FLEXTECH STUDY AND HEATING/COOLING MASTER PLAN

For

Ulster County Law Enforcement Center
380 Boulevard
Kingston, NY 12402

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

Final Report Date: 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 Law Enforcement Center

380 Boulevard
Kingston, NY 12402

Prepared for:

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17 Pearl Street

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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 Law Enforcement Center - 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 fuel oil.

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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 Law Enforcement Center - Kingston, NY.

Interviews with County personnel and equipment surveys of the Ulster County Law Enforcement Center - 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 Automated System (BAS). Historic design documents, energy bills, and BAS 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 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 January 2018 through December 2018, the Ulster County Law Enforcement Center used a total of 4,634,829 kWh at a cost of $559,577.

Over the same time period, 97,570 gallons of fuel oil #2 were consumed at a cost of $212,015 and used for heating and domestic hot water. Propane deliveries totaled 12,828 gallons at a cost of $17,162, but not considered further because it supplies kitchen cooking and a minimal terminal unit. The emergency generators utilize diesel.

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 type below.

Utility Type	Avg. Unit Cost	$/MMBtu
Electric Energy (Central Hudson)	$0.102/kWh	$29.84/MMbtu
Electric Demand (Central Hudson)	$9.69 /kW	--
#2 Fuel Oil (KoscoHeritage/Paraco and Bottini)	$2.17/gallon	$15.57/MMbtu
Natural Gas Interruptible (Central Hudson)	$0.570/therm	$5.70/MMbtu

3,413 Btu = 1 kWh; 139,600 Btu = 1 gallon #2 fuel oil; 100,000 Btu = 1 therm

Note: Natural gas rates from Central Hudson Gas & Electric Corporation Service Classification 8 / Rate G-3, as provided by the customer.

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

- Solar Thermal DHW
- Cooling Energy Thermal Storage

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

- Condensing Natural Gas Boiler
- Decoupled DHW Natural Gas Boilers
- Biomass Boiler and a Condensing Natural Gas Boiler (also with decoupled DHW)

For each qualified measure, energy use and projected cost savings were calculated using spreadsheet analysis. ECM analysis, life-cycle cost 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 CHP pre-feasibility model results and 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 Law Enforcement Center

Energy Conservation Measure Energy Savings Summary - 380 Boulevard, Kingston NY 12402

	Measure Description	Measure Status (See Notes)	kWh Savings	kW Savings	NG mmBtu Savings	Oil mmBtu Savings	Total mmBtu Savings	Annual Cost Savings	Project Cost	Payback (Years)
PFS 1	Install Solar Thermal DHW	NR			1,086		1,086	$9,356	$406,817	43.5
PFS 2	Install Cooling Energy Thermal Storage	NR		817			0	$8,032	$300,000	37.4
ECM 1	Install a HHW Condensing Boiler	ME			-6,047	6,791	744	$71,256	$439,100	6.2
ECM 2	Install Natural Gas DHW Boilers	NR			-4,895	5,557	662	$58,618	$243,600	4.2
ECM 3	Install Biomass Boiler with HHW Condensing Boiler	NR			-3,456	9,701	*966*	$22,258	$440,200	19.8
FA PFS 1	Install Solar Thermal DHW	RS			95	48	143	$1,286	$58,117	45.2
FA PFS 2	Install Cooling Energy Thermal Storage	RS	No change from PFS 2 above							
FA ECM 1	Install a HHW Condensing Boiler	RME			-8,411	9,838	1,427	$105,230	$1,010,200	9.6
Totals (All Measures)			**0**	**817**	**-16,667**	**25,144**	**3,198**	**$195,425**	**$2,052,117**	**10.5**
Totals R, I, and RNE Only			**0**	**0**	**-8,411**	**9,838**	**1,427**	**$105,230**	**$1,010,200**	**9.6**

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
ECM 3 Total mmBtu Saving includes 5,279 mmBtu is biomass fuel use.
PFS 1 assumes solar will displace natural gas usage
PFS 2's kW savings is cumulative annual

Annual cost savings for R/I/RNE measures:	$105,230	Base year costs - proposed annual cost savings	$666,362
Base year energy costs		% savings	13.6%
Electric	$559,577		
#2 Fuel Oil	$212,015		
	$771,592		

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 2018 utility rates (Appendix A) and rates provided by the customer for natural gas.
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 (and recommended in Figure 1), the annual savings currently projected in this analysis are $105,230 per year. This would reduce the annual energy costs by approximately 13.6% from the base amount of $771,592 to a proposed amount of $668,362. The estimated capital cost associated with implementing all recommended energy conservation measures is $1,010,200 with a simple payback period of 9.6 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 Law Enforcement Center is a 277,000 square foot Law Enforcement Center located in Kingston, NY. The building is occupied by the Ulster County Jail and also serves as headquarters for the Sheriff's Patrol and Civil Divisions and is therefore occupied all hours of the year. The two story building with basement was constructed in 2007 and contains inmate cells, visitation, kitchen, cafeteria, meeting rooms, offices, mezzanines, mechanical areas, corridors, storage, and restrooms. The facility is elaborate and has experienced very little change of use since opening.

Architectural Features

The Ulster County Law Enforcement Center is a masonry and steel framed structure. The roof is built up with flat black EPDM. The staff stated during the interview that the roof has both structural and water penetration issues. In addition, areas of the building shell were noted as porous, which results in moisture permeation through the wall. Insulation values are assumed to match the performance defined in the construction design documents. The windows are original to the building, are non-operable, and have insulated glazing with aluminum frames.

Heating, Air Conditioning, and Controls

The boilers are the primary focus of this study. The following description emphasizes their performance, existing conditions, and control parameters.

Cooling is supplied by (2) VSD water cooled centrifugal chillers, coupled with a pair of cooling towers. Staff noted during the interview that the cooling towers are unable to keep up with load at peak cooling. They also indicated that the towers provide free cooling, but this was not found in the design drawings. Chilled water distribution is provided by a variable-flow primary/secondary system with lead/lag pumps. The condenser water pumps also operate lead/lag but are constant speed.

Heating is provided by three 3-pass, dual fuel (natural gas & #2 oil), water-backed, horizontal firetube boilers manufactured by Sellers Engineering Co. These boilers are used for both building heat and domestic hot water generation. They are non-condensing boilers which were installed in 2006. These boilers use propane as an ignition source but maintain firing with #2 oil.

The boilers heat a propylene glycol/water mix that heats the spaces through terminal equipment. Domestic hot water is generated by this same glycol/water mix piped into vertical tank/heat exchangers located in various locations in the building.

The boilers are piped in a primary/secondary arrangement with a duplex secondary pump setup distributing glycol/water mix past the boilers and out to the building and back. The secondary pumps operate in a lead-lag arrangement and are variable-speed pumps controlled to maintain a set pressure at the far limits of the piping system.

There are three primary pumps piped in parallel drawing water from the secondary piping loop, to the boilers and back to the secondary loop. The primary pumps are not dedicated to any boiler, but instead operate on a one-for-one basis with the boilers. Two-way control valves open at each boiler to allow flow through the boiler when it is called to operate and one of the primary pumps is commanded on.

Each of the boilers has experienced tube failures with all of them having to be retubed three times each. There is no expectation to retube any of the boilers more than four times. Depending on the amount of welding done during previous repairs, it is possible none of the boilers can be retubed a fourth time.

Boiler control was added to the existing Automated Logic system two years ago and allows a warm up cycle during rotation. Previously, when a boiler was called upon to operate, the associated two-way control valve was commanded open and a primary pump started. The boiler would then begin operating at a high-fire rate for a period of time before modulating down.

Now the lag boiler continues to operate until the new lead boiler reaches operating temperature and the burner starts at low-fire instead of a high-fire rate before modulating up. Boiler rotation is presently scheduled via the BAS for every Wednesday.

Only one boiler is typically needed to meet the building load. The burners are dual fuel, so natural gas can be utilized when service is made available. A recent boiler efficiency test was not provided for this study, but the boilers are serviced semi-annually.

The boilers also supply hot water to 14 domestic hot water storage tanks with internal heat exchangers. This arrangement requires the boilers to be enabled year-round. The domestic hot water is stored at 130-140°F and recirculated at 110°F to support sinks, showers, laundry, and kitchen activities.

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 @ 40°F OAT and 160°F HWS @ 80°F OAT. This schedule is constrained to meet the domestic water requirements. De-coupling domestic water heating from the main boilers would decrease non-heating season energy usage.

Table 1

Boiler Schedule						
B-	**Manufacturer**	**Model Number**	**Input MBH**	**Output MBH**	**Design Thermal Efficiency**	**Fuel**
1	Sellers	SY-300-W	12263	10043	81.9%	Oil #2
2	Sellers	SY-300-W	12263	10043	81.9%	Oil #2
3	Sellers	SY-300-W	12263	10043	81.9%	Oil #2

HVAC in the facility includes (40) AHUs, (2) RTUs, (94) exhaust fans, and an assortment of electric, gas, and HW terminal units. AHU characteristics are as follows:

- All AHUs have hot water (HW) coils, and:
- (32) have chilled water (CW) coils
- (10) have air-to-air heat exchangers with re-heat coils
- (7) serve as MUA's
- (12) have air-side economizers
- Fan VSD's are installed on variable volume systems
- Systems operate 24/7/365

Electrical Systems

Interior and exterior lighting systems were recently upgraded with LED. Lighting sensor upgrades are planned.

