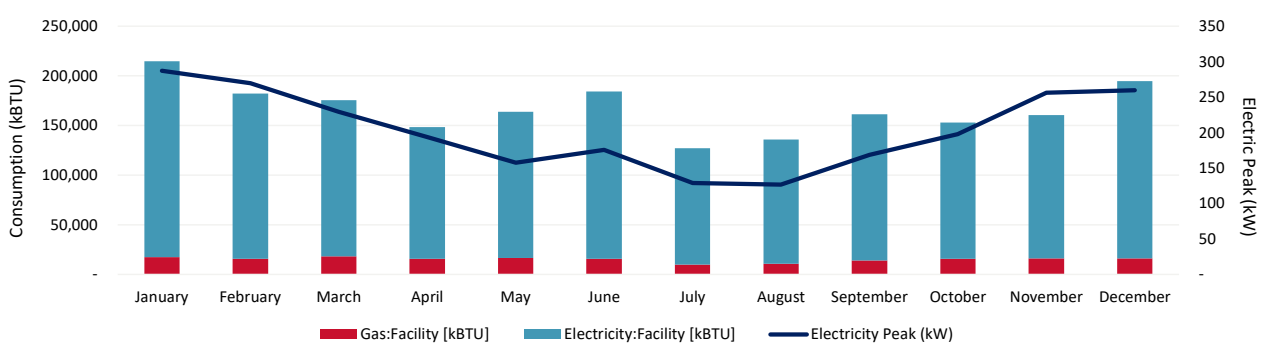
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Building Characteristics

Durham County | Center for Senior Life Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	406 Rigsbee Ave, Durham, NC 27701	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Electric Resistance
Building Type	Senior Center	Cooling Generation	Split-System DX
Year Built	2006 (2020 reno)	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	35,180	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	2	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	11
		Weekday Opening Time	Monday-Friday, 8:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

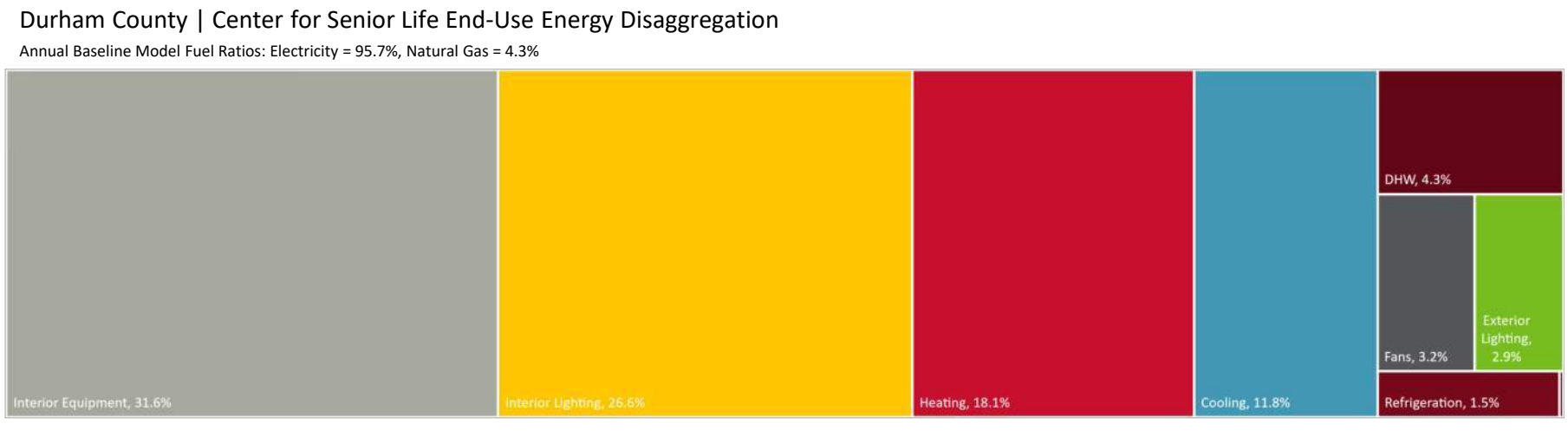


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

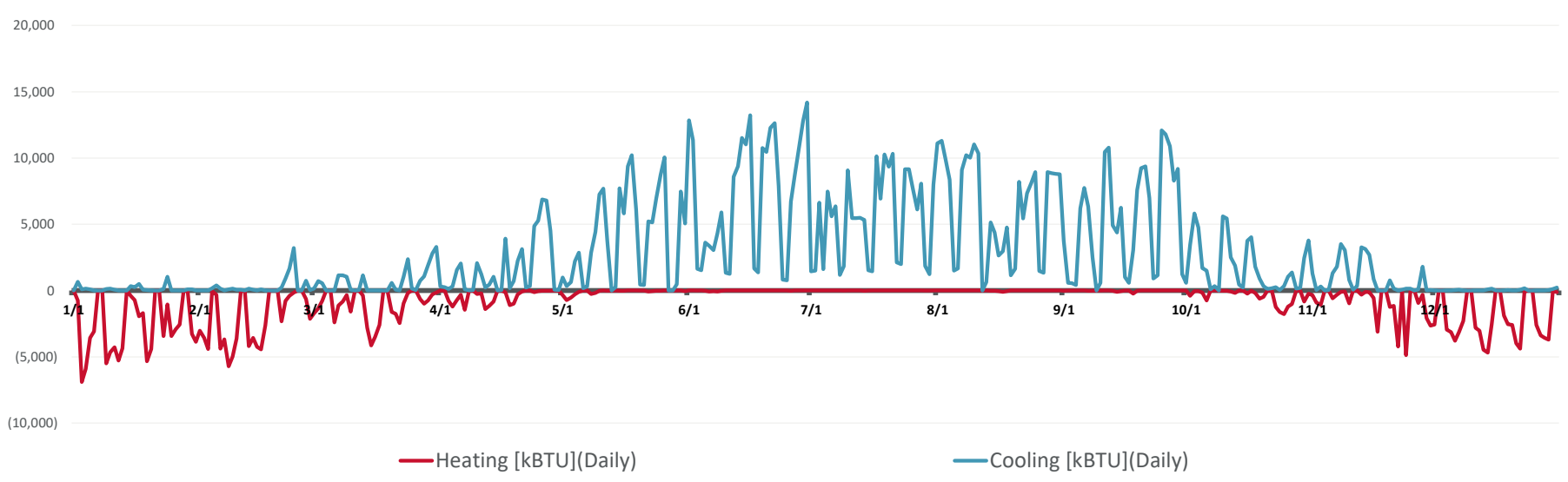


56.90 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	57,859.47	287.18	173.36
February	48,728.97	269.54	157.68
March	46,105.95	229.41	183.11
April	38,803.01	193.63	159.51
May	43,195.79	157.39	165.02
June	49,395.13	175.44	156.21
July	34,294.03	129.15	100.14
August	36,672.98	126.63	107.03
September	43,107.33	168.86	141.59
October	40,305.41	198.06	155.55
November	42,361.92	256.47	160.69
December	52,284.28	259.96	163.38
ANNUAL	533,114.28	-	1,823.27
PEAK	57,859.47	287.18	183.11

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) AHU-1 electric pre-heating coil, 40kw; (1) AHU-2 electric pre-heating coil, 20kw; (1) AHU-3 electric pre-heating coil, 20kw; (mult.) single-duct VAV terminal electric reheat, step control, approx. 300kw total;
Domestic Hot Water	(2) direct-vent condensing gas storage water heaters, 100 gallon, AO Smith BTH-199-970, 199 MBH input, 228 gph recovery, mfg. 2005, recirc pumps, 120F loop and 140F loop, water heaters manifolded

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**533,114.3**	**811.5**	**54.0**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**533,114.3**	**811.5**	**54.0**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,900.7 MMBTU								1,900.7 MMBTU			
Energy Cost	**$57,174.15**	**$997.61**	**$1.65**						**$57,174.15**	**$997.61**	**$1.65**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$58,171.76 $US								$58,171.76 $US			
Carbon	**151.4**	**4.3**	**4.42**	**0.0**	**0.0**	**0.0**	**NA**	**NA**	**151.4**	**4.3**	**4.42**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	155.7 MT CO2e								155.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace condensing unit CU-1 with (3) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 180 FLA @ 460V/3ph); *Replace condensing units CU-2&3 with (2) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 120 FLA @ 460V/3ph); *Replace (3) AHU DX coil sections, with hydronic coils; *Add (3) vertical inline pumps with VFDs (assume 3hp each)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**533,114.3**	**811.5**	**54.0**	**0.0**	**0.0**	**(42,005.1)**	**NA**	**NA**	**491,109.2**	**811.5**	**50.0**	**7.5%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,900.7 MMBTU								1,757.3 MMBTU			
Energy Cost	**$57,174.15**	**$997.61**	**$1.65**						**$51,847.62**	**$997.61**	**$1.50**	**9.2%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$58,171.76 $US								$52,845.23 $US			
Carbon	**151.4**	**4.3**	**4.42**	**0.0**	**0.0**	**(11.9)**	**NA**	**NA**	**139.4**	**4.3**	**4.09**	**7.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	155.7 MT CO2e								143.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace gas water heaters with (2) electric storage, 119 gallon, 54kw input, Bradford White model CEHD120(A)54 3*CF (total 108kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**533,114.3**	**811.5**	**54.0**	**NA**	**NA**	**NA**	**(811.5)**	**18,151.5**	**551,265.8**	**0.0**	**53.5**	**1.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,900.7 MMBTU								1,881.5 MMBTU			
Energy Cost	**$57,174.15**	**$997.61**	**$1.65**						**$58,751.72**	**$0.00**	**$1.67**	**-1.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$58,171.76 $US								$58,751.72 $US			
Carbon	**151.4**	**4.3**	**4.42**	**NA**	**NA**	**NA**	**(4.3)**	**5.2**	**156.5**	**0.0**	**4.45**	**-0.5%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	155.7 MT CO2e								156.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas boiler WH-1 with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (2) electric storage, 119 gallon, 54kw input, Bradford White model CEHD120(A)54 3*CF; (total 130kw + 108kw - non simultaneous)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**533,114.3**	**811.5**	**54.0**	**NA**	**NA**	**NA**	**(811.5)**	**3,696.5**	**536,810.8**	**0.0**	**52.1**	**3.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,900.7 MMBTU								1,832.1 MMBTU			
Energy Cost	**$57,174.15**	**$997.61**	**$1.65**						**$57,492.50**	**$0.00**	**$1.63**	**1.2%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$58,171.76 $US								$57,492.50 $US			
Carbon	**151.4**	**4.3**	**4.42**	**NA**	**NA**	**NA**	**(4.3)**	**1.0**	**152.4**	**0.0**	**4.33**	**2.1%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	155.7 MT CO2e								152.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$644,452.00	$0.00	$0.00	$0.00	($870,850.66)	NA	-100.0000%	0.0000	NA	NA	$0.00
HVAC Pathway 2	$3,764,558.00	$5,326.53	$0.00	$5,326.53	($4,974,670.67)	-7.0578%	-6.3638%	0.0221	NA	NA	$608.19
DHW Pathway 1	$31,823.00	($1,577.58)	$997.61	($579.96)	($52,863.02)	-9.0183%	NA	-0.2293	NA	NA	($42.99)
DHW Pathway 2	$560,639.00	($318.35)	$997.61	$679.26	($740,884.01)	-7.0356%	-6.3677%	0.0221	NA	NA	$166.31

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$37,697.00
DHW Existing Replacement:	$51,840.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

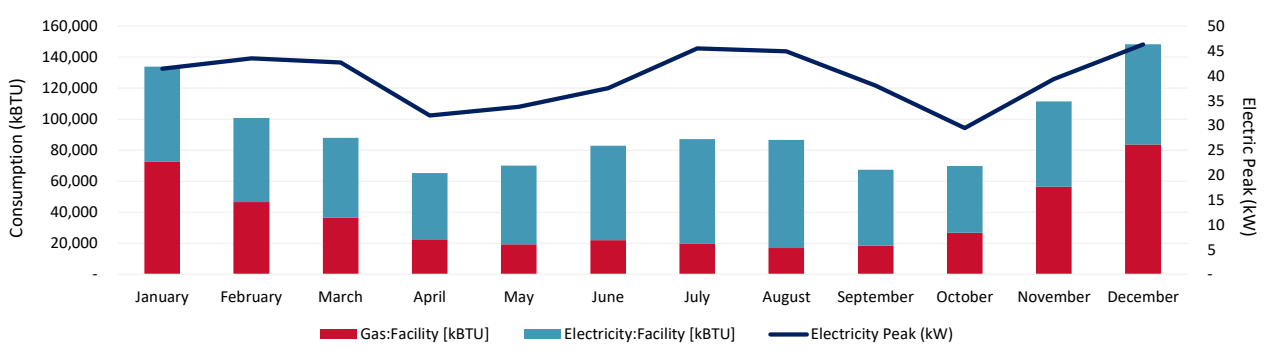
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Building Characteristics

Durham County | Community Shelter Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	412 Liberty St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Gas Furnance RTUs
Building Type	Shelter	Cooling Generation	DX RTUs
Year Built	2002	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	17,816	Heating / Cooling / Vent Distribution	CV Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

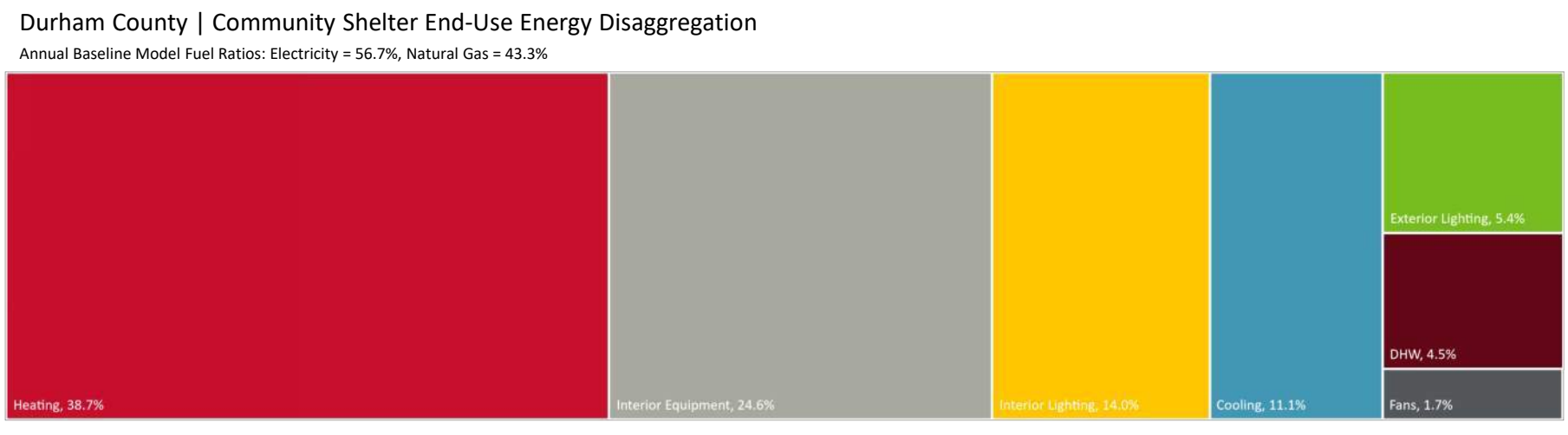


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

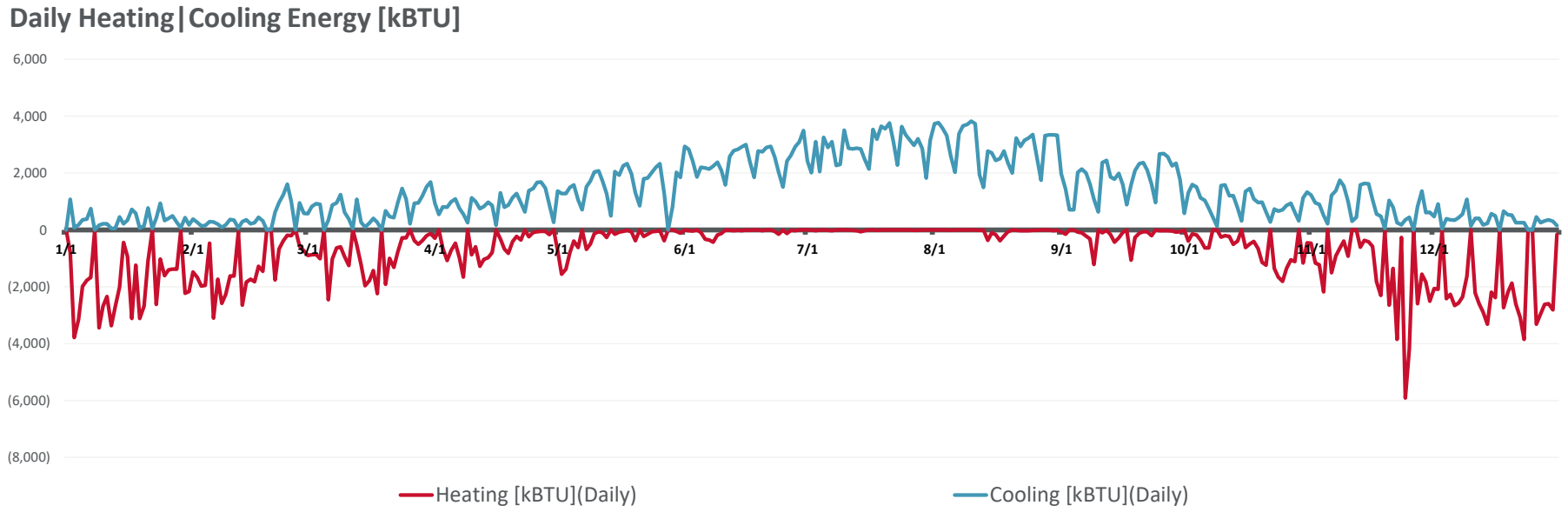


62.45 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	17,973.62	41.44	727.00
February	15,860.56	43.52	467.00
March	15,083.56	42.72	365.50
April	12,484.92	32.04	227.50
May	14,808.84	33.80	195.50
June	17,842.84	37.52	221.00
July	19,727.24	45.56	198.00
August	20,426.36	44.92	170.00
September	14,279.44	38.04	187.50
October	12,570.28	29.48	270.00
November	16,157.40	39.36	564.00
December	18,918.92	46.32	838.50
ANNUAL	196,133.98	-	4,431.50
PEAK	20,426.36	46.32	838.50

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	RTU gas furnaces, (1) RTU-3, 115 mbh input, 93 mbh ouptut; RTU heat-pump (2) nominal 10-ton heat pump; (1) "AHU-5" gas furnace, 115 mbh input, 93 mbh output; (3) RTU gas furnace, 72 mbh input, 59 mbh output; (2) Large commercial gas clothes dryers, 50-lb capacity, 145 mbh input each; (2) standard residential gas clothes dryers;
Domestic Hot Water	(1) Direct-vent condensing gas storage water heater, Rheem model GHE100SU-400A, mfg 2019, 100 gallon, 399 mbh input, 456 gph recovery, recirc pump; (1) Natural draft gas storage water heater, AO Smith model BTR-400A-118, 100 gallon, 390 mbh input, 378 gph recovery, mfg 1992, recirc pump;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace gas-fired RTUs with electric resistance coils.

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	0.0	(4,052.4)	81,884.7	NA	NA	278,018.7	1,049.7	59.2	10.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,179.6 MMBTU								1,053.8 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$31,962.08	$1,247.11	$1.86	-35.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$24,512.14 $US								$33,209.19 $US			
Carbon	55.7	27.1	4.65	0.0	(21.5)	23.2	NA	NA	78.9	5.6	4.74	-2.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	82.8 MT CO2e								84.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace (5) gas-fired RTUs with new heat-pump RTUs, (3) 3-ton heat-pump unit, w/ economizer, 9kw elec heat, Trane model WHC036; (1) 4-ton heat-pump unit, w/ economizer, 27kw elec heat, Trane model WHC048; (1) 6-ton heat-pump unit, w/ economizer, 27kw elec heat, Trane model WHC074; *Replace (3) gas clothes dryers with (1) lrg commercial electric dryer, 60kw, (2) standard residential electric clothes dryers

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	0.0	(4,052.4)	38,249.4	NA	NA	234,383.4	1,049.7	50.8	23.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,179.6 MMBTU								904.9 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$23,623.92	$1,247.11	$1.40	-1.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$24,512.14 $US								$24,871.03 $US			
Carbon	55.7	27.1	4.65	0.0	(21.5)	10.9	NA	NA	66.5	5.6	4.05	12.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	82.8 MT CO2e								72.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	Replace (2) gas water heaters with (4) electric storage water heaters, 119 gallon, 54kw input each (216 kw total)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	NA	NA	NA	(1,049.7)	23,031.3	219,165.2	4,052.4	64.7	2.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,179.6 MMBTU								1,153.2 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$20,550.66	$4,814.67	$1.42	-3.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$24,512.14 $US								$25,365.33 $US			
Carbon	55.7	27.1	4.65	NA	NA	NA	(5.6)	6.5	62.2	21.5	4.70	-1.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	82.8 MT CO2e								83.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	*Replace (2) gas water heaters with (4) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (4) electric storage, 119 gallon, 54kw input, Bradford White model CEHD120(A)54 3*CF; (total 260kw + 216kw - non simultaneous)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	196,134.0	5,102.0	66.2	NA	NA	NA	(1,049.7)	5,012.4	201,146.3	4,052.4	61.3	7.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	1,179.6 MMBTU								1,091.7 MMBTU			
Energy Cost	$18,450.36	$6,061.78	$1.38						$18,892.19	$4,814.67	$1.33	3.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$24,512.14 $US								$23,706.86 $US			
Carbon	55.7	27.1	4.65	NA	NA	NA	(5.6)	1.4	57.1	21.5	4.41	5.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	82.8 MT CO2e								78.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	-$76,192.17	($13,511.71)	$4,814.67	($8,697.04)	($69,080.76)	NA	NA	NA	NA	NA	($87.89)
HVAC Pathway 2	-$45,939.17	($5,173.56)	$4,814.67	($358.89)	$65,977.09	NA	NA	NA	NA	NA	$543.91
DHW Pathway 1	$86,338.00	($2,100.30)	$1,247.11	($853.19)	($131,700.06)	-8.3164%	NA	-0.1288	NA	NA	($49.13)
DHW Pathway 2	$1,147,479.00	($441.83)	$1,247.11	$805.28	($1,530,629.86)	-7.1341%	-7.6194%	0.0129	NA	NA	$211.76

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$210,211.00
DHW Existing Replacement:	$84,548.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

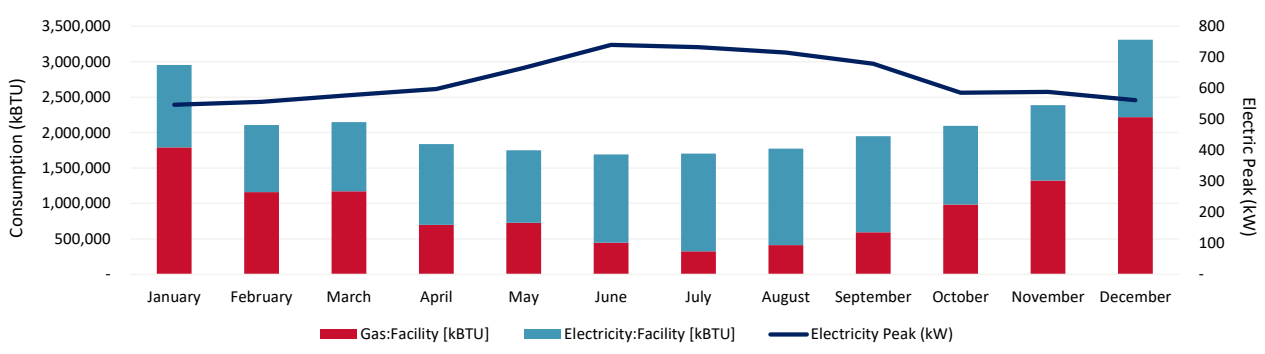
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Building Characteristics

Durham County | Detention Center Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	219 S Mangum St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Steam Boiler
Building Type	Detention Center	Cooling Generation	Water-Cooled Chiller
Year Built	1996	Domestic Hot Water Generation	Steam Conversation Water Heater
Floor Area (ft2)	290,919	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	8	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

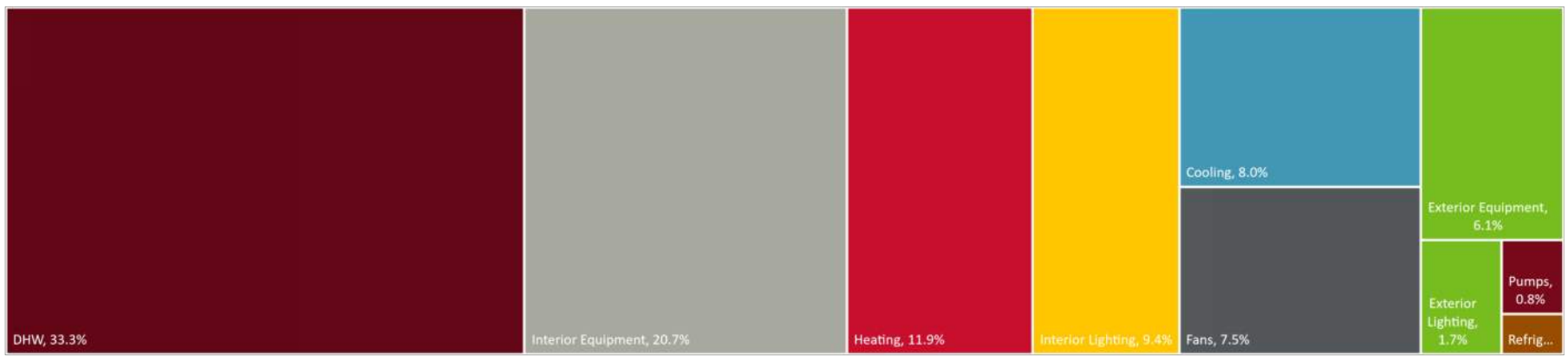


88.34 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	340,672.67	546.84	17,910.00
February	277,107.48	556.56	11,590.00
March	286,112.16	577.80	11,705.00
April	332,652.95	597.24	7,005.00
May	299,910.96	666.00	7,295.00
June	363,469.32	739.80	4,510.00
July	403,601.76	732.96	3,275.00
August	398,194.56	714.96	4,155.00
September	397,277.64	679.32	5,915.00
October	325,185.48	586.08	9,845.00
November	310,484.88	588.60	13,250.00
December	319,424.76	561.96	22,190.00
ANNUAL	4,054,094.63	-	118,645.00
PEAK	403,601.76	739.80	22,190.00

Annual Baseline Model Predicted End-Use Energy Disaggregation

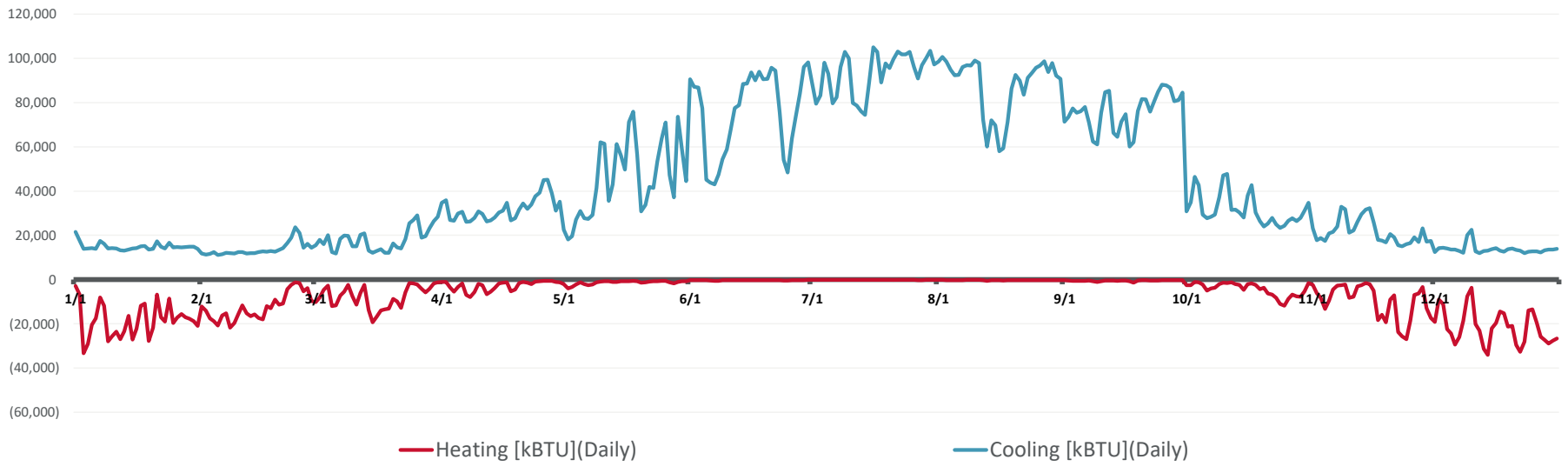
Durham County | Detention Center End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 54.8%, Natural Gas = 45.2%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(2) Steam boilers, unknown capacity, assumed 500 BHP each, 17250 lbs/hr, 20922 mbh nat. gas input each, estimated based on feedwater pump nameplate; Heating water boilers - (2?) Camus "DynaForce" 2000 Mbh input, 1896 Mbh output, direct-vent condensing, unknown design water temps;(3?) Laundry clothes dryers - 270 Mbh input nat. gas;
Domestic Hot Water	1000 gallon storage tank, unkown heating capacity, assumed to be steam converters

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification

*Replace steam boilers with (4) electric steam boilers, 2480kw each, 9.92 MW total, Cleaver-Brooks HSB-425, 2987A @ 460V/3ph each;
*Replace heating water boilers with (2) electric boilers, 445kw each (890 kw total), 8-step control, Lochinvar BWX3-445C;
*Replace (3?) laundry clothes dryers with electric, 60kw input each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	0.0	(34,751.1)	770,103.1	NA	NA	4,824,197.7	79,419.6	83.9	3.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	25,253.6 MMBTU								24,406.8 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$432,443.62	$24,528.61	$1.57	-16.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$392,299.19 $US								$456,972.23 $US			
Carbon	1,151.0	606.4	6.04	0.0	(184.6)	218.6	NA	NA	1,369.6	421.8	6.16	-1.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	1,757.4 MT CO2e								1,791.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification

*Replace steam boilers with (4) electric steam boilers, 2480kw each, 9.92 MW total, Cleaver-Brooks HSB-425, 2987A @ 460V/3ph each;
*Replace heating water boilers with (8) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 480 FLA @ 460V/3ph);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	0.0	(34,751.1)	734,031.8	NA	NA	4,788,126.4	79,419.6	83.5	3.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	25,253.6 MMBTU								24,283.7 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$429,212.93	$24,528.61	$1.56	-15.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$392,299.19 $US								$453,741.55 $US			
Carbon	1,151.0	606.4	6.04	0.0	(184.6)	208.4	NA	NA	1,359.4	421.8	6.12	-1.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	1,757.4 MT CO2e								1,781.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification

*Included in HVAC electrification via assumed steam to DHW converters

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	NA	NA	NA	(79,419.6)	1,750,598.5	5,804,693.1	34,751.1	80.0	7.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	25,253.6 MMBTU								23,286.4 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$526,094.61	$10,732.84	$1.85	-36.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$392,299.19 $US								$536,827.45 $US			
Carbon	1,151.0	606.4	6.04	NA	NA	NA	(421.8)	497.0	1,648.0	184.6	6.30	-4.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	1,757.4 MT CO2e								1,832.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification

*Included in HVAC electrification via assumed steam to DHW converters

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,054,094.6	114,170.7	86.8	NA	NA	NA	(79,419.6)	1,750,598.5	5,804,693.1	34,751.1	80.0	7.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	25,253.6 MMBTU								23,286.4 MMBTU			
Energy Cost	$357,037.73	$35,261.45	$1.35						$526,094.61	$10,732.84	$1.85	-36.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$392,299.19 $US								$536,827.45 $US			
Carbon	1,151.0	606.4	6.04	NA	NA	NA	(421.8)	497.0	1,648.0	184.6	6.30	-4.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	1,757.4 MT CO2e								1,832.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$1,130,715.00	($75,405.88)	$10,732.84	($64,673.04)	($2,866,997.42)	NA	NA	-0.8764	NA	NA	($1,736.79)
HVAC Pathway 2	$1,746,436.00	($72,175.20)	$10,732.84	($61,442.36)	($3,630,854.81)	NA	NA	-0.5385	NA	NA	($1,214.51)
DHW Pathway 1	$0.00	($169,056.87)	$24,528.61	($144,528.26)	($2,991,167.86)	NA	NA	NA	NA	NA	($3,833.43)
DHW Pathway 2	$0.00	($169,056.87)	$24,528.61	($144,528.26)	($2,991,167.86)	NA	NA	NA	NA	NA	($3,833.43)

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.
Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.
Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.
Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.
Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.
Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$1,108,440.00
DHW Existing Replacement:	$6,633.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Durham County | Courthouse | Electrification Pathways

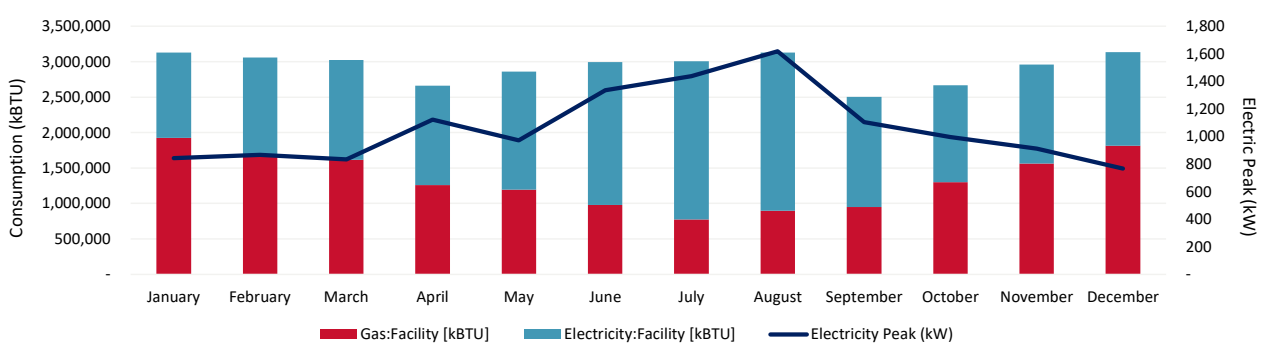
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Building Characteristics

Durham County | Courthouse Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	510 S Dillard St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Fire-Tube Boiler
Building Type	Courthouse	Cooling Generation	Water-Cooled Chiller
Year Built	2013	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	318,533	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	10	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

