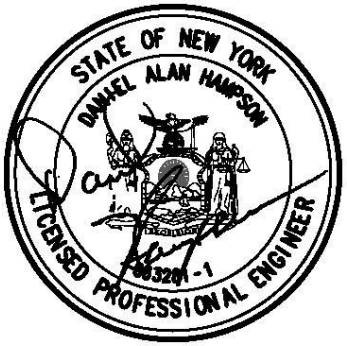
FLEXTECH STUDY AND HEATING/COOLING MASTER PLAN

For

Ulster County Office Building
244 Fair St.
Kingston, NY 12402

New York State Energy Research and Development Authority
17 Columbia Circle
Albany, New York 12203-6399



Final Report: 09-17-2019

For questions regarding this report, please contact FlexTech@nyserda.ny.gov.

We hope the findings of this report will assist you in making decisions about energy efficiency improvements in your facility. Thank you for your participation in this program.

State of New York
Andrew Cuomo, Governor

New York State Energy Research and Development Authority

FLEXTECH ENERGY STUDY

Ulster County Office Building

244 Fair St.
Kingston, NY 12402

Prepared for:

Ulster County
Ulster County Department of the Environment
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Kingston, NY 12402

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ABSTRACT

Ulster County has a strong track record of being a leader in green power use and environmental sustainability. Ulster County has demonstrated its commitment to clean energy by participating in the New York State Energy Research and Development Authority (NYSERDA) Clean Energy Communities Program and was the first County in New York State to achieve the designation of a Clean Energy Community.

Pursuant to Executive Order Number 1-2016, Ulster County is required to decrease greenhouse gas emissions associated with its operations (through conservation, efficiency, and on-site renewable generation) by 25% by 2025 and 80% by 2050, using the County's 2012 greenhouse gas emission inventory as a baseline.

The purpose of this study was to investigate and report on near term heating needs, using energy efficient equipment, and clean alternatives to natural gas combustion equipment for long-term energy reduction plans at the Ulster County Office Building - Kingston, NY.

Data was gathered by an experienced team of HVAC and energy engineers during on-site surveys through the visual observation of the building and its energy consuming systems, interviews with operating personnel, and analysis of energy records pertaining to electricity and natural gas.

TABLE OF CONTENTS

PROJECT TEAM AND INFORMATION

The follow table presents the individual professionals that lead and participated in the energy study activities. The name, certifications, and qualifications of the Consultants' staff that performed and were involved with the energy study are:

Role and Name	Contact Information	Certifications & Experience	Applicable Experience
Lead Engineer Daniel Hampson GPI	DHampson@gpinet.com (518) 453-9431	PE	37 years
Project Manager Brendan Kelly L&S Energy Services	BKelly@LS-Energy.com (518) 383-9405 x 214	PE, CEM, LEED® AP, CGI	21 years
Project Manager Tom Lamb GPI	TLamb@gpinet.com (518) 453-9431		30 years
QA/QC Ron Slosberg L&S Energy Services	RSlosberg@LS-Energy.com (518) 383-9405 x 216	CEM, CMVP, LEED® AP, EBCP	30 years
HVAC Engineer Daniel Ryan GPI	DRyan@gpinet.com (518) 453-9431		22 years
Energy Engineer Mike Stiles L&S Energy Services	MStiles@LS-Energy.com (518) 383-9405 x219	CEM, PhD	30 years

We would like to thank the staff at Ulster County, especially Nick Hvozda and David Gruskiewicz, for their time and effort during our site visits and with subsequent information requests. Should you have any questions, please do not hesitate to contact Daniel Hampson (518) 453-9431 x 1519 or Brendan Kelly (518) 383-9405 x 214.

Sincerely,

GPI

Daniel Hampson, PE
Vice President and Director of MEP-FP

EXECUTIVE SUMMARY

DESCRIPTION OF STUDY

The focus of this Energy Study was to evaluate the replacement of boiler equipment, while simultaneously developing an implementable strategy for reducing energy use through the application of best-available clean heating and cooling technologies in both the near and long-term at the Ulster County Office Building - Kingston, NY.

Interviews with County personnel and equipment surveys of the Ulster County Office Building - Kingston, NY were conducted by GPI and L&S Energy Services on February 8th, 2019. The purpose of the interviews and equipment survey were to assess the existing heating and cooling systems, energy savings goals, and the operation of the existing Building Energy Management System (BMS). Historic design documents, energy bills, and BMS trend data were provided by the site contact and were reviewed.

Interviews and walk-through audits were performed to gather equipment nameplate data, review operational schedules, and procure annual electric and fossil fuel utility bills and consumption schedules. The layouts and general conditions of the existing HVAC heating and cooling systems were compared to the plans and documentation received. System operation schedules were obtained from the Direct Digital Control (DDC). The goal of these activities was to calculate the building load coefficient (BLC) and the balance point temperature for heating as the basis for recommending energy efficiency improvements.

For the one year period from November 2017 through November 2018, the Ulster County Office Building used a total of 938,560 kWh at a cost of $122,873.

Over the same date period, 29,651 therms of natural gas were consumed at a cost of $25,536 and used for heating and domestic hot water.

A utility bill summary is included in Appendix A. Energy use, costs and rates are based on values provided by the County through Energy Star Portfolio Manager.

The cost per million Btus ($/MMBtu) was calculated for each fuel source below.

Utility Type	Avg. Unit Cost	$/MMBtu
Electric Energy (Central Hudson)	$0.109/kWh	$32.05/MMbtu
Electric Demand (Central Hudson)	$8.17 /kW	--
Natural Gas (Central Hudson)	$0.861/therm	$8.61/MMbtu

3,413 Btu = 1 kWh; 100,000 Btu = 1 therm

A pre-feasibility study (PFS) was conducted for the following clean heating & cooling technologies:

- Air source heat pumps (ASHP)
- Solar Thermal DHW
- Cooling Energy Thermal Storage

The following energy conservation measures (ECMs) were evaluated as feasible options:

- Condensing Natural Gas Boiler
- Biomass Boiler and a Condensing Natural Gas Boiler
- AC-4R VAV Conversion

For each qualified measure, energy use and projected cost savings were calculated using spreadsheet analysis. ECM analysis, life-cycle cost analysis and calculation data are included in Appendix B. The cost estimate for each ECM is included in Appendix C. The simple payback period for each measure was calculated. A description was prepared for each ECM which details baseline and proposed equipment.

Pre-feasibility measures were evaluated using screening level vendor tools or simple spreadsheet calculations. These preliminary studies were also detailed with savings, costs, and paybacks. Life-cycle cost analysis was not completed at the screen level.

The Technology Evaluation section of this study only takes into consideration energy cost savings. Incentives were not incorporated into the economic evaluation of technologies because they may change, or be eliminated by the time the final selected equipment is determined. Incentives should be re-evaluated when the final selected system/technology is selected.

The final section of this report details the selected course of action for the Heating/Cooling Master Plan, supported by detailed (specification-level) cost estimation and economic analysis.

Additionally, NYSERDA/NYPA Geothermal Clean Energy Challenge Stage 1 and 2 reports were provided by the County and summarized. Detailed results are included in Appendix D.

A summary of preliminary energy conservation measures evaluated and those selected for further analysis as part of the HVAC Master Plan are shown in Figure 1 below.

Figure 1

Ulster County Office Building

Energy Conservation Measure Energy Savings Summary - 244 Fair Street, Kingston NY 12402

	Measure Description	Measure Status (See Notes)	kWh Savings	kW Savings	Natural Gas mmBtu Savings	Total mmBtu Savings	Annual Cost Savings	Project Cost	Payback (Years)
PFS 1	Install Solar Thermal DHW	NR			51	51	$439	$16,946	38.6
PFS 2	Install Air Source Heat Pumps	NR	-114,275		2,965	2,575	$10,575	$525,187	49.7
PFS 3	Install Cooling Energy Storage	NR		266.4		0	$2,194	$300,000	136.8
ECM 1	Install a Condensing Natural Gas Boiler (existing conditions baseline)	ME			402	402	$3,461	$109,625	31.7
ECM 1a	Install a Condensing Natural Gas Boiler (code minimum baseline, FYI only)	N/A			232	232	$1,996	$94,625	47.4
ECM 2	Install a Biomass Boiler and a Condensing Natural Gas Boiler	NR			367	367	-$12,740	$310,250	-24.4
ECM 3	Convert AC-4R to VAV	ME	34,591		0	118	$3,523	$48,200	13.7
FA ECM 1	Install Two Condensing Natural Gas Boilers (existing conditions baseline)	RME			402	402	$3,461	$241,600	69.8
FA ECM 3	Convert AC-4R to VAV	RME	No change from ECM 3 above						
Totals (All Measures Excluding 1a)			**-79,684**	**266.4**	**4,187**	**3,915**	**$10,912**	**$1,393,982**	**127.7**
Totals R, I, and RNE Only			**34,591**	**0**	**402**	**520**	**$6,983**	**$241,600**	**34.6**

Measure Status: Recommended (R); Not Recommended (NR); Further Study Recommended (RS); Recommended for Non-Energy Benefits (RNE); Implemented (I); Recommended Mutually Exclusive; Mutually Exclusive
FA measures were selected by the customer for further analysis by the customer as part of the Heating/Cooling Master Plan.
1 MMBtu = 1,000,000 Btu; 3,413 Btu/kWh
ECM 3: Demand kW and kW $ savings are not included, VFD modulation not expected during utility peak times
ECM 5's kW savings is cumulative annual

Annual cost savings for R/I/RNE measures:	$6,983	Base year costs - proposed annual cost savings	$141,425
Base year energy costs		% savings	4.7%
Electric	$122,873		
Natural Gas	$25,536		
Total	$148,408		

GENERAL NOTES:

1. Savings round to nearest whole number.
2. A description of each measure and associated savings are included in the Energy Conservation Measures section.
3. ECM supporting calculations and cost estimates are included in Appendices B and C, respectively.
4. Savings are based upon 2017/2018 utility rates (Appendix A).
5. Interactivity among the individual ECMs was not considered (unless where noted), so the savings may change depending on the combination of improvements implemented.
6. Incentives and O&M costs are not considered.

Based upon full implementation of all ECMs selected by the County for further analysis in the HVAC Master Plan, the annual savings currently projected in this analysis are $6,983 per year. This would reduce the annual energy costs by approximately 4.7% from the base amount of $148,408 to a proposed amount of $141,425. The estimated capital cost associated with implementing all recommended energy conservation measures is $241,600 with a simple payback period of 34.6 years.

This report is the final deliverable under the project's statement of work. Savings assumptions are based on the conditions present at the site at the time of the initial audit.

ASSESSMENT OF SITE CONDITIONS

BUILDING OVERVIEW

The Ulster County Office Building is a 62,396 square foot office building located in Kingston, NY. The building is occupied by DMV, records storage, and other County departments on the following schedule: Monday through Friday, 9:00 AM – 5:00 PM. The six story building with basement was constructed in 1964 and contains offices, mechanical areas, corridors, file vault, and restrooms. The building has experienced multiple space layout reconfigurations over the years, including changes to mechanical and electrical systems.

Architectural Features

The Ulster County Office Building is a steel framed structure with a curtain wall system. Its flat black EPDM roof has been identified for replacement in the County's 2019 – 2024 Capital Improvement Program. Insulation values are assumed to match the performance defined in the construction design documents. A detailed study of the curtain wall systems was completed in 2016.

The windows are original to the building and have tinted insulated glazing, single glazing, and non-thermally broken aluminum frames. Operable windows are installed in all areas except record storage. During the interview, staff indicated that thermal discomfort due to both conductive heat loss and convective drafts were reported in spaces adjacent to the windows.

The main entrances are located on opposite sides of the building and include vestibules. The staff mentioned during the interview that the corridor running between the two doors experiences a wind tunnel effect. We suggested during the site visit that the County investigate adjusting the timing for opening the interior and exterior doors and installing air curtains over the doors to minimize infiltration.

Heating, Air Conditioning, and Controls

A summary of the building HVAC, DHW, and Building Control systems is included below. The boilers are the primary focus of the study, so their performance, existing conditions, and control parameters are discussed in greater detail.

Cooling is supplied to the air handlers in the building from a VSD water cooled centrifugal chiller, coupled with a cooling tower that is planned for replacement. Chilled water and condenser water pumps operated lead/lag with a spare pump and are constant speed. The chilled water system has a single loop, and the design drawings show three-way valves installed at the cooling coils.

Heating is provided by two natural gas fired hot water boilers. Both were installed in 1988 and are near or at the end of their useful lives. Only one boiler is typically needed to meet the peak building load. Staff noted during the interview that burners need frequent adjustments during operation and air slugs are common. A recent boiler efficiency test was not provided for this study, but the boilers are serviced annually. The boilers are enabled through the BMS when the outside air dry bulb temperature falls below 58°F and are always available when outside air temperature falls below 40°F. The boilers are manually switched from lead to lag. The hot water supply set point for each boiler is linearly scaled as a function of outside air temperature (OAT) as follows: 180°F HWS @ 0°F OAT and 120°F HWS @ 60°F OAT.

Table 1

Boiler Schedule						
B-	Manufacturer	Model Number	Input MBH	Output MBH	Design Thermal Efficiency	Fuel
1	Weil McLain	1688	5124	4090	80.0%	NG
2	Weil McLain	1688	5124	4090	80.0%	NG

Three hot water pumps operate at constant speed, lead/lag, to supply hot water to separate systems in the building. The design drawings show three-way valves installed at the heating coils. Staff noted during the interview that water flow to the fifth and sixth floors is inadequate.

Note: If the implementation of variable speed drives is considered for either the chilled water or hot water pumps, then two way valves will need to be installed in place of three-way to achieve differential pressure in the loop.

The air handling systems in the building utilize chilled water (CHW) and hot water (HW) coils to supply conditioned air to the building. Four of five air handlers (AC-1-3 and 5) were installed in 1987. AC-1, 3, and 5 have economizers and reheat coils; they serve the basement, first through fifth floor offices, and the sixth floor.

AC-2 feeds a floor-discharge air curtain installed in front of an interior vestibule door. As previously indicated, an overhead air curtain should replace the floor outlet.

AC-4R is the only component of the distribution system analyzed as an ECM in this study. A VAV system will be evaluated as a replacement. This multi-zone unit was replaced in 1993 and includes a constant speed 7.5 HP fan motor, split DX cooling along with CHW and HW coils. The unit supplies conditioned air to the file vault that spans multiple floors. There is dedicated ductwork with reheat coils and zone dampers; electric reheat coils were recently replaced with hot water coils. An electric

humidifier installed in the main ductwork has been inoperable for close to 5 years and is planned for replacement.

HHW fin tube radiation is installed at various locations on all floors. Five exhaust fans operate on a BMS schedule with set-back schedules for weekends.

Domestic hot water is supplied by natural gas fired stand-alone hot water heaters with storage. There is an aquastat on the circulation loop pump.

Electrical Systems

Staff mentioned during the interview that there are no unused slots left in the electric panels. Interior and exterior lighting systems were recently upgraded with LED. Lighting sensor upgrades are planned.

Process and Plug Loads

Process and plug loads include equipment and systems typically found in office buildings and miscellaneous systems. An air compressor that's at the end of its useful life serves the pneumatic control system.

Building Control System

The building has a Johnson Controls Metasys Building Automation System interfaced with pneumatic controls on the majority of the HVAC and plant equipment. Perimeter fin tube heaters are on unitary thermostats. EmTech currently maintains the system. The control panel is a standalone workstation in the basement. The system has trending capabilities, which are not utilized to their fullest capabilities by the County.

Re-commissioning of the control system should be conducted periodically to ensure sensors are calibrated and trend results are reasonable. Staff noted during the survey that they are working through many alarms on the system. Demand control ventilation is planned for some time in the future.

BUILDING BALANCE POINT TEMPERATURE AND LOAD COEFFICIENT

The balance point temperature and load coefficient are two metrics used to estimate the heating and cooling requirements of a building. Both were computed using historical utility data and weather (temperature) data. Because boiler replacement is the primary focus of this project, calculations were completed for the heating season only. The following high-level summary assumes that the reader is familiar with regression statistics as applied to building energy analysis.

The balance point temperature is the temperature below which a building requires active heating. It is a function not only of the size and composition of a building but also of internal, solar, and other gains. There are several ways to estimate it. For purposes of this report it was based on a heating degree day (HDD) analysis.

The number of heating degree days for a given day is (average daily temperature – degree day base temperature) when that number is greater than zero. A regression analysis is performed on utility heating fuel data as a function of heating degree days for the billing periods[1].

The objective is to select the degree day base temperature that maximizes the correlation coefficient of the regression. By the definition of correlation coefficient, this minimizes the regression's ratio of unexplained variation to total variation with respect to degree day base temperature. The base temperature that maximizes the correlation coefficient is then taken as the balance point temperature of the building.

The results were as follows for the natural gas data:

- HDD base temperature = 58° F giving R^2 (squared correlation coefficient) of 0.988
- Slope = 6.15 therms/day / HDD58/day
- Intercept = 7.49 therms/day

The process is completed by multiplying the regression parameters (slope and intercept) by the estimated efficiency of the heating system – to get an estimate that is independent of the HVAC system. The seasonal efficiency of the heating system was estimated at 76%. Note that this procedure does not change the HDD base temperature or correlation coefficient of the data set.