Staff mentioned during the interview that they're strategizing to reduce Excess RKVA (power factor) charges.

Process and Plug Loads

Process and plug loads include equipment and systems typically found in Law Enforcement Centers and office environments.

Building Control System

The building has an Automated Logic building automation system (BAS), maintained by Eastern Heating and Cooling. The system is accessible remotely and has trending capabilities which are not utilized to their fullest extent by the County. The staff expressed interest in learning about software that overlays the BAS to provide ongoing energy analysis, commissioning, and monitoring/verification of system upgrades.

As part of its evaluation of the BAS, L&S attempted to correlate trend data with boiler room logs, fuel oil delivery records, and other sources of information. Impediments to this process included lack of clear labeling of the data fields, ambiguity as to the physical units of the quantities recorded, and lack of documentation including calibration records.

The BAS's trending capabilities are a valuable resource not only for continuous commissioning of the HVAC plant but also for measurement and verification of equipment upgrades. L&S strongly recommends that the facility work with Eastern Heating and Cooling to bring the BAS to its full potential.

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 metrics were computed using historical utility data and weather (temperature) data. Because boiler replacement is the primary focus of this project, calculations were 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 fuel oil data:

- HDD base temperature = 57° F giving R^2 (squared correlation coefficient) of 0.953
- Slope = 23.45 therms/day / HDD57/day
- Intercept = 152.25 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 78%. 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 = 18.29 therms/day / HDD57/day
- Intercept = 118.75 therms/day

The intercept describes daily usage that is independent of weather conditions. For this facility, it has a large value and is associated with the production of domestic hot water (DHW). To de-couple DHW usage from heating hot water (HHW) usage, the intercept was used in calculations for the

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

former and the slope was used for the latter. This was the basis for evaluating a proposed DHW system that does not rely on the HHW boiler (ECM 2).

These results were used to model proposed boiler energy usage (ECMs 1 and 3) 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 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 76,209 Btu/hr ^{o}F.

PRELIMINARY ENERGY USE ANALYSIS (PEA)

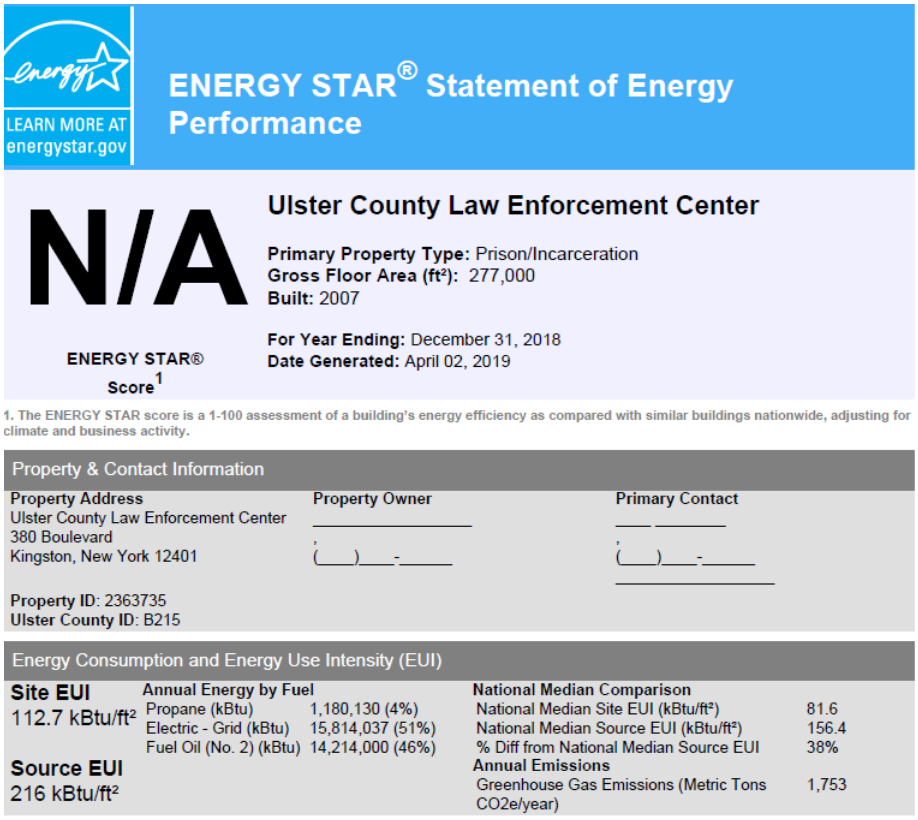
Data and Building Characteristics for EPA Portfolio Manager

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's score card and the building's Energy Usage Intensity (EUI). Due to the lack of a sufficient data base for this type of property, Energy Star was unable to compile a score.

Figure 2



ENERGY STAR® Statement of Energy Performance

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N/A

ENERGY STAR® Score[1]

Ulster County Law Enforcement Center

Primary Property Type: Prison/Incarceration
Gross Floor Area (ft²): 277,000
Built: 2007

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 Law Enforcement Center 380 Boulevard Kingston, New York 12401	_____ , (___)___-_____	___ _____ , (___)___-_____ _____

Property ID: 2363735
Ulster County ID: B215

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
112.7 kBtu/ft²

Source EUI
216 kBtu/ft²

Annual Energy by Fuel	
Propane (kBtu)	1,180,130 (4%)
Electric - Grid (kBtu)	15,814,037 (51%)
Fuel Oil (No. 2) (kBtu)	14,214,000 (46%)

National Median Comparison	
National Median Site EUI (kBtu/ft²)	81.6
National Median Source EUI (kBtu/ft²)	156.4
% Diff from National Median Source EUI	38%
Annual Emissions	
Greenhouse Gas Emissions (Metric Tons CO2e/year)	1,753

The EUI is a building's energy use normalized to floor area. Based on 12 months of energy consumption history the site EUI is 112.7 kBtu/ft². According to Energy Star's Portfolio Manager, the EUI of comparative sites (Prison/Incarceration) is 81.6 kBtu/ft², or 38% more efficient than this site.

TECHNOLOGY EVALUATION

The supporting calculation data for the following 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 Cooling Energy Thermal Storage
ECM-1	Install a HHW Condensing Boiler
ECM-2	Install Natural Gas DHW Boilers
ECM-3	Install a Biomass Boiler and a HHW Condensing Natural Gas Boiler

Supporting Information

- The Law Enforcement Center is slated for a fuel switch from #2 oil to natural gas. Savings for each type of fuel are listed for the boiler and DHW measures. The solar DHW measure assumes that the facility has switched to natural gas. The County communicated the terms associated with natural gas extension to the UCLEC facility from the utility as an interruptible rate structure and implementation the responsibility of the County.

- Heating hot water and DHW measures (ECMs 1 & 2): To cover all options, savings calculations would be given using both a baseline of existing conditions and a baseline based on code-minimum equipment. However, the existing #2 fuel oil boiler's nameplate efficiency is 82%, which is identical to the minimum code efficiency for a natural gas-fired boiler of the same capacity[2]. In the narratives below, incremental implementation costs are compared with absolute costs for these measures given that there would be no energy savings from installing code-minimum equipment.

- ECM 3 (Install a Biomass Boiler and a HHW 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:	$406,817	
Simple Payback:	43.5	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	1,086	mmBtu/Year
Annual Energy Cost Savings:	$9,356	

EXISTING CONDITIONS:

Presently, the HHW boilers also supply hot water to 14 domestic hot water storage tanks with internal heat exchangers (ECM-2 calls for installing gas-fired units at 7 of these 14 stations). The DHW load was estimated to be 4,334 mmBtu/year; the present #2 fuel oil-fired boilers use 5,557 mmBtu/year to meet this load.

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 energy savings (1,086 mmBtu/year). The simple payback was calculated assuming that ECM 2 has been implemented, and with natural gas cost savings payback is about 44 years.

This analysis has not been updated to reflect the interrupted natural gas tariff, or changes to ECM-2. A rate of $0.86/therm (referenced from the UC Office Building) was utilized for natural gas. Please see Further Analysis for PFS-1, on page 24, for further analysis of the selected option.

ACTION ITEMS:

Due to the long payback, this measure is not recommended. The solar benefit will only be useful from about April through October in upstate NY. There are not incentive available for solar DHW in NYS that we're aware of at this time.

PFS-2: Install Cooling Energy Thermal Storage

Project Cost:	$300,000	
Simple Payback:	37.4	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	817	kW
Annual Electric Demand Cost Savings:	$8,032	

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 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 seven months of the year chiller electric demand could be shaved by 50% resulting in a total annual reduction of 817 kW.