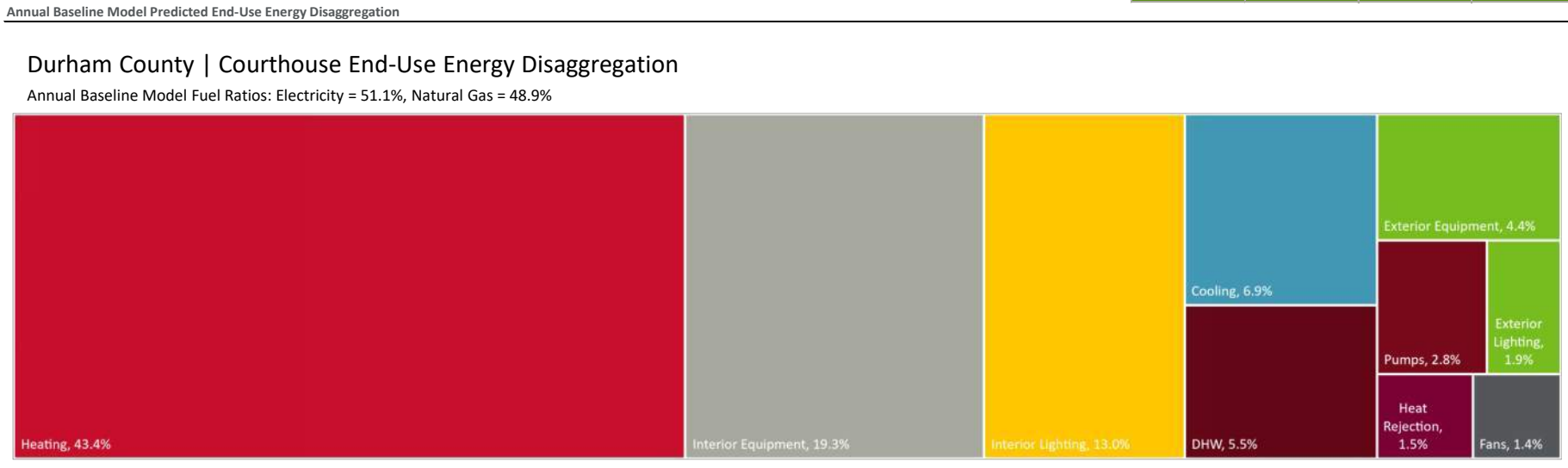


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

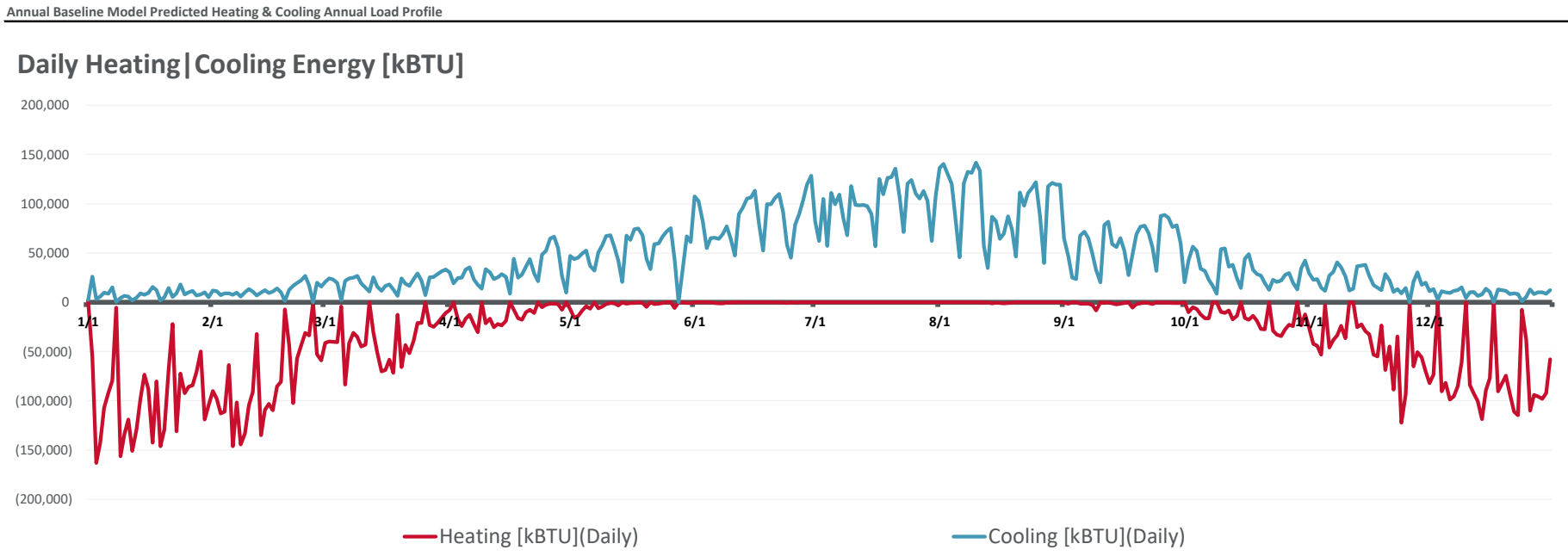


110.28 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	352,210.81	843.60	19,280.00
February	406,627.20	868.00	16,725.00
March	413,037.20	832.80	16,135.00
April	410,062.40	1,122.80	12,610.00
May	487,783.60	970.80	11,945.00
June	590,510.40	1,336.40	9,810.00
July	654,504.80	1,437.20	7,730.00
August	654,228.40	1,618.00	8,965.00
September	454,100.40	1,105.20	9,520.00
October	400,857.20	994.80	12,985.00
November	408,729.60	912.80	15,630.00
December	387,885.20	767.60	18,130.00
ANNUAL	5,620,537.21	-	159,465.00
PEAK	654,504.80	1,618.00	19,280.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(2) fire-tube heating water boilers, 300BHP, Superior Boiler W7-X-1500, 12553 mbh input nat. gas, design 180F LWT 160F EWT, CV primary pumps, VV secondary pumps w/ VFDs
Domestic Hot Water	(2) gas-fired storage domestic water heaters w/ recirc pumps; design scheduled 400 gallon storage, 399 MBH input nat. gas, no nameplate info

HVAC Space Heating Pathway 1

Pathway 1 | Electrification — Replace boilers with (3) electric steam boilers, 1960 kw each, 5.88 MW total, Cleaver-Brooks HSB-424, 2361A @ 460V/3ph each;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	0.0	(165,123.4)	3,515,901.3	NA	NA	9,136,438.5	18,631.4	103.7	12.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	37,558.2 MMBTU								33,045.5 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$959,428.74	$5,094.72	$3.03	-71.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$563,902.92 $US								$964,523.45 $US			
Carbon	1,595.7	976.0	8.07	0.0	(877.0)	998.2	NA	NA	2,593.9	99.0	8.45	-4.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,571.7 MT CO2e								2,692.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification — Replace boilers with (3) electric steam boilers, 1960 kw each, 5.88 MW total, Cleaver-Brooks HSB-424, 2361A @ 460V/3ph each;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	0.0	(165,123.4)	3,515,901.3	NA	NA	9,136,438.5	18,631.4	103.7	12.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	37,558.2 MMBTU								33,045.5 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$959,428.74	$5,094.72	$3.03	-71.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$563,902.92 $US								$964,523.45 $US			
Carbon	1,595.7	976.0	8.07	0.0	(877.0)	998.2	NA	NA	2,593.9	99.0	8.45	-4.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,571.7 MT CO2e								2,692.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification — Replace WHs with (2) electric storage water heater, 400 gallon, 108 kw; Lochinvar CHVX108-400, 130A @ 480V/3ph

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	NA	NA	NA	(18,631.4)	426,240.7	6,046,777.9	165,123.4	116.6	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	37,558.2 MMBTU								37,149.8 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$552,895.02	$45,152.76	$1.88	-6.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$563,902.92 $US								$598,047.78 $US			
Carbon	1,595.7	976.0	8.07	NA	NA	NA	(99.0)	121.0	1,716.7	877.0	8.14	-0.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,571.7 MT CO2e								2,593.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification — Replace gas WHs with (4) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (2) 400 gallon HW storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	5,620,537.2	183,754.7	117.9	NA	NA	NA	(18,631.4)	79,796.3	5,700,333.5	165,123.4	112.9	4.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	37,558.2 MMBTU								35,967.4 MMBTU			
Energy Cost	$513,655.44	$50,247.48	$1.77						$520,868.37	$45,152.76	$1.78	-0.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$563,902.92 $US								$566,021.13 $US			
Carbon	1,595.7	976.0	8.07	NA	NA	NA	(99.0)	22.7	1,618.3	877.0	7.83	3.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,571.7 MT CO2e								2,495.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$1,476,209.22	($445,773.30)	$45,152.76	($400,620.54)	($10,340,498.81)	NA	NA	-4.1837	NA	NA	($6,177.44)
HVAC Pathway 2	$1,476,209.22	($445,773.30)	$45,152.76	($400,620.54)	($10,340,498.81)	NA	NA	-4.1837	NA	NA	($6,177.44)
DHW Pathway 1	$22,350.00	($39,239.58)	$5,094.72	($34,144.86)	($738,534.62)	NA	NA	-23.4535	NA	NA	($1,124.60)
DHW Pathway 2	$939,038.00	($7,212.93)	$5,094.72	($2,118.21)	($1,301,481.86)	-7.4524%	NA	-0.0257	NA	NA	$3,891.59

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

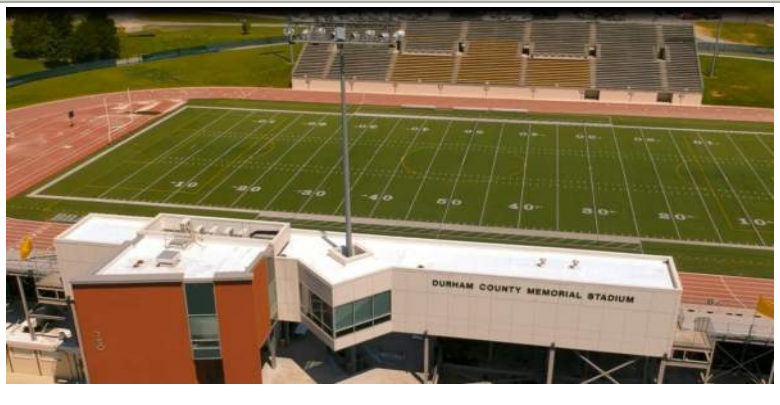
HVAC Existing Replacement:	$597,976.00
DHW Existing Replacement:	$161,933.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

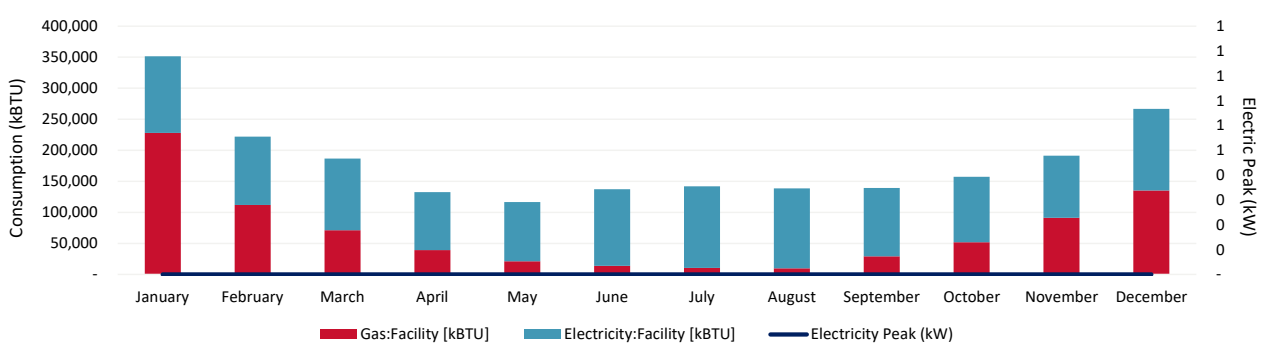
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Building Characteristics

Durham County | Durham County Stadium Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	750 Stadium Dr, Durham, NC 27704	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Direct Fired MAU
Building Type	Stadium/Arena	Cooling Generation	Packaged DX
Year Built	2010 reno	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	14,773	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	2	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Metal Panel	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	Varies
		Weekday Opening Time	Varies
		Weekend Operating Hours	Varies
		Weekend Opening Time	Varies



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary



147.74 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	36,168.34	-	2,278.50
February	32,114.92	-	1,122.50
March	33,812.86	-	715.00
April	27,346.82	-	394.50
May	27,982.58	-	210.00
June	36,237.18	-	136.00
July	38,585.74	-	105.00
August	37,861.44	-	96.00
September	32,416.14	-	289.00
October	30,890.76	-	517.50
November	29,480.66	-	910.50
December	38,429.46	-	1,353.50
ANNUAL	401,326.90	-	8,128.00
PEAK	38,585.74	-	2,278.50

Annual Baseline Model Predicted End-Use Energy Disaggregation

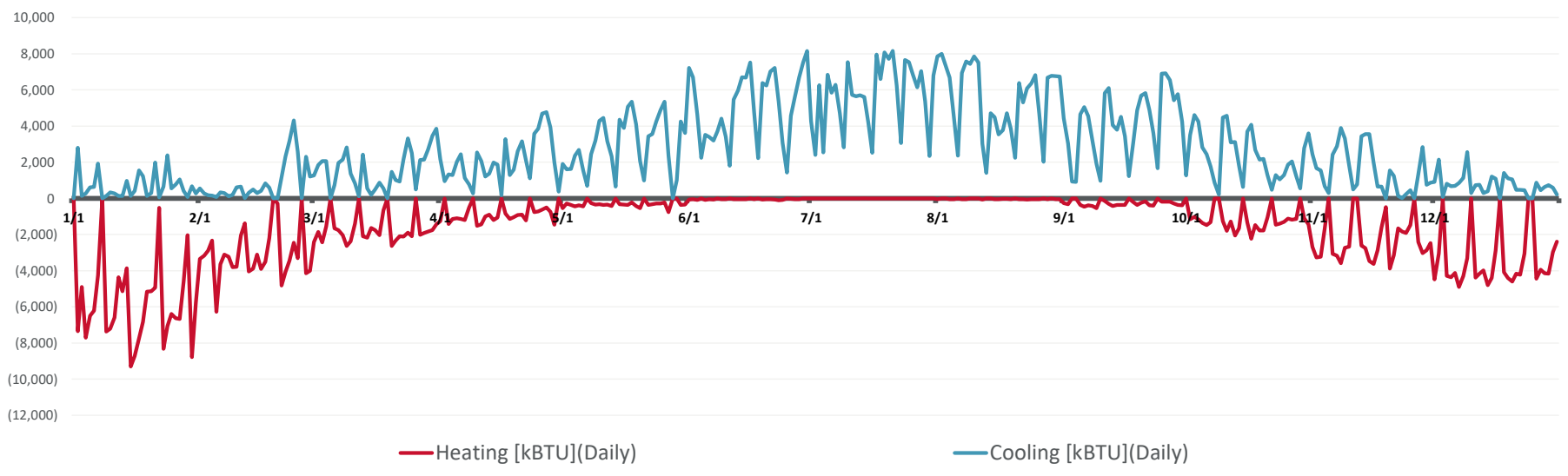
Durham County | Durham County Stadium End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 61.1%, Natural Gas = 38.9%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(3) Indoor make-up air units, 140 MBH direct-fired natural gas; (6) Outdoor make-up air units, 140 MBH direct-fired natural gas; (4) Gas-fired tube radiant heaters, total 210 mbh input; (13) Electric unit heaters, various capacity, total 28 kw; (5) PTAC elec heaters, 18.6 kw total; (5) VRF heat-pump w/o resistance heat, nominal 3-ton outdoor units
Domestic Hot Water	(2) direct-vent NG storage water heaters, 130 gallon, 399 mbh input, 465 gph recovery, paralleled, with recirc pump; State model SUF130400NE, mfg. 2010 (1) direct-vent NG storage water heaters, 100 gallon, 150 mbh input, 178 gph recovery, with recirc pump; State model SUF100150NE, mfg 2021 (1) electric storage water heater, 19 gallon, 1650 W; State model ES620, mfg. 2010; (1) electric storage water heater, 80 gallon, 6 kW, State model PCE822, mfg. 2010; (1) electric storage water heater, 40 gallon, 9 kW, State model PCE402, mfg. 2009;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification

*Replace (3) indoor make-up air units w/ electric heat, 35kw resistance heater, Greenheck model # MSX-P115-H12-MF
*Replace gas-fired tube radiant heaters with (18) electric radiant - Wattco JAD Series Type 1, 3.8kw each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	0.0	(7,649.1)	170,356.6	NA	NA	571,683.5	1,067.5	139.3	8.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,241.4 MMBTU								2,057.9 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$53,489.42	$1,211.60	$3.70	-14.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$47,829.37 $US								$54,701.02 $US			
Carbon	113.9	46.3	10.85	0.0	(40.6)	48.4	NA	NA	162.3	5.7	11.37	-4.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	160.2 MT CO2e								168.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification

"Simple" +
*Replace outdoor make-up air units with (6) Heat-pump DOAS 10-ton nominal, AAON model RN-010, 35kw electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	0.0	(7,649.1)	59,539.4	NA	NA	460,866.3	1,067.5	113.7	25.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,241.4 MMBTU								1,679.7 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$43,039.15	$1,211.60	$3.00	7.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$47,829.37 $US								$44,250.75 $US			
Carbon	113.9	46.3	10.85	0.0	(40.6)	16.9	NA	NA	130.8	5.7	9.24	14.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	160.2 MT CO2e								136.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification

*Replace 119gal gas WHs with (1) electric boiler, 220 kw input w/ 2 x 119 gallon storage tanks. *Replace 100gal gas WH with (1) electric storage water heater, 119 gallon, 13.5 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	NA	NA	NA	(1,067.5)	24,386.6	425,713.5	7,649.1	150.1	1.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,241.4 MMBTU								2,217.9 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$39,861.03	$8,681.73	$3.29	-1.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$47,829.37 $US								$48,542.76 $US			
Carbon	113.9	46.3	10.85	NA	NA	NA	(5.7)	6.9	120.9	40.6	10.93	-0.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	160.2 MT CO2e								161.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification

*Replace 119gal gas WHs with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ 2 x 119 gallon storage tanks. *Replace 100gal gas WH with (1) air-source heat pump water heater (Lochinvar model AHP060, 13.5 kw input, 4.6 COP) + (1) 75 gallon storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	401,326.9	8,716.6	151.7	NA	NA	NA	(1,067.5)	4,594.6	405,921.5	7,649.1	145.6	4.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,241.4 MMBTU								2,150.3 MMBTU			
Energy Cost	$37,936.03	$9,893.34	$3.24						$38,301.80	$8,681.73	$3.18	1.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$47,829.37 $US								$46,983.54 $US			
Carbon	113.9	46.3	10.85	NA	NA	NA	(5.7)	1.3	115.2	40.6	10.55	2.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	160.2 MT CO2e								155.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	-$154,609.52	($15,553.39)	$8,681.73	($6,871.65)	$84,615.67	NA	NA	NA	NA	NA	($394.58)
HVAC Pathway 2	-$48,042.02	($5,103.11)	$8,681.73	$3,578.62	$161,116.23	NA	NA	NA	NA	NA	$1,209.95
DHW Pathway 1	-$6,825.00	($1,924.99)	$1,211.60	($713.39)	($2,943.32)	NA	NA	NA	NA	NA	($63.93)
DHW Pathway 2	$459,502.00	($365.77)	$1,211.60	$845.84	($600,192.52)	-6.9138%	-5.3919%	0.0334	NA	NA	$222.64

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.
Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.
Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.
Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.
Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.
Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$510,183.00
DHW Existing Replacement:	$120,722.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

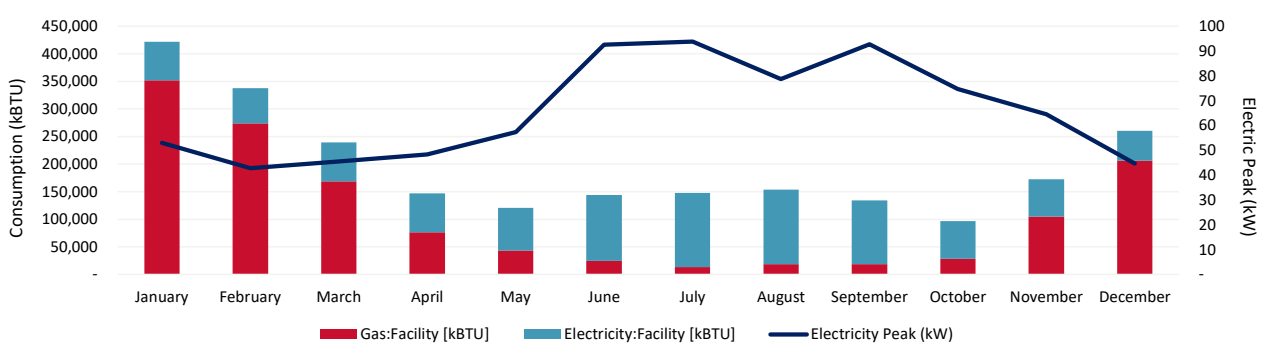
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Building Characteristics

Durham County | Durham County Warehouse Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	4527 Hillsborough Rd, Durham, NC 27705	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Warehouse	Cooling Generation	Packaged DX
Year Built	2000	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	53,520	Heating / Cooling / Vent Distribution	RTUs
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Varies		
Wally Type	Metal	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED/Fluorescent	Weekday Operating Hours	Varies
		Weekday Opening Time	Varies
		Weekend Operating Hours	Varies
		Weekend Opening Time	Varies

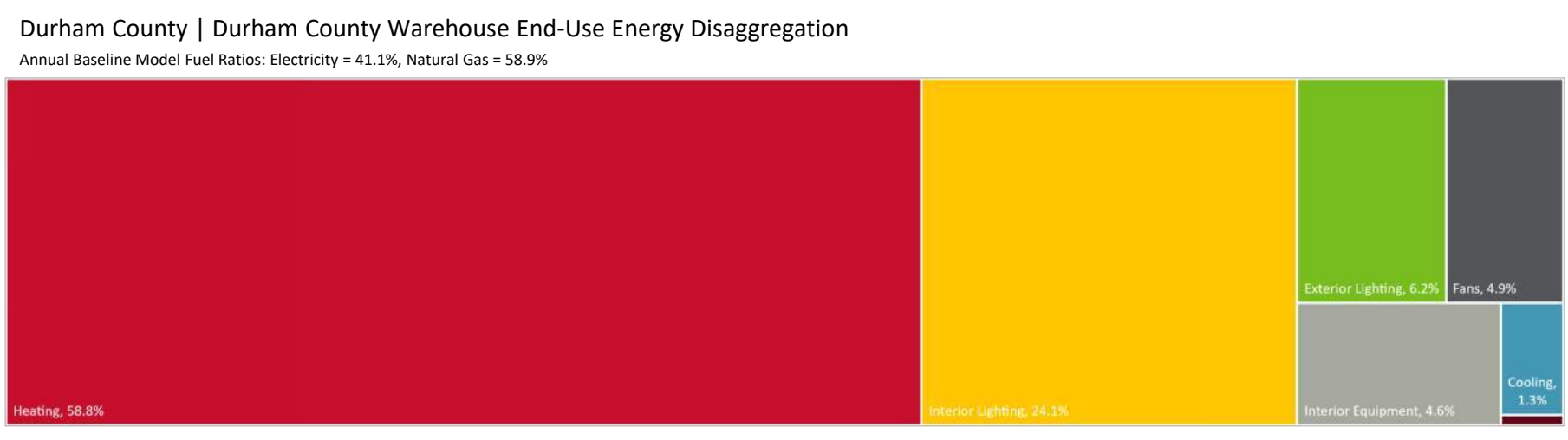


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

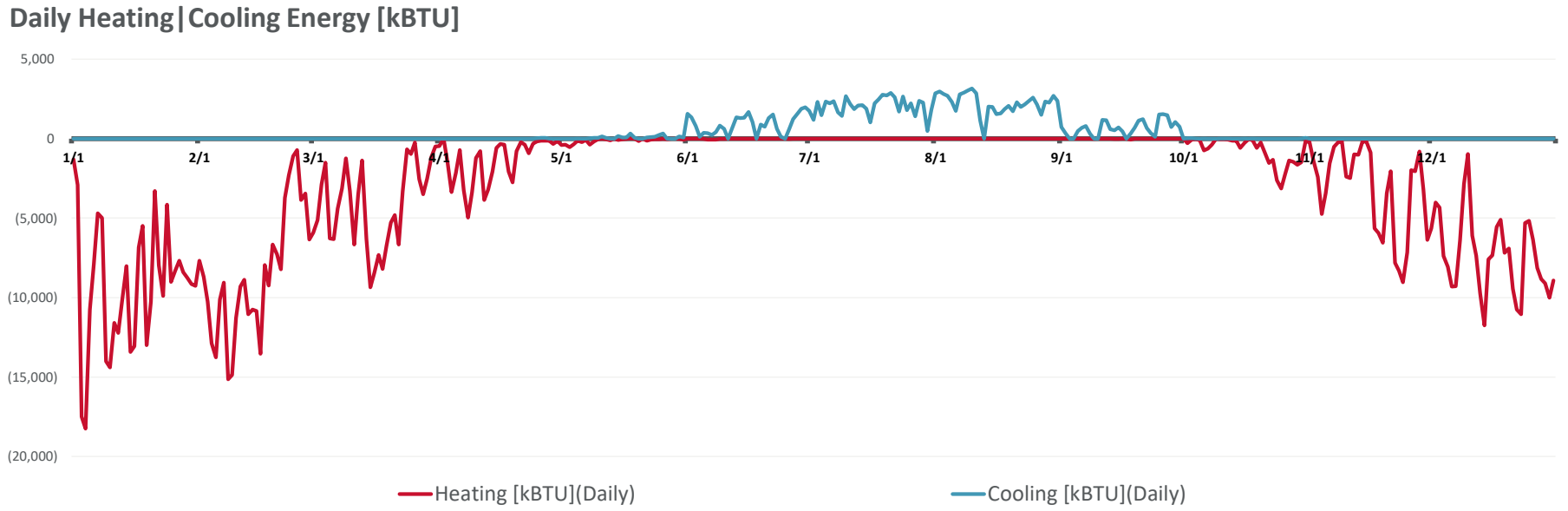


44.37 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	20,513.40	53.04	3,520.00
February	18,743.64	42.80	2,737.50
March	20,769.28	45.48	1,684.00
April	20,564.92	48.28	764.50
May	22,803.20	57.36	431.00
June	34,797.56	92.56	249.00
July	39,400.76	93.80	131.50
August	39,485.24	78.68	189.00
September	33,922.68	92.68	183.00
October	20,071.00	74.68	283.00
November	19,673.40	64.60	1,052.00
December	15,689.24	44.72	2,064.50
ANNUAL	306,434.32	-	13,289.00
PEAK	39,485.24	93.80	3,520.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU gas furnace, 200mbh input; (3) RTU gas furnace, 150mbh input; (1) RTU gas furnace, 400mbh input; (4) Gas-fired unit heaters, unknown capacity
Domestic Hot Water	(1) gas-fired natural draft storage water heater, 50 gallon, 36 mbh input, Rheem model PROG50-36N, mfg. date 09/2023

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (4) electric 3.5kw unit heater. *Replace RTUs with heat-pump units w/ elec heat- (1) 10T heat pump RTU, 54kw electric heat, Trane WHC120; (5) 20T heat pump RTU, 36kw electric heat, Trane WHJ240;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	0.0	(14,963.6)	308,196.9	NA	NA	614,631.2	25.0	39.2	17.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,544.7 MMBTU								2,100.2 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$64,509.79	$28.18	$1.21	-40.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$45,799.63 $US								$64,537.96 $US			
Carbon	87.0	79.6	3.11	0.0	(79.5)	87.5	NA	NA	174.5	0.1	3.26	-4.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	166.6 MT CO2e								174.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas unit heaters with (4) electric 3.5kw unit heater. *Replace RTUs with heat-pump units (1) 10T heat pump RTU, Trane WHC120; (5) 20T heat pump RTU, Trane WHJ240;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	0.0	(14,963.6)	225,497.0	NA	NA	531,931.3	25.0	34.0	28.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,544.7 MMBTU								1,818.0 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$54,726.37	$28.18	$1.02	-19.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$45,799.63 $US								$54,754.54 $US			
Carbon	87.0	79.6	3.11	0.0	(79.5)	64.0	NA	NA	151.0	0.1	2.82	9.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	166.6 MT CO2e								151.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 50 gallon, 9 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	NA	NA	NA	(25.0)	582.5	307,016.8	14,963.6	47.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,544.7 MMBTU								2,544.2 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$28,990.50	$16,832.51	$0.86	-0.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$45,799.63 $US								$45,823.01 $US			
Carbon	87.0	79.6	3.11	NA	NA	NA	(0.1)	0.2	87.2	79.5	3.11	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	166.6 MT CO2e								166.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 119 gallon, 12 kw input, 4.2 COP, Lochinvar CHPA120PD

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	306,434.3	14,988.6	47.5	NA	NA	NA	(25.0)	104.6	306,538.9	14,963.6	47.5	0.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,544.7 MMBTU								2,542.6 MMBTU			
Energy Cost	$28,938.95	$16,860.68	$0.86						$28,948.03	$16,832.51	$0.86	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$45,799.63 $US								$45,780.54 $US			
Carbon	87.0	79.6	3.11	NA	NA	NA	(0.1)	0.0	87.0	79.5	3.11	0.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	166.6 MT CO2e								166.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$371,471.30	($35,570.84)	$16,832.51	($18,738.33)	($857,250.77)	NA	NA	-0.7078	NA	NA	($408.99)
HVAC Pathway 2	$560,236.30	($25,787.42)	$16,832.51	($8,954.91)	($905,895.07)	-8.7356%	NA	-0.1966	NA	NA	$788.42
DHW Pathway 1	$6,346.00	($51.55)	$28.18	($23.38)	($9,001.51)	-7.6970%	NA	-0.0497	NA	NA	($1.65)
DHW Pathway 2	$40,407.00	($9.09)	$28.18	$19.09	($54,132.21)	-7.1808%	-8.5449%	0.0086	NA	NA	$5.27

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$324,778.00
DHW Existing Replacement:	$3,712.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

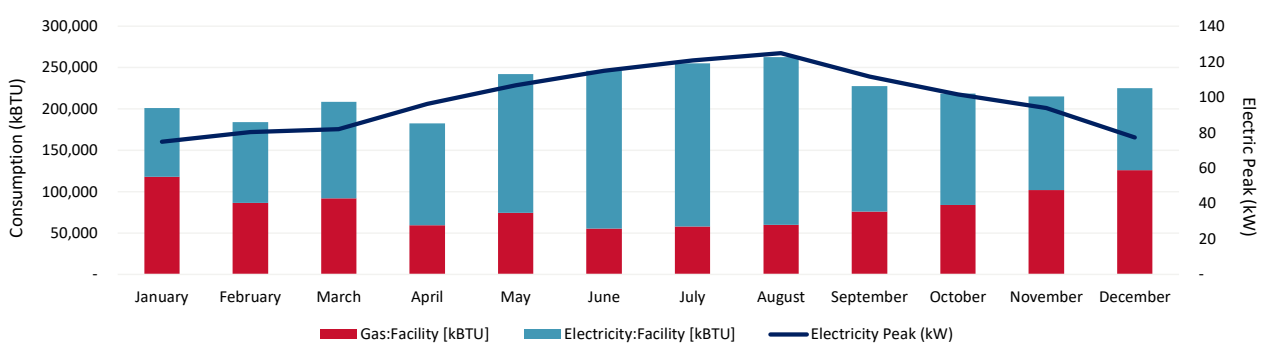
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Building Characteristics

Durham County | East Regional Library Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	211 Lick Creek Ln, Durham, NC 27703	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2005	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	26,649	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

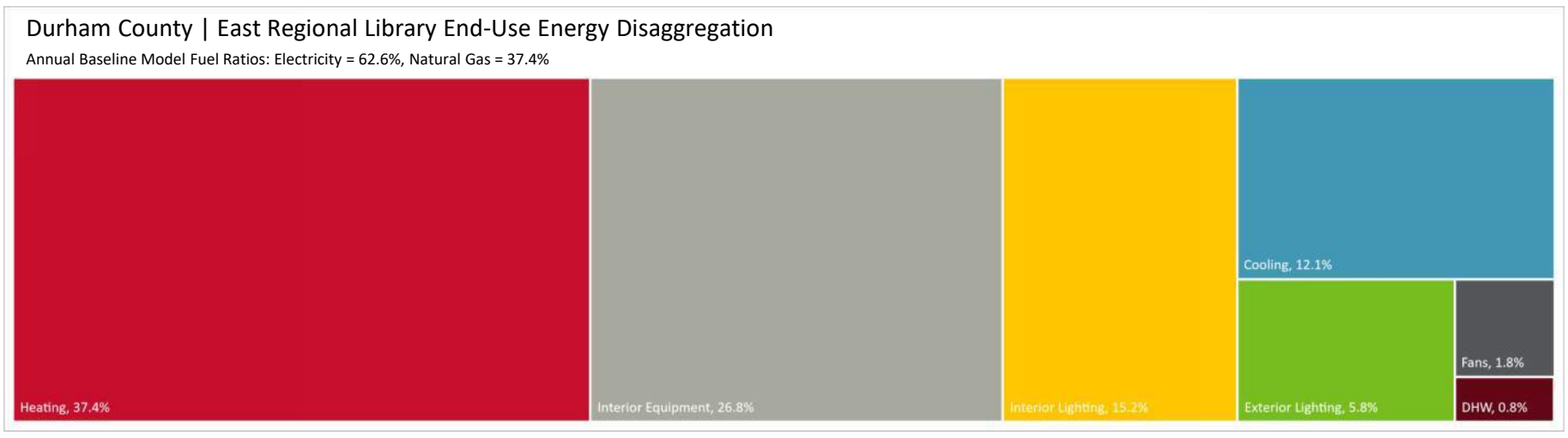


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

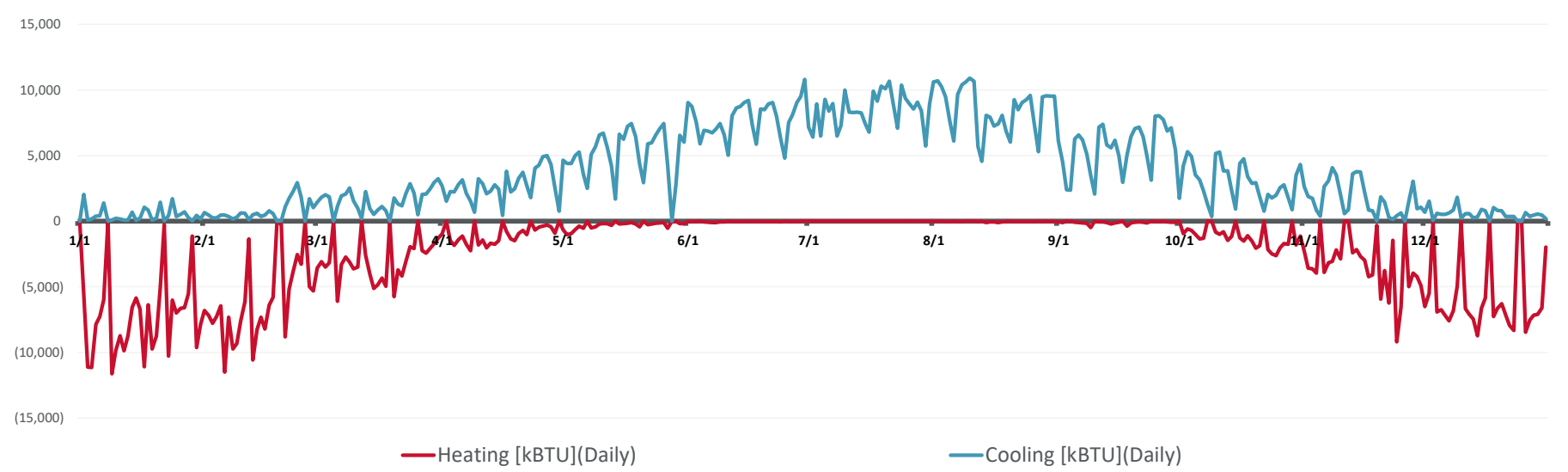


100.15 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	24,467.68	74.84	1,178.00
February	28,558.20	80.28	865.00
March	34,276.72	81.84	918.50
April	36,135.56	96.20	594.50
May	49,141.36	106.76	744.00
June	55,891.20	114.80	556.00
July	57,767.60	120.72	578.00
August	59,362.72	124.80	600.50
September	44,432.76	111.60	760.00
October	39,450.00	101.44	837.50
November	33,112.44	93.92	1,021.00
December	29,010.18	77.20	1,258.50
ANNUAL	491,606.42	-	9,911.50
PEAK	59,362.72	124.80	1,258.50

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 1530 MBH, Output: 1265 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 160 deg F, LWT: 180 deg F, Controls: Heat-Timer SQ Elite 8T Sequencing Controller (for multi-stage control)
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE8220RTA), fuel: electric resistance, capacity: 4000W 1PH/3PH Interlock & 8000W 1PH-3PH Simultaneous, Volume: 80 gal rated, Location: Janitor's Closet off of Lobby

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	0.0	(10,041.5)	261,576.0	NA	NA	753,182.4	0.0	96.5	4.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,682.0 MMBTU								2,570.6 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$75,698.13	$0.00	$2.84	-32.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$56,961.47 $US								$75,698.13 $US			
Carbon	139.6	53.3	7.24	0.0	(53.3)	74.3	NA	NA	213.8	0.0	8.02	-10.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	192.9 MT CO2e								213.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	0.0	(10,041.5)	116,425.6	NA	NA	608,032.0	0.0	77.9	22.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,682.0 MMBTU								2,075.2 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$60,597.68	$0.00	$2.27	-6.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$56,961.47 $US								$60,597.68 $US			
Carbon	139.6	53.3	7.24	0.0	(53.3)	33.1	NA	NA	172.6	0.0	6.48	10.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	192.9 MT CO2e								172.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	NA, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	NA	NA	NA	0.0	0.0	491,606.4	10,041.5	100.6	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,682.0 MMBTU								2,682.0 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$45,647.44	$11,314.03	$2.14	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$56,961.47 $US								$56,961.47 $US			
Carbon	139.6	53.3	7.24	NA	NA	NA	0.0	0.0	139.6	53.3	7.24	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	192.9 MT CO2e								192.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	(1) Commercial Storage Tank Water Heater, fuel: electric heat pump, capacity: 4000W, Volume: 80 gal rated, Efficiency: 3.50 COP, Location: Janitor's Closet off of Lobby