The results that describe the heating load of the building independently of the heating system were found to be:

- Slope = 4.68 therms/day / HDD58/day
- Intercept = 5.70 therms/day

These results were used to model proposed boiler energy usage (ECMs 1 and 2) as detailed in Appendix B. The models were based on projected fuel use in a year of typical weather (using TMY3 data). The model calculations were cast in a form that does not require the use of the building load

[1] See ASHRAE Guideline 14-2002 pgs 139-140, which includes a description of eliminating *sample interval bias* from the data that was used in the present analysis.

coefficient. However for sake of completeness the load coefficient was calculated using the information outlined above.

Recall that the building load coefficient is defined as the quantity UA in the conductive heat transfer formula Btu/hour = UA ΔT. The load coefficient may be derived from the utility data regression slope in the following way:

1. The physical units of the load coefficient are Btu/hour ^{o}F
2. The physical units of the regression slope are therms/HDD, that is, therms/day ^{o}F
3. The conversion of the utility data regression slope to load coefficient is:

Utility regression therms / day deg F * 10^5 Btu/therm * 1 day/24 hours * heating efficiency = Btu / hr deg F

The building load coefficient was thus found to be 19,491 Btu/hr ^{o}F.

PRELIMINARY ENERGY USE ANALYSIS (PEA)

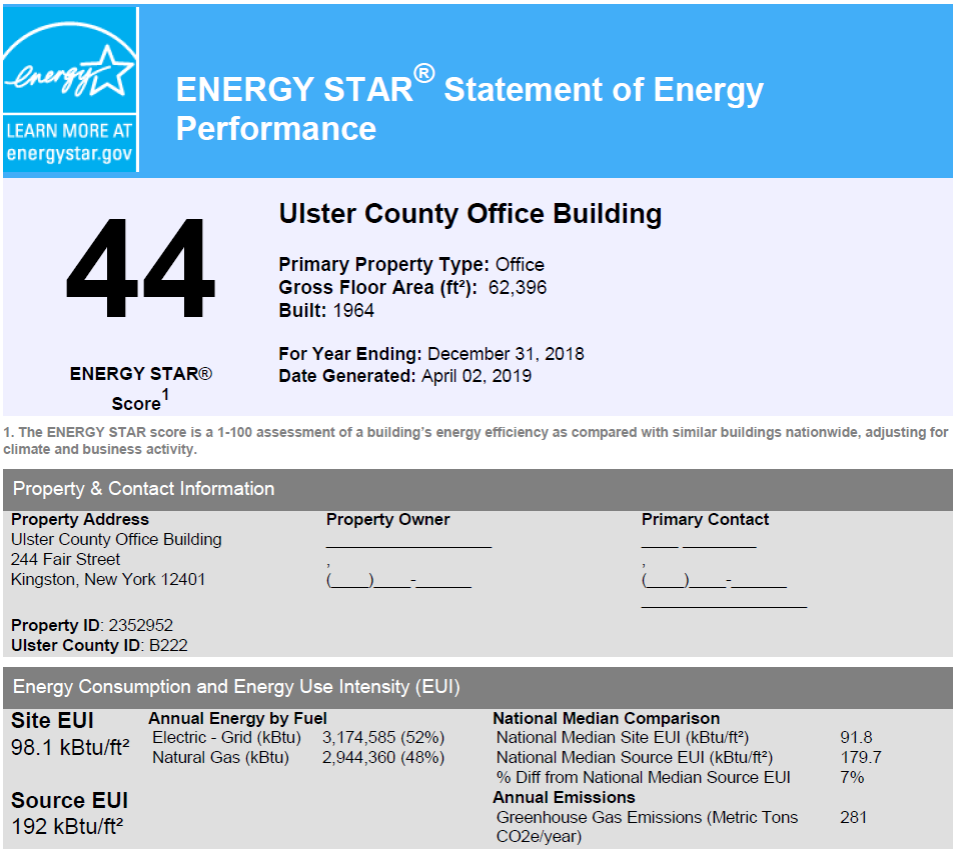
Data and Building Characteristics for EPA Portfolio Manager

The utility data used for energy and cost savings analysis for ECMs is listed in Appendix A. Also included in Appendix A is the Energy Star Data Verification Checklist (DVC). The DVC lists its version of the utility data as well as building age, gross floor area, and other relevant information.

EPA Portfolio Manager Results

Figure 2 shows the Energy Star score and the building's Energy Usage Intensity (EUI). A score of 50 is the median. The building's score is 44 which indicates it is performing slightly under the median for buildings in its class.

Figure 2



ENERGY STAR® Statement of Energy Performance

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44

ENERGY STAR® Score[1]

Ulster County Office Building

Primary Property Type: Office
Gross Floor Area (ft²): 62,396
Built: 1964

For Year Ending: December 31, 2018
Date Generated: April 02, 2019

1. The ENERGY STAR score is a 1-100 assessment of a building's energy efficiency as compared with similar buildings nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address	Property Owner	Primary Contact
Ulster County Office Building 244 Fair Street Kingston, New York 12401	_____ , (___)___-_____	____ _____ , (___)___-_____ _____

Property ID: 2352952
Ulster County ID: B222

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
98.1 kBtu/ft²

Source EUI
192 kBtu/ft²

Annual Energy by Fuel	
Electric - Grid (kBtu)	3,174,585 (52%)
Natural Gas (kBtu)	2,944,360 (48%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	91.8
National Median Source EUI (kBtu/ft²)	179.7
% Diff from National Median Source EUI	7%
Annual Emissions	
Greenhouse Gas Emissions (Metric Tons CO2e/year)	281

The EUI is a building's energy use normalized to floor area. Based on 12 months of energy consumption history the site EUI is 98.1 kBtu/ft². According to Energy Star's Portfolio Manager, the EUI of comparative sites (Office Buildings) is 91.8 kBtu/ft², or 7% more efficient than this site.

TECHNOLOGY EVALUATION

The supporting calculation data for the following Pre-Feasibility Studies (PFSs) and Energy Conservation Measures (ECMs) can be referenced in Appendix B.

ECM No.	Energy Conservation Measure Description
PFS-1	Install Solar Thermal DHW
PFS-2	Install Air Source Heat Pumps
PFS-3	Install Cooling Energy Thermal Storage
ECM-1	Install a Condensing Natural Gas Boiler
ECM-2	Install a Biomass Boiler and a Condensing Natural Gas Boiler
ECM-3	Convert AC-4R to VAV

Supporting Information

- ECM 1 (upgrade to condensing natural gas boiler): Savings calculations used a baseline derived from existing conditions. ECM 1a was created using a baseline assuming a code-minimum boiler. ECM 1a was the basis for determining the *incremental* savings (energy and cost) of the energy-efficient option of ECM 1 over a code-standard installation. The maximum efficiency of the code-minimum boiler was 82%[2]. See the narrative for ECM 1a below for further details.

- ECM 2 (Install a Biomass Boiler and a Condensing Natural Gas Boiler): There is not sufficient supporting information in the industry to estimate CO2 emissions reductions for biomass boilers. For example, Energy Star Portfolio Manager lists CO2 emissions for #2 fuel oil as 74.21 kg/MBtu and wood is listed as 95.05 kg/MBtu, a 28% increase. High efficiency biomass boilers are advertised to reduce CO2 emissions as compared to fuel oil by varying amounts (56% in one study, 1.5 tons of CO2 per ton of pellets in another), however we had a low confidence in using these references for this study due to high variability. Ultimately, low emissions are achieved in high efficiency biomass boilers by installing controls and thermal storage that allow for long on-cycles followed by long off-cycles.

[2] IECC 2015, page C-47, Table C403.2.3(5)

PFS-1: Install Solar Thermal DHW

Project Cost:	$16,946	
Simple Payback:	38.6	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	51	mmBtu/Year
Annual Energy Cost Savings:	$439	

EXISTING CONDITIONS:

Domestic hot water is presently provided by two natural gas-fired hot water heaters.

ECM SPECIFICATIONS:

Install solar-assisted domestic hot water heating. A pre-feasibility study was applied to this measure. An on-line calculator maintained by energy.gov determined there to be minimal energy savings (51 mmBtu/year) with a simple payback of almost 40 years.

ACTION ITEMS:

Due to the modest energy savings and long payback, this measure is not recommended.

PFS-2: Install Air Source Heat Pumps

Project Cost:	$525,187	
Simple Payback:	49.7	Years
Electricity Savings:	-114,275	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	2,965	mmBtu/Year
Annual Energy Cost Savings:	$10,575	

EXISTING CONDITIONS:

Heating and cooling are presently provided by the systems described in the Assessment of Site Conditions section (boilers and chillers).

ECM SPECIFICATIONS:

Replace the existing HVAC infrastructure with variable refrigerant flow (VRF) air source heat pumps. A pre-feasibility study was applied to this measure. Energy savings were estimated using "one line" calculations based on heating and cooling usage derived from utility data and typical heat pump efficiencies (heating COP, cooling SEER). The measure would save on natural gas heating and some electrical energy for cooling at the expense of an increase in electrical energy to operate the heat pumps.

ACTION ITEMS:

This measure is not recommended due to its long payback. This condition is unlikely to change given the high initial cost of VRF systems relative to fuel prices.

PFS-3: Install Cooling Energy Thermal Storage

Project Cost:	$300,000	
Simple Payback:	136.8	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	266.4	kW
Gas Heating Savings:	0	mmBtu/Year
Annual Electric Demand Cost Savings:	$2,194	

EXISTING CONDITIONS:

The existing chillers cool the building with no thermal storage.

ECM SPECIFICATIONS:

Install ice-based storage for cooling. A pre-feasibility study was applied to this measure. The modest cooling requirements for this building were estimated from electric utility data. The savings calculations were based on the potential of this technology to shave peak electric demand. Using typical equipment and performance specs for this technology, it was determined that for six months of the year chiller electric demand could be shaved by 50% resulting in a total annual reduction of 266 kW.

ACTION ITEMS:

This measure is not recommended due to its very long payback.

ECM-1: Install a Condensing Natural Gas Boiler (existing conditions baseline)

Project Cost:	$109,625	
Simple Payback:	31.7	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	402	mmBtu/Year
Annual Energy Cost Savings:	$3,461	
% Reduction in CO2 Emissions:	14%	

EXISTING CONDITIONS:

The Ulster County Office Building receives it heating hot water from two failing standard efficiency natural gas boilers. The performance characteristics are included in Table 1 in the Assessment of Site Conditions section.

ECM SPECIFICATIONS:

Install a natural gas fired high efficiency condensing boiler. Retain one of the existing boilers as a backup.

One condensing boiler was modeled with a full load capacity of 5,124 MBH and an efficiency of 94%, based on manufacturer specifications. The boiler capacity was verified by GPI through a Trane Trace building load simulation. The existing boilers are modeled with a system efficiency of 76%; to account for losses associated with distribution and the age of the system. It is assumed that hot water is supplied from the boiler at the same temperatures as existing, where condensing occurs only during part load operation. As noted in the Assessment of Site Conditions, the second boiler rarely operates.

ACTION ITEMS:

The measure has a long energy savings-based payback. However this ECM is recommended based on the end-of-life conditions of the existing boilers.

ECM-1a: Install a Condensing Natural Gas Boiler (code minimum baseline)

Project Cost:	$94,625	
Simple Payback:	47.4	Years
Electricity Savings:		kWh /Year
Peak Demand Savings:		kW
Gas Heating Savings:	232	mmBtu/Year
Annual Energy Cost Savings:	$1,996	
% Reduction in CO2 Emissions:	8%	

EXISTING CONDITIONS:

The Ulster County Office Building receives it heating hot water from two failing standard efficiency natural gas boilers. The performance characteristics are included in Table 1 in the Assessment of Site Conditions section.

ECM SPECIFICATIONS:

Install a code-minimum efficiency natural gas fired boiler. A 5124 MBH code-standard boiler was modeled with an efficiency that varied linearly between 82% at outdoor temperature of 20° F and 78% at outdoor temperature of 58° F. The boiler capacity was verified by GPI through a Trane Trace building load simulation.

INCREMENTAL DIFFERENCES:

The incremental cost and savings differences between ECMs 1 and 1a are listed in Table 2 (for informational purposes only).

Table 2

	Implementation $	Annual mmBtu Savings	Annual $ Savings
ECM 1	$109,625	402	$3,461
ECM 1a	$94,625	232	$1,996
Incremental Difference	$15,000	170	$1,464

With a $15K greater initial cost, ECM 1 saves more energy and annual cost than ECM 1a.

ECM-2: Install a Biomass Boiler and a Condensing Natural Gas Boiler

Project Cost:	$310,250	
Simple Payback:	N/A	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	367	mmBtu/Year
Annual Energy Cost Savings:	-$12,740	
% Reduction in CO2 Emissions:	See discussion in Supporting Information above	

EXISTING CONDITIONS:

The Ulster County Office Building receives it heating hot water from two failing standard efficiency natural gas boilers. The performance characteristics are included in Table 1 in the Assessment of Site Conditions section.

ECM SPECIFICATIONS:

Install a biomass hot water boiler system sized to handle about 60% of the peak heating load (3074 MBH) in the building and a condensing gas fired boiler for auxiliary heat (2050 MBH). These systems would replace the existing gas fired boilers, of which only one fires at a time (5124 MBH).

Biomass is any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials[3].

The building heat load was calculated via the methods described above. The existing systems were modeled as meeting the load at an average seasonal efficiency of 76%. The fuel requirements for meeting the load with the proposed systems were then calculated. The proposed biomass boiler was modeled at a 100% firing rate with efficiency of 86% based on typical product literature. The proposed condensing boiler was modeled with an efficiency that varied linearly between 85% at outdoor temperature of 20° F and 94% at outdoor temperature of 58° F.

The model projected that in a year of typical weather, the biomass boiler would use 15,685 therms (98 tons pellets) annually and the condensing boiler would use 10,225 therms. The resulting 25,910 therms consumption represents a 12.4% savings over the existing system under the same conditions.

ACTION ITEMS:

As detailed in Appendix B, the energy savings would not be advantageous due to the present

[3] https://www.nyserda.ny.gov/Researchers-and-Policymakers/Biomass

disparities in fuel prices between biomass pellets and natural gas. L&S contacted several pellet suppliers in New York State and Pennsylvania; however none would have vacuum delivery services available for Ulster County. Further, L&S contacted NYSERDA's Renewable Heat New York program management, who also could not identify a supplier. Net cost savings would be on the order of -$13K at present prices giving a negative payback. This measure is not recommended unless fuel prices change to favor the cost of biomass pellets over natural gas.

ECM-3: Convert AC-4R to VAV

Project Cost:	$48,200	
Simple Payback:	13.7	Years
Electricity Savings:	34,591	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	0	mmBtu/Year
Annual Cost Savings:	$3,523	
% Reduction in CO2 Emissions:	37%	

EXISTING CONDITIONS:

AC-4R is multi-zone constant air volume air handling unit with a 7.5 HP fan motor, assumed to have a standard efficiency of 89.5%. There are reheat coils and zone dampers for each thermal zone.

ECM SPECIFICATIONS:

Replace the air handling unit AC-4R with a VAV unit. The system will include a new 7.5 HP supply fan and NEMA premium efficiency motor, controlled by a 7.5 HP VFD. The VAV unit will also include the necessary controls, heating and cooling water coils and dX coil with spit condenser.

ACTION ITEMS:

This measure is recommended.

Discussion of NYSERDA/NYPA Geothermal Clean Energy Challenge Stage 2 Report

The County is participating in the NYSERDA/NYPA Geothermal Clean Energy Challenge. At the onset of this study, the County was in Stage 1 (Summary Report) of the Geothermal Clean Energy Challenge, and we were only tasked with providing insights associated with this stage. In the meantime, the County had a Stage 2 (Advanced Report) completed, so we expanded our efforts to include insights for Stage 2 below. The complete Advanced Report is included in Appendix D.

The Stage 2 building energy model (BEM) analysis of the Office Building was competed with the whole building energy simulation program Energy Plus, through Open Studio software. The estimated energy use was simulated for the single closed loop ground source heat pump (GSHP) system. Energy Plus includes a library of typical loads and system performance characteristics that were likely used to fine tune the energy load patterns, in addition to input parameters provided by the County. The study cautions that the results are still considered preliminary and a detailed feasibility assessment (Stage 3) should be pursued, if the County finds the results of the Stage 2 favorable.

In summary, the Stage 2 report does not specify how the GSHP would be integrated with the existing Office Building HVAC systems, or the type of GSHP system that should be considered, i.e. air to water or water to water. The payback with incentive is estimated to be 15-17 years, which is the median of the range from our experience. The County was approved for Stage 3, which may give an opportunity to flush out some more of the assumptions and look for opportunities to reduce the implementation costs. The assumptions and energy rates used in the GSHP study may be different from the parameters used in this FlexTech study and may be too extensive to list in detail here. The simple payback would be about the same if the rates in this report were used.

HEATING/COOLING MASTER - FURTHER ANALYSIS (FA)

GPI/L&S meet with the County on May 16, 2019 to review the draft Flex Tech Study and technologies evaluated. On July 10, 2019, the County provided guidance to L&S/GPI on a selected course of action to integrate into the final Flex Tech Study and Heating/Cooling Master Plan.

The County selected the following measures for detailed (specification-level) cost estimation and economic analysis for the Ulster County Office Building. Adjustments to energy analysis may also be completed when deemed appropriate and within the project scope of work.

- ECM-1: Install Two Condensing Natural Gas Boilers
- ECM-3: Convert AC-4R to VAV

FA ECM-1: Install Two Condensing Natural Gas Boilers

Project Cost:	$241,600	
Simple Payback:	69.8	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	402	mmBtu/Year
Annual Energy Cost Savings:	$3,461	
% Reduction in CO2 Emissions:	14%	

COUNTY SELECTED COURSE OF ACTION:

Replace the two existing sectional, gas-fired boilers with two new condensing boilers.