ACTION ITEMS:

This measure is not recommended due to its long payback.

ECM-1: Install a HHW Condensing Natural Gas Boiler

Project Cost:	$439,100	
Simple Payback:	6.2	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
#2 Fuel Oil Savings:	6,791	mmBtu/Year
New Gas Heating Usage:	- 6,047	mmBtu/Year
Net Fuel Savings:	744	mmBtu/Year
Net Annual Energy Cost Savings:	$71,256	
% Reduction in CO2 Emissions:	25%	

EXISTING CONDITIONS:

Heating is provided by three inefficient oil-fired fire-tube hot water boilers that were installed in 2002. 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 @ 40°F OAT and 160°F HWS @ 80°F OAT. This schedule is constrained to meet the domestic water requirements.

ECM SPECIFICATIONS:

Install a natural gas fired high efficiency condensing boiler. Retain (or replace in kind) at least one of the existing boilers as a backup for when the condensing boiler is down or natural gas is interrupted. The natural gas boiler is assumed to be interruption 30% of the time (estimated by the customer) and the oil fired boiler takes over.

After deducting the DHW load, one condensing boiler was modeled with a full load capacity of 7,797 MBH and a maximum efficiency of 94%. The existing boilers are modeled with a system efficiency of 78%, to count for losses associated with distribution and potentially high glycol concentrations (the actual glycol levels were not tested and frequency that glycol is added is unknown). The boiler capacity was verified by GPI through a Trane Trace building load simulation. It is assumed that hot water is supplied from the boiler on the OAT same reset schedule as existing. As indicated above, this analysis also assumes that the DHW load is supplemented by another system, so a lower return temperature can be used that will allow for longer periods of condensing (below 140°F). In addition, it is assumed that gas is interrupted 30%

ACTION ITEMS:

This ECM is recommended based on the assumption that DHW load can be decoupled, the condition of the existing boilers and on the payback.

It may also be beneficial to understand the savings associated with the fuel switch as compared to the efficiency improvement:

- Fuel switch: $59,684
- Efficiency improvement: $11,572

A comparison of an in-kind code-minimum oil fired boiler to condensing natural gas boiler was requested by the customer. The boiler cost estimate for a code-minimum (non-condensing) in-kind oil fired boiler is $143,000[3]. The incremental cost of the proposed energy-efficient option over the code-minimum option is $296,100, which results in a simple payback of approximately 4.6 years. The % Reduction in CO2 Emissions = 21%.

[3] RSMeans 2018 Mechanical 23 52 23.20 3400; cost for two (2) 3996 MBH boilers + $6K demo & $2k venting.

ECM-2: Install Natural Gas DHW Boilers

Project Cost:	$243,600	
Simple Payback:	4.2	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
#2 Fuel Oil Savings:	5,557	mmBtu/Year
New Gas Heating Usage:	- 4,895	mmBtu/Year
Net Fuel Savings:	662	mmBtu/Year
Net Annual Energy Cost Savings:	$58,618	
% Reduction in CO2 Emissions:	36%	

EXISTING CONDITIONS:

Presently, the HHW boilers also supply hot water to 7 locations, each with two hot water storage tanks with internal heat exchangers, for a total of 14 units. The DHW load was estimated to be 4,334 mmBtu/year; the present #2 fuel oil-fired boilers use 5,557 mmBtu/year to meet this load.

ECM SPECIFICATIONS:

Install a natural gas fired high efficiency boiler (approximately 319 MBH) at each of the 7 locations to replace one of two storage tanks. The second tank would remain coupled to the HHW boiler plant for back-up for when gas is interrupted or a heater fails.

ACTION ITEMS:

The customer did not select this measure for the HVAC Master Plan due to logistical issues associated with the existing building infrastructure, so it is not recommended.

It may also be beneficial to understand the savings associated with the fuel switch as compared to the efficiency improvement:

- Fuel switch: $48,312
- Efficiency improvement: $10,306

ECM-3: Install a Biomass Boiler and a Condensing HHW Natural Gas Boiler

Project Cost:	$440,200	
Simple Payback:	19.8	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
#2 Fuel Oil Savings:	9,701	mmBtu/Year
New Biomass Pellet Usage:	- 5,279	mmBtu/Year
New Gas Heating Usage:	- 3,456	mmBtu/Year
Net Fuel Savings:	966	mmBtu/Year
Net Annual Energy Cost Savings:	$22,258	
% Reduction in CO2 Emissions:	See discussion in Supporting Information above	

EXISTING CONDITIONS:

Heating is provided by three inefficient oil-fired fire-tube hot water boilers that were installed in 2002.

ECM SPECIFICATIONS:

Install a biomass hot water boiler system sized to handle about 60% of the peak heating load (~ 4678 MBH) in the building and a condensing gas fired boiler for auxiliary heat (~ 3119 MBH). These systems would be sized to replace the existing boiler capacity after deducting the DHW load (see ECM 2).

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[4].

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 78%. 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 52,791 equivalent therms (330 tons of pellets) annually and the condensing boiler would use 34,555 therms. The resulting 87,346 therms consumption represents a 10% savings over the existing system under the same conditions.

This analysis has not been updated to reflect the interrupted natural gas tariff, as oil use was assumed

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

to be eliminated. Therefore, a rate of $0.86/therm (referenced from the UC Office Building) was utilized for natural gas.

ACTION ITEMS:

As detailed in Appendix B, the energy savings would not be advantageous due to the present disparities in fuel prices between biomass pellets and natural gas. There should also be additional evaluation by an installer of the logistics of installing a pellet silo at this facility and securing a pellet supplier. 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. Although not ruled out by payback alone, this measure is recommended for further study if the facility wishes to pursue a biomass option. The County should also review available incentives through NYSERDA's Renewable Heat New York (RHNY) Biomass Program, upon further evaluation.

Discussion of CHP pre-feasibility model results

ERS completed a CHP pre-feasibility model for the Ulster County Law Enforcement Center and a summary of the results was provided by the County for integration into this study. The summary reports energy savings, NYSERDA incentive and simple payback for numerous scenarios associated with: Variable Implementation Cost, Fixed Implementation Cost and energy rates.

At the time of writing this report, NYSERDA's solicitation for the Combined Heat and Power Program (PON 2568) is closed, so no direct incentives are available. NYSERDA is currently exploring programs that will help to promote distributed energy resources (DER), which are technologies that generate or manage the demand of electricity at different points of the grid, such as at homes and businesses, instead of exclusively at power plants. They allow owners to reduce their facilities' carbon footprints, rein in energy costs, and improve utility grid power-outage resiliency.

ERS provided an updated summary table showing simple payback without the incentive for each scenario and is shown in part below. The rates used in this model are based on the utility information provided to ERS at the time of the screening, so they do not align with the rates used in this FlexTech study. If rates that used in this report were used in the analysis, the simple payback would increase by about one year. The full savings summary table and model results can be found Appendix D.

Table 3

Variable Cost	Fixed Cost	Total Cost	kWh Rate	Summer kW Rate	Winter kW Rate	Gas Rate	CHP Gas Rate	Annual kWh	Peak Demand	Annual MMBtu	Optimal Size	Payback
$4,500	$100,000	$550,000	$0.083	$8.68	$8.49	$11.84	$7.50	4,929,057	948	16,311	100-125	13.5
$4,000	$75,000	$475,000										11.6
$4,500	$100,000	$550,000	$0.083	$9.16	$9.16	$9.77	$7.00	4,929,057	948	16,311	100-125	16.0
$4,000	$75,000	$475,000										13.9
$4,500	$100,000	$550,000	$0.090	$9.50	$9.50	$10.50	$7.00	4,929,057	948	16,311	100-125	12.4
$4,000	$75,000	$475,000										10.7

The CHP pre-feasibility model shows that LEC is a good candidate for CHP based on an overall system efficiency of 77.6%, so the County may choose to pursue a more detailed CHP study with the assistance of FlexTech, or wait to see if NYSERDA issues another solicitation that includes incentives associated with the DER initiative discussed above. A detailed analysis of CHP was not part of the scope of work for this FlexTech study; however L&S can complete this work through a separate application.

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 LEC was completed 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 LEC 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 22-25 years, which is on the higher end 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. However, if the rates in this report were used, the simple payback may drop significantly.

HEATING/COOLING MASTER - FURTHER ANALYSIS (FA)

GPI/L&S meet with the County on May 16, 2019 to review the technologies evaluated in the section above from the draft Flex Tech Study. 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, GPI and L&S completed a conference call on July 22, 2019 to review the guidance document.

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

- PFS-1: Install Solar Thermal DHW
- PFS-2: Install Cooling Energy Thermal Storage
- ECM-1: Install a HHW Condensing Natural Gas Boiler

FA PFS-1: Install Solar Thermal DHW

Project Cost:	$58,117	
Simple Payback:	45.2	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
Gas Heating Savings:	95	mmBtu/Year
Oil Heating Savings:	48	mmBtu/Year
Annual Energy Cost Savings:	$1,286	

COUNTY SELECTED COURSE OF ACTION:

Assess solar thermal DHW in further detail as a system to be integrated into the heating loop in the future.