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	491,606.4	10,041.5	100.6	NA	NA	NA	0.0	(3,993.6)	487,612.8	10,041.5	100.1	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,682.0 MMBTU								2,668.4 MMBTU			
Energy Cost	$45,647.44	$11,314.03	$2.14						$45,270.56	$11,314.03	$2.12	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$56,961.47 $US								$56,584.59 $US			
Carbon	139.6	53.3	7.24	NA	NA	NA	0.0	(1.1)	138.4	53.3	7.20	0.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	192.9 MT CO2e								191.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$136,189.00	($30,050.69)	$11,314.03	($18,736.66)	($552,426.72)	NA	NA	-2.0018	NA	NA	($1,067.28)
HVAC Pathway 2	$132,641.00	($14,950.25)	$11,314.03	($3,636.22)	($229,005.92)	-8.7287%	NA	-0.2777	NA	NA	$1,034.36
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	-$3,866.00	$376.88	$0.00	$376.88	$13,176.50	NA	NA	NA	NA	NA	$57.82

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$38,740.00
DHW Existing Replacement:	$5,965.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

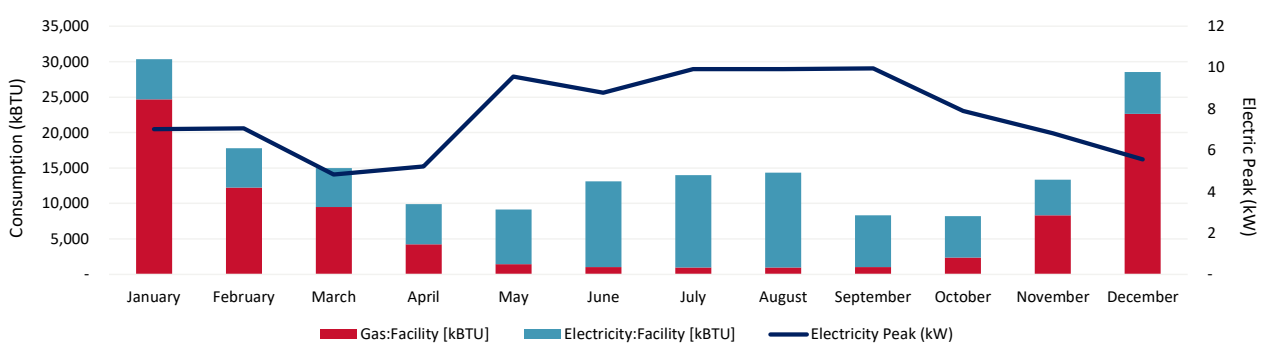
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Building Characteristics

Durham County | Eastern Sheriff's Station Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	5323 Wake Forest Hwy, Durham, NC 27704	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency Services	Cooling Generation	Packaged DX
Year Built	1991	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	3,038	Heating / Cooling / Vent Distribution	Multi-Zone RTU
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Varies		
Wally Type	Brick	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	12:00am-12:00am
		Weekend Operating Hours	24
		Weekend Opening Time	12:00am-12:00am



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

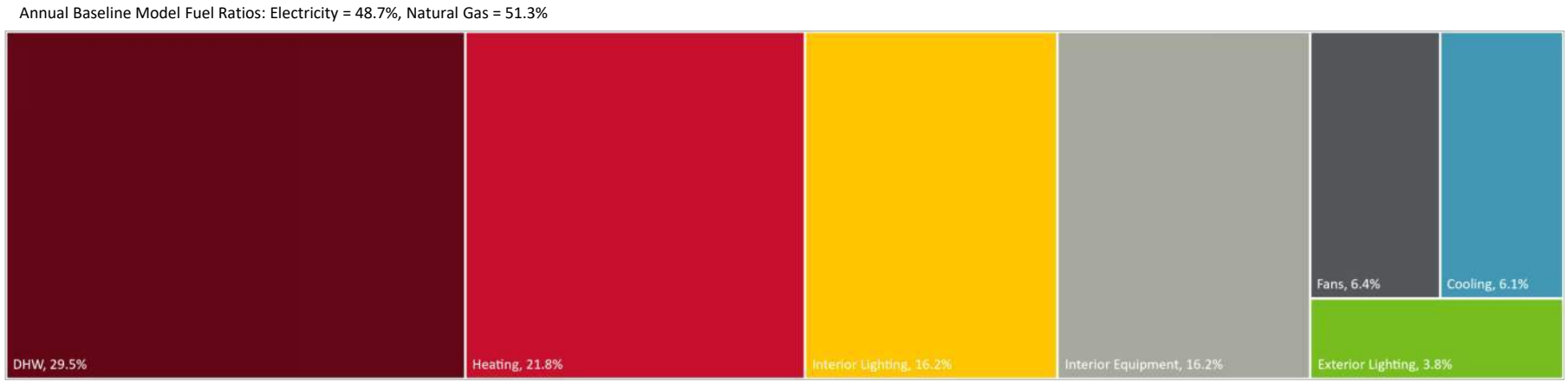


59.96 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	1,648.34	7.03	247.00
February	1,627.46	7.06	122.50
March	1,606.86	4.83	95.00
April	1,659.93	5.23	42.50
May	2,263.90	9.56	14.50
June	3,545.99	8.78	10.50
July	3,823.57	9.94	9.50
August	3,932.29	9.93	9.50
September	2,128.42	9.96	10.50
October	1,708.51	7.90	24.00
November	1,466.03	6.82	83.50
December	1,726.51	5.56	226.50
ANNUAL	27,137.78	-	895.50
PEAK	3,932.29	9.96	247.00

Annual Baseline Model Predicted End-Use Energy Disaggregation

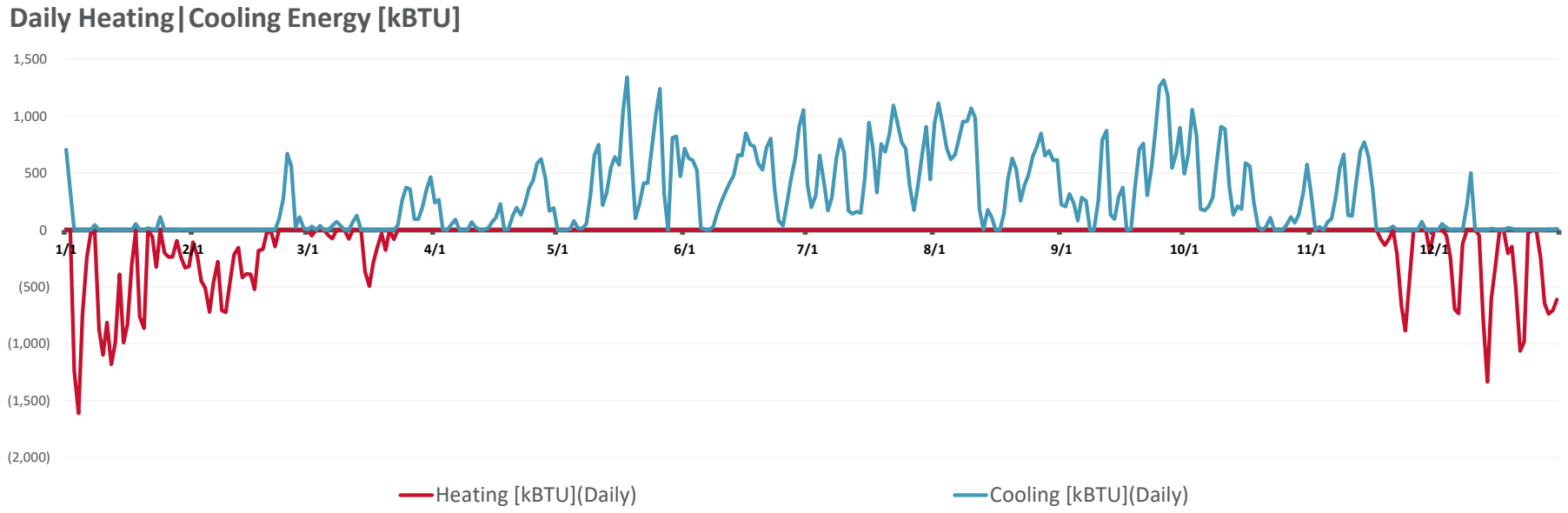
Durham County | Eastern Sheriff's Station End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 48.7%, Natural Gas = 51.3%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU gas furnace, 130 mbh input; (1) gas-fired unit heater, Trane 12mbh input
Domestic Hot Water	(1) gas-fired natural draft storage water heater, 50 gallon, 38 mbh input, Rheen model RHLN11105002141, mfg. date 11/2010, w/ recirc pump

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification: *Replace unit heater with electric 3.5kw unit heater. *Replace RTU with electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	0.0	(535.8)	11,136.7	NA	NA	38,274.5	439.4	57.5	8.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	190.1 MMBTU								174.6 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$5,148.34	$611.49	$1.90	-12.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,104.58 $US								$5,759.83 $US			
Carbon	7.7	5.2	4.24	0.0	(2.8)	3.2	NA	NA	10.9	2.3	4.34	-2.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	12.9 MT CO2e								13.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification: *Replace unit heater with electric 3.5kw unit heater. *Replace RTU with 5-ton heat-pump unit, w/ economizer, 23kw elec heat, Trane model WHC060

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	0.0	(535.8)	6,110.7	NA	NA	33,248.5	439.4	51.8	17.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	190.1 MMBTU								157.4 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$4,536.24	$611.49	$1.69	-0.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,104.58 $US								$5,147.73 $US			
Carbon	7.7	5.2	4.24	0.0	(2.8)	1.7	NA	NA	9.4	2.3	3.88	8.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	12.9 MT CO2e								11.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification: Replace WH with (1) electric storage water heater, 50 gallon, 9 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	NA	NA	NA	(439.4)	10,062.2	37,200.0	535.8	59.4	5.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	190.1 MMBTU								180.5 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$5,072.42	$745.62	$1.92	-14.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,104.58 $US								$5,818.04 $US			
Carbon	7.7	5.2	4.24	NA	NA	NA	(2.3)	2.9	10.6	2.8	4.41	-4.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	12.9 MT CO2e								13.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification: Replace WH with (1) heat-pump storage water heater, 119 gallon, 12 kw input, 4.2 COP, Lochinvar CHPA120PD

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,137.8	975.2	62.6	NA	NA	NA	(439.4)	1,927.2	29,065.0	535.8	50.3	19.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	190.1 MMBTU								152.8 MMBTU			
Energy Cost	$3,747.46	$1,357.11	$1.68						$4,011.02	$745.62	$1.57	6.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,104.58 $US								$4,756.64 $US			
Carbon	7.7	5.2	4.24	NA	NA	NA	(2.3)	0.5	8.3	2.8	3.65	13.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	12.9 MT CO2e								11.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$6,035.25	($1,400.88)	$745.62	($655.25)	($20,204.98)	NA	NA	-1.4775	NA	NA	($16.12)
HVAC Pathway 2	$17,980.00	($788.78)	$745.62	($43.15)	($23,430.36)	-6.4235%	-5.2372%	0.0356	NA	NA	$56.66
DHW Pathway 1	$4,739.00	($1,324.95)	$611.49	($713.46)	($20,001.20)	NA	NA	-2.1233	NA	NA	($26.67)
DHW Pathway 2	$39,061.00	($263.56)	$611.49	$347.94	($43,984.68)	-5.4427%	-1.5116%	0.1667	NA	NA	$91.12

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$41,210.00
DHW Existing Replacement:	$5,663.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Durham County | EMS #2 - Old Fayetteville Road | Electrification Pathways

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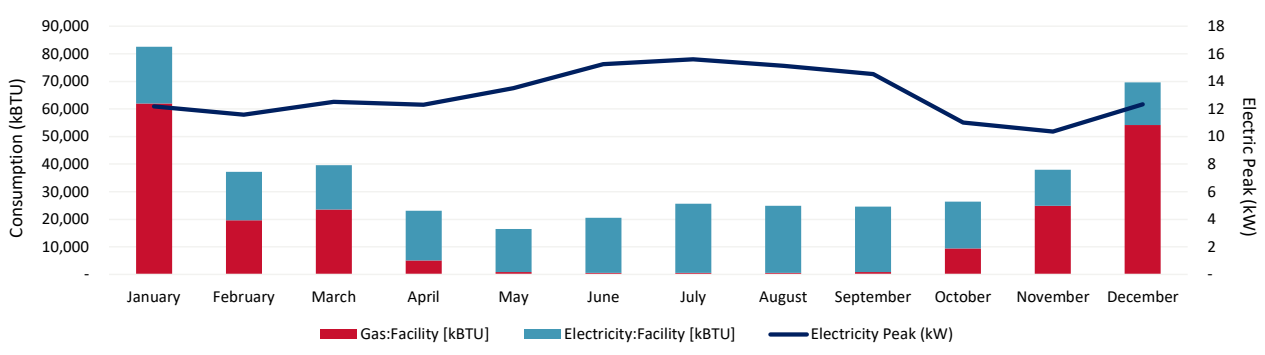
Building Characteristics

Durham County | EMS #2 - Old Fayetteville Road Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	615 Old Fayetteville St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency Services	Cooling Generation	Packaged DX
Year Built	2007	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	6,990	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Varies		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED/Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	12:00am-12:00am
		Weekend Operating Hours	24
		Weekend Opening Time	12:00am-12:00am



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

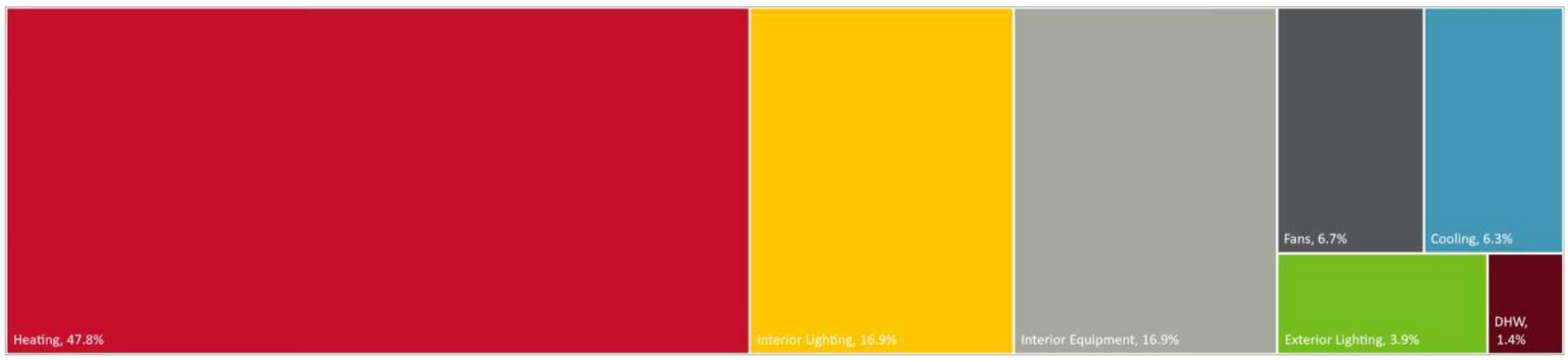


61.26 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	5,998.10	12.18	620.00
February	5,154.42	11.58	196.00
March	4,711.30	12.52	235.00
April	5,277.36	12.30	50.00
May	4,576.50	13.52	8.50
June	5,850.90	15.24	5.00
July	7,369.84	15.60	5.00
August	7,121.92	15.14	6.00
September	6,933.38	14.52	8.50
October	4,976.63	11.02	94.00
November	3,820.92	10.36	249.00
December	4,515.74	12.34	542.00
ANNUAL	66,307.01	-	2,019.00
PEAK	7,369.84	15.60	620.00

Annual Baseline Model Predicted End-Use Energy Disaggregation

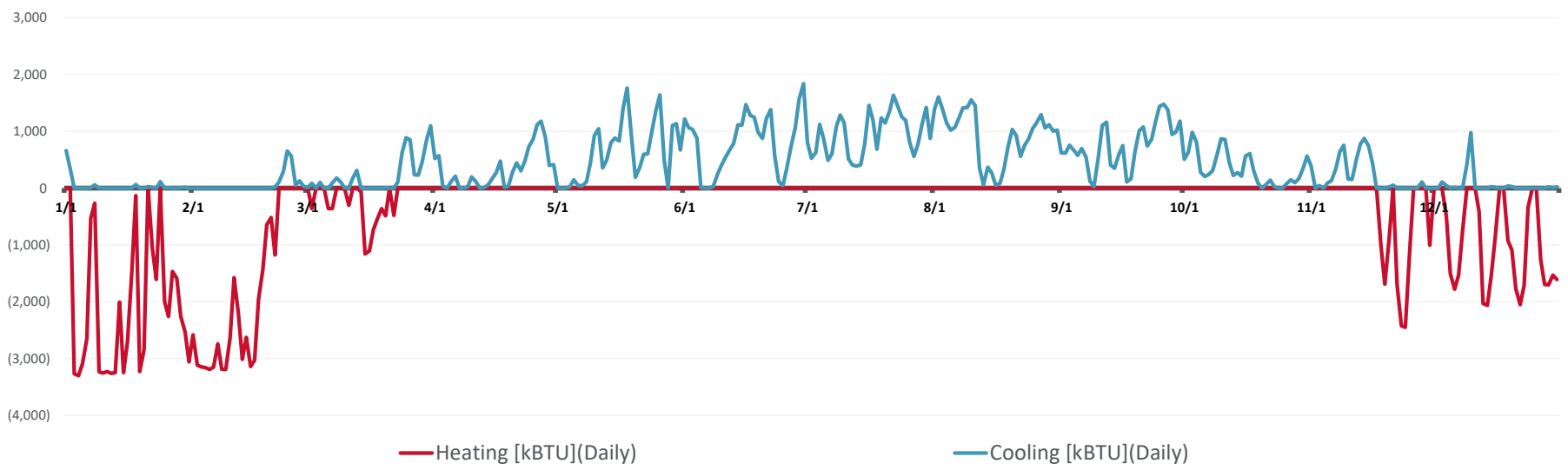
Durham County | EMS #2 - Old Fayetteville Road End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 52.2%, Natural Gas = 47.8%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(2) Split-system gas furnace, Trane model TUX1C080, 80mbh input; (1) Gas-fired unit heater, Trane model GAND010, 100mbh input;
Domestic Hot Water	(1) electric storage water heater, 50 gallon, 6kw, State model CSB526, mfg. date 9/2006;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace gas unit heater with (1) electric 30kw unit heater. *Replace split-systems with electric heat.

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	0.0	(2,068.5)	47,803.4	NA	NA	114,110.4	0.0	55.7	10.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	433.2 MMBTU								389.5 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$11,752.91	$0.00	$1.68	-13.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$10,335.93 $US								$11,752.91 $US			
Carbon	18.8	11.0	4.26	0.0	(11.0)	13.6	NA	NA	32.4	0.0	4.63	-8.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	29.8 MT CO2e								32.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas unit heater with (1) electric 30kw unit heater. *Replace split-systems with heat-pumps- (1) 5-ton HP condensing unit + AHU w/ 20kw electric heater; (1) 4-ton HP condensing unit + AHU w/ 15kw electric heater;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	0.0	(2,068.5)	34,585.5	NA	NA	100,892.5	0.0	49.3	20.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	433.2 MMBTU								344.3 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$10,588.00	$0.00	$1.51	-2.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$10,335.93 $US								$10,588.00 $US			
Carbon	18.8	11.0	4.26	0.0	(11.0)	9.8	NA	NA	28.6	0.0	4.10	3.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	29.8 MT CO2e								28.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	NA	NA	NA	0.0	0.0	66,307.0	2,068.5	62.0	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	433.2 MMBTU								433.2 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$7,718.03	$2,617.90	$1.48	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$10,335.93 $US								$10,335.93 $US			
Carbon	18.8	11.0	4.26	NA	NA	NA	0.0	0.0	18.8	11.0	4.26	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	29.8 MT CO2e								29.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	66,307.0	2,068.5	62.0	NA	NA	NA	0.0	(1,173.0)	65,134.0	2,068.5	61.4	0.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	433.2 MMBTU								429.1 MMBTU			
Energy Cost	$7,718.03	$2,617.90	$1.48						$7,618.72	$2,617.90	$1.46	1.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$10,335.93 $US								$10,236.61 $US			
Carbon	18.8	11.0	4.26	NA	NA	NA	0.0	(0.3)	18.5	11.0	4.22	1.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	29.8 MT CO2e								29.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$18,469.25	($4,034.88)	$2,617.90	($1,416.98)	($48,618.74)	NA	NA	-0.9481	NA	NA	($131.83)
HVAC Pathway 2	$39,793.00	($2,869.97)	$2,617.90	($252.07)	($52,853.54)	-6.3201%	-6.9632%	0.0171	NA	NA	$59.55
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$11,611.00	$99.32	$0.00	$99.32	($13,594.38)	-5.9523%	-2.0556%	0.1336	NA	NA	$16.98

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$59,759.00
DHW Existing Replacement:	$3,461.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

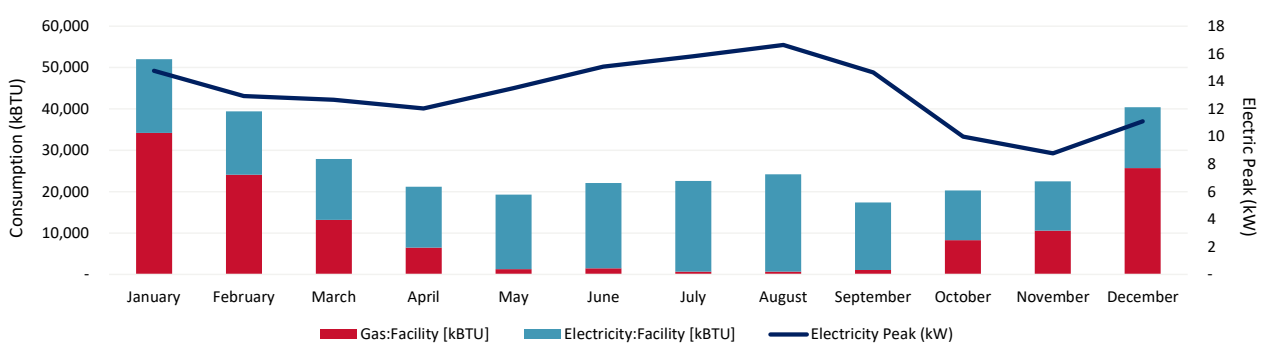
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Building Characteristics

Durham County | EMS #6 Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	226 Milton Rd, Durham, NC 27712	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency Services	Cooling Generation	Split-System DX
Year Built	1990	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	7,805	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent/LED	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

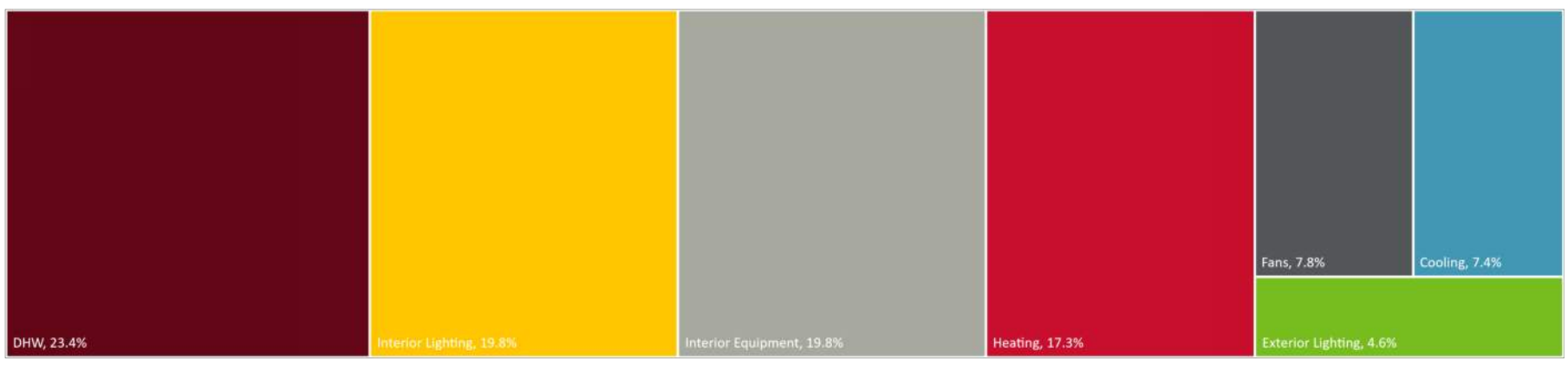


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

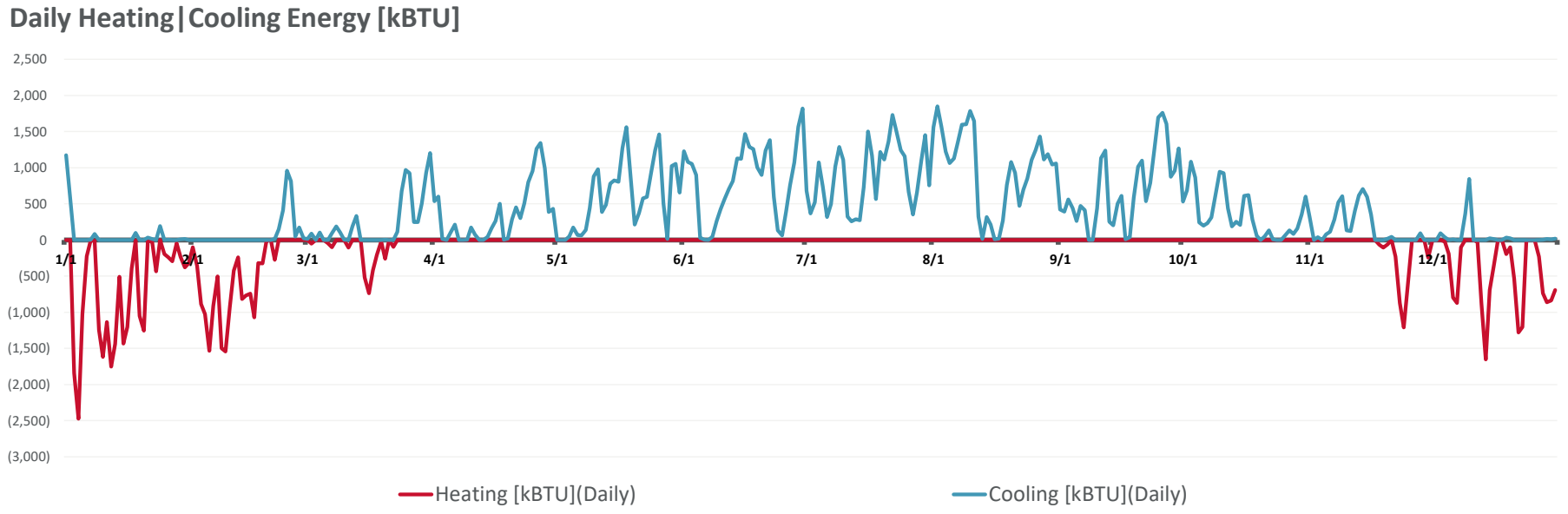


42.19 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	5,227.20	14.78	342.00
February	4,494.96	12.94	241.00
March	4,296.90	12.68	132.00
April	4,293.98	12.04	65.00
May	5,277.84	13.50	12.50
June	6,030.04	15.06	15.00
July	6,431.70	15.82	6.50
August	6,887.84	16.64	6.50
September	4,782.84	14.66	11.00
October	3,541.54	9.98	82.50
November	3,511.24	8.78	105.50
December	4,285.30	11.10	257.50
ANNUAL	59,061.38	-	1,277.00
PEAK	6,887.84	16.64	342.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Gas-fired unit heater, Sterling; (2) Gas furnace, direct vent, 3-ton indoor AHU, Trane, 80 mbh input; (1) Gas-fired unit heater, Dayton model 3E228B, 100 mbh input, 80 mbh output, mfg 1994; (1) Electric 2.5-ton indoor AHU, Trane model GAM2A0A30S, 7.2 kw, mfg 2013;
Domestic Hot Water	(1) Gas-fired storage water heater, natural draft, 75 gal, Rheem model 42V75F, 75.1 mbh input, 73 gph recovery, installed 2011;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (2) electric 30kw unit heater, Modine PTE300 (60kw total); *Replace (2) split-systems with (2) 3-ton split-system heat pump condensing unit and AHU with 20 kw heater (40 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	0.0	(757.5)	12,688.3	NA	NA	71,749.7	622.0	39.3	9.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	339.5 MMBTU								307.1 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$8,520.59	$842.17	$1.20	-4.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,970.76 $US								$9,362.76 $US			
Carbon	16.8	7.3	3.09	0.0	(4.0)	3.6	NA	NA	20.4	3.3	3.03	1.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	24.1 MT CO2e								23.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas unit heaters with (2) electric 30kw unit heater, Modine PTE300 (60kw total); *Replace (3) split-systems with (1) 10-ton VRF system inverter heat pump condensing unit + (3) indoor AHUs [condensing unit 55 MCA, 90 MOP @ 208V/3ph, AHUs each 6 MCA, 15 MOP @ 208V/1ph] {Vendor estimate for system equip cost - $100k};

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	0.0	(757.5)	12,395.9	NA	NA	71,457.2	622.0	39.2	9.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	339.5 MMBTU								306.1 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$8,476.33	$842.17	$1.19	-3.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,970.76 $US								$9,318.50 $US			
Carbon	16.8	7.3	3.09	0.0	(4.0)	3.5	NA	NA	20.3	3.3	3.02	2.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	24.1 MT CO2e								23.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 80 gallon, 18kw input, Bradford White model CEHD80(A)18 3*CF (total 18kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	NA	NA	NA	(622.0)	14,444.2	73,505.5	757.5	41.8	3.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	339.5 MMBTU								326.6 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$8,328.47	$1,025.67	$1.20	-4.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,970.76 $US								$9,354.13 $US			
Carbon	16.8	7.3	3.09	NA	NA	NA	(3.3)	4.1	20.9	4.0	3.19	-3.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	24.1 MT CO2e								24.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WH with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	59,061.4	1,379.5	43.5	NA	NA	NA	(622.0)	2,903.3	61,964.7	757.5	36.8	15.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	339.5 MMBTU								287.2 MMBTU			
Energy Cost	$7,102.93	$1,867.83	$1.15						$7,350.19	$1,025.67	$1.07	6.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,970.76 $US								$8,375.85 $US			
Carbon	16.8	7.3	3.09	NA	NA	NA	(3.3)	0.8	17.6	4.0	2.77	10.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	24.1 MT CO2e								21.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$64,827.67	($1,417.66)	$1,025.67	($392.00)	($93,429.31)	-7.7087%	NA	-0.0665	NA	NA	$21.48
HVAC Pathway 2	$347,409.67	($1,373.40)	$1,025.67	($347.74)	($474,349.69)	-7.3370%	NA	-0.0104	NA	NA	$25.72
DHW Pathway 1	$5,220.00	($1,225.54)	$842.17	($383.37)	($13,136.46)	NA	NA	-0.8623	NA	NA	($40.65)
DHW Pathway 2	$14,619.00	($247.26)	$842.17	$594.91	($5,195.27)	0.6706%	2.2172%	0.7370	24.00	NA	$126.45

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$34,888.00
DHW Existing Replacement:	$8,274.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Durham County | Fire Marshall | Electrification Pathways

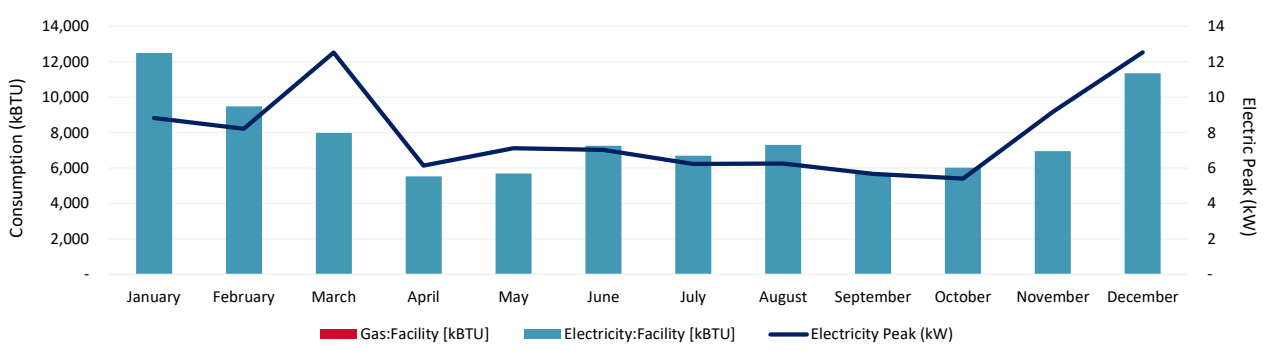
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Building Characteristics

Durham County | Fire Marshall Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	120 E Parrish St, Durham, NC 27701	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Electric Resistance
Building Type	Office	Cooling Generation	Split-System DX
Year Built	1985	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	3,872	Heating / Cooling / Vent Distribution	Split System Units
Stories	3	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

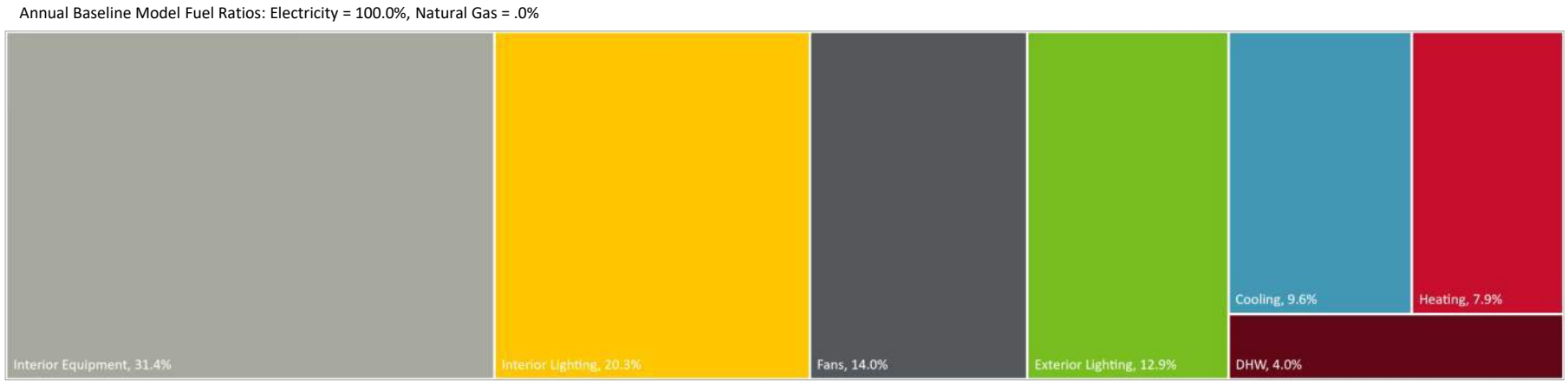


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

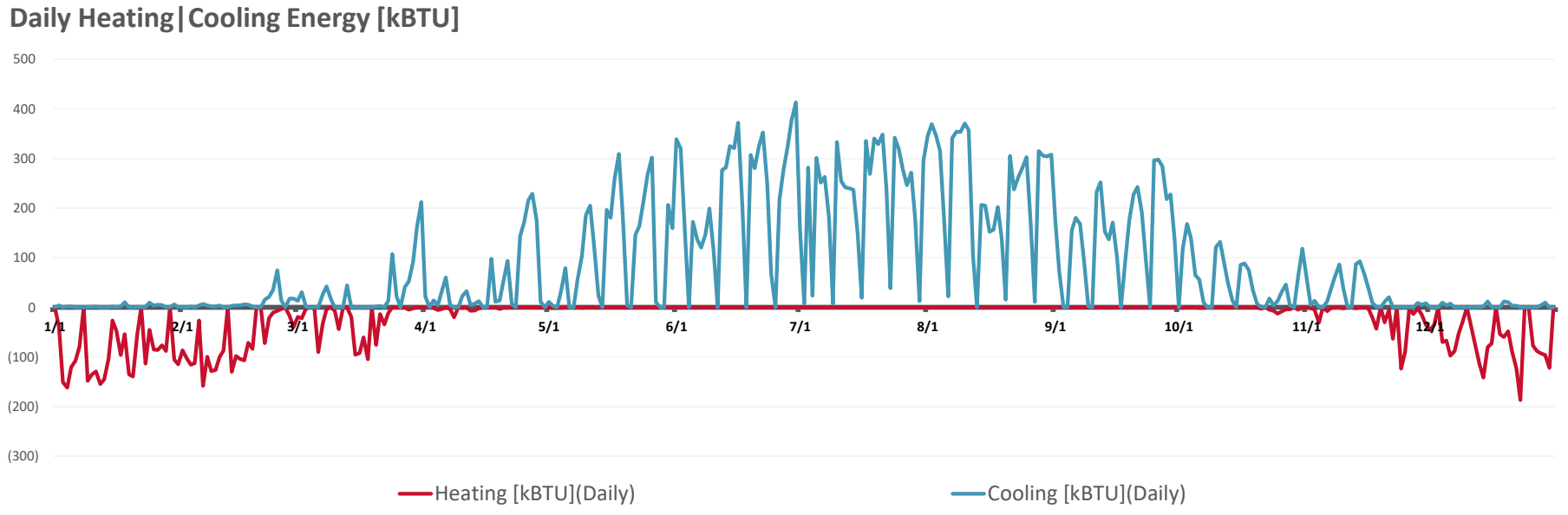


23.88 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	3,662.91	8.82	-
February	2,775.90	8.21	-
March	2,339.02	12.52	-
April	1,617.72	6.13	-
May	1,665.41	7.12	-
June	2,129.76	7.02	-
July	1,960.46	6.23	-
August	2,143.23	6.25	-
September	1,670.81	5.68	-
October	1,765.12	5.41	-
November	2,038.95	9.19	-
December	3,323.28	12.53	-
ANNUAL	27,092.53	-	-
PEAK	3,662.91	12.53	-