EXISTING CONDITIONS:

The Ulster County Office Building receives it heating hot water from two failing standard efficiency natural gas boilers. The performance characteristics are included in Table 1 in the Assessment of Site Conditions section.

COUNTY SOW SPECIFICATIONS:

Work to include replacement of the two original 120 HP gas-fired cast iron sectional boilers with two 120 HP gas-fired condensing boilers. Gas-fired burners shall be modulating. The design basis for these will be Cleaver Brooks. Replace existing heating system service valves in Mechanical Room. Modify or replace existing systems as needed. Modify the existing Building Management System control sequences to operate the heating system to take advantage of condensing mode as frequently as possible and schedule operation of boilers in lead-lag arrangement. Automatically reset the supply water temperature in accordance with the New York State Energy Code.

As per the scope of work for this project, the assumption that only one boiler runs at a time has not changed from the preliminary analysis for ECM-1; one condensing boiler was modeled with a full load capacity of 5,124 MBH and an efficiency of 94%, based on manufacturer specifications. The customer noted that both boilers occasionally run at the same time (during peak heating), however, the loads in the analysis are based on historical energy use, so this should not have a significant impact on the energy savings estimate.

Considering two boilers are being replaced, rather than just one, the energy savings-based payback essentially doubled.

FA ECM-3: Convert AC-4R to VAV

Project Cost:	$48,200	
Simple Payback:	13.7	Years
Electricity Savings:	34,591	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	0	mmBtu/Year
Annual Cost Savings:	$3,523	
% Reduction in CO2 Emissions:	37%	

COUNTY SELECTED COURSE OF ACTION:

Convert AC-4R to VAV.

EXISTING CONDITIONS:

AC-4R is multi-zone constant air volume air handling unit with a 7.5 HP fan motor, assumed to have a standard efficiency of 89.5%. There are reheat coils and zone dampers for each thermal zone.

COUNTY SOW SPECIFICATIONS:

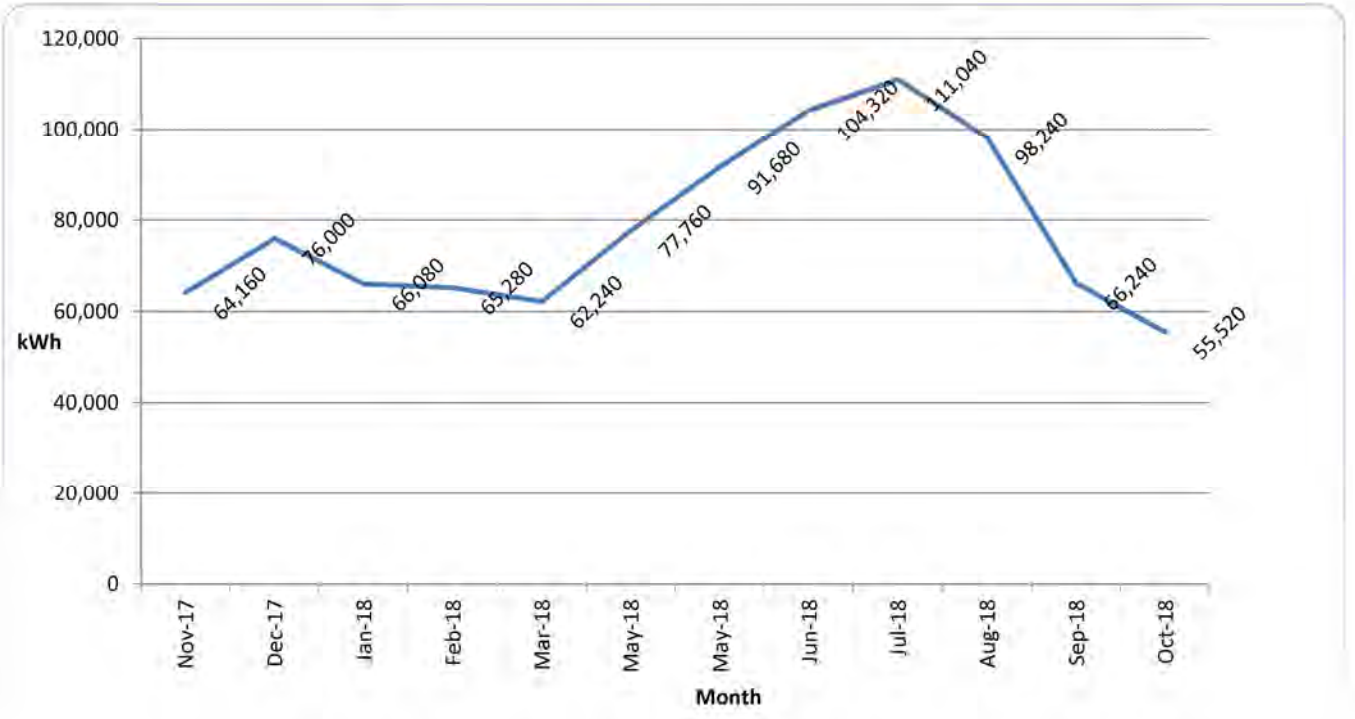
Work to include replacement of existing AC-4R with a VAV unit/system. This unit currently is a two-deck multizone unit with DX, chilled water and hot water coils. Reconfigure each existing zone as a VAV zone. DX and chilled water are there for redundancy. Maintain DX, chilled water and hot water functionality.

Appendix A – Utility Bill Summary

Facility: Ulster County Office Building
Address: 244 Fair St.
City: Kingston, NY
ZIP: 12402

Utility Provider: Central Hudson Gas & Electric

From	To	Total Use kWh	Utility kW Demand	Utility Energy $	Utility Demand $	Utility $/kWh	Utility $/kW	Total Electricity $
11/13/2017	12/14/2017	64,160	152.0	$6,924	$1,161	$0.108	$7.640	$8,086
12/14/2017	1/17/2017	76,000	171.2	$7,777	$1,308	$0.102	$7.640	$9,085
1/17/2018	2/15/2018	66,080	155.2	$6,968	$1,186	$0.105	$7.642	$8,154
2/16/2018	3/20/2018	65,280	147.2	$7,095	$1,350	$0.109	$9.171	$8,445
3/21/2018	5/1/2018	62,240	150.4	$6,789	$1,149	$0.109	$7.640	$7,938
5/2/2018	5/22/2018	77,760	238.4	$8,715	$1,821	$0.112	$7.638	$10,536
5/23/2018	6/21/2018	91,680	252.8	$9,833	$1,931	$0.107	$7.638	$11,764
6/22/2018	7/19/2018	104,320	257.6	$11,054	$2,121	$0.106	$8.234	$13,175
7/20/2018	8/21/2018	111,040	249.6	$12,100	$2,154	$0.109	$8.630	$14,254
8/22/2018	9/20/2018	98,240	270.4	$10,826	$2,334	$0.110	$8.632	$13,160
9/21/2018	10/17/2018	66,240	233.6	$7,860	$2,016	$0.119	$8.630	$9,876
10/18/2018	11/15/2018	55,520	193.6	$6,730	$1,671	$0.121	$8.631	$8,401
		938,560	**206.0**	**$102,671**	**$20,202**	**$0.110**	**$8.147**	**$122,873**



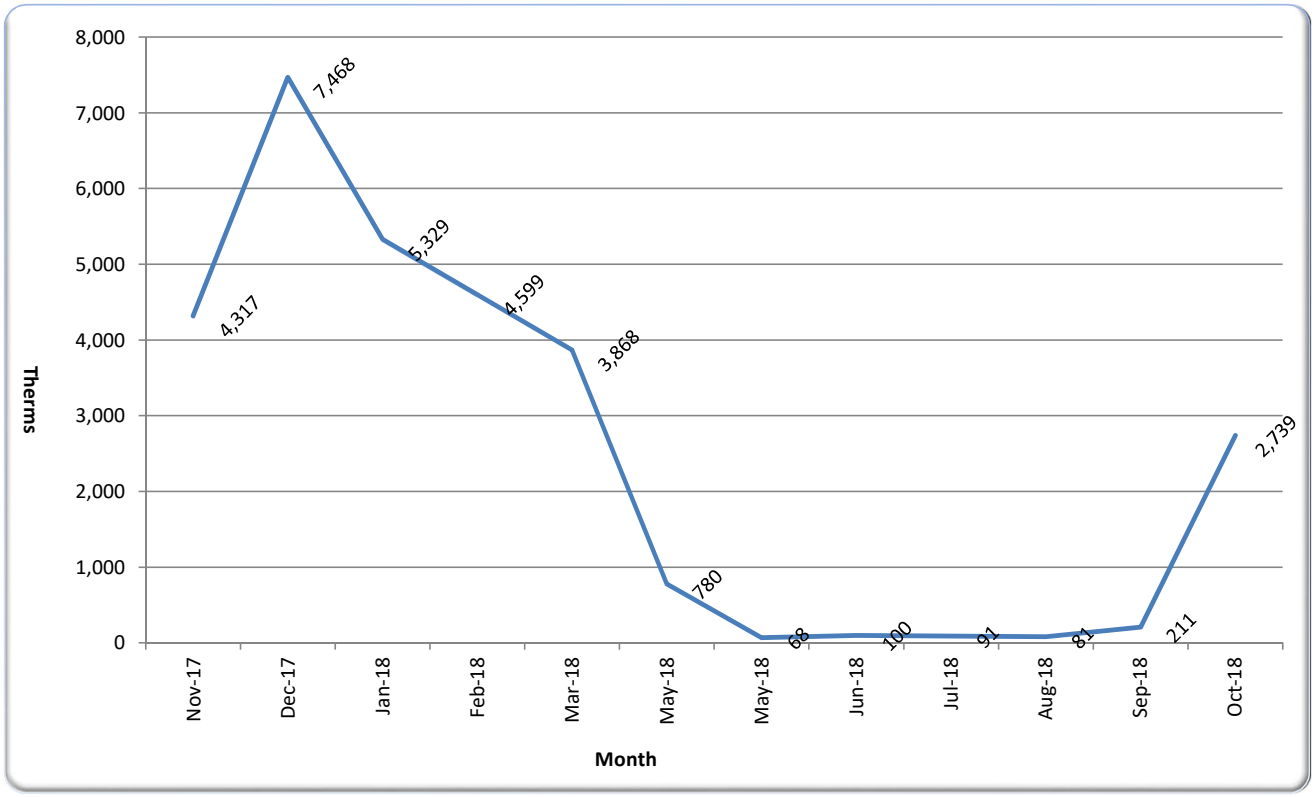
Facility: Ulster County Office Building
Address: 244 Fair St.
City: Kingston, NY
ZIP: 12402

Utility Provider: Central Hudson Gas and Electric Natural Gas **BTU Content (Btu/therm):** 100,000

From	To	Natural Gas Therms	NG $	Supply $	Total Natural Gas $	Total $/therm
11/13/2017	12/14/2017	4,317	$1,439	*$2,229*	$3,668	$0.850
12/14/2017	1/17/2017	7,468	$2,084	*$3,856*	$5,940	$0.795
1/17/2018	2/15/2018	5,329	$1,950	*$2,751*	$4,701	$0.882
2/16/2018	3/20/2018	4,599	$1,801	*$2,374*	$4,175	$0.908
3/21/2018	5/1/2018	3,868	$1,210	*$1,997*	$3,207	$0.829
5/2/2018	5/22/2018	780	$347	$394	$741	$0.950
5/23/2018	6/21/2018	68	$79	$35	$114	$1.674
6/22/2018	7/19/2018	100	$98	$52	$150	$1.500
7/20/2018	8/21/2018	91	$92	$48	$140	$1.535
8/22/2018	9/20/2018	81	$84	$42	$125	$1.544
9/21/2018	10/17/2018	211	$130	$108	$238	$1.126
10/18/2018	11/15/2018	2,739	$896	$1,441	$2,337	$0.853
		29,651	**$4,736**	**$6,491**	**$25,535**	**$0.861**

NOTE: Supply costs in italics not provided - amount shown is estimated

$/MMBtu:	$8.61



ENERGY STAR® Data Verification Checklist

44

ENERGY STAR ® Score[1]

Ulster County Office Building

Registry Name: Ulster County Office Building
Property Type: Office
Gross Floor Area (ft²): 62,396
Built: 1964

For Year Ending: Dec 31, 2018
Date Generated: Apr 2, 2019

1. The ENERGY STAR score is a 1-to-100 assessment of a building's energy efficiency as compared with similar building nationwide, adjusting for climate and business activity.

Property & Contact Information

Property Address
Ulster County Office Building
244 Fair Street
Kingston, New York 12401

Property ID: 2352952
Ulster County ID: B222

Property Owner
_____
,
(____)____-_____

Primary Contact
____ _____
,
(____)____-_____
_____

1. Review of Whole Property Characteristics

Basic Property Information

1) Property Name: Ulster County Office Building ☐ Yes ☐ No

Is this the official name of the property?

If "No", please specify: _____

2) Property Type: Office ☐ Yes ☐ No

Is this an accurate description of the primary use of this property?

3) Location: ☐ Yes ☐ No

244 Fair Street
Kingston, New York 12401

Is this correct and complete?

4) Gross Floor Area: 62,396 ft² ☐ Yes ☐ No

Is value an accurate account of the gross floor area for the property?

5) Average Occupancy (%): 100 ☐ Yes ☐ No

Is this occupancy percentage accurate for the entire 12 month period being assessed?

6) Number of Buildings: 1 ☐ Yes ☐ No

Does this number accurately represent all structures?

7) Whole Property Verification: ☐ Yes ☐ No

Does this application represent the entire property? If any space or energy use has been excluded from this property, please describe it in the notes section below.

Notes:

Indoor Environmental Quality

1) Outdoor Air Ventilation ☐ Yes ☐ No

Does this property meet the minimum ventilation rates according to ANSI/ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality?

2) Thermal Environmental Conditions ☐ Yes ☐ No

Does this property meet the acceptable thermal environmental conditions according ANSI/ ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy?

3) Illumination ☐ Yes ☐ No

Does this property meet the minimum illumination levels as recommended by the Illuminating Engineering Society of North America (IESNA) Lighting Handbook?

Notes:

2. Review of Property Use Details

Office: UCOB

This Use Detail is used to calculate the 1-100 ENERGY STAR Score.

1) Gross Floor Area: 62,396 ft²

☐ Yes ☐ No

Is this the total size, as measured between the outside surface of the exterior walls of the building(s)? This includes all areas inside the building(s) such as: occupied tenant areas, common areas, meeting areas, break rooms, restrooms, elevator shafts, mechanical equipment areas, and storage rooms. Gross Floor Area should not include interstitial plenum space between floors, which may house pipes and ventilation. Gross Floor Area is not the same as rentable, but rather includes all area inside the building(s). Leasable space would be a sub-set of Gross Floor Area. In the case where there is an atrium, you should count the Gross Floor Area at the base level only. Do not increase the size to accommodate open atrium space at higher levels. The Gross Floor Area should not include any exterior spaces such as balconies or exterior loading docks and driveways.

2) Weekly Operating Hours: 60

☐ Yes ☐ No

Is this the total number of hours per week that the property is occupied by the majority of the employees? It does not include hours when the HVAC system is starting up or shutting down, or when property is occupied only by maintenance, security, cleaning staff, or other support personnel. For properties with a schedule that varies during the year, use the schedule most often followed.

3) Number of Workers on Main Shift: 204

☐ Yes ☐ No

Is this the total number of workers present during the primary shift? This is not a total count of workers, but rather a count of workers who are present at the same time. For example, if there are two daily eight hour shifts of 100 workers each, the Number of Workers on Main Shift value is 100. Number of Workers on Main Shift may include employees of the property, sub-contractors who are onsite regularly, and volunteers who perform regular onsite tasks. Number of Workers should not include visitors to the buildings such as clients, customers, or patients.

4) Number of Computers: 173

☐ Yes ☐ No

Is this the total number of computers, laptops, and data servers at the property? This number should not include tablet computers, such as iPads, or any other types of office equipment.

5) Percent That Can Be Heated: 100

☐ Yes ☐ No

Is this the total percentage of the property that can be heated by mechanical equipment?

6) Percent That Can Be Cooled: 100

☐ Yes ☐ No

Is this the total percentage of the property that can be cooled by mechanical equipment? This includes all types of cooling from central air to individual window units.

Notes:

Parking: Parking Use

This Use Detail is used to calculate the 1-100 ENERGY STAR Score.

1) Open Parking Lot Size: 45,500 ft²

☐ Yes ☐ No

Is this the total area that is lit and used for parking vehicles? Open Parking Lot Size refers specifically to open area, which may include small shading covers but does not include any full structures with roofs. Parking lot size may include the area of parking spots, lanes, and driveways.

2) Partially Enclosed Parking Garage Size: 0 ft²

☐ Yes ☐ No

Is this the total area of parking structures that are partially enclosed? This includes parking garages where each level is covered at the top, but the walls are partially or fully open.

3) Completely Enclosed Parking Garage: 0 ft²

☐ Yes ☐ No

Is this the total area of parking structures that are completely enclosed on all four sides and have a roof? This includes underground parking or fully enclosed parking on the first few stories of a building.

4) Supplemental Heating: No

☐ Yes ☐ No

Is this the correct answer to whether your parking garage has Supplemental Heating, which is a heating system to pre-heat ventilation air and/or maintain a minimum temperature during winter months?