EXISTING CONDITIONS:

Presently, the HHW boilers also supply hot water to 14 domestic hot water storage tanks with internal heat exchangers (ECM 2 calls for installing gas-fired units at 7 of these 14 stations).

COUNTY SOW SPECIFICATIONS:

Work to include the installation of new solar thermal collection system with collectors to be installed on the roof of the existing Boiler Plant section with a new storage tank installed within the existing Boiler Room. System shall interface with existing Kitchen/Laundry water heaters WH-7 and WH-7A. Prior to sizing of system, coordinate with the County to install a water meter on the cold water feed to the water heaters. Usage data from this meter shall be used to size collector and storage system. Design basis shall be Viessmann model Vitosol 200-FM with ThermProtect switching absorber layer. Collector controls shall interface with existing Building Management System.

Trend temperatures and flow rates from the HHW boilers to the storage tanks for an appropriate period of time to capture a typical load cycle.

This measure was reassessed using the energy.gov on-line calculator for just the 2 domestic hot water storage tanks at a pre-feasibility level, to keep within the project scope of work. No further action was taken to assess integrating into the heating loop or implementation with a roof replacement, as prices may change in time. Detailed implementation costs and energy analysis should be pursued in further detail when the County decides to pursue this measure.

The solar benefit will only be useful from about April through October in upstate NY. There are not incentive available for solar DHW in NYS that we're aware of at this time.

FA PFS-2: Install Cooling Energy Thermal Storage

Project Cost:	$300,000	
Simple Payback:	37.4	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	816.6	kW
Annual Electric Demand Cost Savings:	$8,032	

COUNTY SELECTED COURSE OF ACTION:

Assess integration of cooling energy thermal storage.

EXISTING CONDITIONS:

The existing chillers cool the building with no thermal storage.

COUNTY SOW SPECIFICATIONS:

A SOW was not developed by GPI or requested by the County, as it required further evaluation as an as a valuable option.

Further energy analysis beyond pre-feasibility is outside the project scope of work and the installation cost should be reevaluated when the County decides to pursue this measure

FA ECM-1: Install a HHW Condensing Natural Gas Boiler

Project Cost:	$1,010,200	
Simple Payback:	9.6	Years
Electricity Savings:	0	kWh /Year
Peak Demand Savings:	0	kW
#2 Fuel Oil Savings:	9,838	mmBtu/Year
New Gas Heating Usage:	- 8,411	mmBtu/Year
Net Fuel Savings:	1,427	mmBtu/Year
Net Annual Energy Cost Savings:	$105,230	
% Reduction in CO2 Emissions:	24%	

COUNTY SELECTED COURSE OF ACTION:

Replace the three existing "Sellers" boiler with one natural gas fired condensing boiler, and two "Cleaver-Brooks" dual fuel (gas, #2 F.O.) boilers. Include any alternative recommendations on how to configure dual fuel boilers to achieve maximum efficiency (i.e. alternate make/model/sizing/quantity) while still meeting the building load with redundancy.

EXISTING CONDITIONS:

Heating and DHW is provided by three inefficient oil-fired fire-tube hot water boilers that were installed in 2002. 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 @ 40°F OAT and 160°F HWS @ 80°F OAT. This schedule is constrained to meet the domestic water requirements.

COUNTY SOW SPECIFICATIONS:

Work to include replacement of the three original 300 HP Sellers wetback firetube boilers with two 300 HP non-condensing firetube boilers and one 300 HP condensing boiler. Non-condensing boilers shall operate on No.2 fuel oil or natural gas with automatic change-over based on input from the Building Management System. Burners shall be modulating. The condensing boiler shall be placed first in line on the return water system and operate on natural gas. The design basis for both will be Cleaver Brooks. 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.

In concert with the selected course of action, the economic analysis has been updated to reflect the replace of all three boilers. Although outside the scope of work, the energy analysis was updated to reflect the assumption that the DHW load will remain on the hot water loop. The DHW operation will require higher supply water temperatures to be maintained and result in less efficient operation of the condensing boiler.

It may also be beneficial to understand the savings associated with the fuel switch as compared to the efficiency improvement:

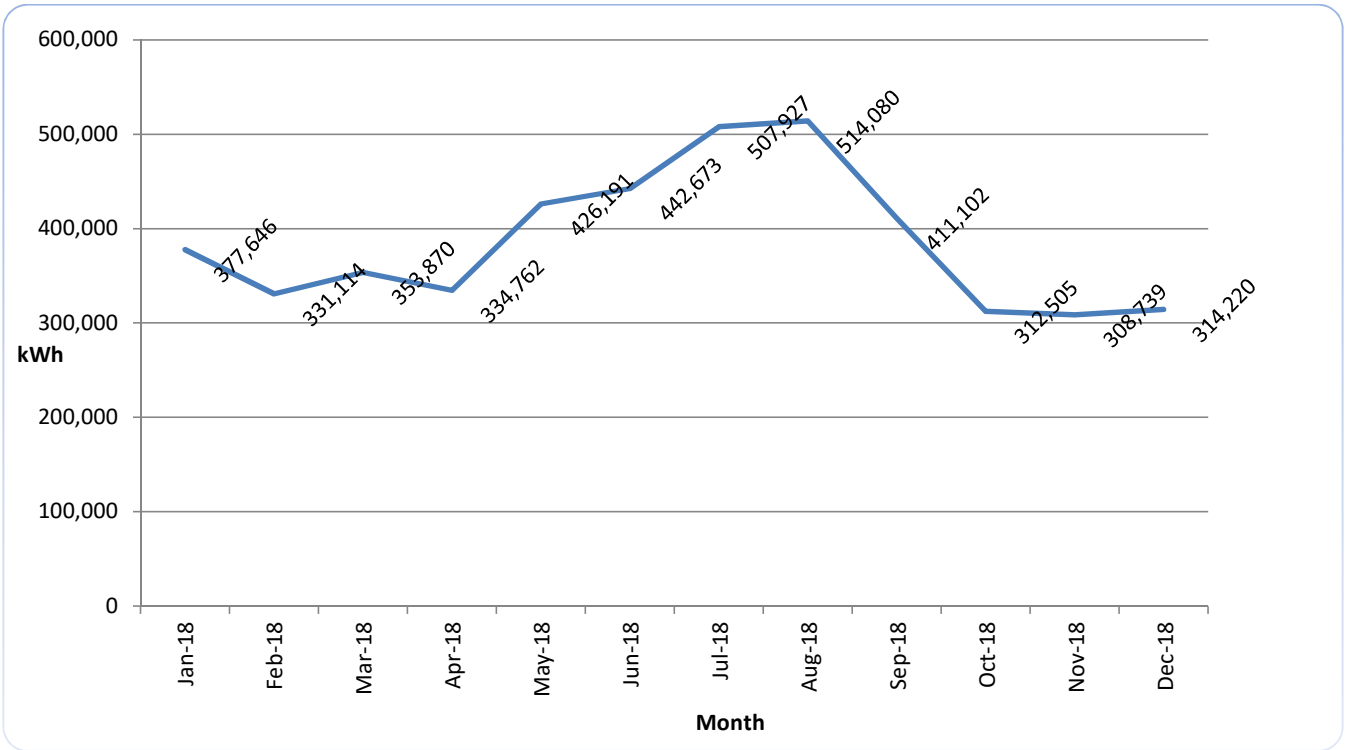
- Fuel switch: $83,015
- Efficiency improvement: $22,216

Appendix A – Utility Bill Summary

Facility: Ulster County Law Enforcement Center
Address: 380 Boulevard
City: Kingston, NY
ZIP: 12401

Utility Provider: Central Hudson Gas & Electric

From	To	Total Use kWh	Utility kW Demand	Utility Energy $	Utility Demand $	Utility $/kWh	Utility $/kW	Total Electricity $
1/1/2018	1/31/2018	377,646	671.5	$37,019	$6,084	$0.098	$9.060	$43,103
2/1/2018	2/28/2018	331,114	648.0	$33,456	$5,871	$0.101	$9.060	$39,327
3/1/2018	3/31/2018	353,870	625.9	$35,827	$5,671	$0.101	$9.060	$41,497
4/1/2018	4/30/2018	334,762	755.5	$36,006	$6,845	$0.108	$9.060	$42,851
5/1/2018	5/31/2018	426,191	816.9	$43,583	$7,401	$0.102	$9.060	$50,984
6/1/2018	6/30/2018	442,673	873.8	$44,240	$7,917	$0.100	$9.060	$52,156
7/1/2018	7/31/2018	507,927	894.4	$52,562	$9,194	$0.103	$10.280	$61,756
8/1/2018	8/31/2018	514,080	1,005.1	$53,367	$10,332	$0.104	$10.280	$63,699
9/1/2018	9/30/2018	411,102	886.5	$42,494	$9,113	$0.103	$10.280	$51,607
10/1/2018	10/31/2018	312,505	720.2	$33,556	$7,404	$0.107	$10.280	$40,960
11/1/2018	11/30/2018	308,739	569.7	$31,172	$5,857	$0.101	$10.280	$37,029
12/1/2018	12/31/2018	314,220	570.0	$28,748	$5,860	$0.091	$10.280	$34,607
		4,634,829	**753.1**	**$472,029**	**$87,548**	**$0.102**	**$9.670**	**$559,577**