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) 2.5-ton AHU electric heater, Goodman model ARUF030-00A, 10 kw; (1) 5-ton AHU electric heater, Goodman model ARUF61D14, 20 kw; (1) electric baseboard heater;
Domestic Hot Water	(1) Electric storage water heater, 40 gal, American Water Heater model E61-40R-045DV, mfg 2003;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	N/A - already electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,092.5	0.0	23.9	0.0	0.0	0.0	NA	NA	27,092.5	0.0	23.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	92.5 MMBTU								92.5 MMBTU			
Energy Cost	$3,817.04	$0.00	$0.99						$3,817.04	$0.00	$0.99	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,817.04 $US								$3,817.04 $US			
Carbon	7.7	0.0	1.99	0.0	0.0	0.0	NA	NA	7.7	0.0	1.99	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.7 MT CO2e								7.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,092.5	0.0	23.9	0.0	0.0	0.0	NA	NA	27,092.5	0.0	23.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	92.5 MMBTU								92.5 MMBTU			
Energy Cost	$3,817.04	$0.00	$0.99						$3,817.04	$0.00	$0.99	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,817.04 $US								$3,817.04 $US			
Carbon	7.7	0.0	1.99	0.0	0.0	0.0	NA	NA	7.7	0.0	1.99	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.7 MT CO2e								7.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,092.5	0.0	23.9	NA	NA	NA	0.0	0.0	27,092.5	0.0	23.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	92.5 MMBTU								92.5 MMBTU			
Energy Cost	$3,817.04	$0.00	$0.99						$3,817.04	$0.00	$0.99	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,817.04 $US								$3,817.04 $US			
Carbon	7.7	0.0	1.99	NA	NA	NA	0.0	0.0	7.7	0.0	1.99	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.7 MT CO2e								7.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) water heaters with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	27,092.5	0.0	23.9	NA	NA	NA	0.0	(714.6)	26,377.9	0.0	23.3	2.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	92.5 MMBTU								90.0 MMBTU			
Energy Cost	$3,817.04	$0.00	$0.99						$3,725.56	$0.00	$0.96	2.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,817.04 $US								$3,725.56 $US			
Carbon	7.7	0.0	1.99	NA	NA	NA	0.0	(0.2)	7.5	0.0	1.93	2.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.7 MT CO2e								7.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$2,187.78	$0.00	$0.00	$0.00	($2,956.35)	NA	-100.0000%	0.0000	NA	NA	$0.00
HVAC Pathway 2	$2,187.78	$0.00	$0.00	$0.00	($2,956.35)	NA	-100.0000%	0.0000	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$17,688.00	$91.48	$0.00	$91.48	($21,971.51)	-6.4795%	-3.2798%	0.0808	NA	NA	$10.35

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$7,214.00
DHW Existing Replacement:	$4,970.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Durham County | General Services | Electrification Pathways

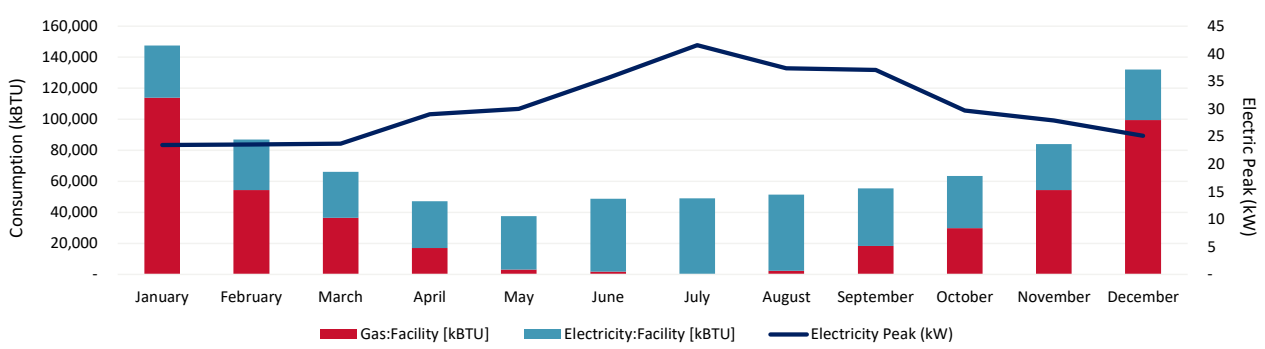
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Building Characteristics

Durham County | General Services Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	310 S Dillard, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Furnace RTUs
Building Type	Office	Cooling Generation	DX RTUs
Year Built	1994	Domestic Hot Water Generation	Electric Instanteneous Water Heater
Floor Area (ft2)	10,387	Heating / Cooling / Vent Distribution	CV Air-Handlers
Stories	2	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

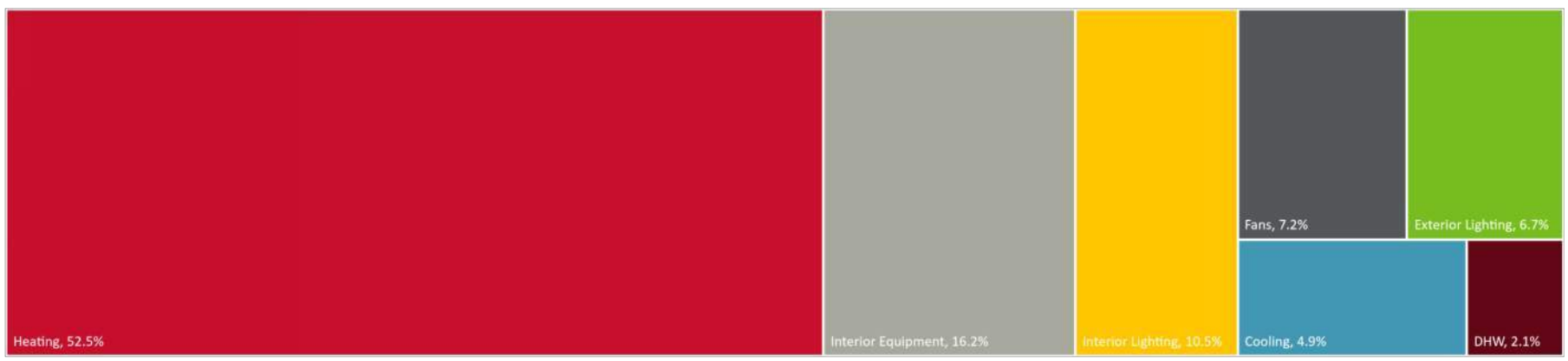


83.75 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	9,887.24	23.46	1,138.50
February	9,502.56	23.56	545.00
March	8,699.50	23.72	365.00
April	8,878.20	29.02	170.00
May	10,094.12	30.04	30.50
June	13,784.64	35.64	18.00
July	14,320.34	41.56	1.50
August	14,378.80	37.40	23.50
September	10,814.04	37.06	184.50
October	9,881.42	29.68	298.00
November	8,722.80	27.94	543.00
December	9,599.38	25.12	994.00
ANNUAL	128,563.04	-	4,311.50
PEAK	14,378.80	41.56	1,138.50

Annual Baseline Model Predicted End-Use Energy Disaggregation

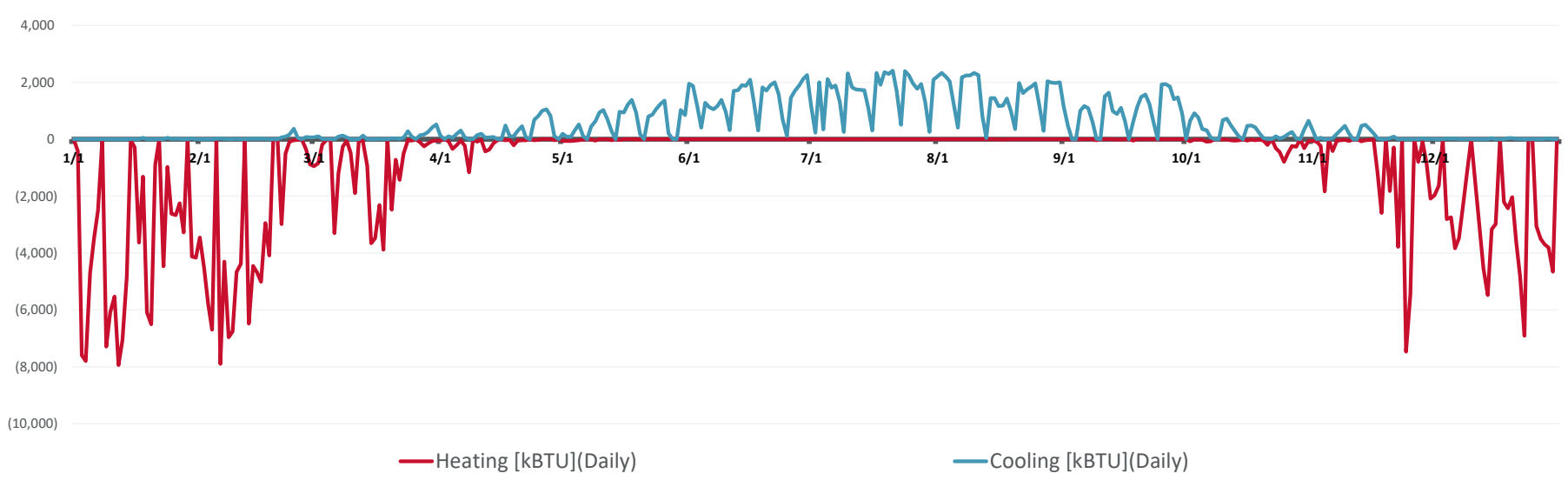
Durham County | General Services End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 47.5%, Natural Gas = 52.5%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU-2 gas furnace, 80 mbh input, 64.8 mbh output; (1) RTU-1 gas furnace, 400 mbh input, 324 mbh output; (1) RTU gas furnace, 240 mbh input, 195 mbh output; (1) electric nunit heater;
Domestic Hot Water	(2) undersink electric instantaneous, Stiebel Eltron, 3 kw; (1) electric storage water heater, AO Smith model DEN-52-100, 55 gallon, 6 kw, mfg 2022;

Generated: 06/28/2024 © HDR

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace (3) RTUs with electric resistance heating coils.

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	0.0	(4,843.2)	102,082.4	NA	NA	230,645.4	0.0	75.8	14.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	923.1 MMBTU								787.2 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$31,470.07	$0.00	$3.03	-67.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,770.38 $US								$31,470.07 $US			
Carbon	36.5	25.7	5.99	0.0	(25.7)	29.0	NA	NA	65.5	0.0	6.30	-5.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	62.2 MT CO2e								65.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Replace (3) RTUs with (1) 3-ton heat pump RTU, w/ economizer, 18 kw elec heat, Trane model WHC036; ; (1) 15-ton heat pump RTU w/ economizer, 54 kw electric heat, Trane WHJ180; (1) 20-Ton heat pump RTU w/ economizer, 72 kw electric heat, Trane WHJ240;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	0.0	(4,843.2)	45,827.3	NA	NA	174,390.4	0.0	57.3	35.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	923.1 MMBTU								595.2 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$20,941.19	$0.00	$2.02	-11.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,770.38 $US								$20,941.19 $US			
Carbon	36.5	25.7	5.99	0.0	(25.7)	13.0	NA	NA	49.5	0.0	4.77	20.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	62.2 MT CO2e								49.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	NA, already electric

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	NA	NA	NA	0.0	0.0	128,563.0	4,843.2	88.9	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	923.1 MMBTU								923.1 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$12,950.66	$5,819.72	$1.81	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,770.38 $US								$18,770.38 $US			
Carbon	36.5	25.7	5.99	NA	NA	NA	0.0	0.0	36.5	25.7	5.99	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	62.2 MT CO2e								62.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	128,563.0	4,843.2	88.9	NA	NA	NA	0.0	(3,655.8)	124,907.3	4,843.2	87.7	1.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	923.1 MMBTU								910.6 MMBTU			
Energy Cost	$12,950.66	$5,819.72	$1.81						$12,658.64	$5,819.72	$1.78	1.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$18,770.38 $US								$18,478.36 $US			
Carbon	36.5	25.7	5.99	NA	NA	NA	0.0	(1.0)	35.5	25.7	5.89	1.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	62.2 MT CO2e								61.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$77,777.25	($18,519.41)	$5,819.72	($12,699.69)	($359,203.25)	NA	NA	-2.4177	NA	NA	($166.10)
HVAC Pathway 2	$114,659.00	($7,990.53)	$5,819.72	($2,170.81)	($186,877.54)	-8.5442%	NA	-0.2061	NA	NA	$648.42
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$1,020.00	$292.02	$0.00	$292.02	$4,783.42	36.5378%	6.9291%	4.4704	4.00	5.00	$52.93

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$202,449.00
DHW Existing Replacement:	$9,132.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

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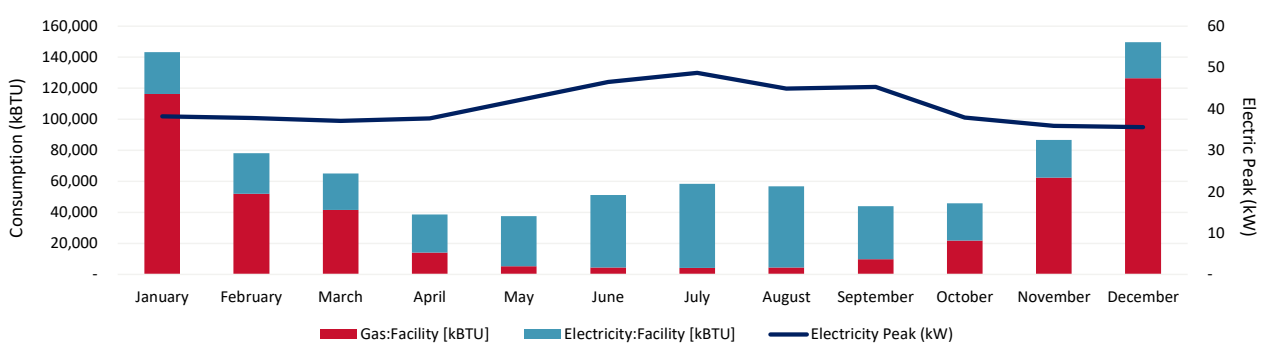
Building Characteristics

Durham County | Head Start Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	215 W Seminary, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Daycare	Cooling Generation	Packaged DX
Year Built	2003	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	13,370	Heating / Cooling / Vent Distribution	Single-Zone Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	11
		Weekday Opening Time	Monday-Friday, 7:00am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

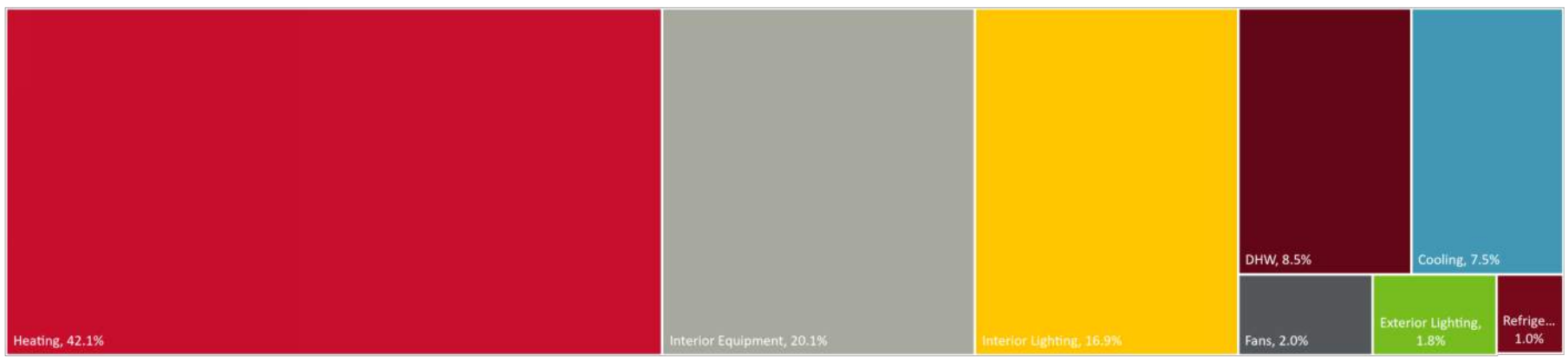


63.96 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	7,884.06	38.18	1,163.00
February	7,621.96	37.82	520.00
March	6,819.62	37.12	417.00
April	7,173.26	37.76	142.00
May	9,443.52	42.12	53.50
June	13,720.34	46.56	43.50
July	15,945.92	48.72	41.00
August	15,347.52	44.92	44.00
September	10,037.50	45.34	98.50
October	7,071.66	37.92	217.00
November	7,093.58	35.92	624.50
December	6,800.88	35.60	1,264.50
ANNUAL	114,959.82	-	4,628.50
PEAK	15,945.92	48.72	1,264.50

Annual Baseline Model Predicted End-Use Energy Disaggregation

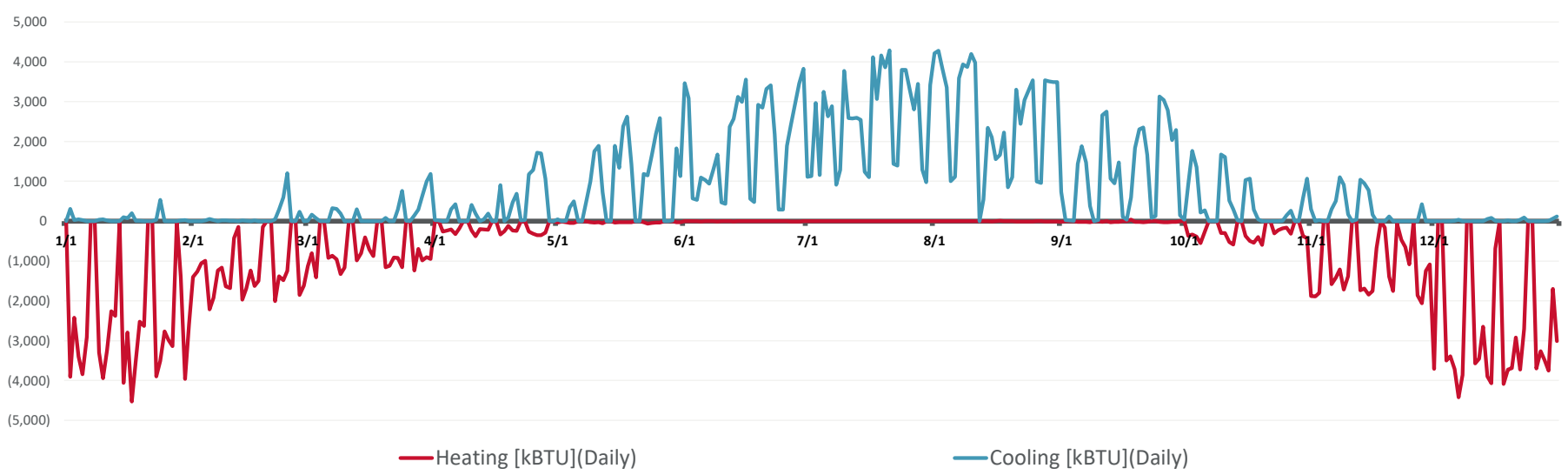
Durham County | Head Start End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 49.3%, Natural Gas = 50.7%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU#1 gas furnace, 250mbh input; (1) RTU#3 gas furnace, 250mbh input; (1) RTU#2 gas furnace, 120mbh input; (1) air curtain elec heater, 13kw input, Mars model LPV272
Domestic Hot Water	(1) gas-fired storage water heater, 100 gallon, 199 mbh input, State model SBD100199NET, mfg. 2007; (1) gas-fired storage water heater, 89 gallon, 154 mbh input, AO Smith model BTC154964, mfg. 1996

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace RTUs with w/ elec heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	114,959.8	4,028.0	59.5	0.0	(3,479.9)	78,084.0	NA	NA	193,043.8	548.2	53.4	10.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	795.2 MMBTU								713.7 MMBTU			
Energy Cost	$12,344.27	$4,798.37	$1.28						$20,112.88	$653.02	$1.55	-21.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$17,142.64 $US								$20,765.89 $US			
Carbon	32.6	21.4	4.04	0.0	(18.5)	22.2	NA	NA	54.8	2.9	4.32	-6.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	54.0 MT CO2e								57.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Replace RTUs with heat-pump units w/ elec heat-(1) 20T heat pump RTU, 54kw electric heat, Trane WHJ240; (1) 12.5T heat pump RTU, 54kw electric heat, Trane WHJ180; (1) 7.5T heat pump RTU, 27kw elec heat, Trane WHC092;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	114,959.8	4,028.0	59.5	0.0	(3,479.9)	28,280.6	NA	NA	143,240.4	548.2	40.7	31.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	795.2 MMBTU								543.7 MMBTU			
Energy Cost	$12,344.27	$4,798.37	$1.28						$15,112.80	$653.02	$1.18	8.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$17,142.64 $US								$15,765.82 $US			
Carbon	32.6	21.4	4.04	0.0	(18.5)	8.0	NA	NA	40.7	2.9	3.26	19.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	54.0 MT CO2e								43.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 119 gallon, 54kw; (1) electric storage water heater, 119 gallon, 36kw;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	114,959.8	4,028.0	59.5	NA	NA	NA	(548.2)	12,633.8	127,593.6	3,479.9	58.6	1.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	795.2 MMBTU								783.5 MMBTU			
Energy Cost	$12,344.27	$4,798.37	$1.28						$13,402.71	$4,145.35	$1.31	-2.4%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$17,142.64 $US								$17,548.06 $US			
Carbon	32.6	21.4	4.04	NA	NA	NA	(2.9)	3.6	36.2	18.5	4.09	-1.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	54.0 MT CO2e								54.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	*Replace gas WHs with (2) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) w/ x 119 gallon storage tank each

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	114,959.8	4,028.0	59.5	NA	NA	NA	(548.2)	2,308.5	117,268.3	3,479.9	56.0	5.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	795.2 MMBTU								748.2 MMBTU			
Energy Cost	$12,344.27	$4,798.37	$1.28						$12,539.31	$4,145.35	$1.25	2.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$17,142.64 $US								$16,684.66 $US			
Carbon	32.6	21.4	4.04	NA	NA	NA	(2.9)	0.7	33.3	18.5	3.87	4.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	54.0 MT CO2e								51.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$80,002.50	($7,768.61)	$4,145.35	($3,623.26)	($174,682.82)	NA	NA	-0.6158	NA	NA	($187.94)
HVAC Pathway 2	$158,116.00	($2,768.53)	$4,145.35	$1,376.82	($174,734.05)	-5.1746%	-1.2924%	0.1822	NA	NA	$533.17
DHW Pathway 1	-$2,111.00	($1,058.44)	$653.02	($405.42)	($4,145.97)	NA	NA	NA	NA	NA	($34.43)
DHW Pathway 2	$487,107.00	($195.04)	$653.02	$457.98	($647,010.17)	-7.0902%	-6.9691%	0.0170	NA	NA	$115.07

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$173,946.00
DHW Existing Replacement:	$43,300.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

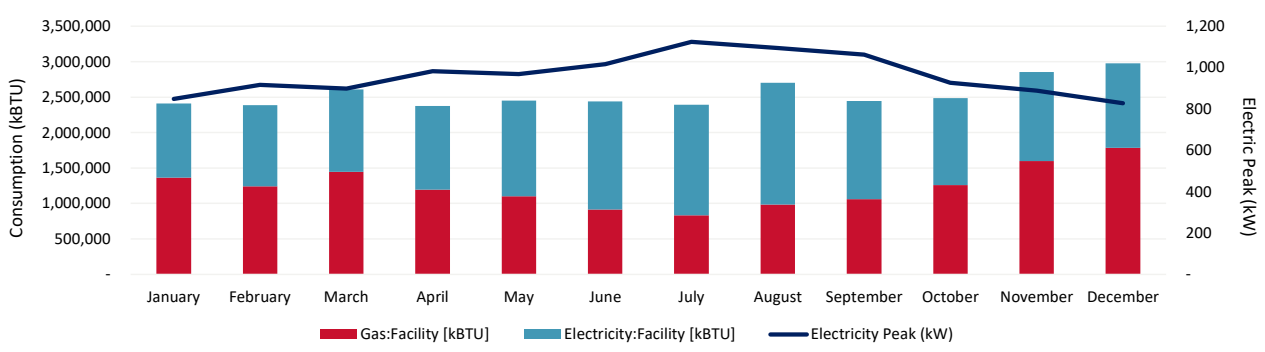
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Building Characteristics

Durham County | Health and Human Services Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	414 E Main St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Condensing Boilers
Building Type	Office	Cooling Generation	Water-Cooled Chiller
Year Built	2010	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	293,507	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	3	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Metal Panel	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

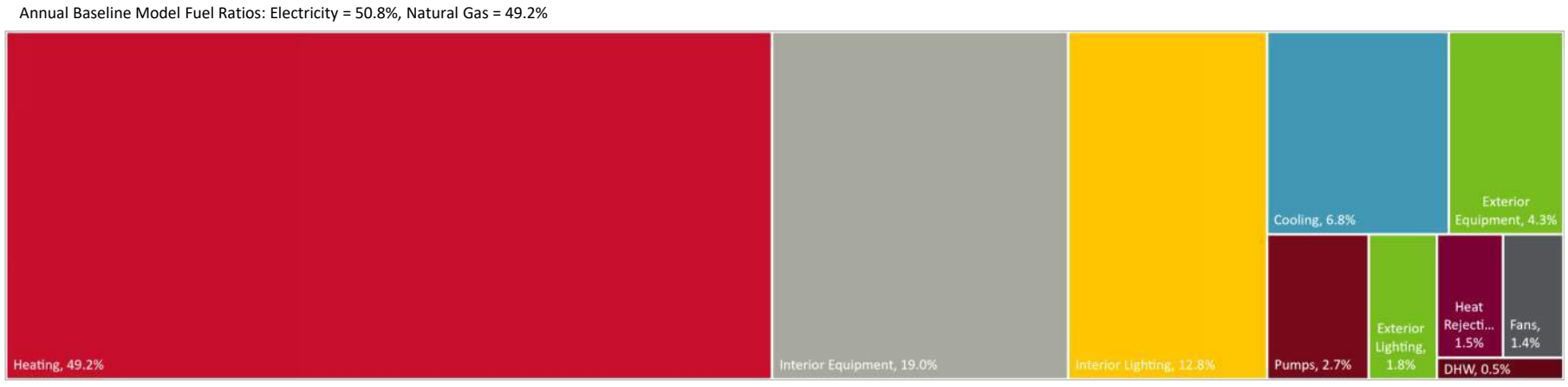


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

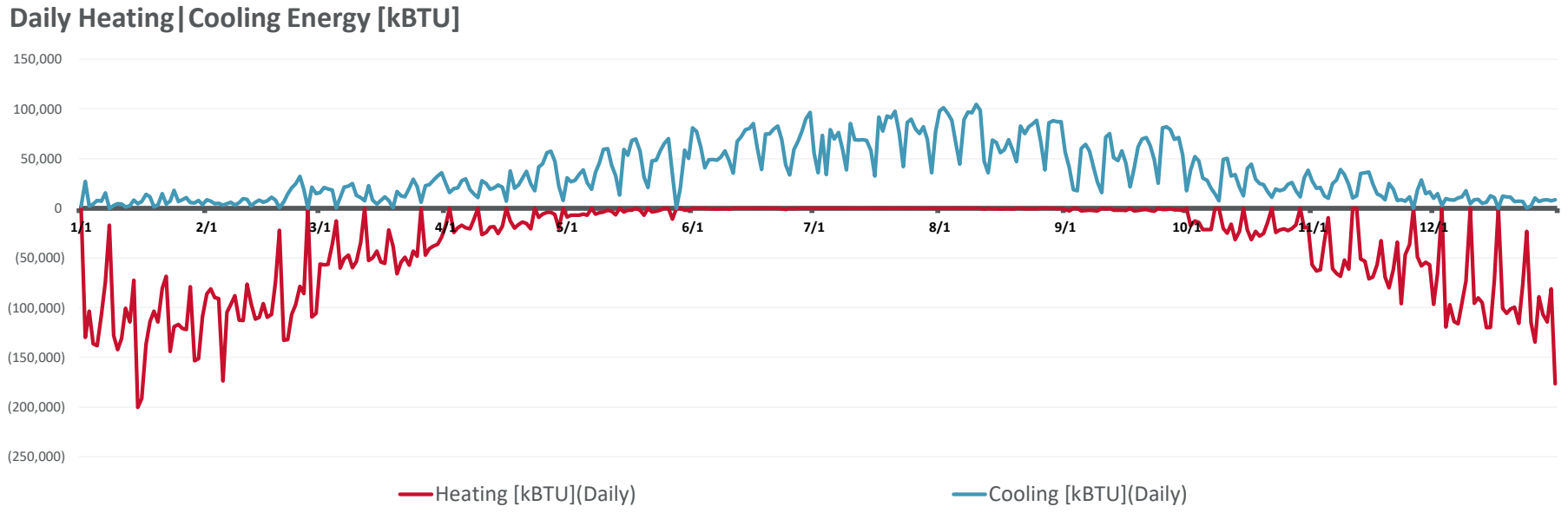


104.00 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	306,491.60	849.20	13,640.00
February	334,398.81	916.80	12,445.00
March	339,764.40	898.80	14,470.00
April	346,738.80	983.20	11,935.00
May	393,707.99	968.80	11,050.00
June	446,508.00	1,017.20	9,135.00
July	455,864.80	1,124.40	8,350.00
August	502,478.00	1,095.60	9,870.00
September	404,731.81	1,063.20	10,620.00
October	360,537.20	926.00	12,575.00
November	368,721.00	888.40	15,970.00
December	348,899.80	827.60	17,875.00
ANNUAL	4,608,842.20	-	147,935.00
PEAK	502,478.00	1,124.40	17,875.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(4) HW gas-fired boilers, Hydrotherm KN-2, 1999 mbh input, 1799 output, 120F EWT 160F LWT, CV primary pumps; (2) 10hp VV secondary pumps w/ VFDs;
Domestic Hot Water	(1) Electric storage water heater, State model PCE302OLSA, 30 gallon, 9kw, mfg. 2015; (1) Electric storage water heater, Bradford White model LE140L3, 38 gallon, 4.5kw; mfg. 8/2021; (1) Electric storage water heater, State model CSB12018IFEAB, 119 gallon, 18kw, mfg. 2013; (1) electric

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace boilers with (4) 520 kw electric boilers, 8-step control, Lochinvar BWX24-520F

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	0.0	(152,254.0)	3,939,073.6	NA	NA	8,547,915.8	0.0	99.4	5.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	30,955.2 MMBTU								29,173.8 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$803,806.11	$0.00	$2.74	-69.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$473,170.39 $US								$803,806.11 $US			
Carbon	1,308.5	808.7	7.21	0.0	(808.7)	1,118.3	NA	NA	2,426.8	0.0	8.27	-14.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,117.2 MT CO2e								2,426.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	"Simple" + *Replace chillers with (2) 375-ton magnetic bearing centrifugal heat-recover chillers, Trane "Agility" HDWA400, full load 0.65 kw/ton, IPLV 0.32 kw/ton; *Add 1200 gpm plate & frame heat exchanger

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	(51,829.8)	(152,254.0)	1,300,823.4	NA	NA	5,857,835.8	0.0	68.1	35.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	30,955.2 MMBTU								19,992.6 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$550,510.36	$0.00	$1.88	-16.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$473,170.39 $US								$550,510.36 $US			
Carbon	1,308.5	808.7	7.21	(14.7)	(808.7)	369.3	NA	NA	1,663.1	0.0	5.67	21.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,117.2 MT CO2e								1,663.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	NA	NA	NA	0.0	0.0	4,608,842.2	152,254.0	105.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	30,955.2 MMBTU								30,955.2 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$429,229.24	$43,941.15	$1.61	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$473,170.39 $US								$473,170.39 $US			
Carbon	1,308.5	808.7	7.21	NA	NA	NA	0.0	0.0	1,308.5	808.7	7.21	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,117.2 MT CO2e								2,117.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	4,608,842.2	152,254.0	105.5	NA	NA	NA	0.0	0.0	4,608,842.2	152,254.0	105.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	30,955.2 MMBTU								30,955.2 MMBTU			
Energy Cost	$429,229.24	$43,941.15	$1.61						$429,229.24	$43,941.15	$1.61	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$473,170.39 $US								$473,170.39 $US			
Carbon	1,308.5	808.7	7.21	NA	NA	NA	0.0	0.0	1,308.5	808.7	7.21	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	2,117.2 MT CO2e								2,117.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$1,995,310.47	($374,576.87)	$43,941.15	($330,635.72)	($9,568,137.49)	NA	NA	-2.5487	NA	NA	($15,790.71)
HVAC Pathway 2	$3,716,647.47	($121,281.12)	$43,941.15	($77,339.97)	($6,549,530.05)	-9.9870%	NA	-0.3041	NA	NA	$23,159.13
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$22,501.00	$0.00	$0.00	$0.00	($30,405.69)	NA	-100.0000%	0.0000	NA	NA	$0.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$221,144.00
DHW Existing Replacement:	$20,735.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

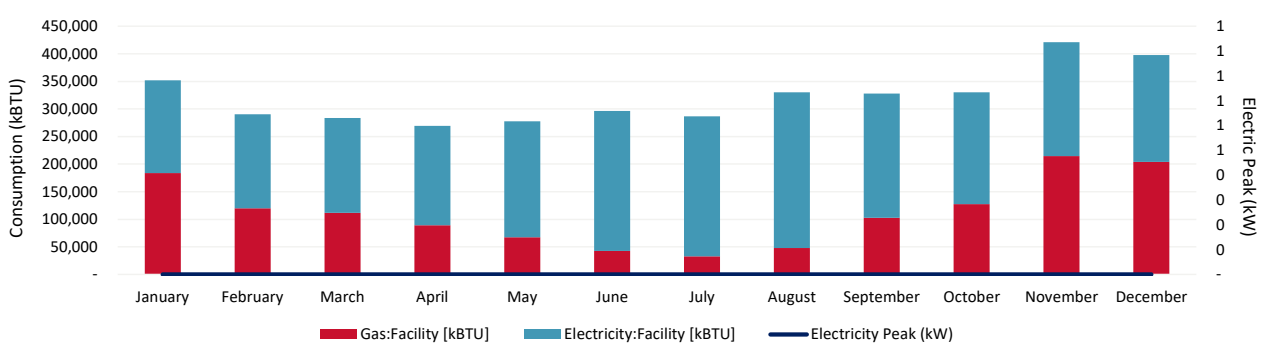
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Building Characteristics

Durham County | Judicial Building Annex Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	201 N Roxboro St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Condensing Boilers
Building Type	Office	Cooling Generation	Packaged DX
Year Built	1974	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	25,692	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	3	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