Notes:

3. Review of Energy Consumption

Data Overview

Site Energy Use Summary	
Natural Gas (kBtu)	2,944,360.2 (48%)
Electric - Grid (kBtu)	3,174,585.4 (52%)
Total Energy (kBtu)	6,118,945.6

Energy Intensity	
Site (kBtu/ft²)	98.1
Source (kBtu/ft²)	192

National Median Comparison	
National Median Site EUI (kBtu/ft²)	91.8
National Median Source EUI (kBtu/ft²)	179.7
% Diff from National Median Source EUI	6.9%

Emissions (based on site energy use)	
Greenhouse Gas Emissions (Metric Tons CO2e)	281.3

Power Generation Plant or Distribution Utility:
Central Hudson Gas & Elec Corp

Note: All values are annualized to a 12-month period. Source Energy includes energy used in generation and transmission to enable an equitable assessment.

Summary of All Associated Energy Meters

The following meters are associated with the property, meaning that they are added together to get the total energy use for the property. Please see additional tables in this checklist for the exact meter consumption values. **Note: please review all meter entries, making note of any unusual entries, and, if they are correct, provide a manual note to explain.**

Meter Name	Fuel Type	Start Date	End Date	Associated With:
3620023000_Fixed Usage Lighting	Electric - Grid	01/01/2010	In Use	Ulster County Office Building
3620023000_NG_Supl	Natural Gas	05/01/2018	In Use	Ulster County Office Building
3620022000_Elec_Sup	Electric - Grid	03/20/2009	In Use	Ulster County Office Building
3620023000_NG_Supl Energy_CLOSED	Natural Gas	11/01/2014	05/01/2018	Ulster County Office Building
3620022000_Elec_Del	Electric - Grid	08/19/2009	In Use	Ulster County Office Building
3620023000_NG_Deli	Natural Gas	07/18/2009	In Use	Ulster County Office Building

Total Energy Use ☐ **Yes** ☐ **No**

Do the meters shown above account for the total energy use of this property during the reporting period of this application?

Additional Fuels ☐ **Yes** ☐ **No**

Do the meters above include all fuel types at the property? That is, no additional fuels such as district steam, generator fuel oil have been excluded.

On-Site Solar and Wind Energy ☐ **Yes** ☐ **No**

Are all on-site solar and wind installations reported in this list (if present)? All on-site systems must be reported.

Notes:

Summary of Additional Meters

None of the following meters are associated with the property meaning that they are not added together to account for the total energy use of the property.

Meter Name	Fuel Type	Start Date	End Date	Associated With:
EVSE_06	Electric - Grid	07/01/2015	In Use	None

Sub (or Ancillary) Meter Energy Use ☐ Yes ☐ No

Are the meters in this list all sub-meters or other ancillary meters that do not need to be added to the total energy for the reporting period of this application?

Notes:

Electric - Grid Meter: 3620023000_Fixed Usage Lighting (kWh (thousand Watt-hours))

Associated With: Ulster County Office Building

Start Date	End Date	Usage	Green Power?
01/01/2018	01/31/2018	573	No
02/01/2018	02/28/2018	477	No
03/01/2018	03/31/2018	465	No
04/01/2018	04/30/2018	411	No
05/01/2018	05/31/2018	369	No
06/01/2018	06/30/2018	327	No
07/01/2018	07/31/2018	354	No
08/01/2018	08/31/2018	396	No
09/01/2018	09/30/2018	438	No
10/01/2018	10/31/2018	504	No
11/01/2018	11/30/2018	546	No
12/01/2018	12/31/2018	600	No
	Total Consumption (kWh (thousand Watt-hours)):		5,460
	Total Consumption (kBtu (thousand Btu)):		18,629.5

Total Energy Consumption for this Meter ☐ Yes ☐ No

Do the fuel consumption totals shown above include consumption of all energy tracked through this meter that affect energy calculations for the reporting period of this application (i.e., do the entries match the utility bills received by the property)?

Notes:

Natural Gas Meter: 3620023000_NG_Supply_Agera (ccf (hundred cubic feet))

Associated With: Ulster County Office Building

Start Date	End Date	Usage
05/01/2018	05/22/2018	0
05/22/2018	06/21/2018	0
06/21/2018	07/19/2018	0
07/19/2018	08/21/2018	0
08/21/2018	09/20/2018	0
09/20/2018	10/17/2018	0
10/17/2018	11/15/2018	0
11/15/2018	12/19/2018	0
12/19/2018	01/23/2019	0
	Total Consumption (ccf (hundred cubic feet)):	0
	Total Consumption (kBtu (thousand Btu)):	0

Total Energy Consumption for this Meter ☐ **Yes** ☐ **No**

Do the fuel consumption totals shown above include consumption of all energy tracked through this meter that affect energy calculations for the reporting period of this application (i.e., do the entries match the utility bills received by the property)?

Notes:

Electric - Grid Meter: 3620022000_Elec_Supply (kWh (thousand Watt-hours))

Associated With: Ulster County Office Building

Start Date	End Date	Usage	Green Power?
12/14/2017	01/17/2018	0	No
01/17/2018	02/15/2018	0	No
02/15/2018	03/20/2018	0	No
03/20/2018	04/19/2018	0	No
04/19/2018	05/22/2018	0	No
05/22/2018	06/19/2018	0	No
06/19/2018	07/19/2018	0	No
07/19/2018	08/21/2018	0	No
08/21/2018	09/20/2018	0	No
09/20/2018	10/17/2018	0	No
10/17/2018	11/15/2018	0	No
11/15/2018	12/19/2018	0	No
12/19/2018	01/23/2019	0	No
	Total Consumption (kWh (thousand Watt-hours)):		0
	Total Consumption (kBtu (thousand Btu)):		0

Total Energy Consumption for this Meter ☐ **Yes** ☐ **No**

Do the fuel consumption totals shown above include consumption of all energy tracked through this meter that affect energy calculations for the reporting period of this application (i.e., do the entries match the utility bills received by the property)?

Notes:

Natural Gas Meter: 3620023000_NG_Supply_Direct Energy_CLOSED (ccf (hundred cubic feet))

Associated With: Ulster County Office Building

Start Date	End Date	Usage
01/01/2018	01/17/2018	0
01/18/2018	01/31/2018	0
02/01/2018	02/15/2018	0
02/16/2018	02/28/2018	0
03/01/2018	03/20/2018	0
03/21/2018	03/31/2018	0

Start Date	End Date	Usage
04/01/2018	05/01/2018	0
	Total Consumption (ccf (hundred cubic feet)):	0
	Total Consumption (kBtu (thousand Btu)):	0

Total Energy Consumption for this Meter ☐ **Yes** ☐ **No**

Do the fuel consumption totals shown above include consumption of all energy tracked through this meter that affect energy calculations for the reporting period of this application (i.e., do the entries match the utility bills received by the property)?

Notes:

Electric - Grid Meter: 3620022000_Elec_Delivery (kWh (thousand Watt-hours))

Associated With: Ulster County Office Building

Start Date	End Date	Usage	Green Power?
12/14/2017	01/17/2018	76,000	No
01/17/2018	02/15/2018	66,080	No
02/16/2018	03/20/2018	65,280	No
03/21/2018	04/19/2018	62,240	No
04/20/2018	05/22/2018	77,760	No
05/23/2018	06/19/2018	91,680	No
06/20/2018	07/19/2018	104,320	No
07/20/2018	08/21/2018	111,040	No
08/22/2018	09/20/2018	98,240	No
09/21/2018	10/17/2018	66,240	No
10/18/2018	11/15/2018	55,520	No
11/16/2018	12/19/2018	67,040	No
12/20/2018	01/23/2019	69,280	No
	Total Consumption (kWh (thousand Watt-hours)):	1,010,720	
	Total Consumption (kBtu (thousand Btu)):	3,448,576.6	

Total Energy Consumption for this Meter ☐ **Yes** ☐ **No**

Do the fuel consumption totals shown above include consumption of all energy tracked through this meter that affect energy calculations for the reporting period of this application (i.e., do the entries match the utility bills received by the property)?

Notes:

Natural Gas Meter: 3620023000_NG_Delivery (ccf (hundred cubic feet))

Associated With: Ulster County Office Building

Start Date	End Date	Usage
12/14/2017	01/17/2018	7,468
01/17/2018	02/15/2018	5,329
02/16/2018	03/20/2018	4,599
03/21/2018	05/01/2018	3,868
05/02/2018	05/22/2018	780
05/23/2018	06/21/2018	68
06/22/2018	07/19/2018	100
07/20/2018	08/21/2018	91
08/22/2018	09/20/2018	81
09/21/2018	10/17/2018	211
10/18/2018	11/15/2018	2,739
11/16/2018	12/19/2018	5,177
12/20/2018	01/23/2019	6,242
	Total Consumption (ccf (hundred cubic feet)):	36,753
	Total Consumption (kBtu (thousand Btu)):	3,770,857.8

Total Energy Consumption for this Meter ☐ **Yes** ☐ **No**

Do the fuel consumption totals shown above include consumption of all energy tracked through this meter that affect energy calculations for the reporting period of this application (i.e., do the entries match the utility bills received by the property)?

Notes:

4. Signature & Stamp of Verifying Licensed Professional

_____ (Name) visited this site on _____ (Date). Based on the conditions observed at the time of the visit to this property, I verify that the information contained within this application is accurate and in accordance with the Licensed Professional Guide.

Signature _____

Date _____

Licensed Professional

____ _____
,
(____)____-_____
_____

NOTE: When applying for the ENERGY STAR, the signature of the Verifying Professional must match the stamp.

Professional Engineering Stamp

(if applicable)

Appendix B – ECM Calculation Data

UCOB PFS 1: SOLAR DHW SCREEN

Background Info

2,735 therms/yr DHW UCOB balance temp & building load coefficient

F:\Mike Stiles\Ulster Co Law Enforcement Center (UCLEC)\UCOB
UCOB Summary
Domestic hot water is provided by two (2) natural gas-fired hot water heaters

Ulster County Office Building_mechanicals_from 2010 audit
21/36: Bradford White Magnum PHCC natural gas fired DHW
80 gal 250 MBH input

Third-Party Screening Tool
https://apps1.eere.energy.gov/femp/solar_hotwater_system/

ENERGY.GOV
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
Federal Energy Management Program

EERE » Federal Energy Management Program

Solar Hot Water System Calculator

Use the FEMP solar hot water calculator to estimate what size of solar system will work best for your Federal facility and how much it will cost.

The Energy Independence and Security Act (EISA) of 2007 Section 523 requires new Federal buildings and major renovations to meet 30% of hot water demand using solar hot water equipment if it is life-cycle cost effective. This tool can help meet that goal.

Follow the steps below to calculate approximate solar hot water system size and cost needed to meet the Energy Independence and Security Act (EISA) of 2007 Section 523 solar hot water requirement for new Federal construction and major renovations.

Step 1. Enter project and location information.

Project Name
UCOB

Select the nearest city/state
NY, ALBANY

ZIP Code
12402

Continue

Step 2. Calculate Hot Water Load and System Size

Select the appropriate building type from the drop-down menu. Tips on average Federal facility hot water load will be displayed to help complete the remaining fields. Then, enter the desired cold and hot water temperatures. Common temperatures are pre-entered for convenience, but can be changed to match your conditions.

Building Type
Office

Amount of Water Usage (M) - gallons / person / day / person
1

Number of person(s)
200

Cold Water Temperature (°F)(T_{cold})
50

Hot Water Temperature (°F)(T_{hot})
130

Calculate Load

Water Usage Estimates
Office: 1 gal/day/person
School: 2 gal/day/person
Barracks: 10 gal/day/person
Dormitory: 13 gal/day/person
Residence: 30 gal/day/person
Food Service: 2 gal/meal
Motel: 15 gal/day/room
Hospital: 18 gal/day/bed

Estimated System Size: 16.80 m^2

Step 3. Estimate System Cost and Annual Savings

Annual energy and cost savings are calculated based on the current hot water heater fuel type, fuel price, and water heater efficiency level. Select the appropriate fuel type from the drop-down menu. The average efficiency level and fuel cost is provided, but can be changed to match your conditions.

Water Heater Type
GAS: 0.43 - 0.86, assume 0.57

Efficiency
0.75

Energy Cost / 1,000 cu. ft.
8.61

Calculate Energy Savings

UCOB PFS 1: SOLAR DHW SCREEN

Final Report

Based on the data provided, the results for your facility includes the following. Note that these outputs do not include available incentives or rebates.

SITE INFORMATION

Project Name	UCOB
Nearest City	NY, ALBANY
ZIP Code	12402

INPUT VALUES

Building Type	Office
Amount of Water Usage	200 gal/day
Number of person(s)	200
Cold Water Temperature	50 (°F)(T_{cold})
Hew Water Temperature	130 (°F)(T_{hot})
Water Heater Fuel Type	gas
Water Heater Efficiency	0.75
Average Fuel Price	$8.61/1,000 cu. ft.

CALCULATIONS

System Size	16.80 m^2
System Cost	$16,945.80
Annual Energy Savings	14,939.00 kWh/year
Annual Cost Savings	$427.33 based on $8.61/$1,000 cu. ft.
SIR	0.61
Simple Payback	29.69 years
Solar Fraction	79.00%
Annual Greenhouse Gas Reduction	5,961.26 lbs. of CO_2

Savings Summary

Calculator savings:	14,939	kWh
Conversion factor:	3,413	Btu/kWh
	0.003413	mmBtu/kWh

Solar mmBtu savings = 51

Natural gas cost savings:

$8.612 $/mmBtu natural gas (proposed)

Cost savings = $439

UCOB PFS 2: AIR SOURCE HEAT PUMP SCREENING CALCULATIONS

Existing Equipment

Heating

Boiler type	Natural gas fired hot water boiler
Make, model, age	Weil McClain Model 1688; 1988
MBH input	5124
# units	1 (there are two but one is used at a time)
Total MBH input	5,124
Efficiency	79.8% nameplate; boilers are well maintained
Assumed maximum efficiency	76.0%
Assumed avg seasonal efficiency	73.4%

Cooling

Equipment Year	Unit	Type	Comments
2003	VSD Chiller	York MaxE Centrifugal Chiller Model YTG1A1B2-CHJ	237.6 ton cooling coil capacity (from Trane-Trace analysis)

Strategy for Screening: Heating

Issues

The goal is to compare existing with proposed equipment performance, given that existing heating is from A natural gas-fired boiler, proposed is from air source heat pump(s)

Strategy

Convert existing building heating load, natural gas consumption to equivalent kWh

Building load 22,482 therms
See: UCOB BIOMASS + CONDENSING BOILER MODEL
3413 Btu/kWh
658,707 kWh equivalent heating load (FYI)

Assumptions about proposed heat pumps

High-efficiency
In order to effectively operate all season, must have good COP to low outdoor air temperature
>>> This requires a variable refrigerant flow (VRF) system
Example heating COP is thus assumed = 3.3
(Example system: Mitsubishi PUMY or PURY -- *not a recommendation, for illustrative purposes only*)

Existing boiler usage base year (setup for savings calculation)

29,651 therms annual usage
3413 Btu/kWh
868,766 kWh equivalent heating usage (FYI)

Heat Pump Energy Usage Calculation: Heating

$$Proposed\ kWh = \#of\ Units\ x \left(\frac{kBtuh_{out}}{Unit}\right) x \left(\frac{1}{COP_{ee}}\right) x \frac{EFLH_{heat}}{3.413}$$

From above; use building load to get usage:

# of Units x (kBtuhout/unit) x EFLHheat = 22,482 therms x 100 kBtu/therm = 2,248,167 kBtu

COP = 3.3

Proposed kWh = 199,608 kWh

Strategy for Screening: Cooling

Issues

Need to estimate existing cooling energy usage & system efficiency

Strategy

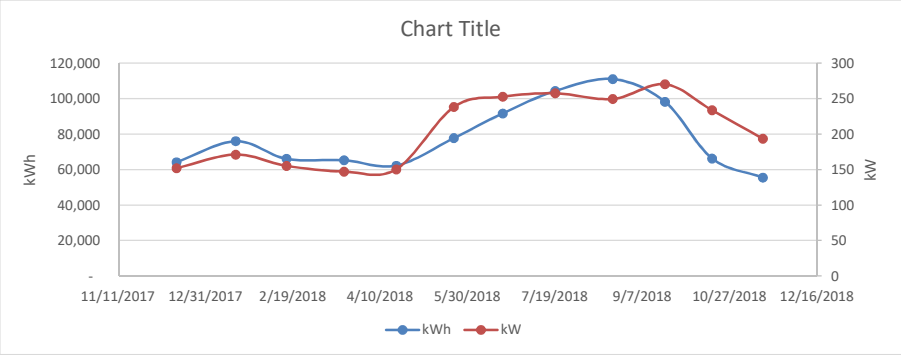
Rough estimates from base year utility data

UCOB PFS 2: AIR SOURCE HEAT PUMP SCREENING CALCULATIONS

Existing system analysis

Utility data for base year:

Read Date	kWh	kW
12/14/2017	64,160	152
1/17/2018	76,000	171.2
2/15/2018	66,080	155.2
3/20/2018	65,280	147.2
4/19/2018	62,240	150.4
5/22/2018	77,760	238.4
6/19/2018	91,680	252.8
7/19/2018	104,320	257.6
8/21/2018	111,040	249.6
9/20/2018	98,240	270.4
10/17/2018	66,240	233.6
11/15/2018	55,520	193.6



Re-order data for further analysis:

Read Date	kWh	Avg non-cooling kWh
11/15/2018	55,520	
12/14/2017	64,160	
1/17/2018	76,000	64,880
2/15/2018	66,080	
3/20/2018	65,280	
4/19/2018	62,240	

	kWh	kWh - Avg non clg kWh	
5/22/2018	77,760	12,880	
6/19/2018	91,680	26,800	
7/19/2018	104,320	39,440	
8/21/2018	111,040	46,160	
9/20/2018	98,240	33,360	
10/17/2018	66,240	1,360	
		160,000	total base year cooling usage

Existing operational parameters

$$Baseline\ kWh = \#\ of\ Units\ x\ Tons\ per\ Unit\ x \left(\frac{12}{SEER_{base}}\right) x\ EFLH_{cooling}$$

baseline kWh =	160,000	
# of units x tons/unit =	237.6	tons (See Existing Equipment, above)
SEERbase =	7	*estimated based on engineering experience*
EFLHcooling =	392.8	...and assume this remains constant for proposed equipment

UCOB PFS 2: AIR SOURCE HEAT PUMP SCREENING CALCULATIONS

Heat Pump Energy Usage Calculation: Cooling

$$Proposed\ kWh = \#\ of\ Units\ x\ Tons\ per\ Unit\ x\ \left(\frac{12}{SEER_{ee}}\right)\ x\ EFLH_{cooling}$$

where SEERee is for the proposed energy-efficient equipment

For the Mitsubishi PUMY unit referenced above, SEER ~ 15

Proposed kWh = 74,667

Energy and Cost Savings Summary

	Heating		Cooling
	therms	kWh	kWh
Existing	29,651	0	160,000
Proposed	0	199,608	74,667
Savings	29,651	(199,608)	85,333
	therms	kWh	kWh

Net energy savings: 29,651 therms
(114,275) kWh

Utility Rates: $0.131 $/kWh blended
$0.861 $/therm natural gas

	Heating		Cooling
	therms	kWh	kWh
Existing	$25,536	$0	$20,947
Proposed	$0	$26,132	$9,775
Savings	$25,536	-$26,132	$11,172

$10,575 net cost savings

Estimated Implementation Cost and Simple Payback

RSMeans Mechanical 2018
23 81 29.10 1010 Multi-Zone Split *Assume labor includes demolition of existing equipment & prep for new*

Material	Labor	Total
$32,322	$778	$33,100

for 15 ton system

Assume cost scales proportionally according to 238 tons / 15 tons:

Material	Labor	Total
$512,850	$12,337	$525,187

Simple Payback

Cost $525,187
Annual Savings $10,575
Payback 49.7 years

UCOB PFS 3: THERMAL STORAGE SCREENING ANALYSIS

Cooling Demand Estimated from Utility Data

Starting Data (from utility data summary):

End Date	kW	kW $	$/kW	
12/14/2017	152	$1,161	$7.64	
1/17/2018	171.2	$1,308	$7.64	
2/15/2018	155.2	$1,186	$7.64	
3/20/2018	147.2	$1,350	$9.17	
4/19/2018	150.4	$1,149	$7.64	
5/22/2018	238.4	$1,821	$7.64	apparent cooling season billing period
6/19/2018	252.8	$1,931	$7.64	
7/19/2018	257.6	$2,121	$8.23	
8/21/2018	249.6	$2,154	$8.63	
9/20/2018	270.4	$2,334	$8.63	
10/17/2018	233.6	$2,016	$8.63	
11/15/2018	193.6	$1,671	$8.63	

Avg kW for non-cooling season billing period = 161.6
Avg $/kW during cooling season = $8.23 $/kW

End Date	kW	kW - avg kW for non clg season
5/22/2018	238.4	76.8
6/19/2018	252.8	91.2
7/19/2018	257.6	96
8/21/2018	249.6	88
9/20/2018	270.4	108.8
10/17/2018	233.6	72

These values do not show a marked peak, take the average for analysis

88.8 kW avg monthly peak demand increase attributed to cooling

Assumptions and Savings Estimates

Estimated monthly demand charge due to centrifugal chiller =
88.8 kW/month * $8.23 $/kW = $731 monthly existing cost

Estimated % reduction of chiller operation at peak due to thermal storage = 50%
http://illinoisashrae.org/images/meeting/032514/YEA_Conf_Presentations_2014/energy_storage.pdf

Estimated cost savings/month if thermal storage installed = $366
Months of cooling season demand charges (see above) 6
kW demand reduction @ 50% for # months indicated = 266.4
Estimated annual demand savings if thermal storage installed = $2,194

Estimated minimum cost of ice storage (238 ton chiller) = $300,000
http://illinoisashrae.org/images/meeting/032514/YEA_Conf_Presentations_2014/energy_storage.pdf
+ cursory Google search

Simple payback = 136.8 years

UCOB Boiler Replacement			
Ulster County Office Building	**244 Fair Street**	**Kingston, NY 12402**	
ECM 1 - Install Condensing Natural Gas Boiler			
Existing Boiler Input Capacity (MBH ea.):			**5,124**
Proposed Condensing Boiler Input Capacity (MBH ea.):			**5,124**
Bin Temp at Which 100% Load Occurs (deg F)			**2.5**
Bin Temp for Balance Point			**57.5**
Boiler Availability:			**Heating season**
Btus per Therm Conversion Factor:			**100,000**
Existing Boiler Efficiency (assumed system)			**76%**
Proposed Condensing Boiler Efficiency (condensing above 20°F OSA)			**94%**
Proposed Condensing Boiler Efficiency (non-condensing below 20°F OSA)			**85%**
$/therm natural gas			**$ 0.86**
Gas Savings (mmBtu)			**402**
Gas Savings Cost			**$3,461**
Total Savings ($)			**$3,461**

Notes: For this example, condensing boiler assumed 100% of existing boiler capacity. Actual capacities to be determined at design.

Determine Existing Boiler Heating Usage:

Usage was analyzed using utility billing data from 2/17/17 to 11/15/18

Assumptions and Approach:

1. The model of heating energy usage is based on utility natural gas data that is billed monthly.
2. Usage is modeled by a regression analysis; its parameters are functions of heating degree days (HDD).
3. TMY3 data is from Poughkeepsie Dutchess Co AP; date, time, and outdoor air dry bulb temperature

See: Building Load Determination section of report for more details on regression analysis

4. Excerpts below are from 8760 model

TMY3 Data Excerpt:

Date	Time	Dry-bulb (F)	HDhr @58°F base
1/1/2005	1:00	35.6	22.4
1/1/2005	2:00	33.8	24.2
1/1/2005	3:00	37.4	20.6
1/1/2005	4:00	39.2	18.8
1/1/2005	5:00	33.8	24.2
1/1/2005	6:00	46.4	11.6
1/1/2005	7:00	35.6	22.4
1/1/2005	8:00	44.6	13.4
1/1/2005	9:00	44.6	13.4
1/1/2005	10:00	51.8	6.2
1/1/2005	11:00	53.6	4.4
1/1/2005	12:00	55.4	2.6
1/1/2005	13:00	53.6	4.4
1/1/2005	14:00	51.8	6.2
1/1/2005	15:00	50	8
…	…	…	…

Regression analysis results:

therms/day = 6.1549 therms/HDD58 + 7.4944 therms/day

ECM 1 - Install Condensing Natural Gas Boiler

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Existing usage therms * Existing efficiency

Regression analysis results:
therms/day = 4.6777 therms/HDD58 + 5.6957 therms/day

Therms Usage by Regression -- Building Load Excerpt:

Date	Time	Therms
1/1/2005	1:00	4.6
1/1/2005	2:00	5.0
1/1/2005	3:00	4.3
1/1/2005	4:00	3.9
1/1/2005	5:00	5.0
1/1/2005	6:00	2.5
1/1/2005	7:00	4.6
1/1/2005	8:00	2.8
1/1/2005	9:00	2.8
1/1/2005	10:00	1.4
1/1/2005	11:00	1.1
1/1/2005	12:00	0.7
1/1/2005	13:00	1.1
1/1/2005	14:00	1.4
…	…	…

Building Load

Total Sum - Therms Monthly:	
Jan	5,054
Feb	4,008
Mar	2,537
Apr	1,442
May	658
Jun	286
Jul	193
Aug	258
Sep	418
Oct	1,668
Nov	2,000
Dec	3,962
Total	22,482

In a year of typical weather, existing system builidng load was estimated to be
22,482 therms

Apply 8760 hour model to existing system usage in a year of typical weather:
Hourly usage = hourly load / existing efficiency (76%)

Therms Usage by Regression -- Existing Excerpt:

Date	Time	Therms
1/1/2005	1:00	6.1
1/1/2005	2:00	6.5
1/1/2005	3:00	5.6
1/1/2005	4:00	5.1
1/1/2005	5:00	6.5
1/1/2005	6:00	3.3
1/1/2005	7:00	6.1
1/1/2005	8:00	3.7
1/1/2005	9:00	3.7
1/1/2005	10:00	1.9
1/1/2005	11:00	1.4
1/1/2005	12:00	1.0
1/1/2005	13:00	1.4
1/1/2005	14:00	1.9
1/1/2005	15:00	2.4
…	…	…

Existing NG Usage

Total Sum - Therms Monthly:	
Jan	6,649
Feb	5,273
Mar	3,338
Apr	1,897
May	866
Jun	376
Jul	253
Aug	339
Sep	550
Oct	2,195
Nov	2,631
Dec	5,213
Total	29,581

In a year of typical weather, existing system natural gas usage was estimated to be
29,581 therms

ECM 1 - Install Condensing Natural Gas Boiler

Calculate Condensing Natural Gas Boiler Usage:

Hourly usage = hourly load / condensing boiler efficiency where:

Condensing Boiler Efficiency Parameters

Outdoor air temperature (OAT, deg F) selections:

OAT for maximum condensing efficiency =	58	F
OAT below which condensing stops =	20	F

OAT	effic		
20	85%	m=	0.00237
58	94%	b=	0.80263

Therms Usage -- Proposed Excerpt:

Date	Time	Condensing Boiler:	
1/1/2005	1:00	Efficiency	Total Therms
1/1/2005	2:00	89%	5.2
1/1/2005	3:00	88%	5.6
1/1/2005	4:00	89%	4.8
1/1/2005	5:00	90%	4.4
1/1/2005	6:00	88%	5.6
1/1/2005	7:00	91%	2.7
1/1/2005	8:00	89%	5.2
1/1/2005	9:00	91%	3.1
1/1/2005	10:00	91%	3.1
1/1/2005	11:00	93%	1.6
1/1/2005	12:00	93%	1.2
1/1/2005	13:00	93%	0.8
1/1/2005	14:00	93%	1.2
1/1/2005	15:00	93%	1.6
...	...	...	...

Proposed Usage

Total Sum - Therms Monthly:	
	Boiler
Jan	5,863
Feb	4,636
Mar	2,860
Apr	1,600
May	716
Jun	307
Jul	205
Aug	276
Sep	451
Oct	1,856
Nov	2,244
Dec	4,548
Totals	25,563

Savings Summary

System	Usage	Costs	
	NG (Therms)		
Existing	29,581	$	25,476
Proposed:	25,563	$	22,015
Savings	**4,018**	**$**	**3,461**

NIST BLCC 5.3-18: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case: Existing NG Boiler

Alternative: ECM 1 - Install Condensing Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCOB\Utility Bills\BLCC5\BLCC5 - UCOB - fuel v.2.xml
Date of Study:	Tue Sep 17 12:29:49 EDT 2019
Project Name:	Ulster County Office Building
Project Location:	New York
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Brendan Kelly
Base Date:	April 1, 2019
Service Date:	April 1, 2020
Study Period:	30 years 0 months(April 1, 2019 through March 31, 2049)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$0	$109,625	-$109,625
Future Costs:			
Energy Consumption Costs	$560,824	$483,897	$76,927
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$0	$0
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
Subtotal (for Future Cost Items)	$560,824	$483,897	$76,927
Total PV Life-Cycle Cost	$560,824	$593,522	-$32,698

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$76,927
- Increased Total Investment	$109,625

Net Savings -$32,698

Savings-to-Investment Ratio (SIR)

SIR = 0.70

SIR is lower than 1.0; project alternative is not cost effective.

Adjusted Internal Rate of Return

AIRR = 1.79%

AIRR is lower than your discount rate; project alternative is not cost effective.

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Discounted Payback never reached during study period.

Simple Payback occurs in year 27

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Natural Gas	2,958.1 MBtu	2,556.3 MBtu	401.8 MBtu	11,650.8 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Natural Gas	2,958.1 MBtu	2,556.3 MBtu	401.8 MBtu	11,650.8 MBtu

Emissions Reduction Summary

Energy Type	Average Base Case	Annual Alternative	Emissions Reduction	Life-Cycle Reduction
Natural Gas				
CO2	156,253.77 kg	135,029.75 kg	21,224.02 kg	615,423.86 kg
SO2	1,261.02 kg	1,089.73 kg	171.28 kg	4,966.66 kg
NOx	131.10 kg	113.29 kg	17.81 kg	516.34 kg
Total:				
CO2	156,253.77 kg	135,029.75 kg	21,224.02 kg	615,423.86 kg
SO2	1,261.02 kg	1,089.73 kg	171.28 kg	4,966.66 kg
NOx	131.10 kg	113.29 kg	17.81 kg	516.34 kg

NIST BLCC 5.3-18: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case: Existing NG Boiler

Alternative: FA ECM 1 - Install Condensing Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCOB\Utility Bills\BLCC5\BLCC5 - UCOB - fuel v.2.xml
Date of Study:	Tue Sep 17 12:31:09 EDT 2019
Project Name:	Ulster County Office Building
Project Location:	New York
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Brendan Kelly
Base Date:	April 1, 2019
Service Date:	April 1, 2020
Study Period:	30 years 0 months(April 1, 2019 through March 31, 2049)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$0	$241,600	-$241,600
Future Costs:			
Energy Consumption Costs	$560,824	$483,897	$76,927
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$0	$0
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
Subtotal (for Future Cost Items)	$560,824	$483,897	$76,927
Total PV Life-Cycle Cost	$560,824	$725,497	-$164,673

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$76,927
- Increased Total Investment	$241,600

Net Savings -$164,673

Savings-to-Investment Ratio (SIR)

SIR = 0.32

SIR is lower than 1.0; project alternative is not cost effective.

Adjusted Internal Rate of Return

AIRR = -0.86%

AIRR is lower than your discount rate; project alternative is not cost effective.

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback never reached during study period.

Discounted Payback never reached during study period.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Natural Gas	2,958.1 MBtu	2,556.3 MBtu	401.8 MBtu	11,650.8 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Natural Gas	2,958.1 MBtu	2,556.3 MBtu	401.8 MBtu	11,650.8 MBtu

Emissions Reduction Summary

Energy Type	Average Annual Emissions Base Case	Alternative	Reduction	Life-Cycle Reduction
Natural Gas				
CO2	156,253.77 kg	135,029.75 kg	21,224.02 kg	615,423.86 kg
SO2	1,261.02 kg	1,089.73 kg	171.28 kg	4,966.66 kg
NOx	131.10 kg	113.29 kg	17.81 kg	516.34 kg
Total:				
CO2	156,253.77 kg	135,029.75 kg	21,224.02 kg	615,423.86 kg
SO2	1,261.02 kg	1,089.73 kg	171.28 kg	4,966.66 kg
NOx	131.10 kg	113.29 kg	17.81 kg	516.34 kg

UCOB Boiler Replacement			
Ulster County Office Building	**244 Fair Street**	**Kingston, NY 12402**	
ECM 1a - Install Condensing Natural Gas Boiler			
Existing Boiler Input Capacity (MBH ea.):			**5,124**
Proposed Condensing Boiler Input Capacity (MBH ea.):			**5,124**
Bin Temp at Which 100% Load Occurs (deg F)			**2.5**
Bin Temp for Balance Point			**57.5**
Boiler Availability:			**Heating season**
Btus per Therm Conversion Factor:			**100,000**
Code Standard Min Boiler Efficiency (assumed)			**78%**
Code Standard Max Boiler Efficiency (below 20°F OSA)			**82%**
Proposed Max Condensing Boiler Efficiency (condensing above 20°F OSA)			**94%**
Proposed Min Condensing Boiler Efficiency (non-condensing below 20°F OSA)			**85%**
$/therm natural gas			**$ 0.86**
Gas Savings (mmBtu)			**232**
Gas Savings Cost			**$1,996**
Total Savings ($)			**$1,996**

Notes: For this example, condensing boiler assumed 100% of existing boiler capacity. Actual capacities to be determined at design.
Code std max efficiency from: IECC 2015, page C-47, Table C403.2.3(5)

Determine Existing Boiler Heating Usage:

Usage was analyzed using utility billing data from 2/17/17 to 11/15/18

Assumptions and Approach:

1. The model of heating energy usage is based on utility natural gas data that is billed monthly.
2. Usage is modeled by a regression analysis; its parameters are functions of heating degree days (HDD).
3. TMY3 data is from Poughkeepsie Dutchess Co AP; date, time, and outdoor air dry bulb temperature

See: Building Load Determination section of report for more details on regression analysis

4. Excerpts below are from 8760 model

TMY3 Data Excerpt:

Date	Time	Dry-bulb (F)	HDhr @58°F base
1/1/2005	1:00	35.6	22.4
1/1/2005	2:00	33.8	24.2
1/1/2005	3:00	37.4	20.6
1/1/2005	4:00	39.2	18.8
1/1/2005	5:00	33.8	24.2
1/1/2005	6:00	46.4	11.6
1/1/2005	7:00	35.6	22.4
1/1/2005	8:00	44.6	13.4
1/1/2005	9:00	44.6	13.4
1/1/2005	10:00	51.8	6.2
1/1/2005	11:00	53.6	4.4
1/1/2005	12:00	55.4	2.6
1/1/2005	13:00	53.6	4.4
1/1/2005	14:00	51.8	6.2
1/1/2005	15:00	50	8
…	…	…	…

Regression analysis results:
therms/day = 6.1549 therms/HDD58 + 7.4944 therms/day

ECM 1a - Install Condensing Natural Gas Boiler

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Existing usage therms * Existing efficiency *(existing eff assumed to be 76% seasonal avg)*

Regression analysis results:
therms/day = 4.6777 therms/HDD58 + 5.6957 therms/day

Therms Usage by Regression -- Building Load Excerpt:

Date	Time	Therms
1/1/2005	1:00	5
1/1/2005	2:00	4,008
1/1/2005	3:00	2,537
1/1/2005	4:00	1,442
1/1/2005	5:00	658
1/1/2005	6:00	286
1/1/2005	7:00	193
1/1/2005	8:00	258
1/1/2005	9:00	418
1/1/2005	10:00	1,668
1/1/2005	11:00	2,000
1/1/2005	12:00	3,962
1/1/2005	13:00	22,482
1/1/2005	14:00	-

Building Load

Total Sum - Therms Monthly:	
Jan	5,054
Feb	4,008
Mar	2,537
Apr	1,442
May	658
Jun	286
Jul	193
Aug	258
Sep	418
Oct	1,668
Nov	2,000
Dec	3,962
Total	22,482

In a year of typical weather, existing system builidng load was estimated to be
22,482 therms

Apply 8760 model to a case of code standard efficiency boiler for baseline

Hourly usage = hourly load / code std efficiency where:

OAT for min assumed code std efficiency =			58
OAT below which code std eff is max =			20
OAT	effic		
20	82%	m=	-0.0011
58	78%	b=	0.8411

Therms Usage for Code Standard Excerpt:

Date	Time	Therms
1/1/2005	1:00	5.7
1/1/2005	2:00	6.2
1/1/2005	3:00	5.3
1/1/2005	4:00	4.9
1/1/2005	5:00	6.2
1/1/2005	6:00	3.2
1/1/2005	7:00	5.7
1/1/2005	8:00	3.6
1/1/2005	9:00	3.6
1/1/2005	10:00	1.8
1/1/2005	11:00	1.4
1/1/2005	12:00	1.0
1/1/2005	13:00	1.4
1/1/2005	14:00	1.8
1/1/2005	15:00	2.3
...	...	...