Notes:

Facility: Ulster County Law Enforcement Center
Address: 380 Boulevard
City: Kingston, NY
ZIP: 12401

Utility Provider: Paraco and Bottini
KoscoHeritage

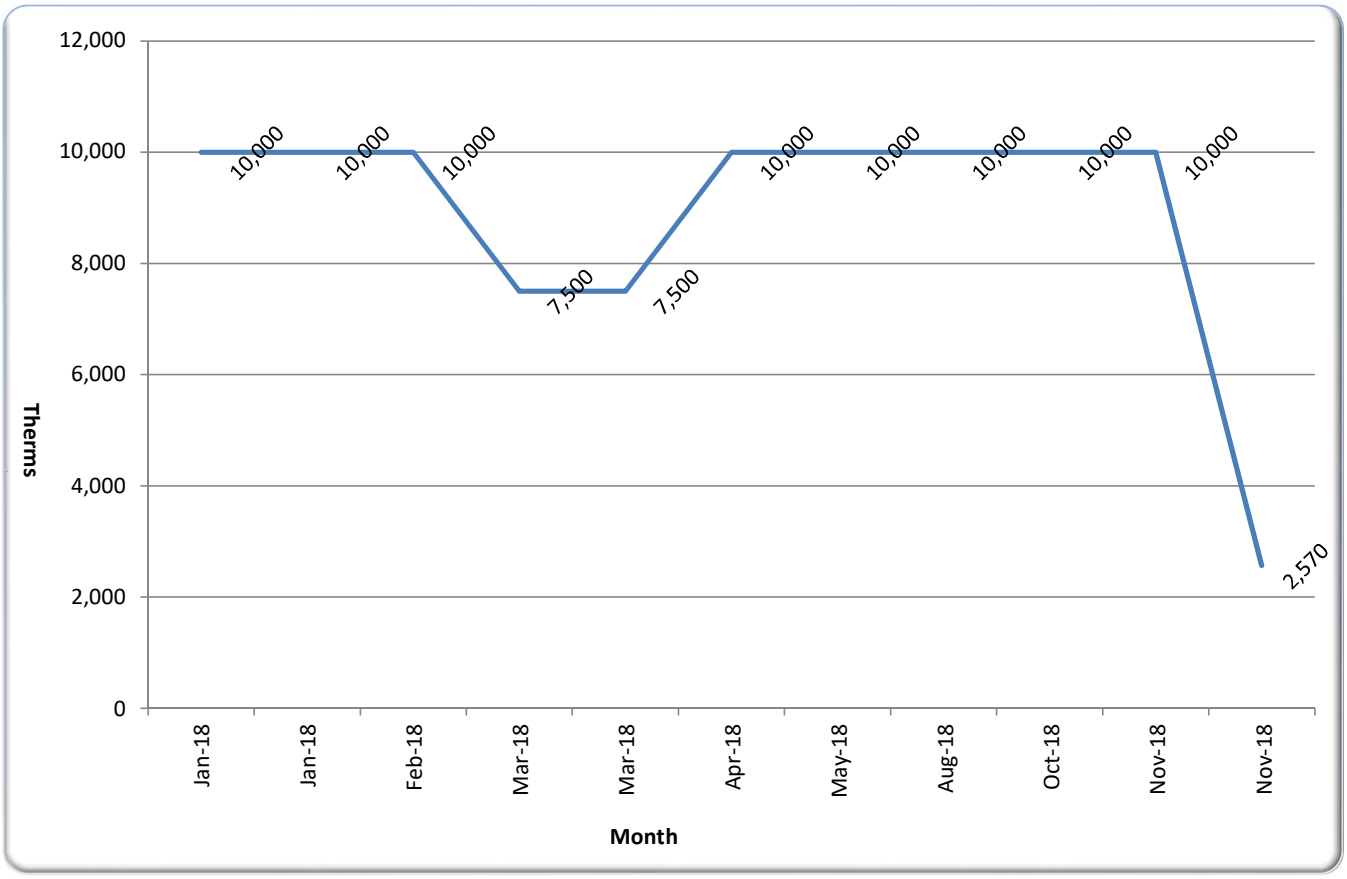
BTU Content (Btu/Gallon): 139,600

Deliveries only

From	To	Delivered Gallons	Fuel Oil $	Total $/gallon	Equivalent MMbtu's
1/9/2018	1/19/2018	10,000	$22,517	$2.252	1,396
1/19/2018	2/8/2018	10,000	$22,256	$2.226	1,396
2/8/2018	3/6/2018	10,000	$20,290	$2.029	1,396
3/6/2018	3/27/2018	7,500	$16,135	$2.151	1,047
3/27/2018	4/9/2018	7,500	$16,087	$2.145	1,047
4/9/2018	5/3/2018	10,000	$23,059	$2.306	1,396
5/3/2018	8/16/2018	*10,000*	*$21,730*	*$2.173*	*1,396*
8/16/2018	10/5/2018	*10,000*	*$21,730*	*$2.173*	*1,396*
10/5/2018	11/1/2018	10,000	$23,841	$2.384	1,396
11/1/2018	11/27/2018	10,000	$21,087	$2.109	1,396
11/27/2018	12/14/2018	2,570	$3,284	$1.278	359
		97,570	**$212,015**	**$2.173**	**13,621**

$/MMBtu:	$15.57

NOTE: Gallons delivered in italics not provided - amount shown is estimated



ENERGY STAR® Data Verification Checklist

N/A

ENERGY STAR ® Score[1]

Ulster County Law Enforcement Center

Registry Name: Ulster County Law Enforcement Center
Property Type: Prison/Incarceration
Gross Floor Area (ft²): 277,000
Built: 2007

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	Property Owner	Primary Contact
Ulster County Law Enforcement Center 380 Boulevard Kingston, New York 12401	_____ , (____)____-_____	____ _____ , (____)____-_____ _____

Property ID: 2363735
Ulster County ID: B215

1. Review of Whole Property Characteristics

Basic Property Information

1) **Property Name:** Ulster County Law Enforcement Center ☐ Yes ☐ No

Is this the official name of the property?

If "No", please specify: _____

2) **Property Type:** Prison/Incarceration ☐ Yes ☐ No

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

3) **Location:** ☐ Yes ☐ No

380 Boulevard
Kingston, New York 12401

Is this correct and complete?

4) **Gross Floor Area:** 277,000 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: Office Use

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

1) Gross Floor Area: 28,307 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: 65 ← default

☐ 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: 65.11 ← default

☐ 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: 56.61 ← default

☐ 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:

Prison/Incarceration: Prison/Incarceration Use

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

1) Gross Floor Area: 248,693 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: 168 ☐ 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: 153 ☐ 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: Not entered ☐ 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.

Notes:

3. Review of Energy Consumption

Data Overview

Site Energy Use Summary		National Median Comparison	
Propane (kBtu)	1,180,130 (4%)	National Median Site EUI (kBtu/ft²)	81.6
Electric - Grid (kBtu)	15,814,036.9 (51%)	National Median Source EUI (kBtu/ft²)	156.4
Fuel Oil (No. 2) (kBtu)	14,214,000.4 (46%)	% Diff from National Median Source EUI	38.1%
Total Energy (kBtu)	31,208,167.3		

Energy Intensity		Emissions (based on site energy use)	
Site (kBtu/ft²)	112.7	Greenhouse Gas Emissions (Metric Tons CO2e)	1,752.8
Source (kBtu/ft²)	216		

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:
3121237500_Elec_Sup	Electric - Grid	09/16/2009	In Use	Ulster County Law Enforcement Center
334821C-2_Propane_F	Propane	01/01/2018	12/31/2018	Ulster County Law Enforcement Center
344008B-1_Propane_F	Propane	01/01/2018	In Use	Ulster County Law Enforcement Center
704321-1_Fuel Oil_Bottini_CLOSED	Fuel Oil (No. 2)	01/01/2012	12/31/2018	Ulster County Law Enforcement Center
3121237500_Elec_Del	Electric - Grid	09/15/2009	In Use	Ulster County Law Enforcement Center
334821C-1_Fuel Oil_Paraco	Fuel Oil (No. 2)	01/01/2018	In Use	Ulster County Law Enforcement Center

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_02	Electric - Grid	09/01/2015	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: 3121237500_Elec_Supply (kWh (thousand Watt-hours))