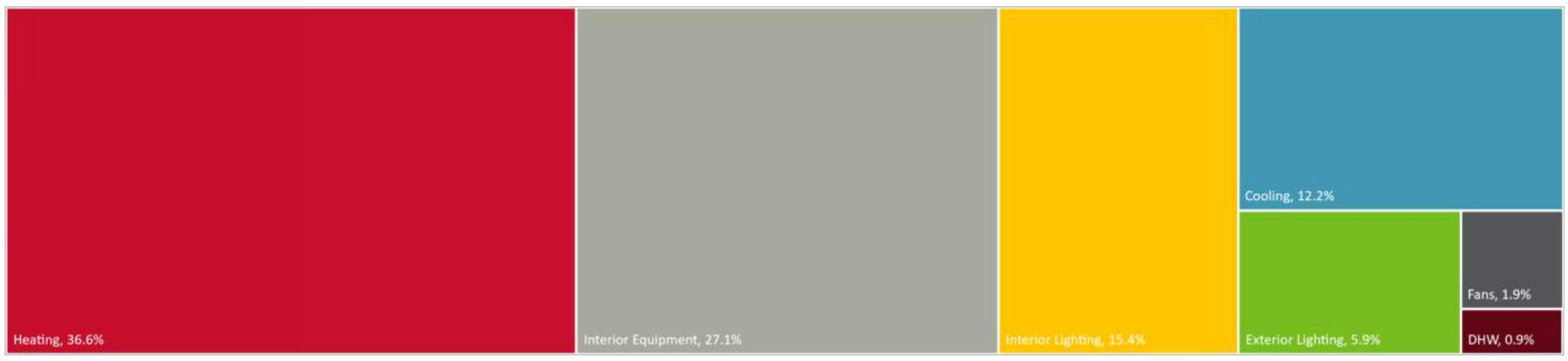


150.35 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	49,291.56	-	1,834.50
February	49,948.63	-	1,201.00
March	50,535.06	-	1,115.00
April	52,791.13	-	890.50
May	61,488.74	-	674.50
June	74,550.52	-	423.00
July	74,424.04	-	326.00
August	82,739.88	-	477.00
September	66,018.00	-	1,025.00
October	59,394.36	-	1,276.50
November	60,556.60	-	2,143.00
December	56,626.24	-	2,042.50
ANNUAL	738,364.76	-	13,428.50
PEAK	82,739.88	-	2,143.00

Annual Baseline Model Predicted End-Use Energy Disaggregation

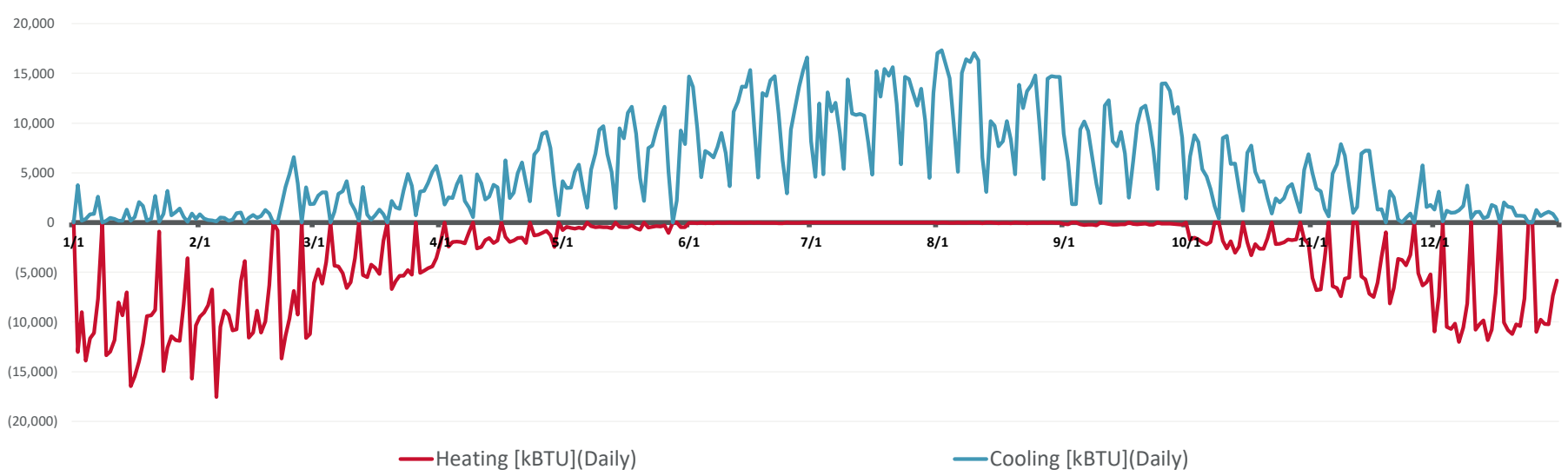
Durham County | Judicial Building Annex End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 63.4%, Natural Gas = 36.6%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) RTU-1 electric resistance pre-heat, 90 kw (smallest available from manuf.); Basment - electric reheat at terminal units; 1st & 2nd floors - hot water reheat at terminal units, electric baseboard heat in entrance lobbies; (2) Outdoor gas-fired HW boilers on roof, Lochinvar "KnightXL" outdoor condensing boilers, model & serial numbers not visible, assumed 400mbh input, 30 gpm CV primary pumps, 75 gpm VV secondary pump
Domestic Hot Water	(1) electric storage water heater, 50 gallon, 12kw, State model CSB5212, mfg. date 2019; recirc pump and master TMV

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace (2) gas boilers with (2) electric boilers, 96kw each (192 kw total)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	738,364.8	14,558.1	154.7	0.0	(14,558.1)	368,409.8	NA	NA	1,106,774.5	0.0	147.0	5.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,975.8 MMBTU								3,777.4 MMBTU			
Energy Cost	$68,811.62	$16,102.77	$3.31						$102,398.26	$0.00	$3.99	-20.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$84,914.39 $US								$102,398.26 $US			
Carbon	209.6	77.3	11.17	0.0	(77.3)	104.6	NA	NA	314.2	0.0	12.23	-9.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	286.9 MT CO2e								314.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) gas boilers with (2) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 120 FLA @ 460V/3ph)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	738,364.8	14,558.1	154.7	0.0	(14,558.1)	174,428.5	NA	NA	912,793.2	0.0	121.3	21.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,975.8 MMBTU								3,115.3 MMBTU			
Energy Cost	$68,811.62	$16,102.77	$3.31						$84,432.37	$0.00	$3.29	0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$84,914.39 $US								$84,432.37 $US			
Carbon	209.6	77.3	11.17	0.0	(77.3)	49.5	NA	NA	259.1	0.0	10.09	9.7%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	286.9 MT CO2e								259.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	738,364.8	14,558.1	154.7	NA	NA	NA	0.0	0.0	738,364.8	14,558.1	154.7	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,975.8 MMBTU								3,975.8 MMBTU			
Energy Cost	$68,811.62	$16,102.77	$3.31						$68,811.62	$16,102.77	$3.31	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$84,914.39 $US								$84,914.39 $US			
Carbon	209.6	77.3	11.17	NA	NA	NA	0.0	0.0	209.6	77.3	11.17	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	286.9 MT CO2e								286.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 119 gallon, 12 kw input, 4.2 COP, Lochinvar CHPA120PD

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	738,364.8	14,558.1	154.7	NA	NA	NA	0.0	(6,366.3)	731,998.4	14,558.1	153.9	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,975.8 MMBTU								3,954.1 MMBTU			
Energy Cost	$68,811.62	$16,102.77	$3.31						$68,233.02	$16,102.77	$3.28	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$84,914.39 $US								$84,335.78 $US			
Carbon	209.6	77.3	11.17	NA	NA	NA	0.0	(1.8)	207.8	77.3	11.10	0.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	286.9 MT CO2e								285.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$188,135.89	($33,586.64)	$16,102.77	($17,483.87)	($584,777.93)	NA	NA	-1.3002	NA	NA	($1,390.66)
HVAC Pathway 2	$1,844,360.89	($15,620.75)	$16,102.77	$482.02	($2,443,753.15)	-6.9732%	-6.6585%	0.0195	NA	NA	$1,418.01
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$0.00	$578.60	$0.00	$578.60	$12,208.81	NA	NA	NA	NA	NA	$92.18

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$51,304.00
DHW Existing Replacement:	$3,880.00

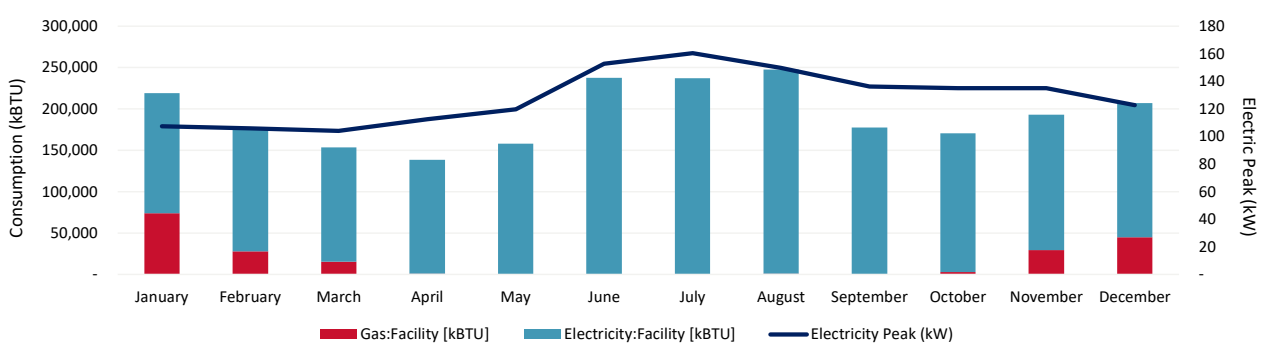
Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

Building Characteristics

Durham County | JRC Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	326 E Main St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	RTU Furnace
Building Type	Office	Cooling Generation	RTU DX
Year Built	1926	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	40,623	Heating / Cooling / Vent Distribution	Multi-Zone RTUs
Stories	3	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Various		
Wally Type	Masonry	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

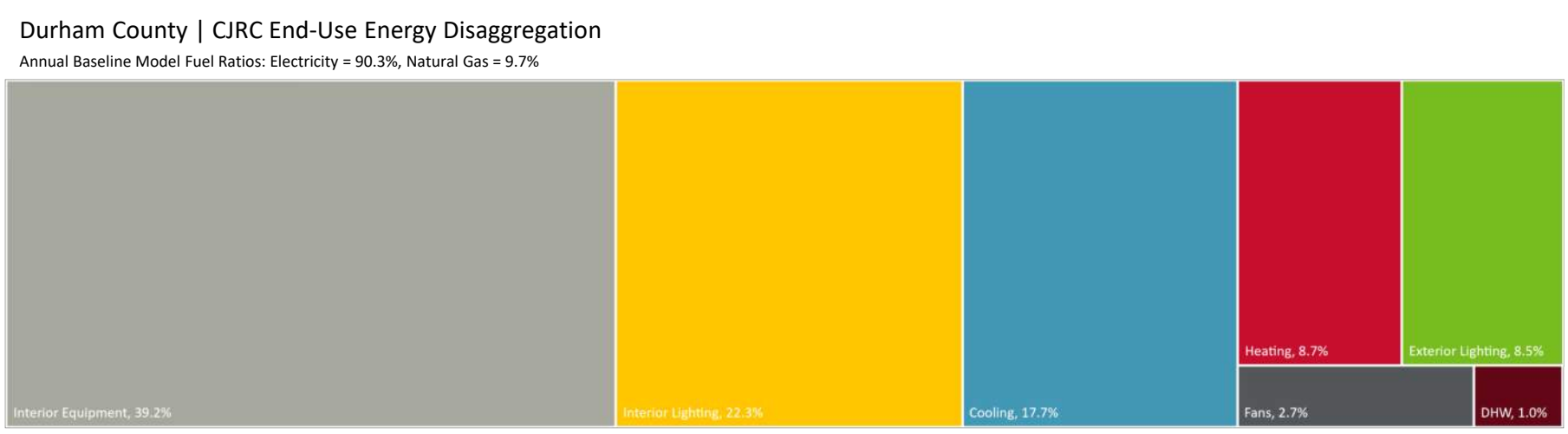


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

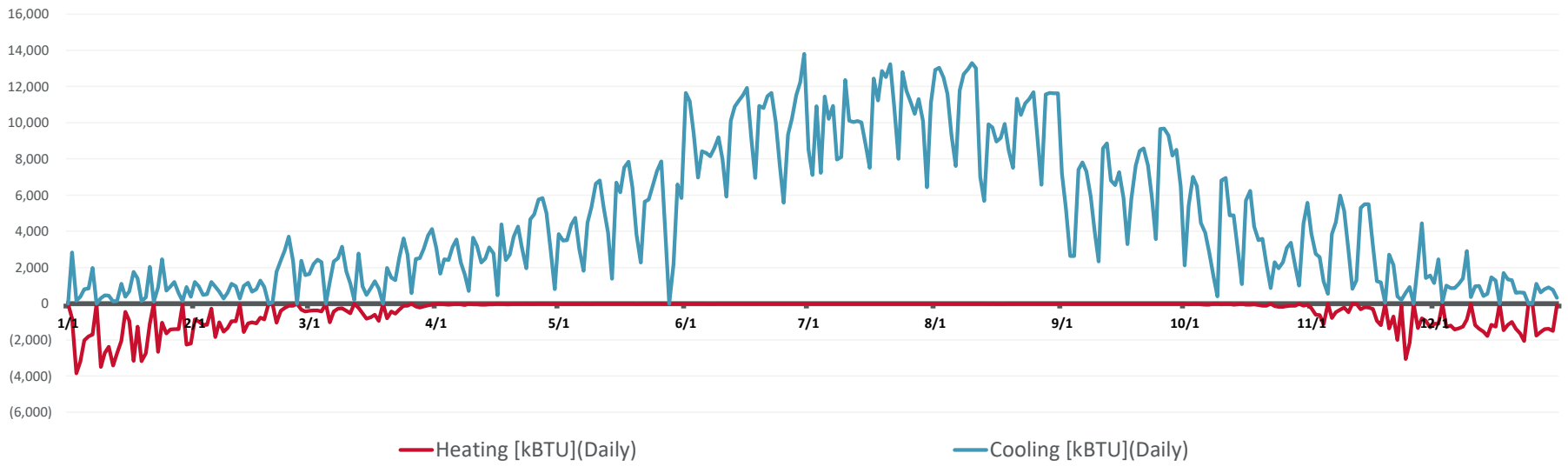


57.05 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	42,531.92	107.52	739.00
February	44,035.32	106.04	278.00
March	40,448.92	104.08	154.50
April	40,278.36	112.60	10.00
May	46,203.48	119.68	5.00
June	69,452.20	152.88	5.00
July	69,430.24	160.44	-
August	72,246.04	149.72	10.00
September	52,048.56	136.32	-
October	49,165.36	134.96	26.50
November	47,983.40	135.04	292.50
December	47,533.88	122.68	448.00
ANNUAL	621,357.68	-	1,968.50
PEAK	72,246.04	160.44	739.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	Split-system AHU unknown kW electric resistance; Large RTU #3 natural gas furnace, 350 MBH input, 2-stage control; RTU #2 NG furnace 250 MBH input; RTU #1 NG furnace 250 MBH input; MAU-3 NG furnace 90 MBH input; RTU #4 NG furnace 250 MBH input; VRV-HP multi-split heat
Domestic Hot Water	(1) Direct Vent Storage tank water heater (AO Smith #BPD-75 200), fuel- NG, 70 MBH input, 75 gallon storage, build date 8/3/2010.

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace split-system condensing w/ heat pump, nominal 7.5-ton

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	0.0	(2,161.9)	44,029.8	NA	NA	665,387.5	106.7	56.2	2.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,347.5 MMBTU								2,281.6 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$63,076.14	$135.88	$1.56	-3.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$60,885.29 $US								$63,212.02 $US			
Carbon	176.4	12.0	4.64	0.0	(11.5)	12.5	NA	NA	188.9	0.6	4.66	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	188.5 MT CO2e								189.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace RTU#1 & RTU#2 with 25-ton heat-pump RTUs with 72kw electric heat, *Replace RTU#4 with 17.5-ton heat-pump RTU with 54kw electric heat, *Replace MAU-3 with heat-pump DOAS, AAON model # RQ-004 with 20kw electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	0.0	(2,161.9)	20,992.7	NA	NA	642,350.4	106.7	54.2	6.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,347.5 MMBTU								2,203.0 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$60,068.15	$135.88	$1.48	1.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$60,885.29 $US								$60,204.03 $US			
Carbon	176.4	12.0	4.64	0.0	(11.5)	6.0	NA	NA	182.4	0.6	4.50	2.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	188.5 MT CO2e								182.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	Replace WH with (1) electric storage water heater, 119 gallon, 13.5 kw input

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	NA	NA	NA	(106.7)	2,340.8	623,698.5	2,161.9	57.7	0.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,347.5 MMBTU								2,344.9 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$58,227.01	$2,752.63	$1.50	-0.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$60,885.29 $US								$60,979.64 $US			
Carbon	176.4	12.0	4.64	NA	NA	NA	(0.6)	0.7	177.1	11.5	4.64	-0.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	188.5 MT CO2e								188.6 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) air-source heat pump water heater (Lochinvar model AHP060, 13.5 kw input, 4.6 COP) + (1) 75 gallon storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	621,357.7	2,268.6	57.8	NA	NA	NA	(106.7)	476.5	621,834.2	2,161.9	57.6	0.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,347.5 MMBTU								2,338.5 MMBTU			
Energy Cost	$57,996.78	$2,888.51	$1.50						$58,043.10	$2,752.63	$1.50	0.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$60,885.29 $US								$60,795.72 $US			
Carbon	176.4	12.0	4.64	NA	NA	NA	(0.6)	0.1	176.5	11.5	4.63	0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	188.5 MT CO2e								188.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$53,658.00	($5,079.36)	$2,752.63	($2,326.73)	($115,044.63)	NA	NA	-0.5866	NA	NA	($51.89)
HVAC Pathway 2	$158,511.00	($2,071.37)	$2,752.63	$681.26	($193,262.93)	-6.1052%	-2.8175%	0.0977	NA	NA	$281.66
DHW Pathway 1	$5,964.00	($230.23)	$135.88	($94.35)	($9,726.23)	-8.9303%	NA	-0.2069	NA	NA	($4.98)
DHW Pathway 2	$58,607.00	($46.32)	$135.88	$89.57	($76,982.22)	-6.9711%	-5.8116%	0.0280	NA	NA	$22.01

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$331,751.00
DHW Existing Replacement:	$7,892.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

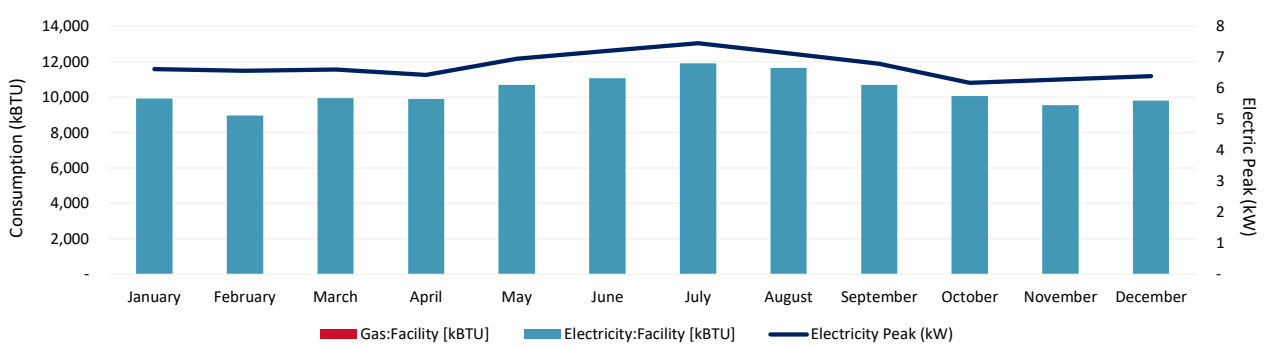
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Building Characteristics

Durham County | JSD Transitional Living Facility Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	1204 E Club Blvd, Durham, NC 27704	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Ductless Heat Pump
Building Type	Recovery Center	Cooling Generation	Split-System DX
Year Built	1963	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	2,050	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Wood Panel w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

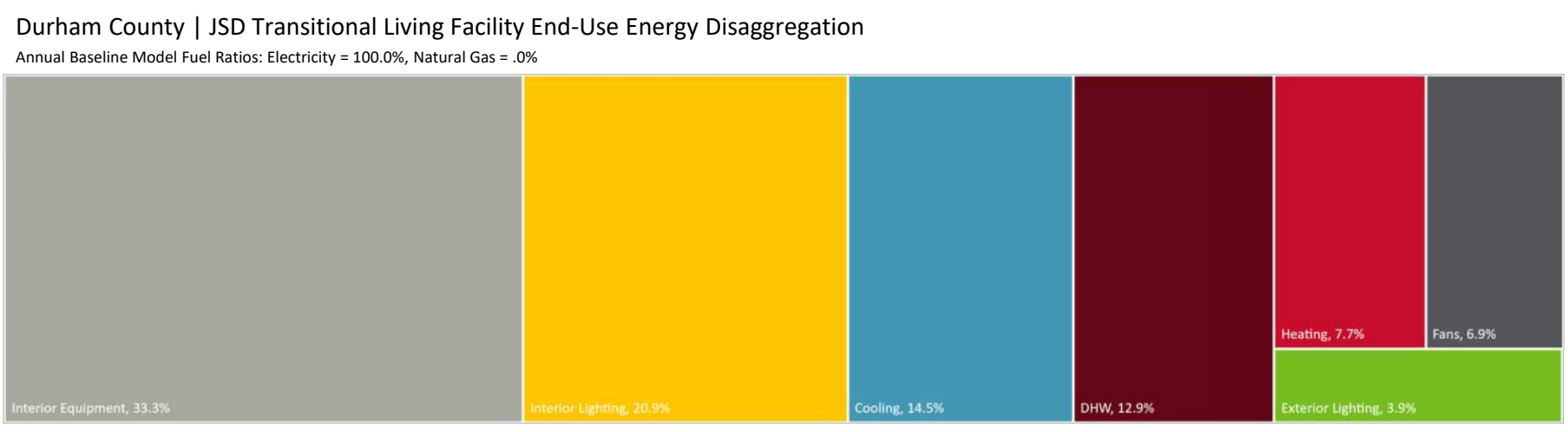


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

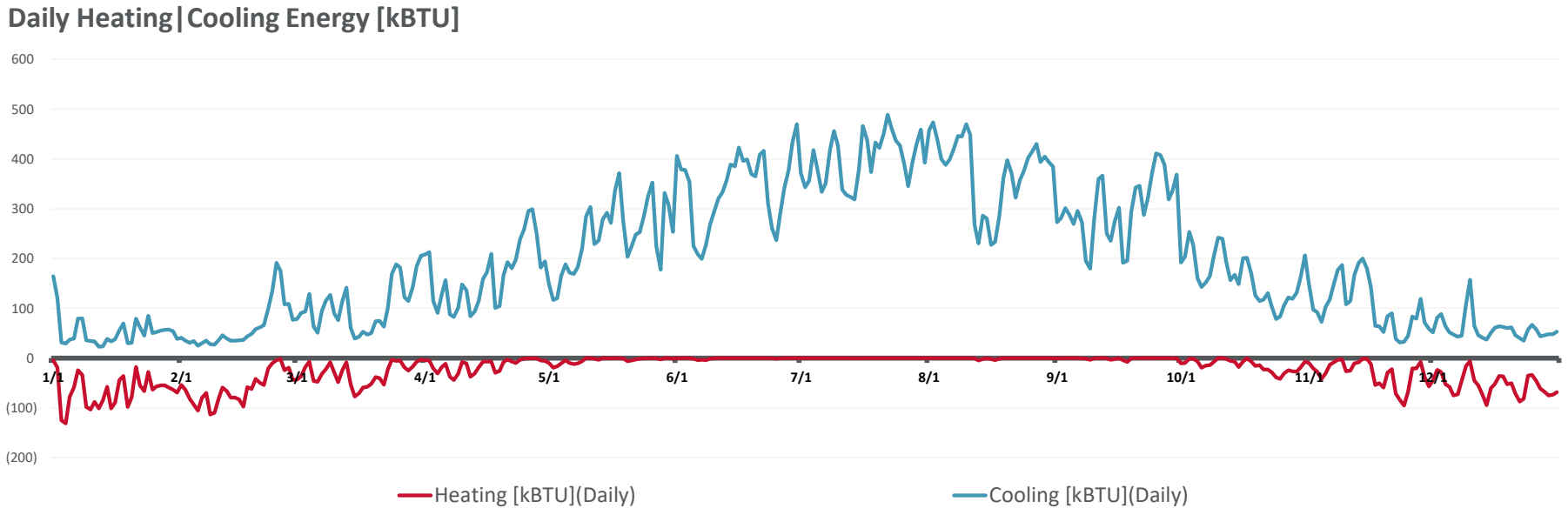


60.54 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	2,906.70	6.61	-
February	2,628.59	6.56	-
March	2,910.61	6.60	-
April	2,902.10	6.44	-
May	3,129.26	6.94	-
June	3,240.27	7.20	-
July	3,489.11	7.45	-
August	3,413.50	7.12	-
September	3,133.97	6.79	-
October	2,946.08	6.17	-
November	2,794.56	6.28	-
December	2,870.96	6.38	-
ANNUAL	36,365.71	-	-
PEAK	3,489.11	7.45	-

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(5) Ductless heat pump systems; (Mult.) Electric baseboard heaters
Domestic Hot Water	(1) Electric storage water heater, 50 gal, 4.5 kw, State model EN6-50-DORS110, mfg 2019; (1) Electric storage water heater, 40 gal, 4.5 kw, State model EN6-40-DORT110, mfg 2019;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	N/A - already heat pumps

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	36,365.7	0.0	60.5	0.0	0.0	0.0	NA	NA	36,365.7	0.0	60.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	124.1 MMBTU								124.1 MMBTU			
Energy Cost	$5,118.35	$0.00	$2.50						$5,118.35	$0.00	$2.50	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,118.35 $US								$5,118.35 $US			
Carbon	10.3	0.0	5.04	0.0	0.0	0.0	NA	NA	10.3	0.0	5.04	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	10.3 MT CO2e								10.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	36,365.7	0.0	60.5	0.0	0.0	0.0	NA	NA	36,365.7	0.0	60.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	124.1 MMBTU								124.1 MMBTU			
Energy Cost	$5,118.35	$0.00	$2.50						$5,118.35	$0.00	$2.50	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,118.35 $US								$5,118.35 $US			
Carbon	10.3	0.0	5.04	0.0	0.0	0.0	NA	NA	10.3	0.0	5.04	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	10.3 MT CO2e								10.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	36,365.7	0.0	60.5	NA	NA	NA	0.0	0.0	36,365.7	0.0	60.5	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	124.1 MMBTU								124.1 MMBTU			
Energy Cost	$5,118.35	$0.00	$2.50						$5,118.35	$0.00	$2.50	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,118.35 $US								$5,118.35 $US			
Carbon	10.3	0.0	5.04	NA	NA	NA	0.0	0.0	10.3	0.0	5.04	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	10.3 MT CO2e								10.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) water heaters with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	36,365.7	0.0	60.5	NA	NA	NA	0.0	(3,219.4)	33,146.4	0.0	55.2	8.9%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	124.1 MMBTU								113.1 MMBTU			
Energy Cost	$5,118.35	$0.00	$2.50						$4,713.01	$0.00	$2.30	7.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$5,118.35 $US								$4,713.01 $US			
Carbon	10.3	0.0	5.04	NA	NA	NA	0.0	(0.9)	9.4	0.0	4.59	8.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	10.3 MT CO2e								9.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
HVAC Pathway 2	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$14,617.00	$405.34	$0.00	$405.34	($11,199.15)	-2.8325%	0.8671%	0.4330	NA	NA	$46.61

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$29,816.00
DHW Existing Replacement:	$6,816.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

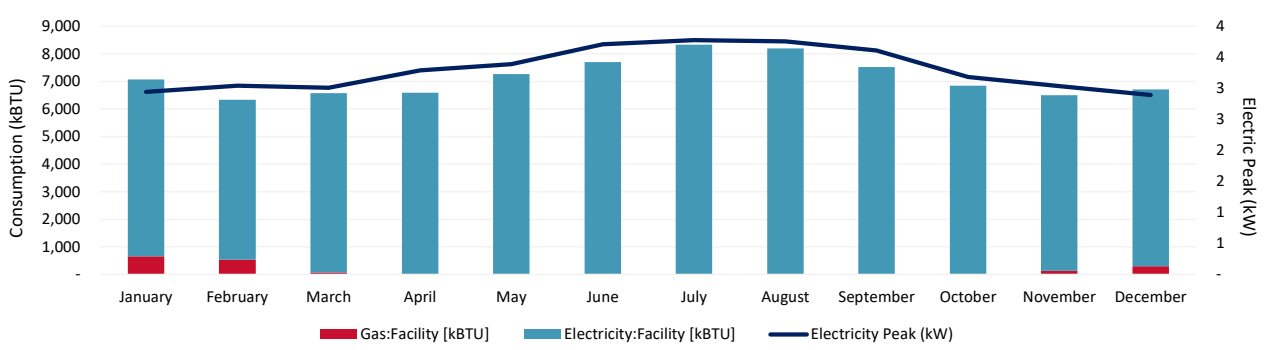
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Building Characteristics

Durham County | Leesville VFD Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	7305 Leesville Rd, Durham, NC 27703	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Unit Heater
Building Type	Emergency Services	Cooling Generation	Split-System DX
Year Built	1988	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	1,017	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent/LED	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

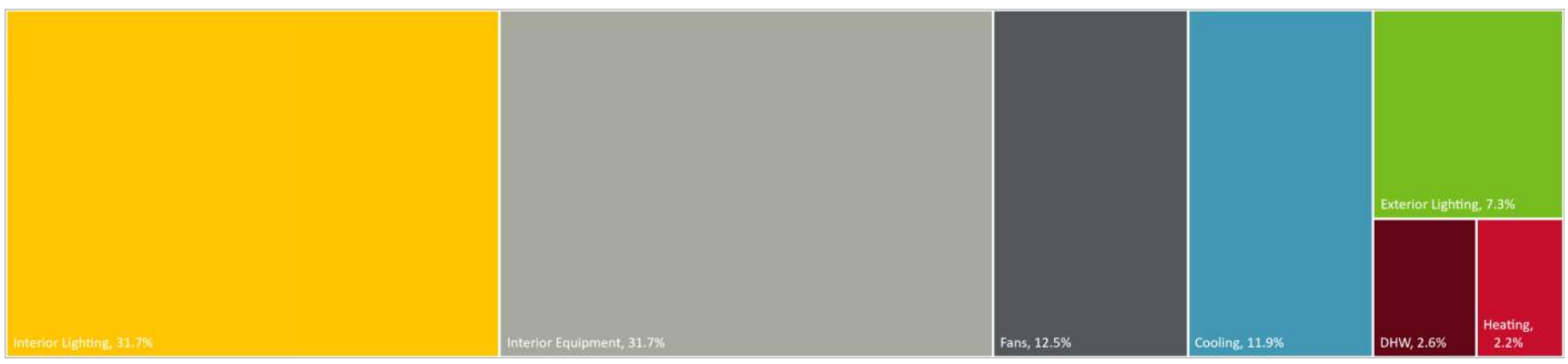


84.18 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	1,877.22	2.94	6.56
February	1,696.81	3.04	5.37
March	1,905.76	3.01	0.66
April	1,928.53	3.29	-
May	2,126.06	3.39	-
June	2,257.67	3.71	-
July	2,441.57	3.78	-
August	2,401.32	3.75	-
September	2,203.01	3.61	-
October	2,006.59	3.18	0.00
November	1,867.31	3.04	1.29
December	1,877.89	2.89	2.99
ANNUAL	24,589.74	-	16.86
PEAK	2,441.57	3.78	6.56

Annual Baseline Model Predicted End-Use Energy Disaggregation

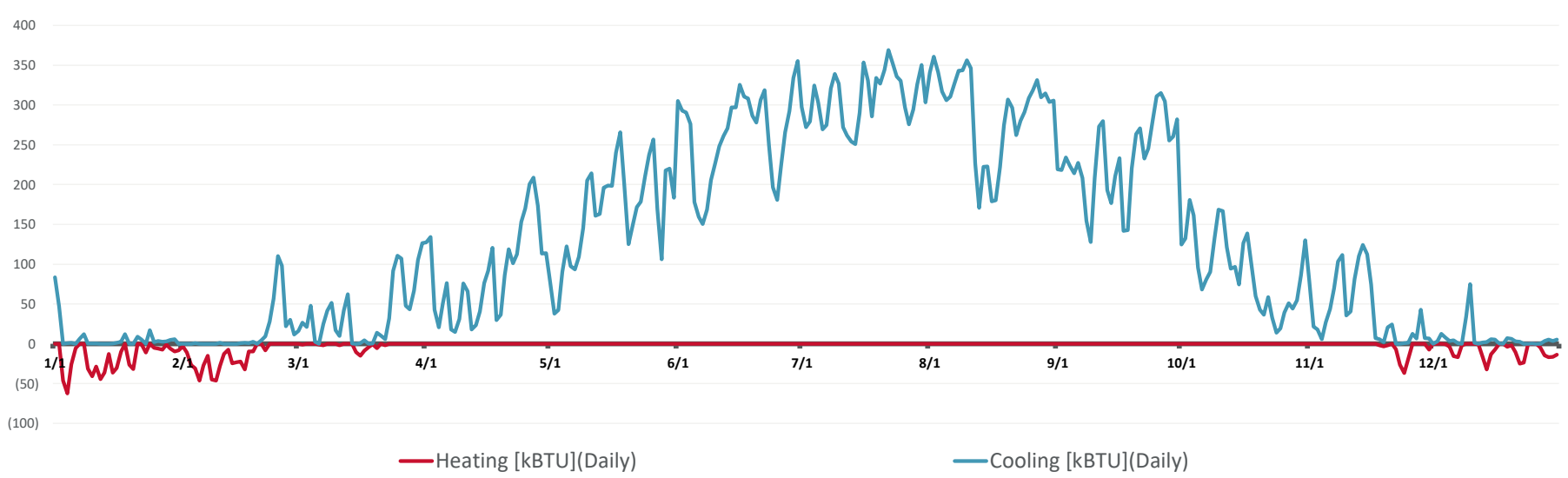
Durham County | Leesville VFD End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 97.8%, Natural Gas = 2.2%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) gas-fired unit heater, Reznor "V3 Tcore 2", assumed 180 mbh input; (1) Heat pump 2.5-ton AHU, Carrier model FB4CNF030, 7.4 kw;
Domestic Hot Water	(1) Electric storage water heater, 40 gal, 4.5 kw, AO Smith model EES-40-912, mfg 1985;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace gas unit heater with (2) electric 30kw unit heater, Modine PTE300 (60kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	24,589.7	19.1	84.4	0.0	(19.1)	399.3	NA	NA	24,989.0	0.0	83.9	0.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	85.8 MMBTU								85.3 MMBTU			
Energy Cost	$3,516.78	$19.28	$3.48						$3,573.88	$0.00	$3.51	-1.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,536.06 $US								$3,573.88 $US			
Carbon	7.0	0.1	6.96	0.0	(0.1)	0.1	NA	NA	7.1	0.0	6.98	-0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.1 MT CO2e								7.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems & heat pumps

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	24,589.7	19.1	84.4	0.0	(19.1)	399.3	NA	NA	24,989.0	0.0	83.9	0.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	85.8 MMBTU								85.3 MMBTU			
Energy Cost	$3,516.78	$19.28	$3.48						$3,573.88	$0.00	$3.51	-1.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,536.06 $US								$3,573.88 $US			
Carbon	7.0	0.1	6.96	0.0	(0.1)	0.1	NA	NA	7.1	0.0	6.98	-0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.1 MT CO2e								7.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	24,589.7	19.1	84.4	NA	NA	NA	0.0	0.0	24,589.7	19.1	84.4	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	85.8 MMBTU								85.8 MMBTU			
Energy Cost	$3,516.78	$19.28	$3.48						$3,516.78	$19.28	$3.48	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,536.06 $US								$3,536.06 $US			
Carbon	7.0	0.1	6.96	NA	NA	NA	0.0	0.0	7.0	0.1	6.96	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.1 MT CO2e								7.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	24,589.7	19.1	84.4	NA	NA	NA	0.0	(438.0)	24,151.7	19.1	82.9	1.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	85.8 MMBTU								84.3 MMBTU			
Energy Cost	$3,516.78	$19.28	$3.48						$3,454.13	$19.28	$3.42	1.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$3,536.06 $US								$3,473.41 $US			
Carbon	7.0	0.1	6.96	NA	NA	NA	0.0	(0.1)	6.9	0.1	6.84	1.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	7.1 MT CO2e								7.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$252,266.00	($57.11)	$19.28	($37.83)	($341,640.31)	-7.2942%	NA	-0.0022	NA	NA	($0.60)
HVAC Pathway 2	$252,266.00	($57.11)	$19.28	($37.83)	($341,640.31)	-7.2942%	NA	-0.0022	NA	NA	($0.60)
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$8,852.00	$62.64	$0.00	$62.64	($10,639.95)	-6.1834%	-2.5187%	0.1105	NA	NA	$6.34

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$9,947.00
DHW Existing Replacement:	$1,525.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