Code Std NG Usage

Total Sum - Therms Monthly:	
Jan	6,204
Feb	4,928
Mar	3,159
Apr	1,809
May	834
Jun	365
Jul	247
Aug	329
Sep	531
Oct	2,091
Nov	2,495
Dec	4,889
Total	27,881

In a year of typical weather, code standard natural gas usage was estimated to be
27,881 therms

ECM 1a - Install Condensing Natural Gas Boiler

Calculate Code-Minimum Natural Gas Boiler Usage:

Hourly usage = hourly load / condensing boiler efficiency where:

OAT for maximum condensing efficiency =	58	F
OAT below which condensing stops =	20	F

OAT	effic		
20	85%	m=	0.0024
58	94%	b=	0.8026

Therms Usage -- Proposed Excerpt:

		Condensing Boiler:	
Date	Time	Efficiency	Therms
1/1/2005	1:00	89%	5.2
1/1/2005	2:00	88%	5.6
1/1/2005	3:00	89%	4.8
1/1/2005	4:00	90%	4.4
1/1/2005	5:00	88%	5.6
1/1/2005	6:00	91%	2.7
1/1/2005	7:00	89%	5.2
1/1/2005	8:00	91%	3.1
1/1/2005	9:00	91%	3.1
1/1/2005	10:00	93%	1.6
1/1/2005	11:00	93%	1.2
1/1/2005	12:00	93%	0.8
1/1/2005	13:00	93%	1.2
1/1/2005	14:00	93%	1.6
1/1/2005	15:00	92%	2.0
...	...	...	...

Proposed Usage

Total Sum - Therms Monthly:	
	Boiler
Jan	5,863
Feb	4,636
Mar	2,860
Apr	1,600
May	716
Jun	307
Jul	205
Aug	276
Sep	451
Oct	1,856
Nov	2,244
Dec	4,548
Totals	25,563

Savings Summary

System	Usage	Costs	
	NG (Therms)		
Code Standard:	27,881	$	24,011
Proposed:	25,563	$	22,015
Savings	**2,318**	**$**	**1,996**

NIST BLCC 5.3-18: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case: Code min boiler (ECM 1a)

Alternative: ECM 1 - Install Condensing Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCOB\Utility Bills\BLCC5\BLCC5 - UCOB - fuel v.2.xml
Date of Study:	Tue Sep 17 12:30:20 EDT 2019
Project Name:	Ulster County Office Building
Project Location:	New York
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Brendan Kelly
Base Date:	April 1, 2019
Service Date:	April 1, 2020
Study Period:	30 years 0 months(April 1, 2019 through March 31, 2049)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$94,625	$109,625	-$15,000
Future Costs:			
Energy Consumption Costs	$504,008	$483,897	$20,111
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$0	$0
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
Subtotal (for Future Cost Items)	$504,008	$483,897	$20,111
Total PV Life-Cycle Cost	$598,633	$593,522	$5,111

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$20,111
- Increased Total Investment	$15,000

Net Savings $5,111

Savings-to-Investment Ratio (SIR)

SIR = 1.34

Adjusted Internal Rate of Return

AIRR = 4.01%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 17

Discounted Payback occurs in year 23

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Natural Gas	2,788.1 MBtu	2,556.3 MBtu	231.8 MBtu	6,721.4 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Natural Gas	2,788.1 MBtu	2,556.3 MBtu	231.8 MBtu	6,721.4 MBtu

Emissions Reduction Summary

Energy Type	Average Annual Emissions Base Case	Alternative	Reduction	Life-Cycle Reduction
Natural Gas				
CO2	147,273.97 kg	135,029.75 kg	12,244.22 kg	355,040.44 kg
SO2	1,188.55 kg	1,089.73 kg	98.81 kg	2,865.29 kg
NOx	123.56 kg	113.29 kg	10.27 kg	297.88 kg
Total:				
CO2	147,273.97 kg	135,029.75 kg	12,244.22 kg	355,040.44 kg
SO2	1,188.55 kg	1,089.73 kg	98.81 kg	2,865.29 kg
NOx	123.56 kg	113.29 kg	10.27 kg	297.88 kg

UCOB Boiler Replacement		
Ulster County Office Building	**244 Fair Street**	**Kingston, NY 12402**
ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler		
Existing Boiler Input Capacity (MBH ea.):		**5,124**
Proposed Biomass Boiler Output Capacity (MBH ea.):		**3,074**
Proposed Condensing Boiler Output Capacity (MBH ea.):		**2,050**
Bin Temp at Which 100% Load Occurs (deg F)		**2.5**
Bin Temp for Balance Point		**57.5**
Boiler Availability:		**Heating season**
Btus per Therm Conversion Factor:		**100,000**
Btus per Ton Pellets Conversion Factor:		**16,000,000**
Existing Boiler Efficiency (assumed)		**76%**
Proposed Biomass Boiler Efficiency (product literature)		**86%**
Proposed Condensing Boiler Efficiency (condensing above 20°F OSA)		**94%**
Proposed Condensing Boiler Efficiency (non-condensing below 20°F OSA)		**85%**
$/therm natural gas	**$**	**0.86**
$/therm biomass (pellets)	**$**	**1.88**
$/ton biomass (pellets)	**$**	**300**
Gas Savings (mmBtu)		**367.11**
Gas Savings Cost		**$16,670**
Pellet Use (tons)		**98.03**
Pellet Cost		**$29,409**
Total Savings ($)		**($12,740)**

Notes: For this example, the biomass boiler is assumed 60% capacity and the condensing boiler assumed 40% capacity of existing boiler capacity. Actual capacities to be determined at design.

Determine Existing Boiler Heating Usage:

Usage was analyzed using utility billing data from 2/17/17 to 11/15/18

Assumptions and Approach:

1. The model of heating energy usage is based on utility natural gas data that is billed monthly.
2. Usage is modeled by a regression analysis; its parameters are functions of heating degree days (HDD).
3. TMY3 data is from Poughkeepsie Dutchess Co AP; date, time, and outdoor air dry bulb temperature

See: Building Load Determination section of report for more details on regression analysis

4. Excerpts below are from 8760 model

TMY3 Data

Date	Time	Dry-bulb (F)	HDhr @58°F base
1/1/2005	1:00	35.6	22.4
1/1/2005	2:00	33.8	24.2
1/1/2005	3:00	37.4	20.6
1/1/2005	4:00	39.2	18.8
1/1/2005	5:00	33.8	24.2
1/1/2005	6:00	46.4	11.6
1/1/2005	7:00	35.6	22.4
1/1/2005	8:00	44.6	13.4
1/1/2005	9:00	44.6	13.4
1/1/2005	10:00	51.8	6.2
1/1/2005	11:00	53.6	4.4
1/1/2005	12:00	55.4	2.6
1/1/2005	13:00	53.6	4.4
1/1/2005	14:00	51.8	6.2
1/1/2005	15:00	50	8.0
…	…	…	…

Regression analysis results:

therms/day = 6.1549 therms/HDD58 + 7.4944 therms/day

ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Existing usage therms * Existing efficiency

Regression analysis results:
therms/day = 4.6777 therms/HDD58 + 5.6957 therms/day

Therms Usage by Regression -- Building Load Excerpt:

Date	Time	Therms
1/1/2005	1:00	6.1
1/1/2005	2:00	6.5
1/1/2005	3:00	5.6
1/1/2005	4:00	5.1
1/1/2005	5:00	6.5
1/1/2005	6:00	3.3
1/1/2005	7:00	6.1
1/1/2005	8:00	3.7
1/1/2005	9:00	3.7
1/1/2005	10:00	1.9
1/1/2005	11:00	1.4
1/1/2005	12:00	1.0
1/1/2005	13:00	1.4
1/1/2005	14:00	1.9
...	...	...

Building Load

Total Sum - Therms Monthly:	
Jan	5,054
Feb	4,008
Mar	2,537
Apr	1,442
May	658
Jun	286
Jul	193
Aug	258
Sep	418
Oct	1,668
Nov	2,000
Dec	3,962
Total	22,482

In a year of typical weather, existing system builidng load was estimated to be
22,482 therms

Apply 8760 model to existing system usage in a year of typical weather:
Hourly usage = hourly load / existing efficiency (76%)

Therms Usage by Regression -- Existing Excerpt:

Date	Time	Therms
1/1/2005	1:00	6.1
1/1/2005	2:00	6.5
1/1/2005	3:00	5.6
1/1/2005	4:00	5.1
1/1/2005	5:00	6.5
1/1/2005	6:00	3.3
1/1/2005	7:00	6.1
1/1/2005	8:00	3.7
1/1/2005	9:00	3.7
1/1/2005	10:00	1.9
1/1/2005	11:00	1.4
1/1/2005	12:00	1.0
1/1/2005	13:00	1.4
1/1/2005	14:00	1.9
1/1/2005	15:00	2.4
...	...	...

Existing NG Usage

Total Sum - Therms Monthly:	
Jan	6,649
Feb	5,273
Mar	3,338
Apr	1,897
May	866
Jun	376
Jul	253
Aug	339
Sep	550
Oct	2,195
Nov	2,631
Dec	5,213
Total	29,581

In a year of typical weather, existing system natural gas usage was estimated to be
29,581 therms

ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler

Calculate Biomass Boiler and Condensing Natural Gas Boiler Usage:

Hourly usage = hourly load / proposed equipment efficiency

% Load Sharing:

Biomass	60%
Boiler	40%

Condensing Boiler Efficiency Parameters

Outdoor air temperature (OAT, deg F) selections:

OAT for maximum condensing efficiency =	58	F
OAT below which condensing stops =	20	F

OAT	effic		
20	85%	m=	85%
58	94%	b=	94%

Therms Usage by Regression -- Proposed Excerpt:

		Biomass:		Condensing Boiler:		Total
Date	Time	Efficiency	Therms	Efficiency	Therms	Therms
1/1/2005	1:00	86%	3.2	89%	2.1	5.3
1/1/2005	2:00	86%	3.5	88%	2.2	5.7
1/1/2005	3:00	86%	3.0	89%	1.9	4.9
1/1/2005	4:00	86%	2.7	90%	1.7	4.5
1/1/2005	5:00	86%	3.5	88%	2.2	5.7
1/1/2005	6:00	86%	1.7	91%	1.1	2.8
1/1/2005	7:00	86%	3.2	89%	2.1	5.3
1/1/2005	8:00	86%	2.0	91%	1.3	3.2
1/1/2005	9:00	86%	2.0	91%	1.3	3.2
1/1/2005	10:00	86%	1.0	93%	0.6	1.6
1/1/2005	11:00	86%	0.8	93%	0.5	1.2
1/1/2005	12:00	86%	0.5	93%	0.3	0.8
1/1/2005	13:00	86%	0.8	93%	0.5	1.2
1/1/2005	14:00	86%	1.0	93%	0.6	1.6
...	...	...	...	...	...	...

Proposed Usage

Total Sum - Therms Monthly:		
	Biomass	Boiler
Jan	3,526	2,345
Feb	2,796	1,854
Mar	1,770	1,144
Apr	1,006	640
May	459	287
Jun	200	123
Jul	134	82
Aug	180	110
Sep	291	180
Oct	1,164	742
Nov	1,395	898
Dec	2,764	1,819
Totals	15,685	10,225

Savings Summary

System	Usage		Costs	
	NG (Therms)	Pellets (Tons)		
Existing:	29,581		$	25,476
Proposed:				
Biomass	15,685	98.03	$	29,409
Cond boiler	10,225		$	8,806
Savings	**3,671**	**(98.03)**	**$**	**(12,740)**

NIST BLCC 5.3-18: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case: Existing NG Boiler

Alternative: ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCOB\Utility Bills\BLCC5\BLCC5 - UCOB - fuel v.2.xml
Date of Study:	Tue Sep 17 12:30:42 EDT 2019
Project Name:	Ulster County Office Building
Project Location:	New York
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Brendan Kelly
Base Date:	April 1, 2019
Service Date:	April 1, 2020
Study Period:	30 years 0 months(April 1, 2019 through March 31, 2049)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$0	$310,250	-$310,250
Future Costs:			
Energy Consumption Costs	$560,824	$193,855	$366,969
Energy Demand Charges	$0	$0	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$0	$0
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
Subtotal (for Future Cost Items)	$560,824	$193,855	$366,969
Total PV Life-Cycle Cost	$560,824	$504,105	$56,719

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$366,969
- Increased Total Investment	$310,250

Net Savings $56,719

Savings-to-Investment Ratio (SIR)

SIR = 1.18

Adjusted Internal Rate of Return

AIRR = 3.58%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 17

Discounted Payback occurs in year 23

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Natural Gas	2,958.1 MBtu	1,022.5 MBtu	1,935.6 MBtu	56,125.8 MBtu
Coal	0.0 MBtu	1,568.5 MBtu	-1,568.5 MBtu	-45,481.1 MBtu

Note: Annual Alternative MBtu in coal row is Pellets

Energy Savings Summary (in MBtu)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Natural Gas	2,958.1 MBtu	1,022.5 MBtu	1,935.6 MBtu	56,125.8 MBtu
Coal	0.0 MBtu	1,568.5 MBtu	-1,568.5 MBtu	-45,481.1 MBtu

Emissions Reduction Summary

Energy Type	Average Annual Emissions Base Case	Alternative	Reduction	Life-Cycle Reduction
Natural Gas				
CO2	156,253.77 kg	54,010.84 kg	102,242.92 kg	2,964,694.92 kg
SO2	1,261.02 kg	435.88 kg	825.13 kg	23,926.02 kg
NOx	131.10 kg	45.31 kg	85.78 kg	2,487.36 kg
Coal				
CO2	0.00 kg			
SO2	0.00 kg			
NOx	0.00 kg			
Total:				
CO2	156,253.77 kg			
SO2	1,261.02 kg			
NOx	131.10 kg			

Note: Biomass boiler emissions not known, see report.