Associated With: Ulster County Law Enforcement Center

Start Date	End Date	Usage	Green Power?
01/01/2018	01/31/2018	0	No
02/01/2018	02/28/2018	0	No
03/01/2018	03/31/2018	0	No
04/01/2018	04/30/2018	0	No
05/01/2018	05/31/2018	0	No
06/01/2018	06/30/2018	0	No
07/01/2018	07/31/2018	0	No
08/01/2018	08/31/2018	0	No
09/01/2018	09/30/2018	0	No
10/01/2018	10/31/2018	0	No

Start Date	End Date	Usage	Green Power?
11/01/2018	11/30/2018	0	No
12/01/2018	12/31/2018	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:

Propane Meter: 334821C-2_Propane_Paraco_CLOSED (Gallons)

Associated With: Ulster County Law Enforcement Center

Delivery Date	Quantity
01/17/2018	2,773
10/01/2018	0 ← estimate
11/01/2018	0 ← estimate
Total Consumption (Gallons):	2,773
Total Consumption (kBtu (thousand Btu)):	255,116

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:

Propane Meter: 344008B-1_Propane_Paraco (Gallons)

Associated With: Ulster County Law Enforcement Center

Delivery Date	Quantity
05/02/2018	2,885
05/05/2018	2,600
05/10/2018	2,000
12/11/2018	2,569.5
Total Consumption (Gallons):	10,054.5
Total Consumption (kBtu (thousand Btu)):	925,014

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:

Fuel Oil (No. 2) Meter: 704321-1_Fuel Oil_Bottini_CLOSED (Gallons)

Associated With: Ulster County Law Enforcement Center

Delivery Date	Quantity
10/31/2018	10,000
11/26/2018	10,000
Total Consumption (Gallons):	20,000
Total Consumption (kBtu (thousand Btu)):	2,760,000

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: 3121237500_Elec_Delivery (kWh (thousand Watt-hours))

Associated With: Ulster County Law Enforcement Center

Start Date	End Date	Usage	Green Power?
01/01/2018	01/31/2018	377,646	No
02/01/2018	02/28/2018	331,114	No
03/01/2018	03/31/2018	353,870	No
04/01/2018	04/30/2018	334,762	No
05/01/2018	05/31/2018	426,191	No
06/01/2018	06/30/2018	442,673	No
07/01/2018	07/31/2018	507,927	No
08/01/2018	08/31/2018	514,080	No
09/01/2018	09/30/2018	411,102	No
10/01/2018	10/31/2018	312,505	No
11/01/2018	11/30/2018	308,739	No
12/01/2018	12/31/2018	314,220	No
	Total Consumption (kWh (thousand Watt-hours)):		4,634,829
	Total Consumption (kBtu (thousand Btu)):		15,814,036.5

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:

Fuel Oil (No. 2) Meter: 334821C-1_Fuel Oil_Paraco (Gallons)

Associated With: Ulster County Law Enforcement Center

Delivery Date	Quantity
01/08/2018	10,000
01/18/2018	10,000
02/08/2018	10,000
03/05/2018	10,000
03/23/2018	7,500
04/06/2018	7,500
05/02/2018	10,000
12/13/2018	9,000
12/31/2018	9,000
Total Consumption (Gallons):	83,000
Total Consumption (kBtu (thousand Btu)):	11,454,000

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

UCLEC PFS 1: SOLAR DHW SCREEN

Background Info

F:\Mike Stiles\Ulster Co Law Enforcement Center (UCLEC)\UCLEC
UCLEC Summary

System includes (14) electric water heaters
PVI Industries QuickDraw® Water
(4) Model 4800 P A-IW in mechanical room (2,321,000 Btu/hr input)
(10) Model 1000 P A-IW distributed throughout building (358,000 Btu/hr input)

Note: The Calculator returns savings in kWh, adaptation to UCLEC fuels follows

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
UCLEC

Select the nearest city/state
NY, ALBANY

ZIP Code
12401

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
Barracks

Amount of Water Usage (M) - gallons / person / day / person
10

Number of person(s)
500

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

Total Calculated Load:
981.58 kWh/day for 500 persons using 10 gallons/day/person

Estimated System Size: 419.93 m²

UCLEC PFS 1: SOLAR DHW SCREEN

Background Info

F:\Mike Stiles\Ulster Co Law Enforcement Center (UCLEC)\UCLEC
UCLEC Summary

System includes (14) electric water heaters
PVI Industries QuickDraw® Water
(4) Model 4800 P A-IW in mechanical room (2,321,000 Btu/hr input)
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Note: The Calculator returns savings in kWh, adaptation to UCLEC fuels follows

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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

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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
UCLEC

Select the nearest city/state
NY, ALBANY

ZIP Code
12401

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
Barracks

Amount of Water Usage (M) - gallons / person / day / person
10

Number of person(s)
500

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

Total Calculated Load:
981.58 kWh/day for 500 persons using 10 gallons/day/person

Estimated System Size: 419.93 m²

UCLEC PFS 1: SOLAR DHW SCREEN

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

ELECTRIC: 0.77 - 0.97, assume 0.88

Efficiency

0.88

Energy Cost / kWh

0.121

Calculate Energy Savings

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	UCLEC
Nearest City	NY, ALBANY
ZIP Code	12401

INPUT VALUES

Building Type	
Amount of Water Usage	5,000 gal/day
Number of person(s)	500
Cold Water Temperature	50 (°F)(T_{cold})
How Water Temperature	130 (°F)(T_{hot})
Water Heater Fuel Type	electric
Water Heater Efficiency	0.88
Average Fuel Price	$0.121/kWh

CALCULATIONS

System Size	419.93 m^2
System Cost	$406,817.29
Annual Energy Savings	318,302.60 kWh/year
Annual Cost Savings	$38,514.61 based on $0.121/$kWh
SIR	2.27
Simple Payback	10.56 years
Solar Fraction	78.00%
Annual Greenhouse Gas Reduction	720.798 lbs. of CO_2

UCLEC PFS 1: SOLAR DHW SCREEN

Savings Summary

Calculator savings:	318,303	kWh
Conversion factor:	3,413	Btu/kWh
	0.003413	mmBtu/kWh

Solar mmBtu savings = 1,086

Existing # 2 fuel oil savings:

$15.566 $/mmBtu #2 fuel oil

Cost savings = $16,910 #2 oil

0.1396 mmBtu/gal #2 fuel oil

7,782 gallons #2 fuel oil saved

Natural gas (fuel switch) savings:

$8.612 $/mmBtu natural gas (proposed)

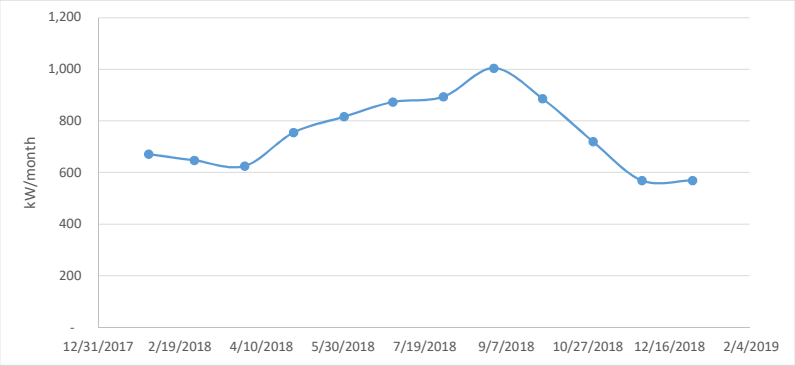
Cost savings = $9,356 nat gas

UCLEC PFS 2: THERMAL STORAGE SCREENING ANALYSIS

Cooling Demand Estimated from Utility Data

Starting Data (from utility data summary):

End Date	kW	kW $	$/kW	
1/31/2018	672	$6,084	$9.06	
2/28/2018	648	$5,871	$9.06	
3/31/2018	626	$5,671	$9.06	
4/30/2018	756	$6,845	$9.06	
5/31/2018	817	$7,401	$9.06	apparent
6/30/2018	874	$7,917	$9.06	cooling
7/31/2018	894	$9,194	$10.28	season
8/31/2018	1,005	$10,332	$10.28	billing
9/30/2018	887	$9,113	$10.28	period
10/31/2018	720	$7,404	$10.28	
11/30/2018	570	$5,857	$10.28	
12/31/2018	570	$5,860	$10.28	



Avg kW for non-cooling season billing period = 617

End Date	kW	kW - avg kW for non clg season	
4/30/2018	756	138	Highlighted cooling kW values show marked peak (almost a factor of 4 difference bt highest & lowest
5/31/2018	817	200	
6/30/2018	874	257	
7/31/2018	894	277	
8/31/2018	1,005	388	
9/30/2018	887	269	
10/31/2018	720	103	

…do not take avg, use monthly profiles

Assumptions and Savings Estimates

Define the cooling kW as (monthly cooling season kW - avg kW for non clg season) per above

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

Savings calculations:

End Date	Cooling kW	50% cooling kW savings	$/kW	50% cooling kW savings x $/kW
4/30/2018	138	69.24	$9.06	$627
5/31/2018	200	99.94	$9.06	$905
6/30/2018	257	128.39	$9.06	$1,163
7/31/2018	277	138.69	$10.28	$1,426
8/31/2018	388	194.04	$10.28	$1,995
9/30/2018	269	134.74	$10.28	$1,385
10/31/2018	103	51.59	$10.28	$530
Totals:		816.63		$8,032

Estimated annual cost savings due to thermal storage

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

Simple payback = 37.4 years

UCLEC Boiler Replacement		
Ulster County Law Enforcement Center	**380 Boulevard Kingston, NY 12402**	
ECM 1 - Install Condensing HHW Natural Gas Boiler		
Existing Boiler Input Capacity (MBH ea.):		**12,263**
Proposed Condensing Boiler Input Capacity (MBH ea.):		**12,263**
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, Natural Gas:		**100,000**
Therms per Gallon #2 Fuel Oil		**1.396**
Existing Boiler Efficiency (assumed system)		**78%**
Proposed Condensing Boiler Efficiency (condensing above 20°F OSA)		**94%**
Proposed Condensing Boiler Efficiency (non-condensing below 20°F OSA)		**85%**
$/therm #2 fuel oil	**$**	**1.56**
$/therm natural gas (proposed) - assumed 30% interrupted	**$**	**0.57**
#2 Fuel Oil Savings (mmBtu)		**6,791**
Natural Gas Savings (proposed usage, mmBtu)		**(6,047)**
Net mmBtu Savings		**743**
#2 Fuel Oil Cost Savings	**$**	**105,700**
Natural Gas Cost (proposed)	**$**	**(34,443)**
Net Total Cost Savings ($)	**$**	**71,256**

Notes: For this example, DHW load is removed, condensing boiler assumed 100% of existing boiler capacity; 30% interrupted and switch to existing oil boiler. Actual capacities to be determined at design.

Determine Existing Boiler Heating Usage:

Usage was analyzed using utility billing data from 1/9/2018 to 12/14/2018

Assumptions and Approach:

1. The model of heating energy usage is based on fuel oil delivery records and boiler room logs.
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 @57°F base
1/1/2005	1:00	35.6	21.4
1/1/2005	2:00	33.8	23.2
1/1/2005	3:00	37.4	19.6
1/1/2005	4:00	39.2	17.8
1/1/2005	5:00	33.8	23.2
1/1/2005	6:00	46.4	10.6
1/1/2005	7:00	35.6	21.4
1/1/2005	8:00	44.6	12.4
1/1/2005	9:00	44.6	12.4
1/1/2005	10:00	51.8	5.2
1/1/2005	11:00	53.6	3.4
1/1/2005	12:00	55.4	1.6
1/1/2005	13:00	53.6	3.4
1/1/2005	14:00	51.8	5.2
1/1/2005	15:00	50	7.0
…	…	…	…

ECM 1 - Install Condensing HHW Natural Gas Boiler

Regression analysis results:
therms/day = 23.4488 therms/HDD57 + 152.2483 therms/day
Note: Only the slope is used for the HHW boiler analysis; the intercept is for ECM 2 DHW

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Regression therms * Existing efficiency

Regression analysis results:
therms/day = 18.2900 therms/HDD57

Therms Usage by Regression -- Building Load Excerpt:

Date	Time	Therms
1/1/2005	1:00	16.3
1/1/2005	2:00	17.7
1/1/2005	3:00	14.9
1/1/2005	4:00	13.6
1/1/2005	5:00	17.7
1/1/2005	6:00	8.1
1/1/2005	7:00	16.3
1/1/2005	8:00	9.4
1/1/2005	9:00	9.4
1/1/2005	10:00	4.0
1/1/2005	11:00	2.6
1/1/2005	12:00	1.2
1/1/2005	13:00	2.6
1/1/2005	14:00	4.0
...	...	...

Building Load

Total Sum - Therms Monthly:	
Jan	18,505
Feb	14,535
Mar	8,717
Apr	4,582
May	1,608
Jun	338
Jul	41
Aug	252
Sep	796
Oct	5,370
Nov	6,688
Dec	14,234
Total	75,667

In a year of typical weather, existing system builidng load was estimated to be
75,667 therms

Apply 8760 hour model to existing system usage in a year of typical weather:
Hourly usage = hourly load / existing efficiency (78%)

Therms Usage by Regression -- Existing Excerpt:

Date	Time	Therms
1/1/2005	1:00	20.9
1/1/2005	2:00	22.7
1/1/2005	3:00	19.1
1/1/2005	4:00	17.4
1/1/2005	5:00	22.7
1/1/2005	6:00	10.4
1/1/2005	7:00	20.9
1/1/2005	8:00	12.1
1/1/2005	9:00	12.1
1/1/2005	10:00	5.1
1/1/2005	11:00	3.3
1/1/2005	12:00	1.6
1/1/2005	13:00	3.3
1/1/2005	14:00	5.1
1/1/2005	15:00	6.8
...	...	...

Existing NG Usage

Total Sum - Therms Monthly:	
Jan	23,724
Feb	18,635
Mar	11,175
Apr	5,874
May	2,062
Jun	434
Jul	52
Aug	323
Sep	1,021
Oct	6,884
Nov	8,575
Dec	18,249
Total	97,008

In a year of typical weather, existing system usage was estimated to be
97,008 therms

ECM 1 - Install Condensing HHW 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 =	57	F
OAT below which condensing stops =	20	F

Gas is assumpted to be interuppted 30% of the time (switch to 78% eff oil boiler).

OAT	effic		
20	85%	m=	0.00243
58	94%	b=	0.80135

Therms Usage -- Proposed Excerpt:

Date	Time	Condensing Boiler:		Oil Fired Boiler:	
		Efficiency	Total Therms	Efficiency	Total Therms
1/1/2005	1:00				
1/1/2005	2:00	89%	12.9	78%	6.3
1/1/2005	3:00	88%	14.0	78%	6.8
1/1/2005	4:00	89%	11.7	78%	5.7
1/1/2005	5:00	90%	10.6	78%	5.2
1/1/2005	6:00	88%	14.0	78%	6.8
1/1/2005	7:00	91%	6.2	78%	3.1
1/1/2005	8:00	89%	12.9	78%	6.3
1/1/2005	9:00	91%	7.3	78%	3.6
1/1/2005	10:00	91%	7.3	78%	3.6
1/1/2005	11:00	93%	3.0	78%	1.5
1/1/2005	12:00	93%	1.9	78%	1.0
1/1/2005	13:00	94%	0.9	78%	0.5
1/1/2005	14:00	93%	1.9	78%	1.0
1/1/2005	15:00	93%	3.0	78%	1.5
...	...	...	...	...	...

Proposed Boiler Usage

Total Sum - Therms Monthly:		
	NG Condensing	Oil Fired
Jan	15,032	7,117
Feb	11,777	5,590
Mar	6,884	3,353
Apr	3,568	1,762
May	1,231	619
Jun	256	130
Jul	31	16
Aug	191	97
Sep	607	306
Oct	4,190	2,065
Nov	5,264	2,572
Dec	11,443	5,475
Totals	60,471	29,103

Savings Summary

System	Usage	Costs	*Fuel Switch:*
	(Therms)		
Existing	97,008	$ 151,000	*#2 fuel oil*
Proposed:	60,471	$ 34,443	*natural gas*
	29,103	$ 45,300	*#2 fuel oil*
Savings	**7,435**	**$ 71,256**	

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 Fuel Oil Boiler

Alternative: ECM 1 - Install Condensing HHW Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCLEC\Utility Bills\BLCC5\BLCC5 - UCLEC v.2.xml
Date of Study:	Tue Sep 17 08:54:24 EDT 2019
Project Name:	Ulster County Law Enforcement Center
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	$439,100	-$439,100
Future Costs:			
Energy Consumption Costs	$3,989,428	$1,956,559	$2,032,869
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)	$3,989,428	$1,956,559	$2,032,869
Total PV Life-Cycle Cost	$3,989,428	$2,395,659	$1,593,769

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$2,032,869
- Increased Total Investment	$439,100

Net Savings	$1,593,769

Savings-to-Investment Ratio (SIR)

SIR = 4.63

Adjusted Internal Rate of Return

AIRR = 8.40%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 5

Discounted Payback occurs in year 6

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	9,701.0 MBtu	2,910.0 MBtu	6,791.0 MBtu	196,915.8 MBtu
Natural Gas	0.0 MBtu	6,047.0 MBtu	-6,047.0 MBtu	-175,342.3 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	9,701.0 MBtu	2,910.0 MBtu	6,791.0 MBtu	196,915.8 MBtu
Natural Gas	0.0 MBtu	6,047.0 MBtu	-6,047.0 MBtu	-175,342.3 MBtu