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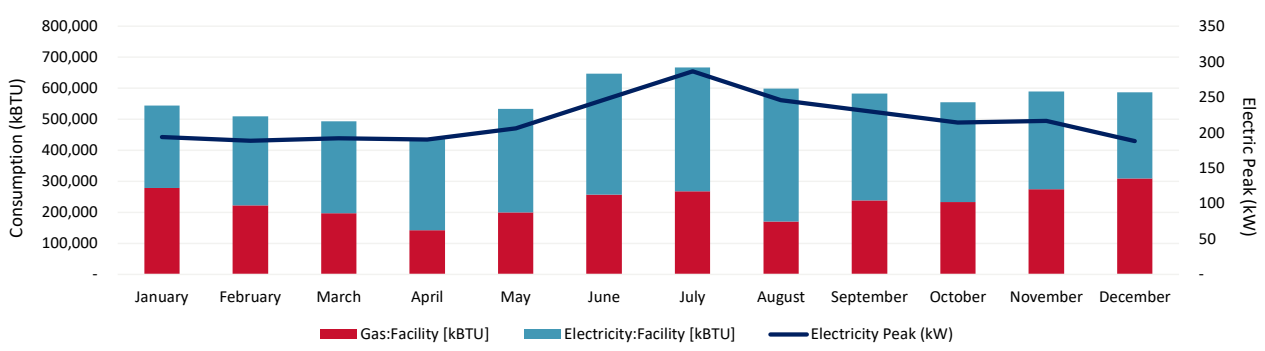
Building Characteristics

Durham County | Main Library Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	300 N Roxboro St, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Direct Vent Condensing Boiler
Building Type	Library	Cooling Generation	Water-Cooled Chiller
Year Built	2019	Domestic Hot Water Generation	Direct Vent Gas Instantaneous Water Hea
Floor Area (ft2)	95,000	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	4	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Metal Panel	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	LED	Weekday Operating Hours	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

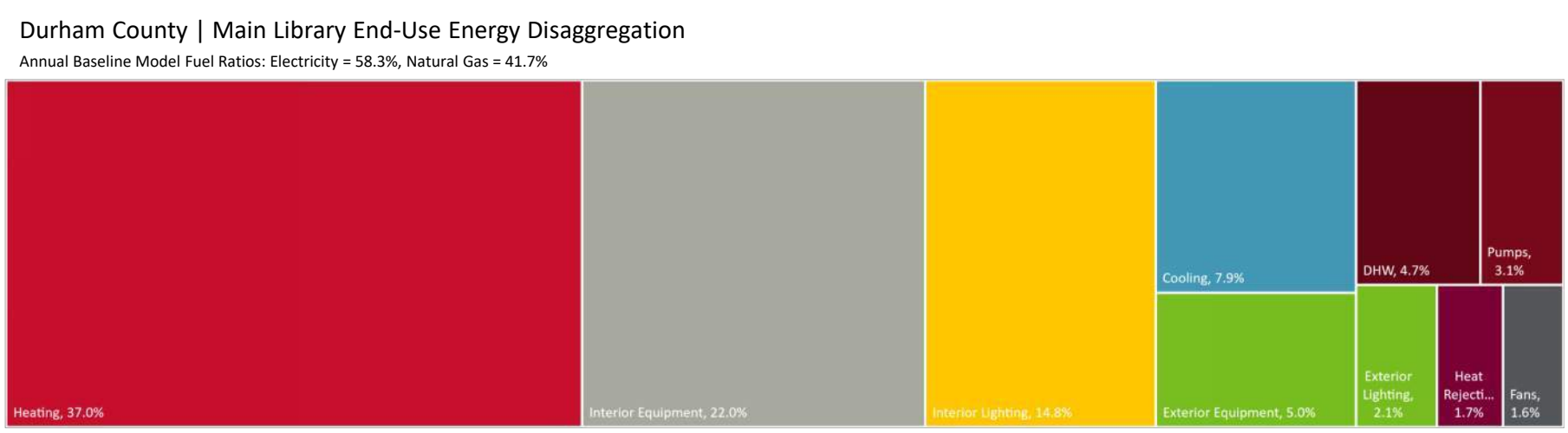


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

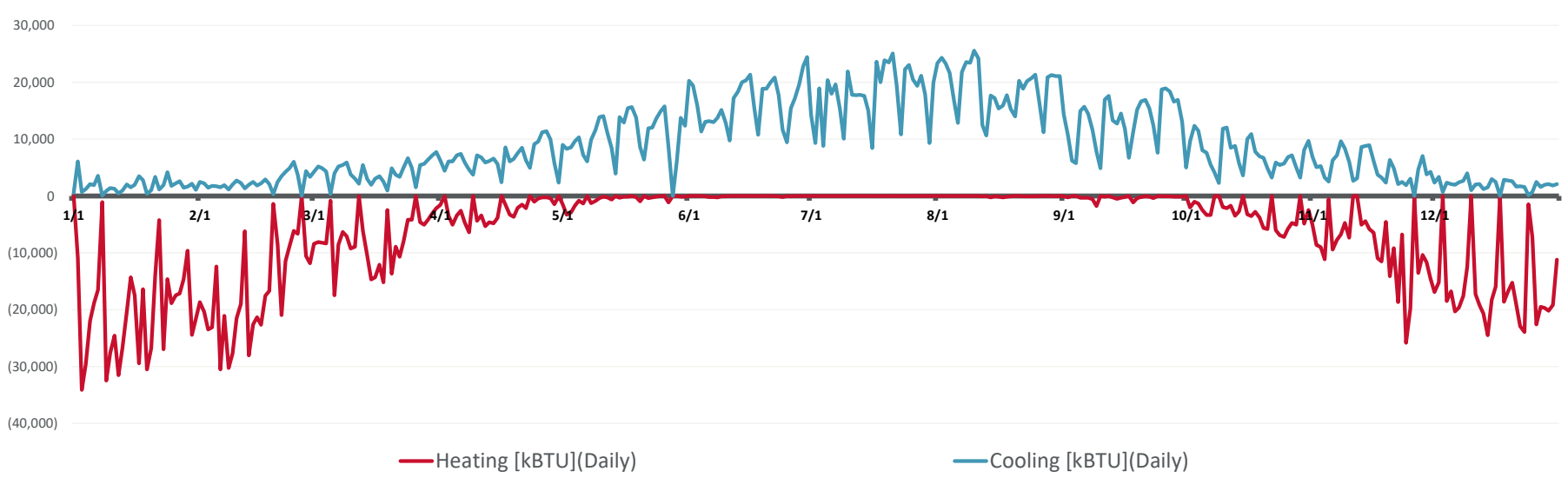


70.99 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	77,650.14	193.80	2,790.50
February	84,188.00	188.20	2,223.00
March	86,648.00	192.20	1,978.50
April	86,275.80	190.40	1,422.50
May	97,930.40	206.00	1,993.00
June	114,303.80	246.40	2,571.50
July	116,858.00	286.40	2,683.50
August	125,429.00	245.40	1,703.00
September	100,753.20	230.00	2,390.50
October	94,207.40	214.20	2,332.00
November	92,029.80	216.40	2,748.50
December	81,509.80	188.00	3,091.50
ANNUAL	1,157,783.33	-	27,928.00
PEAK	125,429.00	286.40	3,091.50

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	Hot water reheat at VAV terminal units, single-duct and parallel fan-powered; (2) Gas-fired direct-vent condensing boilers, Lochinvar "Crest" model FBN1751, 1750 mbh input, 1680 mbh output, mfg 2018, 180F LWT setpoint, 160F EWT; per design terminal unit schedule supply water temp 160F w/ 135F return; VV primary-only pumps w/ VFDs
Domestic Hot Water	(3) direct-vent gas-fired instantaneous water heaters, AO Smith model ATIO-910-100, mfg 2018, 380 mbh input, 8 gpm;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace (2) gas boilers with (2) electric boilers, 492kw each (984 kw total), 8-step control, Lochinvar BWX3-491C

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	0.0	(24,401.2)	724,160.3	NA	NA	1,881,943.6	3,835.8	71.6	-0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,775.2 MMBTU								6,806.6 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$198,933.60	$3,788.83	$2.13	-51.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$133,639.47 $US								$202,722.43 $US			
Carbon	328.7	150.0	5.04	0.0	(129.6)	205.6	NA	NA	534.3	20.4	5.84	-15.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	478.7 MT CO2e								554.7 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	Replace heating water boilers with (6) air-to-water modular heat pump chillers, nominal 30-ton each, Trane AXM-30, 74 kw input each (total single-point power 360 FLA @ 460V/3ph);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	0.0	(24,401.2)	324,210.3	NA	NA	1,481,993.6	3,835.8	57.3	19.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,775.2 MMBTU								5,441.6 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$153,717.32	$3,788.83	$1.66	-17.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$133,639.47 $US								$157,506.15 $US			
Carbon	328.7	150.0	5.04	0.0	(129.6)	92.0	NA	NA	420.7	20.4	4.64	7.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	478.7 MT CO2e								441.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	Replace gas instaneous water heaters with (3) electric instantaneous heaters, 96kw input each (288 kw total), Eemax "SpecAdvantage" model AP096480

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	NA	NA	NA	(3,835.8)	87,601.7	1,245,385.1	24,401.2	70.4	1.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,775.2 MMBTU								6,690.6 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$113,838.57	$24,102.50	$1.45	-3.2%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$133,639.47 $US								$137,941.07 $US			
Carbon	328.7	150.0	5.04	NA	NA	NA	(20.4)	24.9	353.6	129.6	5.09	-0.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	478.7 MT CO2e								483.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WHs with (3) air-source heat pump water heater (Lochinvar model AHP350, 64.5 kw input, 4.3 COP) + (1) 120 gallon HW storage tank

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,157,783.3	28,237.0	71.3	NA	NA	NA	(3,835.8)	16,510.7	1,174,294.1	24,401.2	67.9	4.8%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,775.2 MMBTU								6,448.0 MMBTU			
Energy Cost	$105,748.14	$27,891.33	$1.41						$107,227.84	$24,102.50	$1.38	1.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$133,639.47 $US								$131,330.35 $US			
Carbon	328.7	150.0	5.04	NA	NA	NA	(20.4)	4.7	333.4	129.6	4.87	3.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	478.7 MT CO2e								463.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$532,596.75	($93,185.46)	$24,102.50	($69,082.95)	($2,119,952.52)	NA	NA	-1.9456	NA	NA	($3,875.23)
HVAC Pathway 2	$1,149,708.75	($47,969.19)	$24,102.50	($23,866.68)	($1,999,774.34)	-9.6972%	NA	-0.2872	NA	NA	$1,915.68
DHW Pathway 1	$30,948.00	($8,090.43)	$3,788.83	($4,301.60)	($123,558.10)	NA	NA	-1.9545	NA	NA	($229.33)
DHW Pathway 2	$737,050.00	($1,479.70)	$3,788.83	$2,309.13	($938,227.30)	-6.6414%	-4.0776%	0.0580	NA	NA	$800.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$105,636.00
DHW Existing Replacement:	$40,168.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

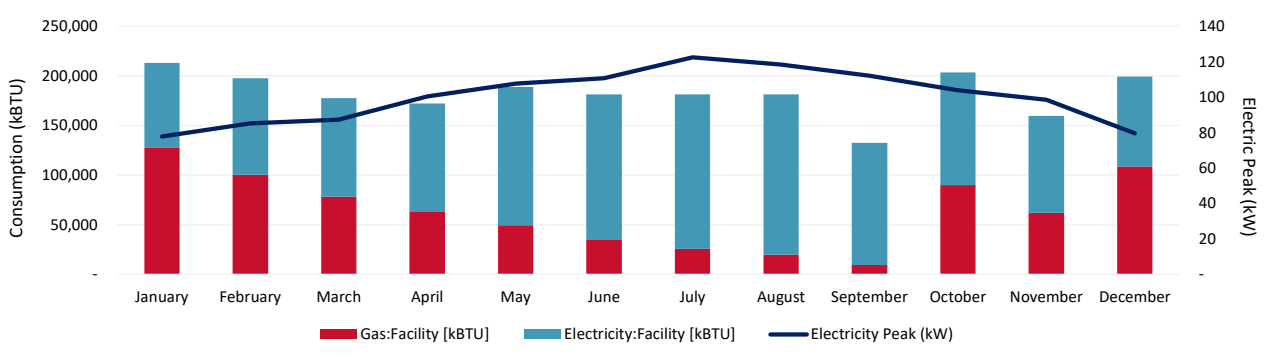
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Building Characteristics

Durham County | North Regional Library Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	221 Milton Rd, Durham, NC 27712	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2006	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	26,649	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

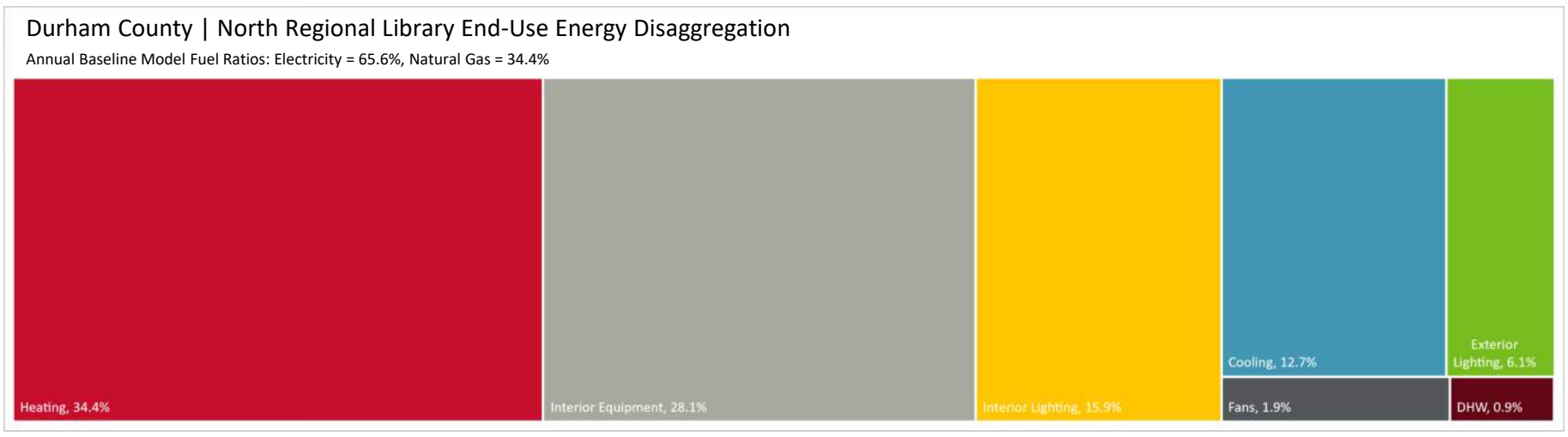


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

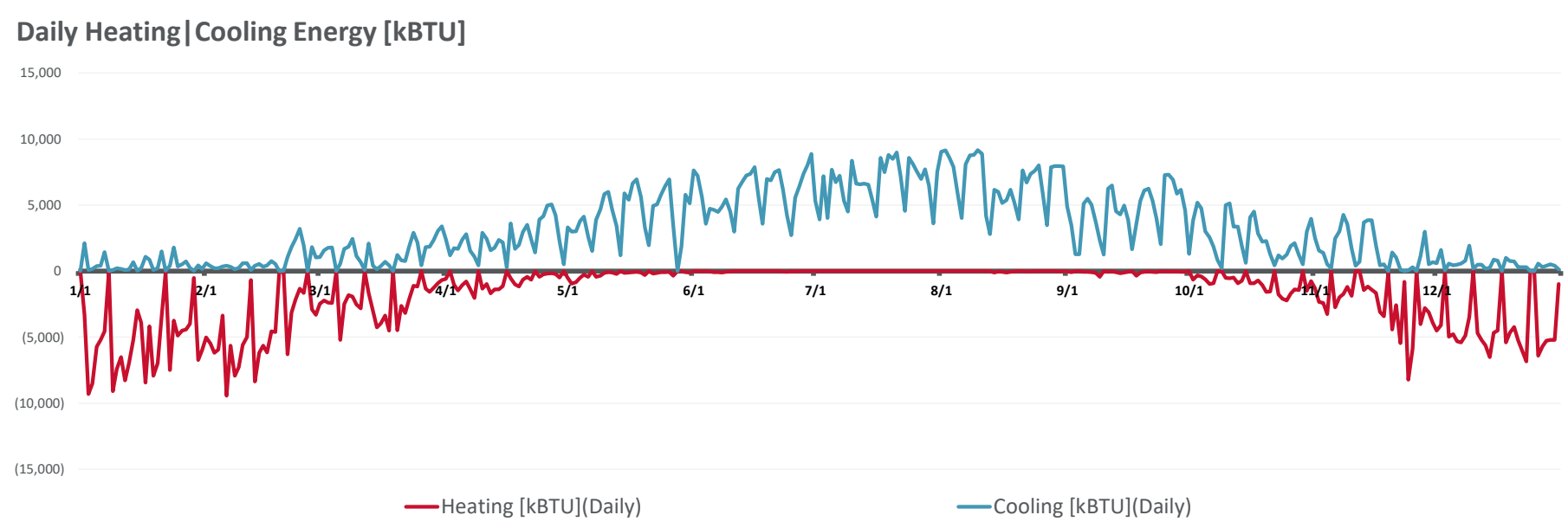


82.10 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	24,910.08	77.80	1,280.50
February	28,510.08	85.20	1,003.50
March	29,148.72	87.20	781.50
April	31,950.16	100.36	629.50
May	40,822.60	107.68	493.50
June	42,709.12	110.68	354.50
July	45,551.52	122.44	258.50
August	47,344.16	118.36	198.00
September	36,018.16	111.96	94.00
October	33,310.04	103.80	899.00
November	28,586.24	98.44	621.50
December	26,619.80	79.56	1,085.50
ANNUAL	415,480.68	-	7,699.50
PEAK	47,344.16	122.44	1,280.50

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 1530 MBH, Output: 1265 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 160 deg F, LWT: 180 deg F, Controls: Heat-Timer SQ Elite 8T Sequencing Controller (for multi-stage control)
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE8220RTA), fuel: electric resistance, capacity: 4000W 1PH/3PH Interlock & 8000W 1PH-3PH Simultaneous, Volume: 80 gal rated, Location: Janitor's Closet off of Lobby

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	0.0	(7,431.3)	194,352.5	NA	NA	609,833.2	0.0	78.1	3.7%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,161.2 MMBTU								2,081.3 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$64,709.81	$0.00	$2.43	-34.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$48,303.67 $US								$64,709.81 $US			
Carbon	118.0	39.5	5.91	0.0	(39.5)	55.2	NA	NA	173.1	0.0	6.50	-10.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	157.4 MT CO2e								173.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	0.0	(7,431.3)	87,938.2	NA	NA	503,418.9	0.0	64.5	20.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,161.2 MMBTU								1,718.2 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$52,560.57	$0.00	$1.97	-8.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$48,303.67 $US								$52,560.57 $US			
Carbon	118.0	39.5	5.91	0.0	(39.5)	25.0	NA	NA	142.9	0.0	5.36	9.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	157.4 MT CO2e								142.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	NA, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	NA	NA	NA	0.0	0.0	415,480.7	7,431.3	81.1	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,161.2 MMBTU								2,161.2 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$40,060.42	$8,243.25	$1.81	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$48,303.67 $US								$48,303.67 $US			
Carbon	118.0	39.5	5.91	NA	NA	NA	0.0	0.0	118.0	39.5	5.91	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	157.4 MT CO2e								157.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	(1) Commercial Storage Tank Water Heater, fuel: electric heat pump, capacity: 4000W, Volume: 80 gal rated, Efficiency: 3.50 COP, Location: Janitor's Closet off of Lobby

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	415,480.7	7,431.3	81.1	NA	NA	NA	0.0	(3,386.7)	412,094.0	7,431.3	80.7	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,161.2 MMBTU								2,149.6 MMBTU			
Energy Cost	$40,060.42	$8,243.25	$1.81						$39,735.95	$8,243.25	$1.80	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$48,303.67 $US								$47,979.20 $US			
Carbon	118.0	39.5	5.91	NA	NA	NA	0.0	(1.0)	117.0	39.5	5.87	0.6%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	157.4 MT CO2e								156.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$135,130.00	($24,649.40)	$8,243.25	($16,406.15)	($509,137.57)	NA	NA	-1.7882	NA	NA	($801.01)
HVAC Pathway 2	$657,269.00	($12,500.15)	$8,243.25	($4,256.90)	($958,351.46)	-7.8705%	NA	-0.0790	NA	NA	$739.77
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$8,278.00	$324.46	$0.00	$324.46	($4,339.75)	-0.8814%	1.7435%	0.6120	NA	NA	$49.04

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

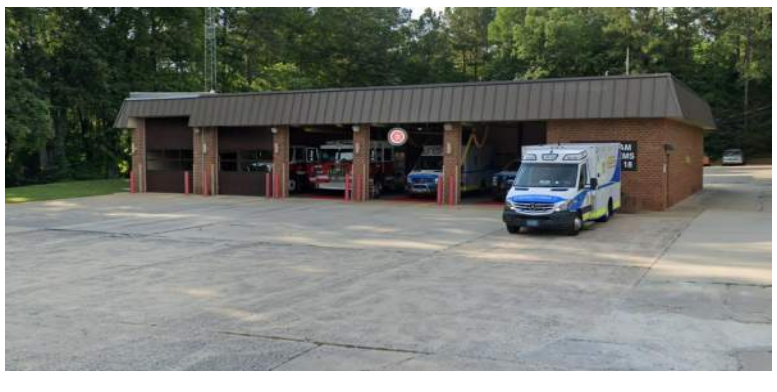
HVAC Existing Replacement:	$38,740.00
DHW Existing Replacement:	$4,611.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

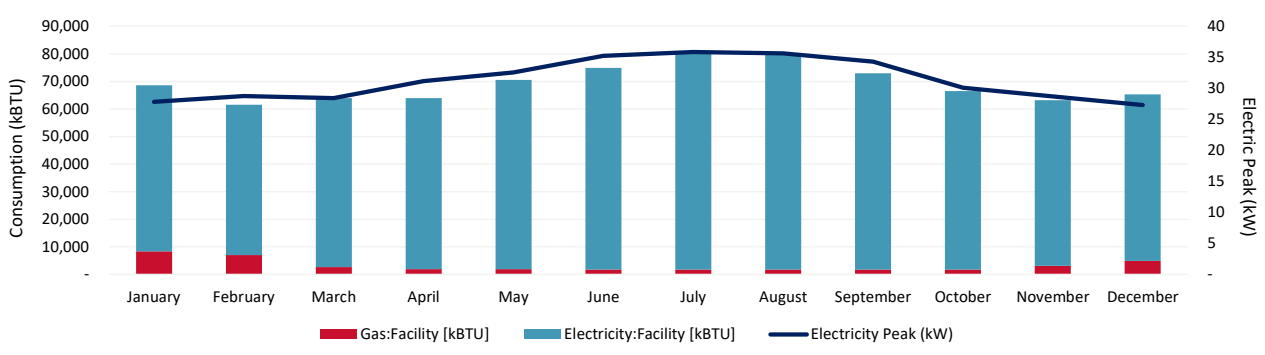
Generated: 06/28/2024 © HDR

Building Characteristics

Durham County | Parkwood VFD #1 Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	1409 Seaton Rd, Durham, NC 27713	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency Services	Cooling Generation	Split-System DX
Year Built	1976	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	9,829	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

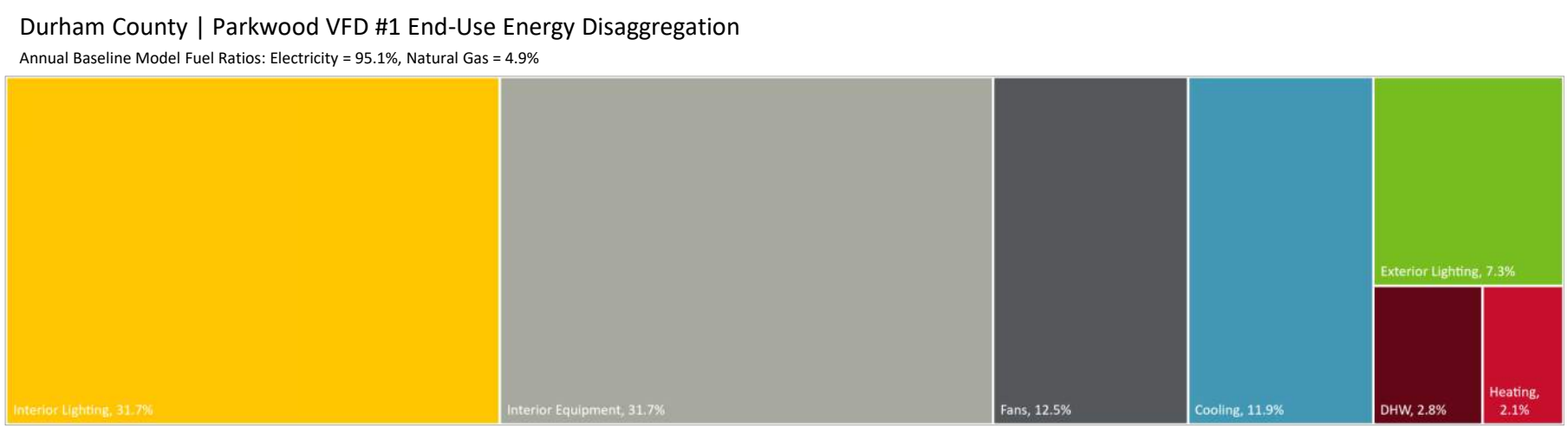


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

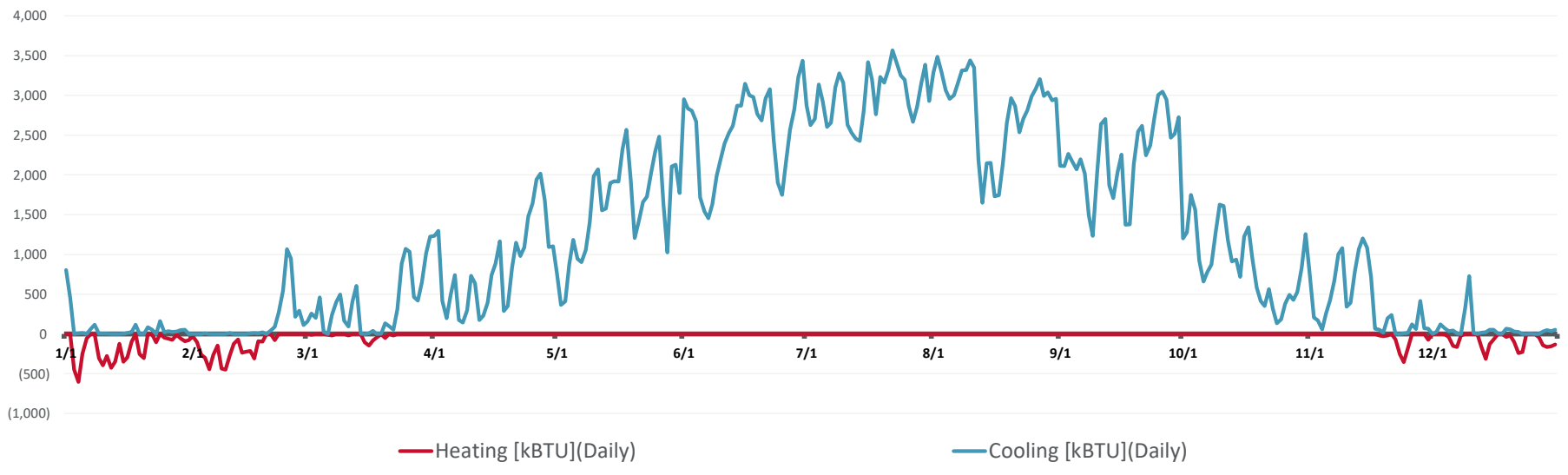


84.63 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	17,673.48	27.78	83.37
February	15,972.75	28.72	70.08
March	17,952.39	28.40	26.26
April	18,200.35	31.16	18.70
May	20,111.83	32.52	18.60
June	21,412.98	35.20	17.35
July	23,188.43	35.84	17.43
August	22,801.89	35.63	17.33
September	20,892.78	34.25	17.01
October	18,967.11	30.10	18.18
November	17,618.64	28.71	30.76
December	17,690.46	27.30	48.47
ANNUAL	232,483.09	-	383.53
PEAK	23,188.43	35.84	83.37

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Direct-vent gas furnace, Trane model S9B1B060U4PSA, 60 mbh input, 55 mbh output, mfg 2015; (4?) Gas-fired radiant tube heaters, Space-Ray, approx. 15' double tube, approx 50 mbh; (3) RTU gas furnaces, no namplate data gathered;
Domestic Hot Water	(1) Gas-fired storage water heater, natural draft, 40 gal, 40 mbh input, 41 gph recovery, State model GS6-40-BCS 400, mfg 2016; (1) Electric storage water heater, 50 gal, 4.5 kw, Rheem model 82MV52-2, mfg. 2008;

Durham County | Parkwood VFD #1 | Electrification Pathways

Generated: 06/28/2024 © HDR

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace (1) split-system with (1) 3-ton split-system heat pump condensing unit and AHU with 20 kw heater; *Replace (3) RTUs with (3) 3-ton heat pump RTU, w/ economizer, 18 kw elec heat, Trane model WHC036 (54 kw total); *Replace (4) gas radiant heaters with (4) electric unit heaters, Modine HER150, 15 kw (60 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	0.0	(185.0)	2,811.8	NA	NA	235,294.9	220.8	83.9	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	834.0 MMBTU								825.1 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$20,906.59	$222.44	$2.15	-0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$21,004.84 $US								$21,129.03 $US			
Carbon	66.0	2.2	6.93	0.0	(1.0)	0.8	NA	NA	66.8	1.2	6.92	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	68.2 MT CO2e								68.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	0.0	(185.0)	2,811.8	NA	NA	235,294.9	220.8	83.9	1.1%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	834.0 MMBTU								825.1 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$20,906.59	$222.44	$2.15	-0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$21,004.84 $US								$21,129.03 $US			
Carbon	66.0	2.2	6.93	0.0	(1.0)	0.8	NA	NA	66.8	1.2	6.92	0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	68.2 MT CO2e								68.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 50 gallon, 6kw input, Bradford White model LE350S3-3 (total 6 kw);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	NA	NA	NA	(220.8)	5,219.9	237,703.0	185.0	84.4	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	834.0 MMBTU								829.8 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$21,004.60	$186.35	$2.16	-0.9%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$21,004.84 $US								$21,190.95 $US			
Carbon	66.0	2.2	6.93	NA	NA	NA	(1.2)	1.5	67.5	1.0	6.97	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	68.2 MT CO2e								68.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace (2) water heaters with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	232,483.1	405.8	84.9	NA	NA	NA	(220.8)	986.7	233,469.8	185.0	83.0	2.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	834.0 MMBTU								815.3 MMBTU			
Energy Cost	$20,596.05	$408.79	$2.14						$20,674.02	$186.35	$2.12	0.7%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$21,004.84 $US								$20,860.36 $US			
Carbon	66.0	2.2	6.93	NA	NA	NA	(1.2)	0.3	66.3	1.0	6.84	1.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	68.2 MT CO2e								67.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$106,372.00	($310.54)	$186.35	($124.19)	($145,917.46)	-7.3983%	NA	-0.0151	NA	NA	$9.40
HVAC Pathway 2	$106,372.00	($310.54)	$186.35	($124.19)	($145,917.46)	-7.3983%	NA	-0.0151	NA	NA	$9.40
DHW Pathway 1	-$213.00	($408.55)	$222.44	($186.11)	($3,109.17)	NA	NA	NA	NA	NA	($15.76)
DHW Pathway 2	$9,901.00	($77.97)	$222.44	$144.47	($9,800.80)	-4.3591%	-0.3405%	0.2675	NA	NA	$45.53

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$42,861.00
DHW Existing Replacement:	$9,853.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

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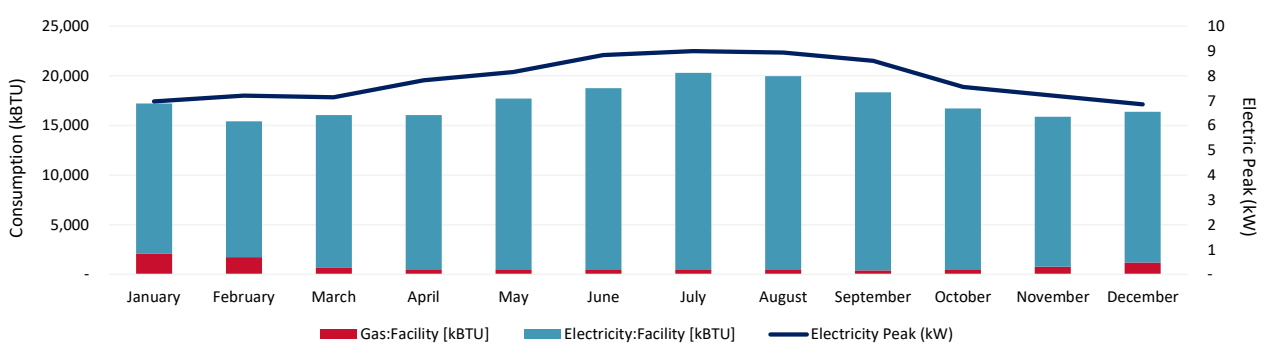
Building Characteristics

Durham County | Parkwood VFD #2 Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	4200 Farrington Rd, Durham, NC 27707	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Emergency Services	Cooling Generation	Split-System DX
Year Built	1984	Domestic Hot Water Generation	Gas Instantaneous Water Heater
Floor Area (ft2)	2,467	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule SGS | Small General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Masonry w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent/LED	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

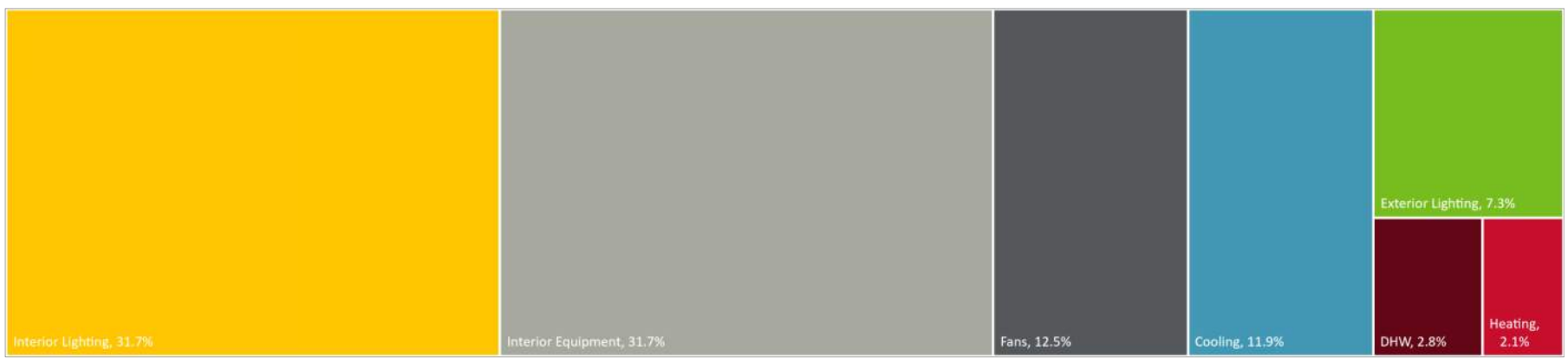


84.63 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	4,435.90	6.97	20.93
February	4,009.03	7.21	17.59
March	4,505.91	7.13	6.59
April	4,568.14	7.82	4.69
May	5,047.91	8.16	4.67
June	5,374.49	8.83	4.36
July	5,820.11	9.00	4.38
August	5,723.09	8.94	4.35
September	5,243.92	8.60	4.27
October	4,760.59	7.56	4.56
November	4,422.14	7.21	7.72
December	4,440.16	6.85	12.16
ANNUAL	58,351.39	-	96.26
PEAK	5,820.11	9.00	20.93