UCOB
ECM 3: AC-4R VAV Conversion

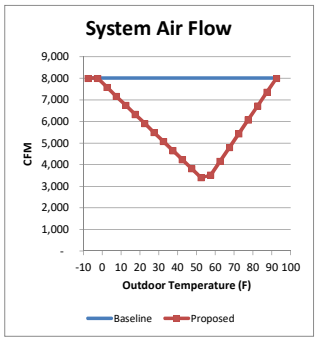
Convert AC-4R from constant volume to VAV by installing a Variable Frequency Drive

Input Parameters	Baseline System	Proposed System
Fan HP	7.5	7.5
Fan CFM	8,000	8,000
Motor Full Load (% of Rate HP)	99.3%	99.3%
Motor Efficiency	89.5%	91.7%
Speed Control	N.A.	VFD
VSD Efficiency	N.A.	98.0%
Minimum VFD Operation	N.A.	40.0%
VFD Power vs Flow Relationship		
$kW = kWo * (\%Flow)^N$ / VFD efficiency, N =		2.2
VFD Operation:		Year-round

Energy Savings	
Electric Energy Savings (kWh)	34,591
Total Demand kW Savings (12 month total)	16.4
Annual kWh Cost Savings ($)	$3,523
Annual Peak Demand Savings ($)	$159
Total Savings	$3,681

Occupied Period

		Existing Operation (Baseline)				Proposed Operation				
Ave. Bin Temp	No. of Hrs	CFM	Fan kW	Fan kWh	Annual kWh	CFM	Fan kW	Fan kWh	Annual kWh	Annual kWh Savings
-7.5	0	8,000	-	-	0	8,000	-	-	0	0
-2.5	0	8,000	-	-	0	8,000	-	-	0	0.0
2.5	2	8,000	6.2	12	12	7,582	5.5	11	11	1.4
7.5	3	8,000	6.2	19	19	7,164	4.9	15	15	4.1
12.5	13	8,000	6.2	81	81	6,746	4.3	55	55	25.5
17.5	62	8,000	6.2	386	386	6,328	3.7	229	229	156.3
22.5	108	8,000	6.2	672	672	5,909	3.2	343	343	328.1
27.5	128	8,000	6.2	796	796	5,491	2.7	346	346	449.5
32.5	160	8,000	6.2	995	995	5,073	2.3	364	364	631.1
37.5	191	8,000	6.2	1,188	1,188	4,655	1.9	359	359	828.3
42.5	152	8,000	6.2	945	945	4,237	1.5	233	233	712.6
47.5	85	8,000	6.2	529	529	3,819	1.2	103	103	425.1
52.5	129	8,000	6.2	802	802	3,401	0.9	122	122	680.5
57.5	151	8,000	6.2	939	939	3,520	1.0	154	154	785.3
62.5	139	8,000	6.2	864	864	4,160	1.5	204	204	660.1
67.5	153	8,000	6.2	951	951	4,800	2.0	308	308	643.4
72.5	185	8,000	6.2	1,150	1,150	5,440	2.7	490	490	659.9
77.5	185	8,000	6.2	1,150	1,150	6,080	3.4	626	626	524.0
82.5	178	8,000	6.2	1,107	1,107	6,720	4.2	751	751	355.7
87.5	63	8,000	6.2	392	392	7,360	5.2	325	325	67.0
92.5	1	8,000	6.2	6	6	8,000	6.2	6	6	0.0
Total	**2088**			**12,983**	**12,983**			**5,045**	**5,045**	**7,938**



Unoccupied Period

		Existing Operation (Baseline)				Proposed Operation				
Ave. Bin Temp	No. of Hrs	CFM	Fan kW	Fan kWh	Annual kWh	CFM	Fan kW	Fan kWh	Annual kWh	Annual kWh Savings
-7.5	2	8,000	6.2	12.4	12	8,000	6.2	12.4	12	0.1
-2.5	22	8,000	6.2	136.8	137	8,000	6.2	136.2	136	0.6
2.5	57	8,000	6.2	354.4	354	7,582	5.5	313.7	314	40.8
7.5	103	8,000	6.2	640.5	640	7,164	4.9	500.3	500	140.2
12.5	163	8,000	6.2	1,013.5	1,014	6,746	4.3	693.6	694	319.9
17.5	380	8,000	6.2	2,362.9	2,363	6,328	3.7	1,404.7	1,405	958.2
22.5	423	8,000	6.2	2,630.2	2,630	5,909	3.2	1,345.3	1,345	1,284.9
27.5	443	8,000	6.2	2,754.6	2,755	5,491	2.7	1,198.9	1,199	1,555.7
32.5	612	8,000	6.2	3,805.4	3,805	5,073	2.3	1,391.4	1,391	2,414.1
37.5	683	8,000	6.2	4,246.9	4,247	4,655	1.9	1,285.1	1,285	2,961.8
42.5	489	8,000	6.2	3,040.6	3,041	4,237	1.5	748.0	748	2,292.6
47.5	370	8,000	6.2	2,300.7	2,301	3,819	1.2	450.3	450	1,850.3
52.5	432	8,000	6.2	2,686.2	2,686	3,401	0.9	407.4	407	2,278.8
57.5	564	8,000	6.2	3,507.0	3,507	3,520	1.0	573.8	574	2,933.2
62.5	667	8,000	6.2	4,147.4	4,147	4,160	1.5	980.0	980	3,167.5
67.5	604	8,000	6.2	3,755.7	3,756	4,800	2.0	1,215.8	1,216	2,539.9
72.5	295	8,000	6.2	1,834.3	1,834	5,440	2.7	782.0	782	1,052.3
77.5	219	8,000	6.2	1,361.8	1,362	6,080	3.4	741.5	742	620.2
82.5	106	8,000	6.2	659.1	659	6,720	4.2	447.3	447	211.8
87.5	28	8,000	6.2	174.1	174	7,360	5.2	144.3	144	29.8
92.5	10	8,000	6.2	62.2	62	8,000	6.2	61.9	62	0.3
Total	**6672**			**41,487**	**41,487**			**14,834**	**14,834**	**26,653**

Peak Demand Savings

							Proposed Operation				
Month	Temp (F)	Min/ Max	CFM	Fan kW		Total kW	CFM	Fan kW		Total kW	Peak kW Savings
Jan	-2.0	Min	8,000	6.2		6.2	7,960	6.1		6.1	0.1
Feb	-0.9	Min	8,000	6.2		6.2	7,870	6.0		6.0	0.2
Mar	19.6	Min	8,000	6.2		6.2	6,154	3.5		3.5	2.7
Apr	71.1	Max	8,000	6.2		6.2	5,256	2.5		2.5	3.8
May	91.9	Max	8,000	6.2		6.2	7,928	6.1		6.1	0.1
Jun	89.1	Max	8,000	6.2		6.2	7,560	5.5		5.5	0.8
Jul	91.0	Max	8,000	6.2		6.2	7,813	5.9		5.9	0.3
Aug	89.1	Max	8,000	6.2		6.2	7,560	5.5		5.5	0.8
Sep	86.0	Max	8,000	6.2		6.2	7,168	4.9		4.9	1.4
Oct	79.0	Max	8,000	6.2		6.2	6,269	3.6		3.6	2.6
Nov	19.0	Min	8,000	6.2		6.2	6,199	3.5		3.5	2.7
Dec	3.9	Min	8,000	6.2		6.2	7,463	5.3		5.3	0.9
Total Demand kW Savings (12 month total)											**16.4**

Formulas & Assumptions

kWo = 0.747 kW/HP * HP * load factor / motor efficiency …kWo is all that's used for existing non-VFD conversion of HP to kW
% flow = CFM / 8,000 fan CFM

Assumes all HVAC equipment is operating to spec
Assumes ancillary devices like dampers are working to spec

Proposed CFM as a function of bin temperature is from typical profiles found from experience with previous projects

NIST BLCC 5.3-18: Comparative Analysis

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

Base Case: Constant Air Volume - AC-4R

Alternative: ECM 3: AC-4R VAV Conversion

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCOB\Utility Bills\BLCC5\BLCC5 - UCOB - ECM-3.xml
Date of Study:	Mon Sep 16 15:54:45 EDT 2019
Project Name:	Ulster County Office Building
Project Location:	New York
Analysis Type:	FEMP Analysis, Energy Project
Analyst:	Brendan Kelly
Base Date:	April 1, 2019
Service Date:	April 1, 2020
Study Period:	30 years 0 months(April 1, 2019 through March 31, 2049)
Discount Rate:	3%
Discounting Convention:	End-of-Year

Comparison of Present-Value Costs

PV Life-Cycle Cost

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs:			
Capital Requirements as of Base Date	$0	$48,200	-$48,200
Future Costs:			
Energy Consumption Costs	$30,178	$11,727	$18,451
Energy Demand Charges	$221	$221	$0
Energy Utility Rebates	$0	$0	$0
Water Costs	$0	$0	$0
Recurring and Non-Recurring OM&R Costs	$0	$0	$0
Capital Replacements	$0	$0	$0
Residual Value at End of Study Period	$0	$0	$0
Subtotal (for Future Cost Items)	$30,399	$11,948	$18,451
Total PV Life-Cycle Cost	$30,399	$60,148	-$29,749

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$18,451
- Increased Total Investment	$48,200

Net Savings -$29,749

Savings-to-Investment Ratio (SIR)

SIR = 0.38

SIR is lower than 1.0; project alternative is not cost effective.

Adjusted Internal Rate of Return

AIRR = -0.24%

AIRR is lower than your discount rate; project alternative is not cost effective.

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback never reached during study period.

Discounted Payback never reached during study period.

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Electricity	12,983.0 kWh	5,045.0 kWh	7,938.0 kWh	230,174.8 kWh

Energy Savings Summary (in MBtu)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Electricity	44.3 MBtu	17.2 MBtu	27.1 MBtu	785.4 MBtu

Emissions Reduction Summary

Energy Type	Average Base Case	Annual Alternative	Emissions Reduction	Life-Cycle Reduction
Electricity				
CO2	5,240.83 kg	3,298.34 kg	1,942.50 kg	56,325.75 kg
SO2	15.43 kg	16.62 kg	-1.19 kg	-34.64 kg
NOx	5.56 kg	4.92 kg	0.64 kg	18.56 kg
Total:				
CO2	5,240.83 kg	3,298.34 kg	1,942.50 kg	56,325.75 kg
SO2	15.43 kg	16.62 kg	-1.19 kg	-34.64 kg
NOx	5.56 kg	4.92 kg	0.64 kg	18.56 kg

Appendix C – ECM Cost Estimates

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: PFS 1 - Install Solar Thermal DHW

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Solar DHW							$16,946	https://apps1.eere.energy.gov/femp/solar_hotwater_system/
	Total					$0	$0	$16,946	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: PFS 2 - Install Air Source Heat Pumps

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Install 238 tons multi-zone split VRV heat pumps					$12,337	$512,850	$525,187	RSMeans 2018 Mechanical 23 81 29.10 1010
	Total					$12,337	$512,850	$525,187	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: PFS 3 - Install Cooling Energy Storage

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Install ice-based thermal storage							$300,000	web search
	Total					$0	$0	$300,000	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: ECM 1 - Install a Condensing Natural Gas Boiler (existing conditions baseline)

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demolition of existing heating equipment	1	ea	$9,625	$0	$9,625	$0	$9,625	RSMeans 2018 Mechanical 23 05 05.10 0370
	Install new ~ 5124 MBH boiler	1	ea	$15,215	$84,785.13	$15,215	$84,785	$100,000	RSMeans 2018 Mechanical 23 52 23.30 3200
	Total					$24,840	$84,785	$109,625	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: ECM 1a - Install a Condensing Natural Gas Boiler (code minimum baseline, FYI only)

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demolition of existing heating equipment	1	ea	$9,625	$0	$9,625	$0	$9,625	RSMeans 2018 Mechanical 23 05 05.10 0370
	Code-minimum 5200 MBH boiler	1	ea					$85,000	Vendor quote
	Total							$94,625	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: ECM 2 - Install a Biomass Boiler and a Condensing Natural Gas Boiler

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demolition of existing heating equipment	2	ea	$9,625	$0	$19,250	$0	$19,250	RSMeans 2018 Mechanical 23 05 05.10 0370
	Install new ~ 3074 MBH pellet boiler	1	ea					$236,000	vendor quote
	Install new ~ 2050 MBH nat gas condensing boiler	1	ea	$8,495	$46,505	$8,495	$46,505	$55,000	RSMeans 2018 Mechanical 23 52 23.30 3080
	Total							$310,250	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: ECM 3 - Convert AC-4R to VAV

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demo existing unit	1	ea	$700	$150	$700	$150	$850	GPI
	Install VAV AHU	1	ea		$18,000		$18,000	$20,000	GPI
	(1) Dx and (1) chilled water coil	1	ea	$2,000	$3,200	$2,000	$3,200	$3,200	GPI
	Remote condensing unit	1	ea		$10,000		$10,000	$10,000	GPI
	VSD and wiring	1	ea	$1,000	$4,000	$1,000	$4,000.00	$5,000	GPI
	DDC controls	20	pnts	$500		$10,000	$0.00	$10,000	GPI
	Total							$48,200	

The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

L&S Energy Services, Inc.

Project Name: **Ulster County Office Building**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: FA ECM 1 - Install a Condensing Natural Gas Boiler (existing conditions baseline)

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Install new ~ 5124 MBH boiler	2	ea					$241,600	GPI
	including an allowance for demo								
	and new venting.								
	Total					$0	$0	$241,600	

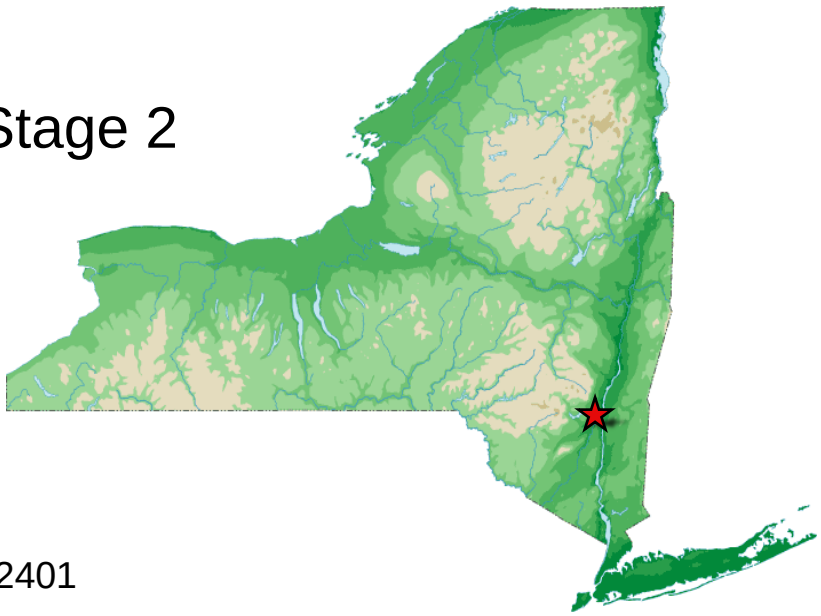
The costs noted above are estimates only and may be modified by changing conditions or the passage of time.

Appendix D – NYSERDA/NYPA Geothermal Clean Energy Challenge

NEW YORK STATE OF OPPORTUNITY.

Geothermal Clean Energy Challenge

Advanced Report – Stage 2



Applicant: Ulster County

Address: 244 Fair St.
Kingston, NY 12401

Site Name: 244 Fair St.

Project Summary

This potential project was modeled as a single closed loop ground source heat pump (GSHP) system with 139 tons of cooling capacity that will serve the building listed on the next page with a total conditioned area of 62,396 square feet. The GSHP system is expected to serve an existing building that will require little to no significant interior modifications during installation to integrate with existing building HVAC systems, and this factor is reflected in the GSHP cost assumptions used in the model.

The analysis in this report is based on the results of a streamlined building energy model (BEM) using the supplemental data you provided for the building associated with your potential GSHP site. The BEM was used to fine-tune the energy load patterns and economic and technical results in this report. The Stage 2 results are very similar to the Stage 1 report. This means that energy load patterns assumed in Stage 1 are consistent with the more granular load modeling performed through the BEM in Stage 2. The positive economic results are driven by the combination of strong expected annual O&M savings and estimated capital costs for the GSHP system that are lower than many other applicants in this program.

As a reminder, the results presented in this report are preliminary, and a detailed feasibility assessment is a necessary next step in thoroughly exploring a GSHP project. Financial and technical support for conducting a detailed design study, including American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Level 2 targeted audits, site geotechnical testing and analyses, and schematic GSHP system design is available to eligible applicants in Stage 3 of the Geothermal Clean Energy Challenge.

Energy, Financial, and Environmental Savings Opportunities from GSHP Implementation

Buildings Included in the Site		
Building Name	**Building Type**	**Building Conditioned Area (sqft)**
Ulster County Office Building	Large Office	62,396

The tables below summarize the savings opportunities estimated for the site in terms of costs, energy and greenhouse gases when comparing the implementation of a ground source heat pump (GSHP) system to the existing (or planned) building HVAC systems.[1]

Note: the value of the carbon emissions included in the table is not directly monetizable by the applicant, but rather reflects the overall value to society provided by the reduced carbon emissions. The value is not used as a factor in the economic analysis in this report. However, the benefits to society can be substantial, particularly when buildings consuming fuel oil switch to GSHP.