Annual Baseline Model Predicted End-Use Energy Disaggregation

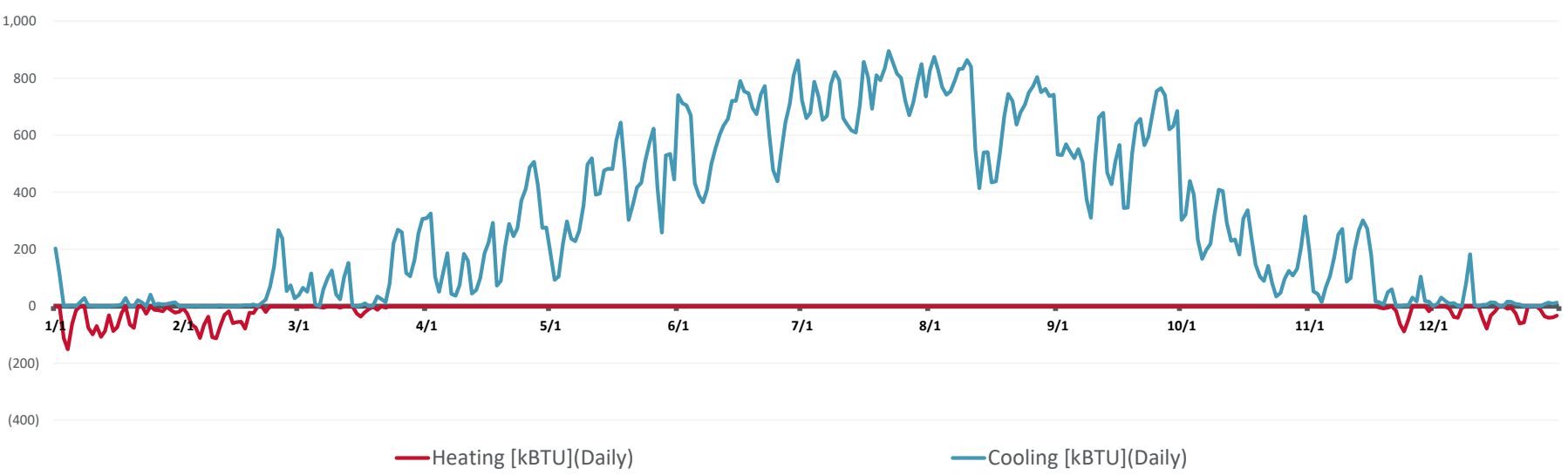
Durham County | Parkwood VFD #2 End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 95.1%, Natural Gas = 4.9%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Direct-vent gas furnace, York model TG9S080B12, 80 mbh input, 76 mbh output, mfg 2009; (2) Gas radiant tube heater, Roberts-Gordon model CTH2-80, 80 mbh input;
Domestic Hot Water	(1) gas-fired instantaneous water heater, Noritz model N-0751M-DVC, 199.8 mbh input, 168 mbh output, 202 gph recovery, mfg 2009;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace (1) split-system with (1) 3-ton split-system heat pump condensing unit and AHU with 20 kw heater; *Replace (2) gas radiant heaters with (3) electric unit heaters, Modine HER150, 15 kw (45 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	58,351.4	101.9	84.9	0.0	(46.4)	968.6	NA	NA	59,320.0	55.4	84.3	0.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	209.3 MMBTU								208.0 MMBTU			
Energy Cost	$7,042.73	$102.60	$2.90						$7,125.23	$55.83	$2.91	-0.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,145.34 $US								$7,181.07 $US			
Carbon	16.6	0.5	6.93	0.0	(0.2)	0.3	NA	NA	16.8	0.3	6.95	-0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.1 MT CO2e								17.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - building uses simple systems

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	58,351.4	101.9	84.9	0.0	(46.4)	968.6	NA	NA	59,320.0	55.4	84.3	0.6%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	209.3 MMBTU								208.0 MMBTU			
Energy Cost	$7,042.73	$102.60	$2.90						$7,125.23	$55.83	$2.91	-0.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,145.34 $US								$7,181.07 $US			
Carbon	16.6	0.5	6.93	0.0	(0.2)	0.3	NA	NA	16.8	0.3	6.95	-0.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.1 MT CO2e								17.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 50 gallon, 27kw input, Bradford White model CEHD50(A)27 3*CF (total 27 kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	58,351.4	101.9	84.9	NA	NA	NA	(55.4)	1,310.2	59,661.5	46.4	84.4	0.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	209.3 MMBTU								208.3 MMBTU			
Energy Cost	$7,042.73	$102.60	$2.90						$7,154.21	$46.77	$2.92	-0.8%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,145.34 $US								$7,200.98 $US			
Carbon	16.6	0.5	6.93	NA	NA	NA	(0.3)	0.4	16.9	0.2	6.97	-0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.1 MT CO2e								17.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace (1) gas water heater with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT (total 12 kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	58,351.4	101.9	84.9	NA	NA	NA	(55.4)	247.7	58,599.0	46.4	83.0	2.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	209.3 MMBTU								204.6 MMBTU			
Energy Cost	$7,042.73	$102.60	$2.90						$7,063.92	$46.77	$2.88	0.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$7,145.34 $US								$7,110.70 $US			
Carbon	16.6	0.5	6.93	NA	NA	NA	(0.3)	0.1	16.6	0.2	6.84	1.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	17.1 MT CO2e								16.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$55,756.23	($82.50)	$46.77	($35.73)	($75,986.08)	-7.3459%	NA	-0.0085	NA	NA	($1.45)
HVAC Pathway 2	$55,756.23	($82.50)	$46.77	($35.73)	($75,986.08)	-7.3459%	NA	-0.0085	NA	NA	($1.45)
DHW Pathway 1	$8,440.00	($111.47)	$55.83	($55.64)	($12,446.08)	-8.0662%	NA	-0.0913	NA	NA	($3.96)
DHW Pathway 2	$15,566.00	($21.19)	$55.83	$34.64	($20,170.46)	-6.8267%	-4.9010%	0.0411	NA	NA	$11.43

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$16,945.00
DHW Existing Replacement:	$5,174.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

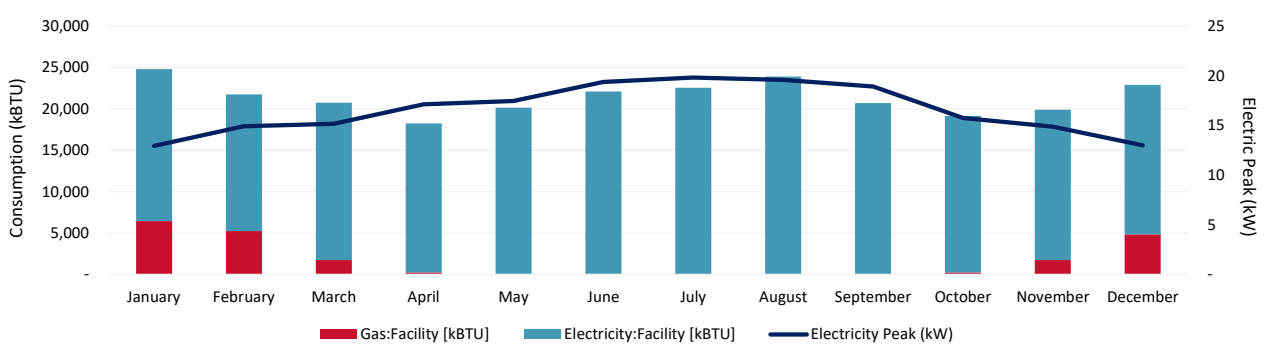
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Building Characteristics

Durham County | Rainbow Assisted Living Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	706 Rigsbee Ave, Durham, NC 27701	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Packaged Furnace
Building Type	Adult Daycare	Cooling Generation	Split-Systme DX
Year Built	1997	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	5,376	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed

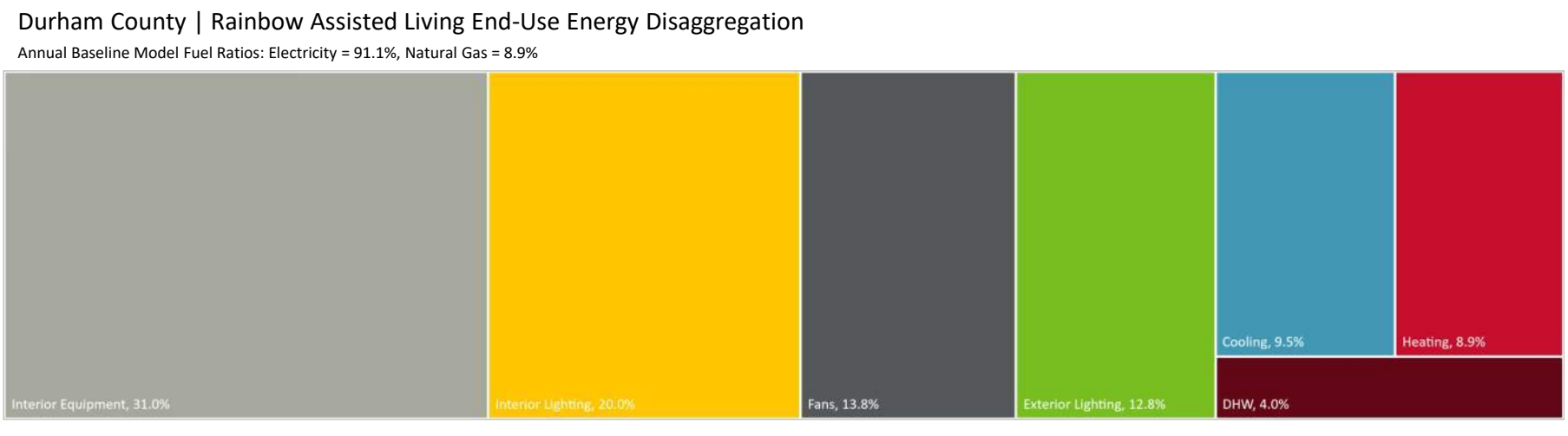


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

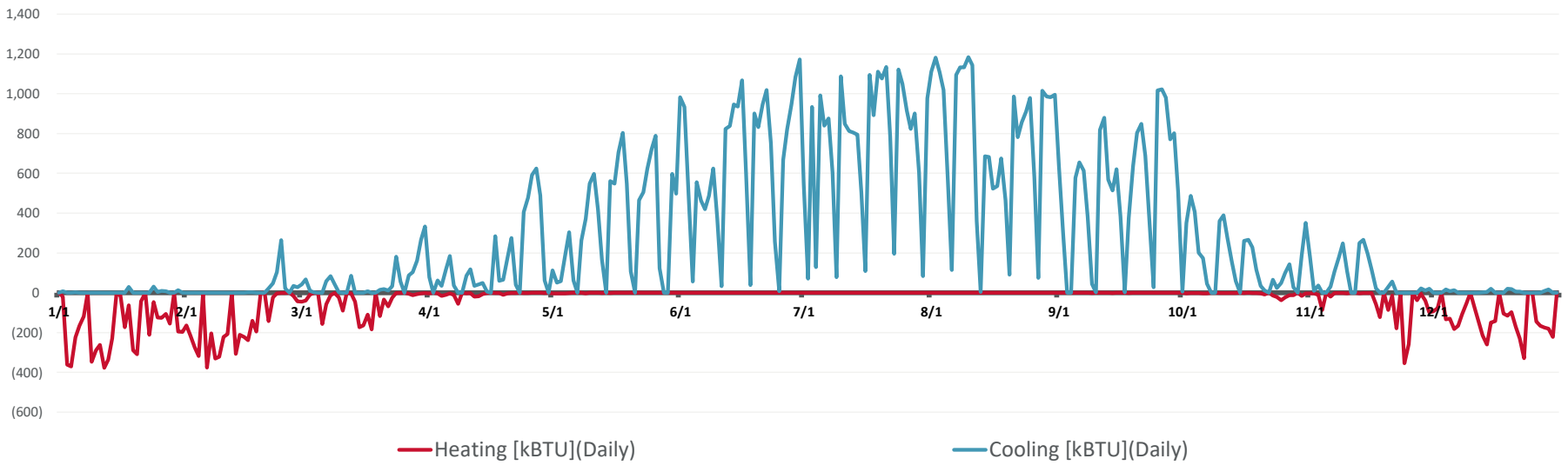


47.81 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	5,374.55	12.94	64.50
February	4,850.22	14.92	52.28
March	5,574.77	15.17	17.46
April	5,284.59	17.13	2.20
May	5,904.94	17.46	0.25
June	6,479.55	19.39	0.00
July	6,611.63	19.83	-
August	7,009.79	19.61	0.01
September	6,063.41	18.92	0.06
October	5,542.76	15.78	2.23
November	5,318.82	14.88	17.46
December	5,295.98	13.02	48.39
ANNUAL	69,311.01	-	204.82
PEAK	7,009.79	19.83	64.50

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) "Unit 1" 5-ton AHU condensing gas furnace, Trane "XB90", mfg 2003; (2) "Unit 2" & "Unit 3" 5-ton AHU non-condensing gas furnace, Trane "XR80", mfg 2006;
Domestic Hot Water	(1) electric storage water heater, 40 gal, 4.5 kw, State model PV-40-20RS0NC, mfg 1995;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace (3) split-systems with (3) 5-ton split-system heat pump condensing units and (3) AHU with 25 kw heaters (75 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**69,311.0**	**230.1**	**48.3**	**0.0**	**(230.1)**	**4,849.5**	**NA**	**NA**	**74,160.5**	**0.0**	**47.1**	**2.5%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	259.6 MMBTU								253.1 MMBTU			
Energy Cost	**$8,174.94**	**$231.76**	**$1.56**						**$8,581.56**	**$0.00**	**$1.60**	**-2.1%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,406.70 $US								$8,581.56 $US			
Carbon	**19.7**	**1.2**	**3.89**	**0.0**	**(1.2)**	**1.4**	**NA**	**NA**	**21.1**	**0.0**	**3.92**	**-0.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	20.9 MT CO2e								21.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	*Replace (3) split-systems with (1) 15-ton VRF system inverter heat pump condensing unit + (3) indoor AHUs [condensing unit 80 MCA, 125 MOP @ 208V/3ph, AHUs each 6 MCA, 15 MOP @ 208V/1ph] {Vendor estimate for system equip cost - $160k}

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**69,311.0**	**230.1**	**48.3**	**0.0**	**(230.1)**	**2,177.1**	**NA**	**NA**	**71,488.1**	**0.0**	**45.4**	**6.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	259.6 MMBTU								244.0 MMBTU			
Energy Cost	**$8,174.94**	**$231.76**	**$1.56**						**$8,363.33**	**$0.00**	**$1.56**	**0.5%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,406.70 $US								$8,363.33 $US			
Carbon	**19.7**	**1.2**	**3.89**	**0.0**	**(1.2)**	**0.6**	**NA**	**NA**	**20.3**	**0.0**	**3.78**	**2.9%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	20.9 MT CO2e								20.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**69,311.0**	**230.1**	**48.3**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**69,311.0**	**230.1**	**48.3**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	259.6 MMBTU								259.6 MMBTU			
Energy Cost	**$8,174.94**	**$231.76**	**$1.56**						**$8,174.94**	**$231.76**	**$1.56**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,406.70 $US								$8,406.70 $US			
Carbon	**19.7**	**1.2**	**3.89**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**19.7**	**1.2**	**3.89**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	20.9 MT CO2e								20.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**69,311.0**	**230.1**	**48.3**	**NA**	**NA**	**NA**	**0.0**	**(1,989.1)**	**67,321.9**	**230.1**	**47.0**	**2.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	259.6 MMBTU								252.8 MMBTU			
Energy Cost	**$8,174.94**	**$231.76**	**$1.56**						**$8,007.90**	**$231.76**	**$1.53**	**2.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$8,406.70 $US								$8,239.67 $US			
Carbon	**19.7**	**1.2**	**3.89**	**NA**	**NA**	**NA**	**0.0**	**(0.6)**	**19.1**	**1.2**	**3.78**	**2.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	20.9 MT CO2e								20.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$78,763.00	($406.63)	$231.76	($174.87)	($109,570.30)	-7.5217%	NA	-0.0295	NA	NA	($7.89)
HVAC Pathway 2	$518,406.00	($188.39)	$231.76	$43.37	($699,056.90)	-7.2475%	-11.7196%	0.0021	NA	NA	$30.80
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$11,827.00	$167.03	$0.00	$167.03	($12,457.40)	-5.0692%	-0.8200%	0.2205	NA	NA	$28.80

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$35,337.00
DHW Existing Replacement:	$1,512.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

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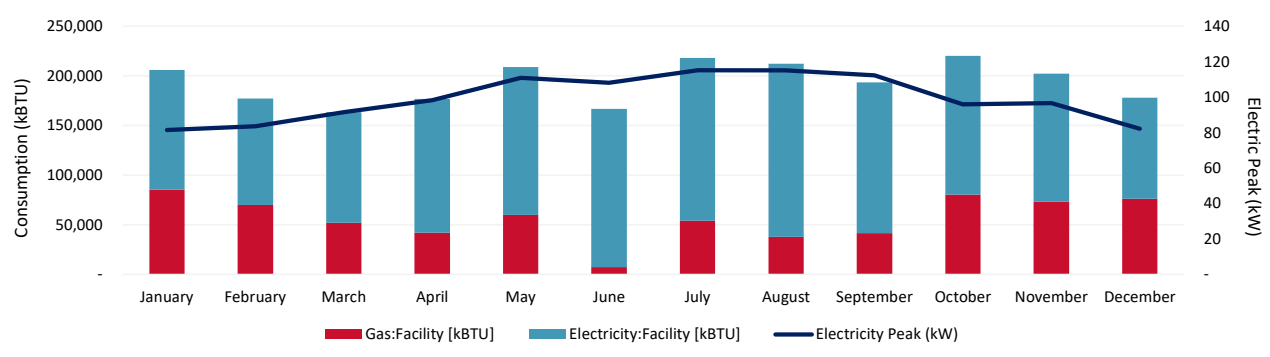
Building Characteristics

Durham County | South Regional Library Building Characteristics

Location | Envelope Basics		Heating | Cooling | Ventilation	
Location	4505 S. Alston Avenue, Durham, NC 27713	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2009	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	27,320	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed

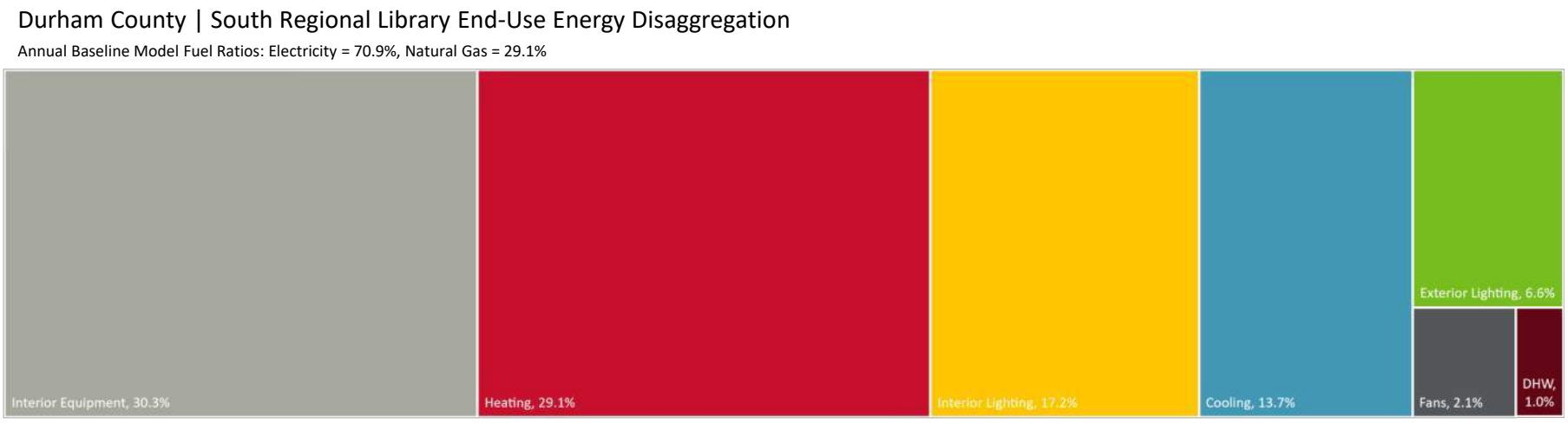


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

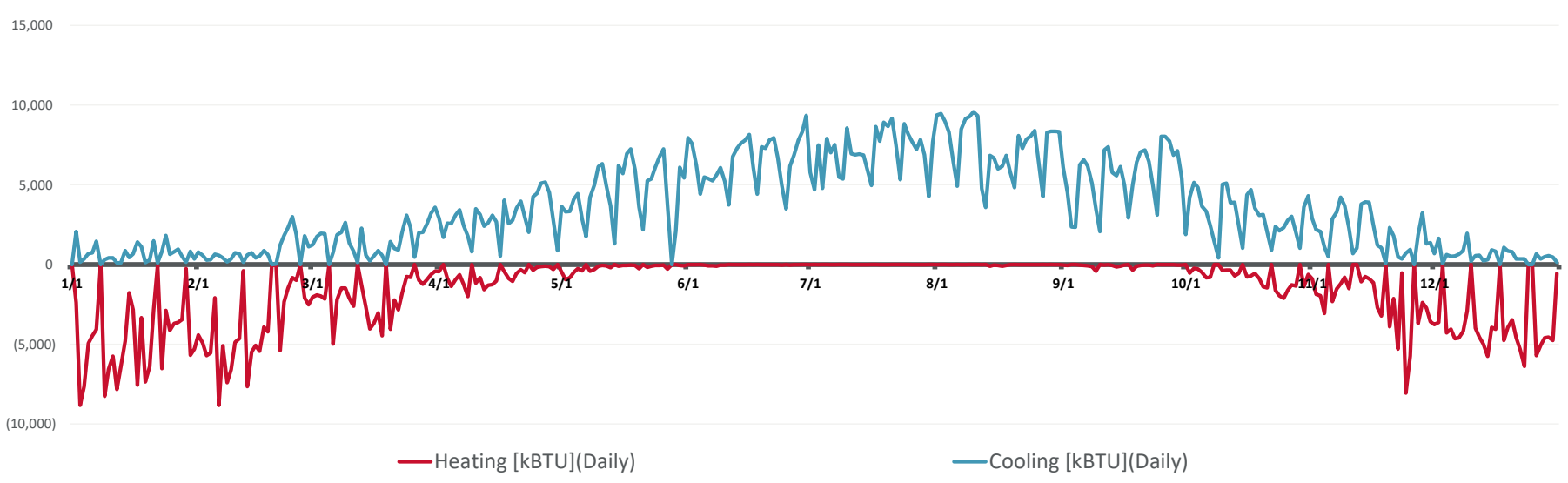


85.04 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	35,412.68	81.44	852.00
February	31,510.64	83.48	698.00
March	32,645.40	91.52	520.50
April	39,506.64	98.16	418.50
May	43,563.16	110.96	600.00
June	46,709.52	108.20	72.50
July	47,984.36	115.16	543.00
August	51,182.24	115.12	376.50
September	44,418.20	112.28	418.00
October	40,968.96	95.96	804.00
November	37,812.36	96.68	733.00
December	29,819.12	82.16	761.00
ANNUAL	481,533.28	-	6,797.00
PEAK	51,182.24	115.16	852.00

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 1530 MBH, Output: 1265 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 160 deg F, LWT: 180 deg F, Controls: Heat-Timer SQ Elite 8T Sequencing Controller (for multi-stage control)
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE8220RTA), fuel: electric resistance, capacity: 4000W 1PH/3PH Interlock & 8000W 1PH-3PH Simultaneous, Volume: 80 gal rated, Location: Janitor's Closet off of Lobby

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**481,533.3**	**6,730.4**	**84.8**	**0.0**	**(6,730.4)**	**169,905.2**	**NA**	**NA**	**651,438.5**	**0.0**	**81.4**	**4.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,316.5 MMBTU								2,223.3 MMBTU			
Energy Cost	**$45,004.94**	**$8,072.20**	**$1.94**						**$68,817.48**	**$0.00**	**$2.52**	**-29.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$53,077.14 $US								$68,817.48 $US			
Carbon	**136.7**	**35.7**	**6.31**	**0.0**	**(35.7)**	**48.2**	**NA**	**NA**	**184.9**	**0.0**	**6.77**	**-7.2%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	172.5 MT CO2e								184.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**481,533.3**	**6,730.4**	**84.8**	**0.0**	**(6,730.4)**	**78,051.4**	**NA**	**NA**	**559,584.7**	**0.0**	**69.9**	**17.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,316.5 MMBTU								1,909.8 MMBTU			
Energy Cost	**$45,004.94**	**$8,072.20**	**$1.94**						**$57,595.81**	**$0.00**	**$2.11**	**-8.5%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$53,077.14 $US								$57,595.81 $US			
Carbon	**136.7**	**35.7**	**6.31**	**0.0**	**(35.7)**	**22.2**	**NA**	**NA**	**158.9**	**0.0**	**5.82**	**7.9%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	172.5 MT CO2e								158.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	NA, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**481,533.3**	**6,730.4**	**84.8**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**481,533.3**	**6,730.4**	**84.8**	**0.0%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,316.5 MMBTU								2,316.5 MMBTU			
Energy Cost	**$45,004.94**	**$8,072.20**	**$1.94**						**$45,004.94**	**$8,072.20**	**$1.94**	**0.0%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$53,077.14 $US								$53,077.14 $US			
Carbon	**136.7**	**35.7**	**6.31**	**NA**	**NA**	**NA**	**0.0**	**0.0**	**136.7**	**35.7**	**6.31**	**0.0%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	172.5 MT CO2e								172.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	(1) Commercial Storage Tank Water Heater, fuel: electric heat pump, capacity: 4000W, Volume: 80 gal rated, Efficiency: 3.50 COP, Location: Janitor's Closet off of Lobby

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	**481,533.3**	**6,730.4**	**84.8**	**NA**	**NA**	**NA**	**0.0**	**(4,003.4)**	**477,529.9**	**6,730.4**	**84.3**	**0.6%**
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	2,316.5 MMBTU								2,302.8 MMBTU			
Energy Cost	**$45,004.94**	**$8,072.20**	**$1.94**						**$44,634.47**	**$8,072.20**	**$1.93**	**0.7%**
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$53,077.14 $US								$52,706.67 $US			
Carbon	**136.7**	**35.7**	**6.31**	**NA**	**NA**	**NA**	**0.0**	**(1.1)**	**135.6**	**35.7**	**6.27**	**0.7%**
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	172.5 MT CO2e								171.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$698,398.00	($23,812.54)	$8,072.20	($15,740.34)	($1,256,642.65)	-10.2445%	NA	-0.3315	NA	NA	($636.91)
HVAC Pathway 2	$692,270.00	($12,590.86)	$8,072.20	($4,518.66)	($1,011,579.31)	-7.9044%	NA	-0.0814	NA	NA	$693.05
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$366.00	$370.47	$0.00	$370.47	$7,322.54	5486.0570%	10.3589%	15.8057	2.00	2.00	$57.97

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$42,924.00
DHW Existing Replacement:	$11,431.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

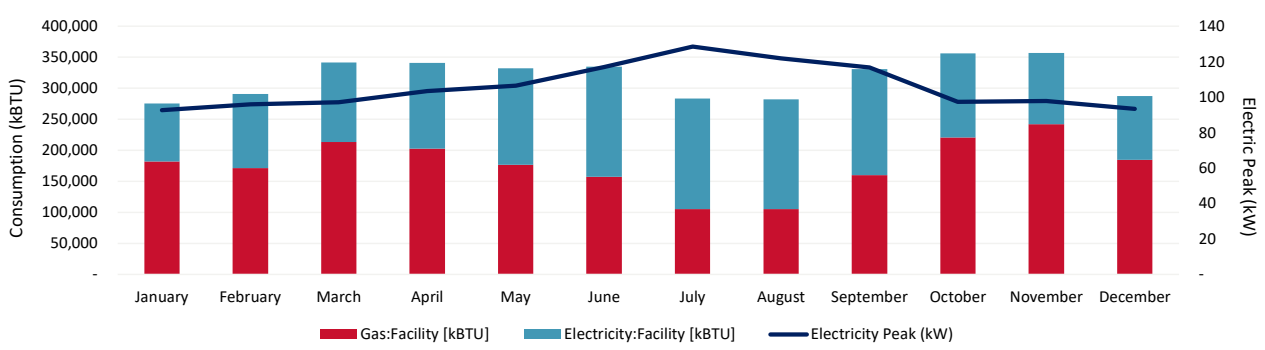
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Building Characteristics

Durham County | Southwest Regional Library Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	3605 Shannon Rd, Durham, NC 27707	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Forced Draft Boiler
Building Type	Library	Cooling Generation	Air-Cooled Chiller
Year Built	2009	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	25,684	Heating / Cooling / Vent Distribution	Multi-Zone Air-Handlers
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wally Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	10.5
		Weekday Opening Time	Monday-Friday, 9:30am
		Weekend Operating Hours	8.5
		Weekend Opening Time	Saturday, 9:30am; Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

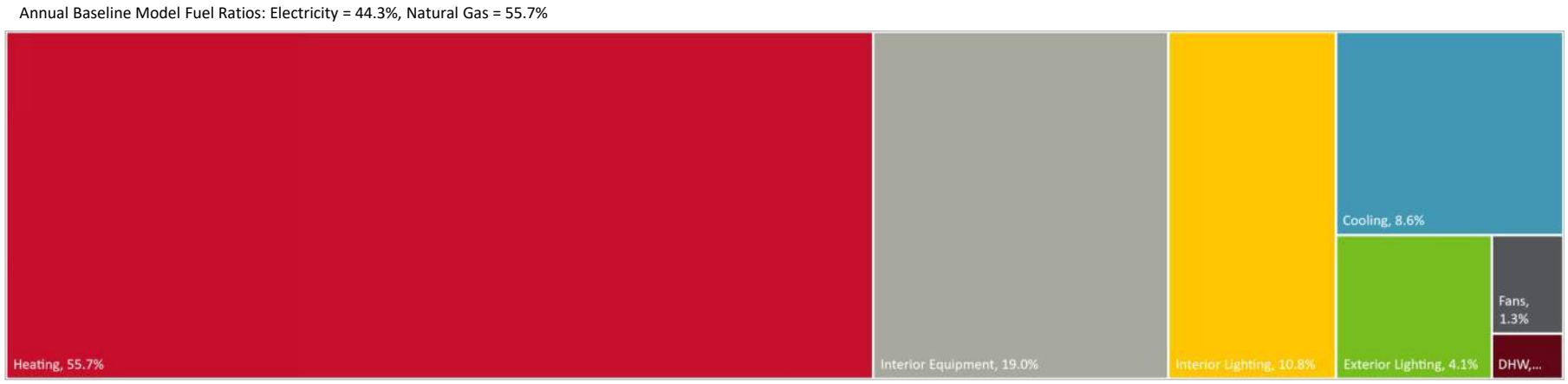


148.45 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	27,395.84	92.64	1,817.00
February	35,010.64	95.94	1,713.50
March	37,606.04	97.16	2,131.50
April	40,492.86	103.38	2,028.00
May	45,489.92	106.42	1,770.00
June	52,064.62	116.94	1,570.50
July	52,141.90	128.50	1,055.50
August	51,908.68	121.76	1,052.00
September	49,942.50	116.80	1,601.50
October	39,773.80	97.42	2,205.50
November	33,596.22	97.88	2,422.50
December	30,148.78	93.30	1,846.00
ANNUAL	495,571.80	-	21,213.50
PEAK	52,141.90	128.50	2,422.50

Annual Baseline Model Predicted End-Use Energy Disaggregation

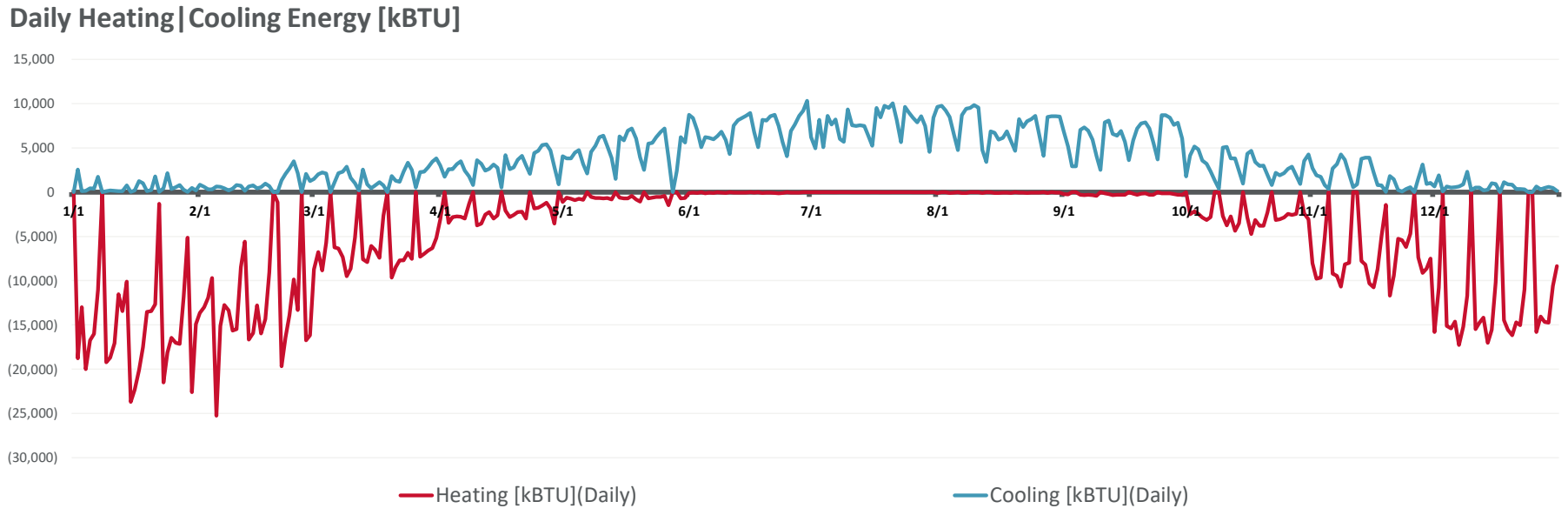
Durham County | Southwest Regional Library End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 44.3%, Natural Gas = 55.7%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile

Daily Heating|Cooling Energy [kBTU]



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(1) Hot Water Boiler (Raypak Hi Delta), fuel: natural gas, Input: 2070 MBH, Output: 1739 MBH, Efficiency: ~82%, Location: Mechanical Room, EWT: 120 deg F, LWT: 160 deg F, Controls: VFD on secondary HWP
Domestic Hot Water	(1) Commercial Storage Tank Water Heater (State Patriot PCE4020LSA), fuel: electric resistance, capacity: 5000W 1PH/3PH Interlock & 10000W 1PH-3PH Simultaneous, Volume: 40 gal rated;

HVAC Space Heating Pathway 1

Pathway 1 | Electrification	(1) Electric Boiler, fuel: electric resistance, Input: 366.5 kW, Output: 1,238 MBH, Efficiency: 0.99 Heating COP, Location: Mechanical Room

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	495,571.8	21,242.4	148.6	0.0	(21,242.4)	530,258.1	NA	NA	1,025,829.9	0.0	136.3	8.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,815.6 MMBTU								3,501.1 MMBTU			
Energy Cost	$46,585.01	$22,768.85	$2.70						$98,539.55	$0.00	$3.84	-42.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$69,353.85 $US								$98,539.55 $US			
Carbon	140.7	112.8	9.87	0.0	(112.8)	150.5	NA	NA	291.2	0.0	11.34	-14.9%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	253.5 MT CO2e								291.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	(1) Air-Cooled Heat Pump Chiller, fuel: electric, Input: 244.9 kW, Output: 1,238 MBH, Efficiency: 3.09 Heating COP, Low Ambient Operation: Supplemental Electric Resistance Heating , Location: Exterior

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	495,571.8	21,242.4	148.6	0.0	(21,242.4)	251,057.7	NA	NA	746,629.5	0.0	99.2	33.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,815.6 MMBTU								2,548.2 MMBTU			
Energy Cost	$46,585.01	$22,768.85	$2.70						$71,775.53	$0.00	$2.79	-3.5%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$69,353.85 $US								$71,775.53 $US			
Carbon	140.7	112.8	9.87	0.0	(112.8)	71.3	NA	NA	212.0	0.0	8.25	16.4%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	253.5 MT CO2e								212.0 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	495,571.8	21,242.4	148.6	NA	NA	NA	0.0	0.0	495,571.8	21,242.4	148.6	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,815.6 MMBTU								3,815.6 MMBTU			
Energy Cost	$46,585.01	$22,768.85	$2.70						$46,585.01	$22,768.85	$2.70	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$69,353.85 $US								$69,353.85 $US			
Carbon	140.7	112.8	9.87	NA	NA	NA	0.0	0.0	140.7	112.8	9.87	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	253.5 MT CO2e								253.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 66 gallon, 6 kw input, 3.7 COP, State model HPSX-66-DHPT;

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	495,571.8	21,242.4	148.6	NA	NA	NA	0.0	(4,118.4)	491,453.4	21,242.4	148.0	0.4%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,815.6 MMBTU								3,801.6 MMBTU			
Energy Cost	$46,585.01	$22,768.85	$2.70						$46,195.87	$22,768.85	$2.69	0.6%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$69,353.85 $US								$68,964.72 $US			
Carbon	140.7	112.8	9.87	NA	NA	NA	0.0	(1.2)	139.5	112.8	9.83	0.5%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	253.5 MT CO2e								252.4 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$657,684.00	($51,954.55)	$22,768.85	($29,185.70)	($1,450,310.74)	NA	NA	-0.6319	NA	NA	($1,923.39)
HVAC Pathway 2	$657,243.00	($25,190.52)	$22,768.85	($2,421.68)	($884,981.61)	-6.8080%	-10.5469%	0.0036	NA	NA	$2,119.17
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	$6,210.00	$389.13	$0.00	$389.13	($180.68)	3.0795%	2.9440%	0.9785	18.00	25.00	$59.63

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$65,607.00
DHW Existing Replacement:	$9,887.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

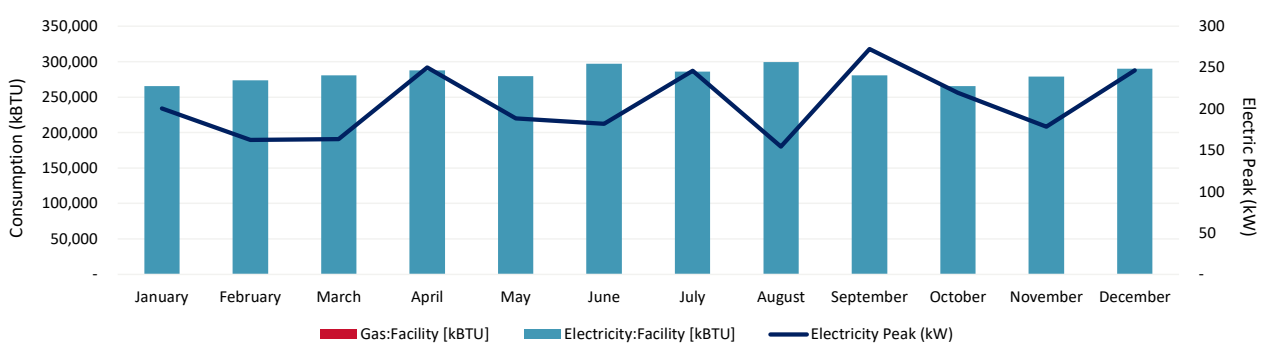
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Building Characteristics

Durham County | TWWTP Admin Building Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	5926 NC-55, Durham, NC 27713	Heating Primary Fuel	Electricity
		Domestic Hot Water Primary Fuel	Natural Gas
IECC Climate Zone	4A	Heating Generation	Water Source Heat Pumps
Building Type	Office	Cooling Generation	Water Source Heat Pumps
Year Built	2001	Domestic Hot Water Generation	Gas Storage-type Water Heater
Floor Area (ft2)	10,580	Heating / Cooling / Vent Distribution	Water Source Heat Pumps
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	Double-pane, Aluminum Frame		
Wall Type	Brick w/ Metal Stud	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	9.5
		Weekday Opening Time	Monday-Friday, 7:30am
		Weekend Operating Hours	0
		Weekend Opening Time	Saturday-Sunday, Closed



Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

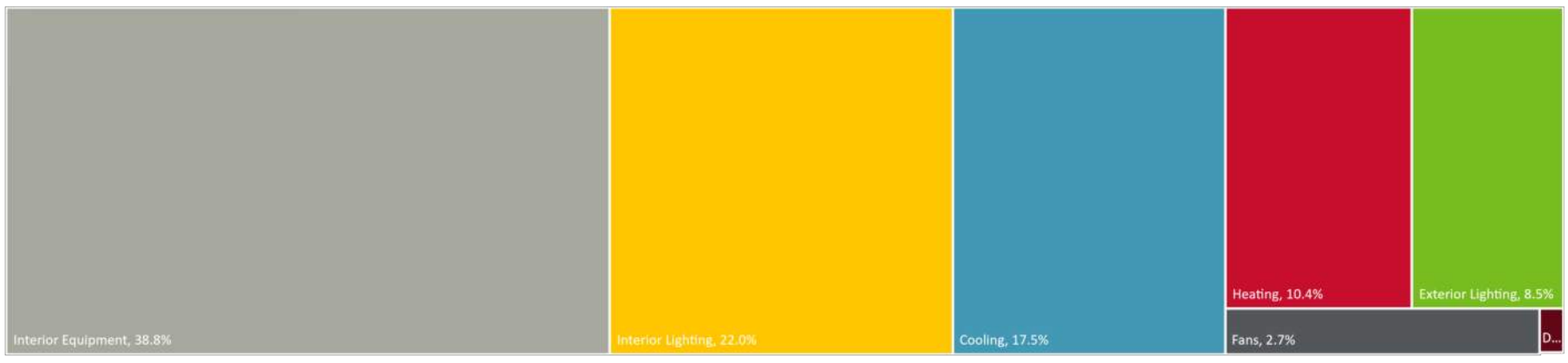


319.95 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	77,667.75	200.40	6.08
February	80,108.70	162.45	5.58
March	82,047.60	163.65	6.30
April	84,088.05	250.20	5.46
May	81,754.80	188.55	5.30
June	86,935.50	182.10	4.77
July	83,601.15	246.30	4.37
August	87,556.80	154.50	4.56
September	82,119.00	272.40	4.39
October	77,693.55	219.45	4.90
November	81,542.25	178.35	5.23
December	84,876.05	246.60	5.68
ANNUAL	989,991.20	-	62.61
PEAK	87,556.80	272.40	6.30

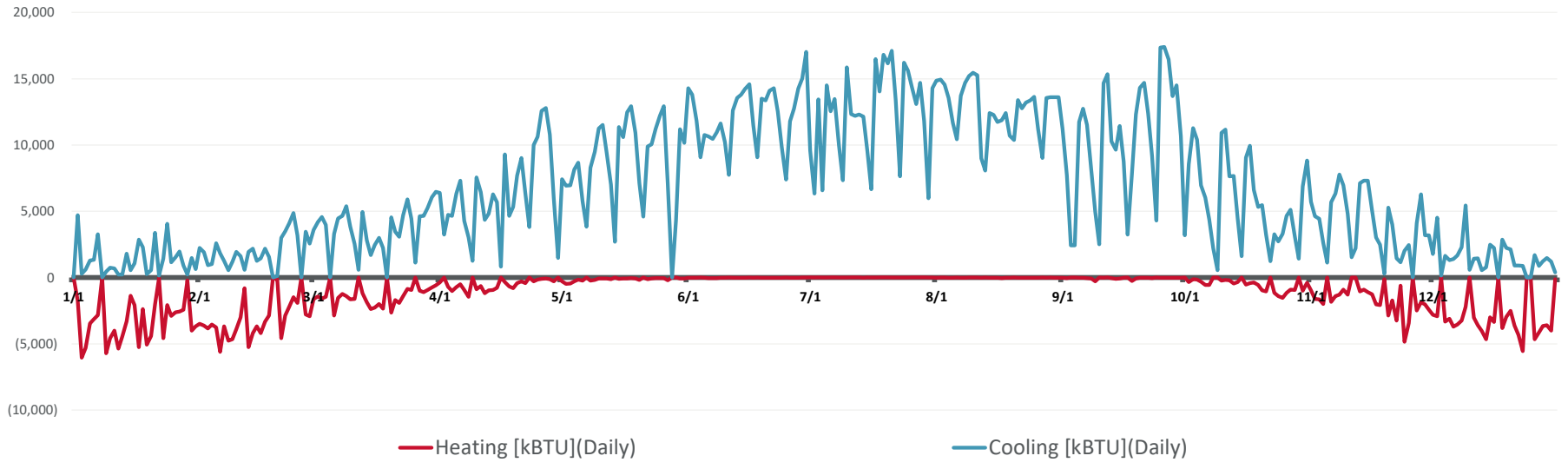
Annual Baseline Model Predicted End-Use Energy Disaggregation

Durham County | TWWTP Admin Building End-Use Energy Disaggregation

Annual Baseline Model Fuel Ratios: Electricity = 99.8%, Natural Gas = .2%



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(mult) Water source heat pumps, no elec resistance backup, reclaim water is condenser source; (6) Gas infrared radiant heaters, propane fired, assumed 50 mbh input;
Domestic Hot Water	(1) Gas-fired direct-vent storage water heater, State model SDV7570PE, 75 gal, 65 mbh input propane, 67 gph recovery, mfg 2004, recirc pump;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	Replace gas radiant heaters with (6) electric unit heaters, Modine HER150, 15 kw (90 kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	0.0	0.0	2,543.4	NA	NA	992,534.6	65.6	320.8	-0.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,385.4 MMBTU								3,394.0 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,378.26	$66.07	$8.74	-0.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$92,150.28 $US								$92,444.33 $US			
Carbon	281.1	0.3	26.60	0.0	0.0	0.7	NA	NA	281.8	0.3	26.67	-0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	281.4 MT CO2e								282.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - already heat pumps

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	0.0	0.0	2,543.4	NA	NA	992,534.6	65.6	320.8	-0.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,385.4 MMBTU								3,394.0 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,378.26	$66.07	$8.74	-0.3%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$92,150.28 $US								$92,444.33 $US			
Carbon	281.1	0.3	26.60	0.0	0.0	0.7	NA	NA	281.8	0.3	26.67	-0.3%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	281.4 MT CO2e								282.1 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	*Replace gas water heater with (1) electric storage water heater, 80 gallon, 18kw input, Bradford White model CEHD80(A)18 3*CF (total 18kw)

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	NA	NA	NA	(65.6)	1,482.1	991,473.3	0.0	319.8	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,385.4 MMBTU								3,383.9 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,226.77	$0.00	$8.72	-0.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$92,150.28 $US								$92,226.77 $US			
Carbon	281.1	0.3	26.60	NA	NA	NA	(0.3)	0.4	281.5	0.0	26.61	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	281.4 MT CO2e								281.5 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace gas WH with (2) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	989,991.2	65.6	320.0	NA	NA	NA	(65.6)	329.0	990,320.2	0.0	319.5	0.2%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	3,385.4 MMBTU								3,379.9 MMBTU			
Energy Cost	$92,084.21	$66.07	$8.71						$92,115.11	$0.00	$8.71	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$92,150.28 $US								$92,115.11 $US			
Carbon	281.1	0.3	26.60	NA	NA	NA	(0.3)	0.1	281.2	0.0	26.57	0.1%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	281.4 MT CO2e								281.2 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$89,031.00	($294.05)	$0.00	($294.05)	($126,512.56)	-7.7739%	NA	-0.0516	NA	NA	($36.83)
HVAC Pathway 2	$89,031.00	($294.05)	$0.00	($294.05)	($126,512.56)	-7.7739%	NA	-0.0516	NA	NA	($36.83)
DHW Pathway 1	$1,509.00	($142.56)	$66.07	($76.49)	($3,495.58)	NA	NA	-0.7143	NA	NA	($3.69)
DHW Pathway 2	$8,372.00	($30.90)	$66.07	$35.17	($10,413.59)	-6.3962%	-3.3175%	0.0795	NA	NA	$13.00

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

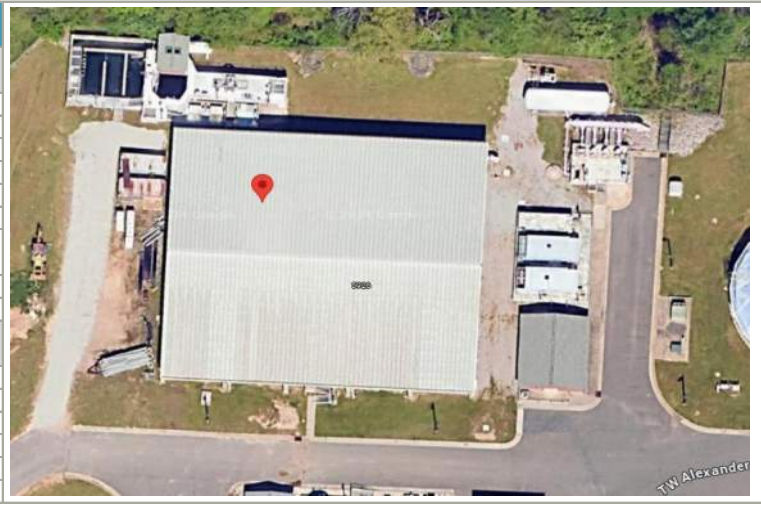
HVAC Existing Replacement:	$17,932.00
DHW Existing Replacement:	$9,851.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

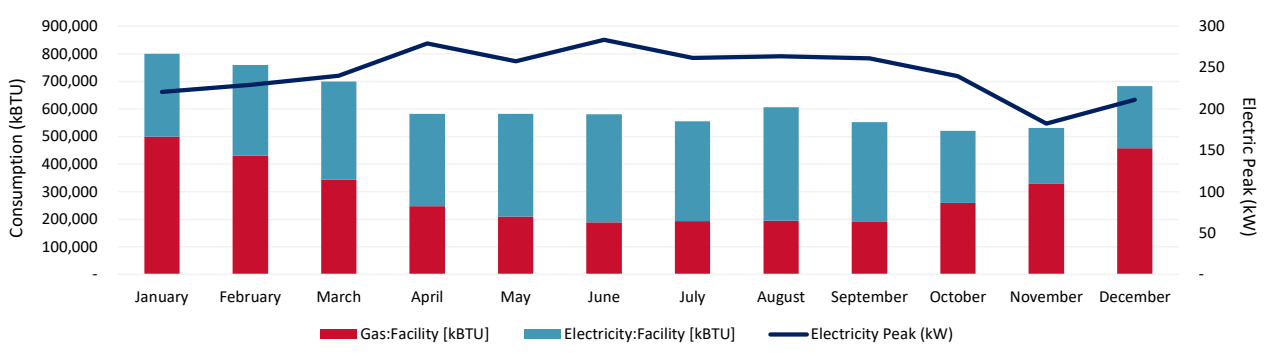
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Building Characteristics

Durham County | TWWTP Sludge Building Building Characteristics			
Location | Envelope Basics		**Heating | Cooling | Ventilation**	
Location	5926 NC-55, Durham, NC 27713	Heating Primary Fuel	Natural Gas
		Domestic Hot Water Primary Fuel	Electricity
IECC Climate Zone	4A	Heating Generation	Gas Unit Heaters
Building Type	Wastewater Treatment Plant	Cooling Generation	Split-System DX
Year Built	2013	Domestic Hot Water Generation	Electric Storage-type Water Heater
Floor Area (ft2)	4,930	Heating / Cooling / Vent Distribution	Split System Units
Stories	1	Electric Rate Structure	Duke Energy Carolinas | Schedule LGS | Large General Service
Window Type	NA		
Wall Type	Metal Building	Natural Gas Rate Structure	Dominion Energy
Interior System Descriptions		**Occupancy Schedule**	
Interior Lighting System	Fluorescent	Weekday Operating Hours	24
		Weekday Opening Time	24/7
		Weekend Operating Hours	24
		Weekend Opening Time	24/7

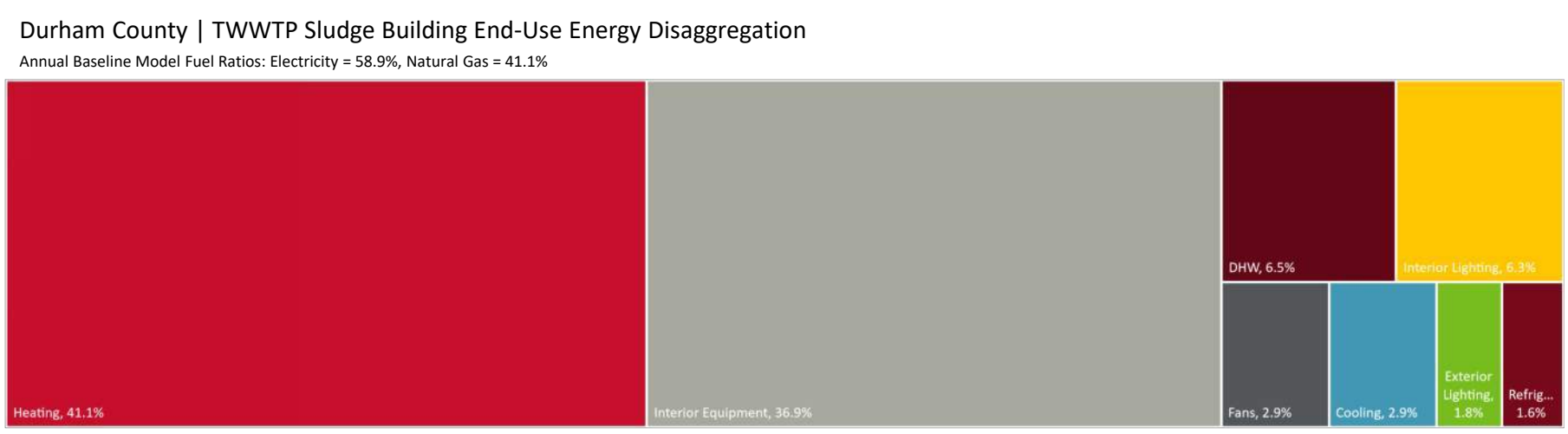


Existing Monthly Consumption (kBTU) & Monthly Electric Peak (kW) Energy Summary

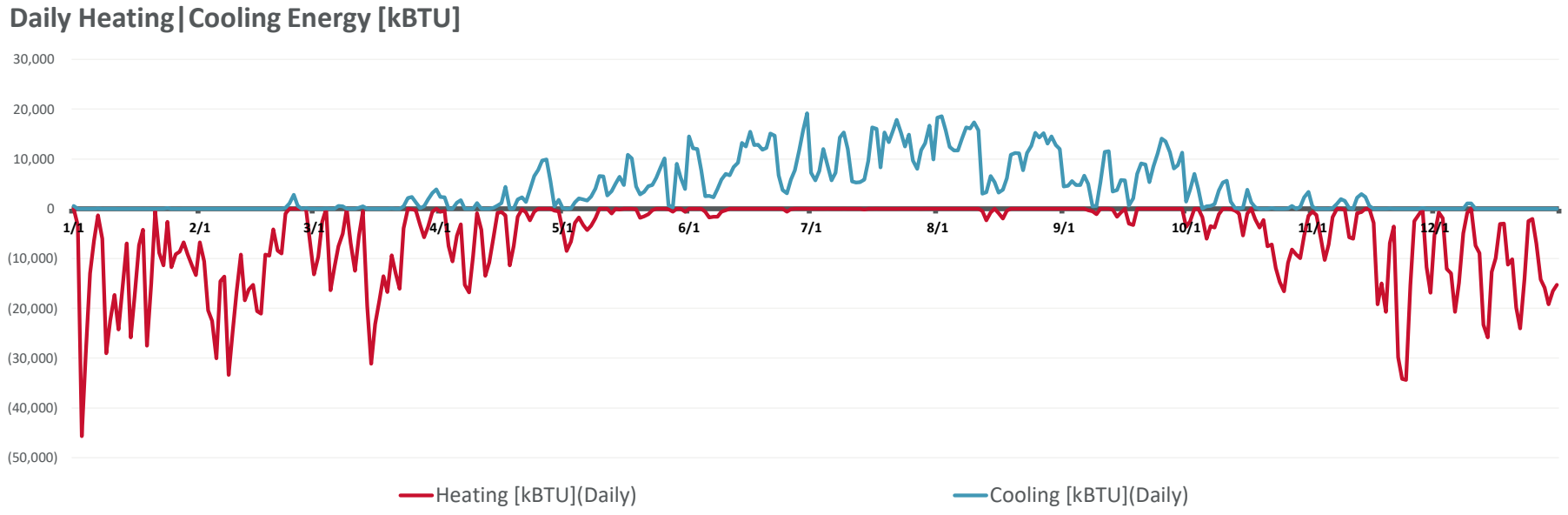


1511.75 kBTU/ft2.yr	Electricity:Facility [kWh]	Electricity:Facility [kW](Monthly Peak)	Gas:Facility [Therms]
January	88,017.96	220.56	4,999.12
February	96,193.40	229.00	4,306.55
March	104,335.60	240.08	3,435.34
April	98,125.88	279.40	2,471.95
May	109,352.08	257.48	2,092.76
June	115,003.24	283.56	1,885.74
July	106,312.00	261.88	1,926.23
August	120,773.76	263.72	1,945.35
September	106,039.68	261.28	1,897.55
October	76,716.40	239.44	2,592.60
November	58,952.76	182.28	3,300.96
December	65,687.54	211.08	4,579.12
ANNUAL	1,145,510.30	-	35,433.27
PEAK	120,773.76	283.56	4,999.12

Annual Baseline Model Predicted End-Use Energy Disaggregation



Annual Baseline Model Predicted Heating & Cooling Annual Load Profile



Existing HVAC Space Heating and Domestic Hot Water System Parameters

HVAC | Space Heating	(2) Gas unit heater, Trane, propane fired, unknown capacity (100 mbh assumed); (1) AHU-2 w/ elec heat, Trane model 4TEE3F31, cap not marked; (1) AHU-1 w/ elec heat, Trane model 4TEE3F37, cap not marked;
Domestic Hot Water	(1) Electric storage water heater, 65 gal, 4.5 kw, Rheem model ELD-66B, mfg 2012;

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HVAC Space Heating Pathway 1

Pathway 1 | Electrification	*Replace gas unit heaters with (2) electric 30kw unit heater, Modine PTE300 (60kw total);

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	0.0	(27,312.4)	579,861.9	NA	NA	1,725,372.2	0.0	1,194.5	11.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,640.8 MMBTU								5,888.6 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$191,598.66	$0.00	$38.86	-42.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$134,834.34 $US								$191,598.66 $US			
Carbon	325.2	145.1	95.39	0.0	(145.1)	164.6	NA	NA	489.8	0.0	99.36	-4.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	470.3 MT CO2e								489.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

HVAC Space Heating Pathway 2

Pathway 2 | High Performance Electrification	N/A - already electric heat

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	0.0	(27,312.4)	579,861.9	NA	NA	1,725,372.2	0.0	1,194.5	11.3%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,640.8 MMBTU								5,888.6 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$191,598.66	$0.00	$38.86	-42.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$134,834.34 $US								$191,598.66 $US			
Carbon	325.2	145.1	95.39	0.0	(145.1)	164.6	NA	NA	489.8	0.0	99.36	-4.2%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	470.3 MT CO2e								489.8 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 1

Pathway 1 | Electrification	N/A, already electric resistance heating

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	NA	NA	NA	0.0	0.0	1,145,510.3	27,312.4	1,347.0	0.0%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,640.8 MMBTU								6,640.8 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$107,322.51	$27,511.82	$27.35	0.0%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$134,834.34 $US								$134,834.34 $US			
Carbon	325.2	145.1	95.39	NA	NA	NA	0.0	0.0	325.2	145.1	95.39	0.0%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	470.3 MT CO2e								470.3 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Domestic Hot Water Pathway 2

Pathway 2 | High Performance Electrification	Replace WH with (1) heat-pump storage water heater, 50 gallon, 6 kw input, 3.8 COP, State model HPSX-50-DHPT

	Baseline Model | Annual			Measure Impacts | Annual					Predicted | Annual			Δ%
	Electricity	Natural Gas	/ ft2	Δ Cooling Electricity	Δ Heating Natural Gas	Δ Heating Electricity	Δ Water Heating Natural Gas	Δ Water Heating Electricity	Electricity	Natural Gas	/ ft2	
Energy	1,145,510.3	27,312.4	1,347.0	NA	NA	NA	0.0	(145,821.5)	999,688.8	27,312.4	1,246.1	7.5%
	kWh	Therms	EUI | kBTU/ft2	kWh	Therms	kWh	Therms	kWh	kWh	Therms	EUI | kBTU/ft2	Δ%
	6,640.8 MMBTU								6,143.2 MMBTU			
Energy Cost	$107,322.51	$27,511.82	$27.35						$93,702.18	$27,511.82	$24.59	10.1%
	$US	$US	ECI | $US/ft2						$US	$US	ECI | $US/ft2	Δ%
	$134,834.34 $US								$121,214.00 $US			
Carbon	325.2	145.1	95.39	NA	NA	NA	0.0	(41.4)	283.8	145.1	86.99	8.8%
	MT CO2e	MT CO2e	CEI | kg CO2e/ft2	MT CO2e					MT CO2e	MT CO2e	CEI | kg CO2e/ft2	Δ%
	470.3 MT CO2e								428.9 MT CO2e			

Notes: *Energy Rates per Duke Energy; Carbon Factors per eGrid Region SRVC (Electricity: 625.90 lbs CO2e/MWh [83.18 kg CO2e/MMBTU] FY2022) & EPA (Natural Gas: 53.115 kg CO2e/MMBTU)*

Results Summary | Financial Assessments

	Incremental First Cost (electrification $ minus in kind replacement $)	Annual Electricity Cost Savings ($US)	Annual Natural Gas Cost Savings ($US)	Annual Total Cost Savings ($US)	40-Year NPV @ 3.00% DR	Internal Rate of Return (%)	Adjusted Internal Rate of Return (%)	Savings / Investment Ratio (SIR)	Simple Payback (Years)	Discounted Payback (Years)	Annual Social Carbon Cost Savings
	Note 6				*Note 5*	*Note 2*	*Note 2*	*Note 3*	*Note 4*	*Note 4*	*Note 1*
HVAC Pathway 1	$7,141.75	($84,276.14)	$27,511.82	($56,764.32)	($1,141,850.66)	NA	NA	-117.3181	NA	NA	($997.31)
HVAC Pathway 2	$7,141.75	($84,276.14)	$27,511.82	($56,764.32)	($1,141,850.66)	NA	NA	-117.3181	NA	NA	($997.31)
DHW Pathway 1	$0.00	$0.00	$0.00	$0.00	$0.00	NA	NA	NA	NA	NA	$0.00
DHW Pathway 2	-$633.00	$13,620.34	$0.00	$13,620.34	$288,250.79	NA	NA	NA	NA	NA	$2,111.36

Note 1 | The current Social Cost of Carbon was set on 02/26/2021 by the Biden Administration, replacing the previous estimates with the estimates developed prior to 2017, adjusted for inflation, amounting to $51 / MT CO2e.

Note 2 | NA = IRR unable to be calculated as FV of investments costs is positive OR FV of investments and FV of benefits are negative/negative.

Note 3 | NA = BCR/SIR unable to be calculated as NPV of investments costs is positive or zero.

Note 4 | NA = Payback Year unable to be calculated as Year 1 has a positive Net Life Cycle Cost OR the measure does not Payback within the study period.

Note 5 | 40-Year NPV determined via NIST Handbook 135 2023 Supplement parameters, including 2023 Discount Rate (3.00%) and NIST South Region Fuel Indices.

Note 6 | Source: HDR Cost Estimation Team. In kind replacements costs utilized:

HVAC Existing Replacement:	$31,457.00
DHW Existing Replacement:	$10,542.00

Note on Building Electrification Results: *Each Electrification Pathway is presented exclusive to any potential Renewable Energy Systems and Building Energy Storage Systems potential opportunities. The decision to include Renewable Energy and Building Energy Storage Systems during the implementation phase would impact energy cost savings in addition to ALL financial impact metrics currently presented.*

F

Appendix F – Light Duty Fleet Charging Infrastructure Guidance Memo

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Light Duty Fleet Charging Infrastructure Guidance

In looking at light duty fleets, we are often confronted with the question of how many chargers are needed. Does every vehicle get their own charging port (1 vehicle to 1 port), can multiple vehicles share charging ports (N vehicles to 1 port), or is a combination needed?

The following table can be used as a guide when determining the number of chargers that might be needed to support a client's fleet. These are generalizations and not dictated final solutions. The table is based on vehicle usage and operations profiles to help evaluate a cost effective and operationally feasible charging solution.

Based on a vehicles profile, each of the following attributes can place a fleet into the shared or dedicated columns as appropriate. Any vehicle usage profile that does not cleanly fit into one of the categories for a specific attribute may be a good candidate for additional evaluation. A vehicle usage profile does not need to meet all profile elements to be placed into a specific category. The goal of the table is to indicate whether the overall usage profile trends towards supported shared charging infrastructure or not.

Table 1: Vehicle Operating Profile Evaluation Criteria

Attribute	Shared Port	Dedicated Port
Daily Energy Usage	Less than 25% SOC	More than 50% SOC
Usage Frequency	2-4 days per week	1 or less days per week (Vehicles that sit for long periods need to be attached to a charger to protect the battery from slowly discharging)
		5 or more days per week
Vehicle Usage Profile	Pool vehicle	Assigned to one driver
		Supports emergency operations
Charging Time Required	Average charging time is less than half the available charging window	Average charging time is more than half the available charging window
Storage Conditions	Outdoors in a temperate climate	Outdoors in a cold climate (below freezing overnight)
	Indoors	
Vehicle Usage Pattern	Predictable and consistent	Highly variable and unpredictable
Charge Management System	Charge management system is used	Charge management system is not used
Power Level	DCFC Chargers	Level 2 Chargers

1:1 Chargers-to-Vehicles

The simplest charging configuration is to have no shared infrastructure. With each vehicle assigned to a dedicated charger, you can be sure that the charger infrastructure will never be the limiting factor when it comes to operational feasibility for the electric fleet. Charge management systems can still be used

with this infrastructure configuration to reduce peak demand. Operationally, the load profile can look like a system where chargers are shared if the management system can keep a limited number of chargers turned on at one time. However, the system is capable of scaling to a much higher power level if all chargers are needed simultaneously for some reason, which is a not a capability available with shared infrastructure. Due to this, operating costs of a 1:1 charging infrastructure arrangement will not be higher than the operating costs of a shared infrastructure arrangement. Any cost difference will mainly come from the up-front capital costs to install the chargers.

1:1 Vehicles-to-Dispensers, 1:N Chargers-to-Dispensers

The simplest shared infrastructure to implement is maintaining a 1:1 ratio of vehicles to dispensers, and multiplexing the chargers at higher ratio of 1:N chargers to dispensers. This configuration is shown in the following figure. This configuration is the simplest to implement because all vehicles have their own dispenser, which allows them to be always plugged in when parked. The complexity of choosing which vehicle to charge at any time is handled by a charge management system. The charge management system can be as simple as round-robin charging in a fixed order through the dispensers, or as complex as a system that prioritizes vehicles based on their SOC and next scheduled use.

This strategy is most often used with DCFC and heavy-duty vehicles like transit buses. The typical use case of light-duty vehicles does not require DCFC, and multiplexing dispensers with a single charger is not something that is done with Level 2 chargers.

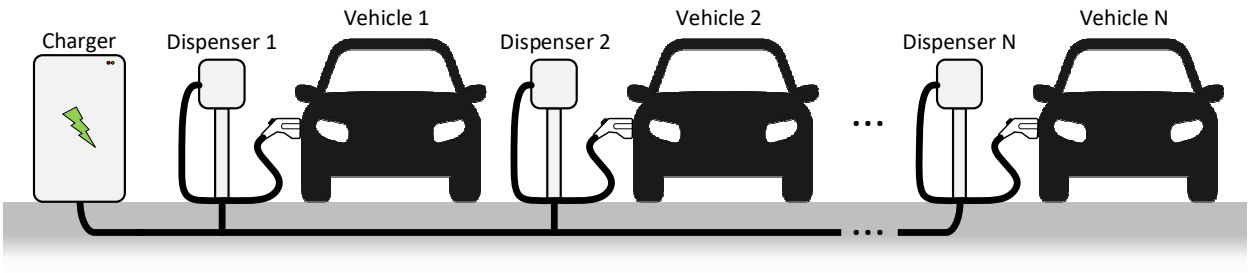


Figure 1: 1:N Charger-to-Dispenser/Vehicle Ratio

The ratio of chargers to dispensers/vehicles in this configuration can be estimated using the following formula. This will require knowing certain information about the use case, or making assumptions where specific information is not known.

$$\#\frac{Vehicles}{Charger} = \left\lfloor \frac{ChargeWindow\ (hour)}{ChargeTime\ (hour)} \right\rfloor$$

$$ChargeTime = \frac{BatterySize\ (kWh) \times SOCUsed\ (\%)}{ChargerPower\ (kW)} \times 1.2$$

For example, consider the following scenario:

- 450 kWh battery
- 50% SOC used daily
- 10 hours available for charging
- 60 kW charger

Charge time is 4.5 hours (the factor of 1.2 accounts for charge curve of vehicle). With a 10-hour window, you can safely charge 2 vehicles per charger.

$$ChargeTime = \frac{450\ kWh \times 50\%}{60\ kW} \times 1.2 = 4.5\ hours$$

$$\#\frac{Vehicles}{Charger} = \left\lfloor \frac{10}{4.5} \right\rfloor = 2$$

1:N Vehicles-to-Dispensers, 1:1 Chargers-to-Dispensers

A more complex shared infrastructure to implement is maintaining a 1:1 ratio of chargers to dispensers, and multiplexing the chargers at higher ratio of 1:N chargers to vehicles. This configuration is shown in the following figure. This is more difficult to implement because vehicles can only be charged when they are attached to the charger, preventing a charge management system from handling scheduling of charge events on a per-vehicle basis without user interaction to move vehicles around.

This charging strategy can be applied to any type of charger and vehicle, including DCFC and Level 2 chargers as well as light-duty or heavy-duty vehicles. Level 2 chargers are typically only available with a single dispenser that is integrated directly into each charger.

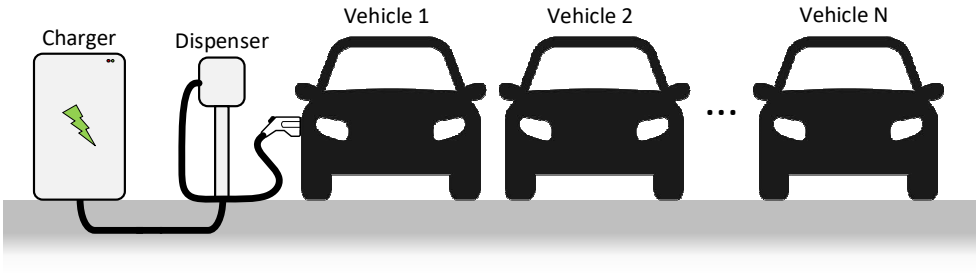


Figure 2: 1:N Charger/Dispenser-to-Vehicle Ratio

With perfect daily charger management (meaning vehicles that require charge are always connected to the charger and chargers are always active during the charging window), the limit of how many vehicles can be used per charger approaches the following limit. This equation compares the daily energy available from the charger (numerator) with the average daily energy consumption of a vehicle (denominator). The factor or 1.1 is to account for the charge curve of the vehicle and inefficiencies in shuffling vehicles between chargers.

$$\#\frac{Vehicles}{Charger} = \left\lfloor \frac{ChargerPower \times ChargeWindow}{\frac{BatterySize \times SOCUsed \times 1.1}{VehicleUsageFrequency}} \right\rfloor$$

For example, consider the following scenario:

- 100 kWh battery
- 30% SOC depleted when used
- Vehicle used once every 3 days
- 7.2 kW charger

- 8 hour charging window

When the vehicle is used it consumes 30 kWh of energy, but it is only used every 3 days so the average daily energy is 10 kWh. The charger can provide 57.8 kWh per charging window, and taking the 10% buffer into account you can provide enough energy for 5 vehicles each day per charger.

$$\#\frac{Vehicles}{Charger} = \left\lfloor \frac{7.2\ kW \times 8\ hr}{\frac{100\ kWh \times \frac{30\%}{day} \times 1.1}{3\ days}} \right\rfloor = \left\lfloor \frac{57.6\ kWh}{11\ kWh} \right\rfloor = 5$$

This is a best-case limit for the ratio of vehicles to chargers and defines a lower bound on the number of chargers needed. In real applications, there are additional factors that will influence the number of chargers that are needed, with each of these factors potentially increasing that number. Several factors that should be considered are included in the following table.

Table 2: Policy Factors Impacting Port Sharing Efficiency

Factor	Impact Considerations
Are vehicles swapped during the charging window?	If vehicles are swapped during the charge window, this requires staff on-site to move vehicles, which is not always practical. If vehicles are not swapped, then only a single vehicle gets charged per window. To maximize charging energy, vehicles should only be connected to the charger if they have been used enough (e.g., multiple days) to require a full charge.
Which vehicles are used each day?	If vehicles are swapped during the charge window, this won't have a major impact since multiple partially discharged vehicles can be restored. If vehicles are not swapped, then this can create a problem if people only take full vehicles each day. A vehicle that isn't fully charged will then sit unused and may not be placed back onto a charger, depending on how charger connections are made (see following factors). A vehicle that sits unused for too long can have the battery fully discharge. It is best if overall utilization is spread among the vehicles in the fleet.
Which vehicles get connected to the charger first?	Ideally, the vehicles with the lowest SOC would be the first to be placed on the chargers. This is especially important if vehicles are not swapped for charging. Whether or not this is practical is dependent on who is responsible for connecting the charger (see following factor).
Who is responsible for connecting vehicles to chargers?	If the driver is responsible for connecting, then they will likely only connect the vehicle they used. If a different vehicle in the lot is in more need of charging, that likely won't impact which vehicle a driver plugs in. Dedicated staff can ensure the most needing vehicle is plugged in, with or without swapping. Without swapping, this can be done by ensuring the best vehicles are plugged in at the beginning of the charging window and then left.

To fully account for these factors, an analysis of the intended policies and procedures for a specific fleet application is required. This is something that should be worked through on a case-by-case basis, and HDR can provide specific guidance and assistance to individual fleets based on their use case. If we know the vehicle use case and the client would like assistance with developing the policies and procedures to

support EV charging with shared infrastructure, we can simulate fleet operations at a high level with different charging policies to determine the impact they would have the infrastructure requirements.

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