Volumetric Savings / Increases	
Annual Propane Savings	0 gallons
Annual Fuel Oil Savings	0 gallons
Annual Natural Gas Savings	2,511 [1000 ft3]
Annual Electricity Increase	91,972 kWh
Annual GHG Emissions Reduction	118 metric tons (CO2e)
Cost Savings ($)	
Annual Energy Bill Savings	$ 10,539
Annual O&M Savings[2]	$ 28,107
Investments & Incentives[3] ($)	
Installed GSHP System Capital Costs (Est. Range)	$ 1,056,364 - $ 1,172,564
Avoided Capital Costs for Traditional HVAC System	$ 240,934
NYSERDA Incentive Payment for GSHP System	$ 166,389
Societal Value of Reduced Carbon Emissions[4]	$ 220,912

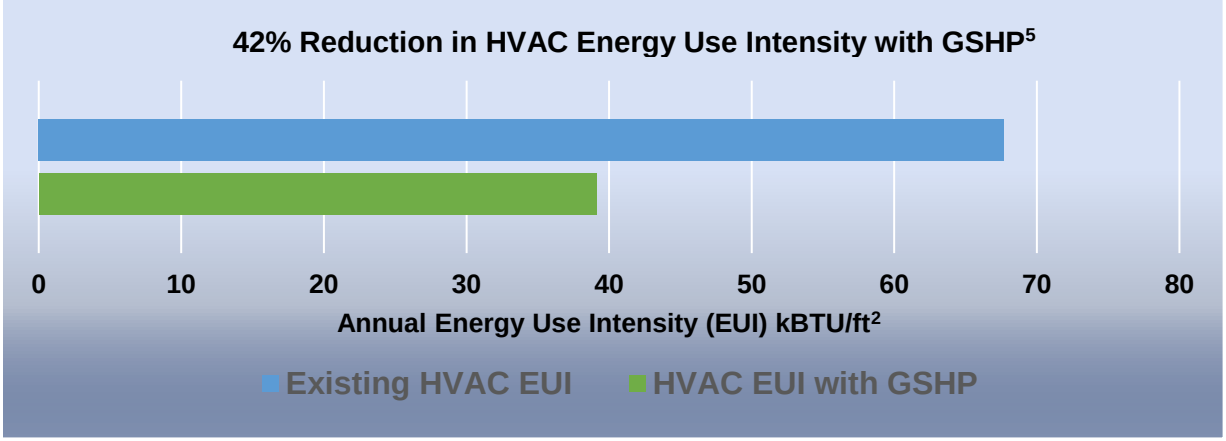
[1] The findings presented in this report are preliminary and should not be used as the sole basis for investment decisions.

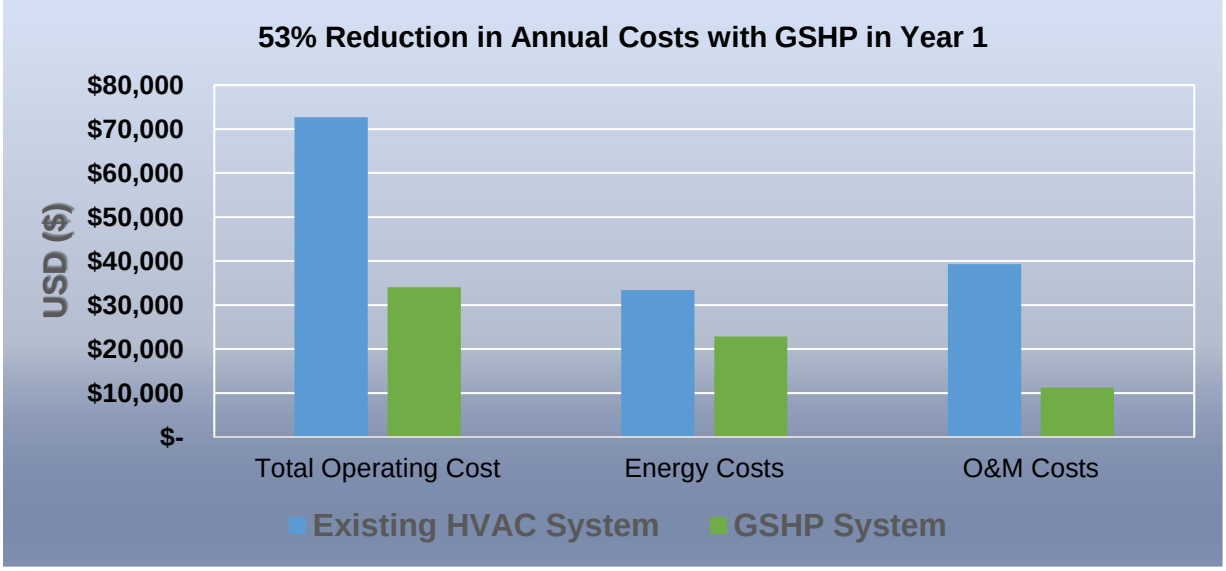
[2] O&M savings include the savings associated with the avoided use of cooling towers at the site.

[3] Estimated capital costs in this report reflect an expected range based on similar projects, but they may differ from the final minimum or maximum project costs that a GSHP site encounters in practice. Further incentives may also be available for GSHP systems through utility programs; contact your utility for more information. For-profit entities with sufficient tax liability may additionally be eligible for a 10% federal tax incentive on GSHP systems.

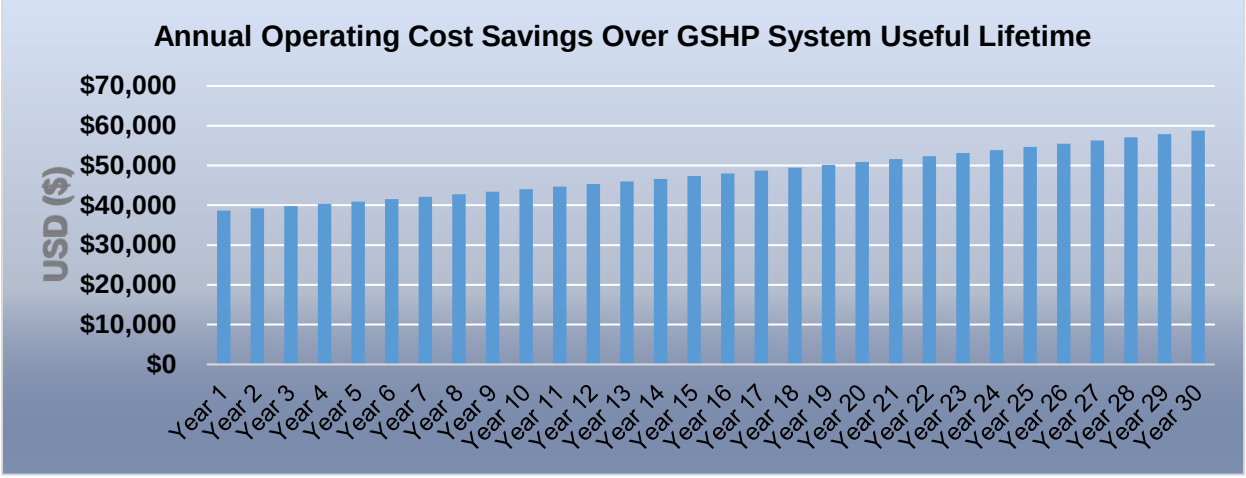
[4] Societal cost of carbon (30 year net present value) calculated using EPA 3% average data in 2017 dollars (https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html)

Excluding NYSERDA Incentive	Including NYSERDA Incentive
GSHP Simple Investment Payback Period (Estimated Range)	
18 - 20 years	15 - 17 years
GSHP Net Present Value (Estimated Range over 30-year life)	
(-$ 134,860) – (-$ 18,660)	$ 31,529 - $ 147,729
GSHP Savings to Investment Ratio (Estimated Range)	
0.88 - 0.98	1.03 - 1.17



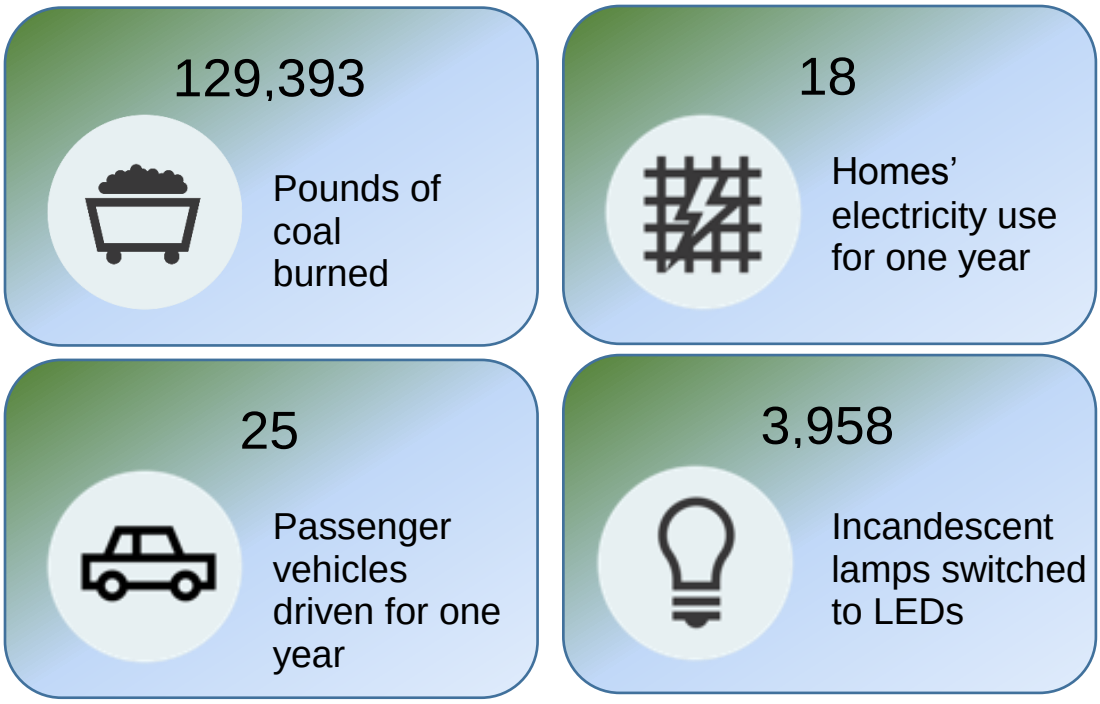


[5] Energy Use Intensity is calculated based on source energy and encompassing all the energy used in delivering energy to a site, including power generation, transmission and distribution losses. (https://www.governor.ny.gov/news/no-88-directing-state-agencies-and-authorities-improve-energy-efficiency-state-buildings)



Greenhouse Gas Reduction Equivalencies

The annual carbon emissions reduction from the implementation of a GSHP system at your site can be translated to an equivalent reduction in any one of the following alternatives, including pounds of coal burned, electricity used by a home in one year, number of passenger vehicles driven in one year, and number of incandescent lightbulbs replaced with LED bulbs.[6]



[6] EPA Greenhouse Gas Equivalencies Calculator (as of November 2018): https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

Environmental Permitting Considerations

Although GSHPs are clean energy technologies, some environmental factors should be considered to best manage the installation process. The following is an introductory, non-comprehensive list of considerations when GSHP boreholes are drilled:

- The drilling process can bring large amounts of ground water to the surface, and this water needs to be managed and disposed of in an appropriate manner. The volume, rate of flow, water quality, and local site conditions dictate the most appropriate approach. Most of the time, settling ponds with geotextile "silt fencing" and/or hay bales is sufficient, which allows an acceptable amount of slightly discolored water to run off via normal storm water drainage systems.
- GSHP projects in Western New York and the Southern Tier (counties west of the Catskill Mountains along the northern border of Pennsylvania) in particular may encounter pockets of natural gas, which must be handled with experience and caution.
- There are no state permits required for geothermal bore holes less than 500 feet deep. All bore holes deeper than 500 feet must apply for a permit from the Department of Environmental Conservation (DEC) for each hole. Local jurisdictions should also be contacted regarding specific requirements.
- Construction and grouting must be done in accordance with federal, state, and local regulations as well as current industry best practices to minimize contamination risk from either surface run-off or cross aquifer sources of contamination.

Additional considerations associated with each type of geothermal loop field can include:

Closed Loop	Open Loop	Standing Column
Less than 500 feet: No additional considerations *Greater than 500 feet*: Must apply for DEC permit; permit may require drift monitoring and/or a bond to cover costs associated with abandonment.	*Supply Well*: Must comply with water well permitting and construction requirements as regulated by the New York State Department of Health (DOH). *Discharge Well*: Must be reviewed by DEC; if initial water quality meets discharge standards and nothing will be substantially added during use, the system is not required to obtain a discharge permit.	Must apply for DEC permit, which requires drift monitoring and a bond to cover abandonment costs. Due to the open nature of the borehole in which groundwater is recirculated, the water chemistry will change as geologic formations are dissolved. This can potentially increase the concentration of dissolved solids or salinity, which can impact the reliability of the heat exchange surfaces.

For more information on different types of GSHP loop fields and on environmental factors in GSHP system construction and operations, please see:

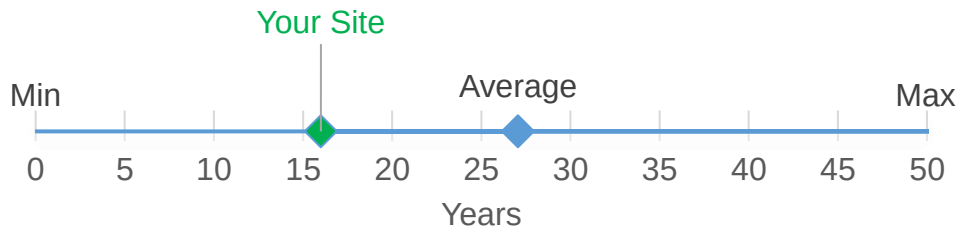
- NYPA's *Geothermal Clean Energy Challenge* website: https://www.nypa.gov/about/geothermalchallenge.
- NYSERDA's *Renewable Heating and Cooling Policy Framework*: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.

- NY-GEO, a nonprofit trade association dedicated to geothermal heating and cooling: https://ny-geo.org/pages/frontpage.
- U.S. Environmental Protection Agency's *Renewable Heating and Cooling* website: https://www.epa.gov/rhc/geothermal-heating-and-cooling-technologies.

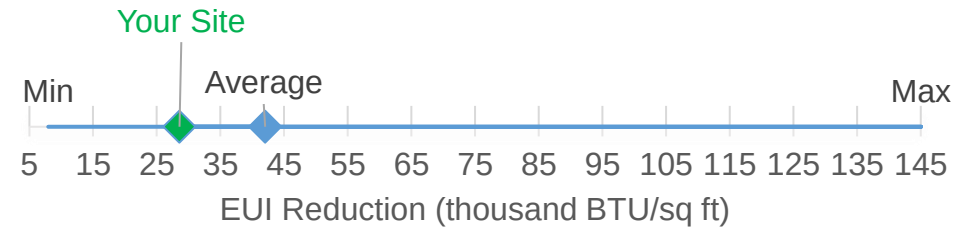
Site Specific Considerations and Selection Criteria

A set of screening criteria was used to determine the most viable sites for the implementation of a GSHP system from those applying to the Geothermal Clean Energy Challenge. The criteria include a quantitative analysis of the technical and economic viability of a potential system and a review of important qualitative implementation factors for potential sites. Your site was one of the top-ranked sites selected to advance to Stage 2 of this Challenge. A description of each criteria is provided on the next page. The graphs below demonstrate how the benefits of a GSHP installation at your site compare to the benefits at other sites that applied. Your site is shown in green, compared with the minimum, maximum, and average values from the pool of applicants.

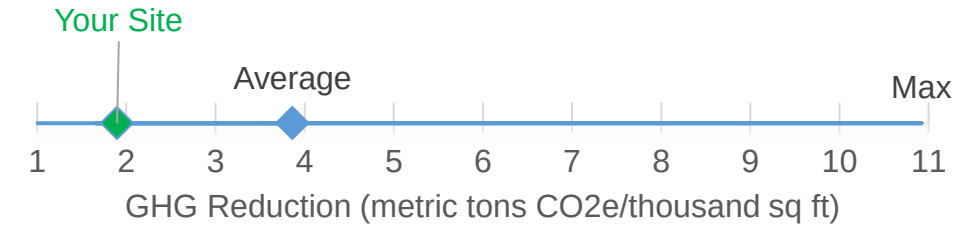
Simple Payback Comparison



Annual Energy Savings Potential



Annual GHG Emissions Reduction



Screening Criteria	Description
Presence of a GSHP Champion	Is there an individual, or group of individuals, within the applicant organization that is significantly invested in making sure a GSHP system is installed at the site? This person can be a facility manager, board member, or any other influential individual. Often the presence of a champion can make or break whether a GSHP system is ultimately implemented.
Accessibility of Data for Screening Analysis	How responsive and forthcoming was the applicant during the facility engagement process? Were they able to provide data at the individual building level, or only at the campus level? Detailed building level data significantly improves the accuracy of the inputs used for the screening analysis and provides a higher level of confidence that the results from this first round economic screening are reliable.
Organizational Readiness to Implement	Does the applicant appear able and willing to pursue implementation of a GSHP system soon? Are there examples of previous or ongoing efficiency and renewable work funded by the applicant? Given the capital-intensive nature of a GSHP project, existing financial commitments for energy savings can help illustrate a readiness to undertake the investment required.
Sustainable Program Commitment	Does a GSHP system integrate into an existing sustainability program that the applicant has created (or is participating in)? Will the GSHP system be able to be tied to educational or community engagement work? A key goal of the Geothermal Clean Energy Challenge is to promote public awareness and education of GSHP systems within the State of New York.
Technical Viability	Are there any significant technical hurdles for implementation of a GSHP system at the site? Is there green or brown field space available on location?
Economic Benefits	Does the preliminary screening indicate that the installation of a GSHP system is financially attractive? The financial merit of the project is evaluated across three different standard financial metrics: Net Present Value (NPV), Savings to Investment Ratio (SIR) and Simple Payback Period.
Greenhouse Gas (GHG) Reductions	How significant are the estimated GHG reduction benefits? Is fuel switching from GHG intensive fuels such as fuel oil planned? GHG benefits are estimated based on reduction in annual metric tons of CO2 emissions.
Site Adds to Program Sectoral Diversity	Is the site part of a sector that is under-represented in the general applicant pool? If so, then the site is helping to add valued diversity to the types of facilities included in the program.
Site Adds to Program Geographic Diversity	Is the site part of a geographic region that is under-represented in the general applicant pool? If so, then the site is helping to add valued diversity to the types of facilities included in the program.