Emissions Reduction Summary

Energy Type	Average Annual Emissions Base Case	Alternative	Reduction	Life-Cycle Reduction
Distillate Fuel Oil (#1, #2)				
CO2	704,053.21 kg	211,194.19 kg	492,859.02 kg	14,291,224.83 kg
SO2	5,036.26 kg	1,510.72 kg	3,525.54 kg	102,228.59 kg
NOx	634.65 kg	190.38 kg	444.28 kg	12,882.46 kg
Natural Gas				
CO2	0.00 kg	319,416.70 kg	-319,416.70 kg	-9,261,991.19 kg
SO2	0.00 kg	2,577.79 kg	-2,577.79 kg	-74,747.19 kg
NOx	0.00 kg	267.99 kg	-267.99 kg	-7,770.75 kg
Total:				
CO2	704,053.21 kg	530,610.89 kg	173,442.32 kg	5,029,233.64 kg
SO2	5,036.26 kg	4,088.52 kg	947.75 kg	27,481.40 kg
NOx	634.65 kg	458.36 kg	176.29 kg	5,111.72 kg

UCLEC Boiler Replacement
Ulster County Law Enforcement Center 380 Boulevard Kingston, NY 12402

ECM 2 - Install Natural Gas DHW Boilers

Existing DHW Heaters (Qty):		**7**
DHW fuel oil use (Intercept from the regression analysis)	**therms/day**	**152.25**
% Time Gas Interupted		**30%**
Existing Boiler Efficiency (assumed system)		**78%**
Proposed Boiler Efficiency (assumed system)		**94%**

Annual Existing DHW Fuel Oil Use:

152.25 therms/day * 365 days/yr = 5,557 mmBtu

DHW load = existing consumption * existing efficiency = 4,335 mmBtu

Proposed DHW energy consumption:

DHW load / proposed efficiency = 4,895 mmBtu

Energy Savings:		existing mmBtu			**5,557**
		proposed mmBtu			**4,895**
		annual mmBtu savings			**662**
Rates:	$15.566	$/mmBtu #2 fuel oil		existing	
	$5.696	$/mmBtu nat gas		interruptible gas rate	
Cost Savings:					
Existing annual cost =	5,557	mmBtu *	$15.566	$/mmBtu =	**$86,499**
Proposed annual cost =	4,895	mmBtu *	$5.696	$/mmBtu =	**$27,881**
			Annual cost savings =		**$58,618**

Implementation Cost Notes:

Assumptions
Heat exchangers are redundant, so only one is operating at a time.
Redundant heat exchanger remains on hot water loop for periods when gas is interrupted (cusomter assumed 30% of time)

Material and labor installation costs:	Qty	$ Each Instal	Total $	Reference
Install natural gas high efficiency DHW boilers, 319 MBH each	7	$34,800	$243,600	Vendor
	Simple payback =		4.2	years

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 Fuel Oil Boiler - DHW Load

Alternative: ECM 2 - Install Natural Gas DHW Boilers

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCLEC\Utility Bills\BLCC5\BLCC5 - UCLEC - ECM-2 v.2.xml
Date of Study:	Tue Sep 17 09:05:55 EDT 2019
Project Name:	Ulster County Law Enforcement Center
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	$243,600	-$243,600
Future Costs:			
Energy Consumption Costs	$2,285,295	$928,040	$1,357,256
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)	$2,285,295	$928,040	$1,357,256
Total PV Life-Cycle Cost	$2,285,295	$1,171,640	$1,113,656

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$1,357,256
- Increased Total Investment	$243,600

Net Savings $1,113,656

Savings-to-Investment Ratio (SIR)

SIR = 5.57

Adjusted Internal Rate of Return

AIRR = 9.07%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 4

Discounted Payback occurs in year 5

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	5,557.1 MBtu	0.0 MBtu	5,557.1 MBtu	161,136.9 MBtu
Natural Gas	0.0 MBtu	4,895.0 MBtu	-4,895.0 MBtu	-141,938.2 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Annual Consumption Base Case	Alternative	Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	5,557.1 MBtu	0.0 MBtu	5,557.1 MBtu	161,136.9 MBtu
Natural Gas	0.0 MBtu	4,895.0 MBtu	-4,895.0 MBtu	-141,938.2 MBtu

Emissions Reduction Summary

Energy Type	Average Annual Emissions Base Case	Alternative	Reduction	Life-Cycle Reduction
Distillate Fuel Oil (#1, #2)				
CO2	403,308.33 kg	0.00 kg	403,308.33 kg	11,694,561.26 kg
SO2	2,884.96 kg	0.00 kg	2,884.96 kg	83,654.03 kg
NOx	363.55 kg	0.00 kg	363.55 kg	10,541.77 kg
Natural Gas				
CO2	0.00 kg	258,565.36 kg	-258,565.36 kg	-7,497,510.65 kg
SO2	0.00 kg	2,086.70 kg	-2,086.70 kg	-60,507.28 kg
NOx	0.00 kg	216.93 kg	-216.93 kg	-6,290.36 kg
Total:				
CO2	403,308.33 kg	258,565.36 kg	144,742.96 kg	4,197,050.61 kg
SO2	2,884.96 kg	2,086.70 kg	798.26 kg	23,146.75 kg
NOx	363.55 kg	216.93 kg	146.62 kg	4,251.41 kg

UCLEC Boiler Replacement		
Ulster County Law Enforcement Center	**380 Boulevard Kingston, NY 12402**	
ECM 3 - Install Biomass Boiler with Condensing HHW Natural Gas Boiler		
Existing Boiler Input Capacity (MBH ea.):		**12,263**
Proposed Boiler Plant Input Capacity (MBH ea.):		**12,263**
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, Natural Gas:		**100,000**
Btus per Ton Pellets Conversion Factor:		**16,000,000**
Therms per Gallon #2 Fuel Oil		**1.396**
Existing Boiler Efficiency (assumed system)		**78%**
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%**
$/therm #2 fuel oil	**$**	**1.56**
$/therm biomass (pellets)	**$**	**1.88**
$/ton biomass (pellets)	**$**	**300**
$/therm natural gas (proposed)	**$**	**0.86**
#2 Fuel Oil Savings (mmBtu)		**9,701**
Natural Gas Savings (proposed usage, mmBtu)		**(3,456)**
Biomass Savings (proposed usage, mmBtu)		**(5,279)**
Net mmBtu Savings		**966**
#2 Fuel Oil Cost Savings		**$151,000**
Natural Gas Cost		**-$29,759**
Biomass Cost		**-$98,982**
Net Total Cost Savings ($)		**$22,258**

Notes:
For this example, the proposed boiler plant is assumed 100% of existing boiler capacity. Actual capacities to be determined at design.
Is also assumed that an interruptible natural gas service could not be used with this system.

Determine Existing Boiler Heating Usage:

Usage was analyzed using utility billing data from 1/9/2018 to 12/14/2018

Assumptions and Approach:

1. The model of heating energy usage is based on fuel oil delivery records and boiler room logs.
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 @57°F base
1/1/2005	1:00	35.6	21.4
1/1/2005	2:00	33.8	23.2
1/1/2005	3:00	37.4	19.6
1/1/2005	4:00	39.2	17.8
1/1/2005	5:00	33.8	23.2
1/1/2005	6:00	46.4	10.6
1/1/2005	7:00	35.6	21.4
1/1/2005	8:00	44.6	12.4
1/1/2005	9:00	44.6	12.4
1/1/2005	10:00	51.8	5.2
1/1/2005	11:00	53.6	3.4
1/1/2005	12:00	55.4	1.6
1/1/2005	13:00	53.6	3.4
1/1/2005	14:00	51.8	5.2
1/1/2005	15:00	50	7.0
...	...	...	...

Regression analysis results:
therms/day = 23.4488 therms/HDD57 + 152.2483 therms/day
Note: Only the slope is used for the HHW boiler analysis; the intercept is for ECM 2 DHW

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 = 18.2900 therms/HDD57

Therms Usage by Regression -- Building Load Excerpt:

Date	Time	Therms
1/1/2005	1:00	16.3
1/1/2005	2:00	17.7
1/1/2005	3:00	14.9
1/1/2005	4:00	13.6
1/1/2005	5:00	17.7
1/1/2005	6:00	8.1
1/1/2005	7:00	16.3
1/1/2005	8:00	9.4
1/1/2005	9:00	9.4
1/1/2005	10:00	4.0
1/1/2005	11:00	2.6
1/1/2005	12:00	1.2
1/1/2005	13:00	2.6
1/1/2005	14:00	4.0
…	…	…

Building Load

Total Sum - Therms Monthly:	
Jan	18,505
Feb	14,535
Mar	8,717
Apr	4,582
May	1,608
Jun	338
Jul	41
Aug	252
Sep	796
Oct	5,370
Nov	6,688
Dec	14,234
Total	75,667

In a year of typical weather, existing system builidng load was estimated to be
75,667 therms

Apply 8760 hour model to existing system usage in a year of typical weather:
Hourly usage = hourly load / existing efficiency (78%)

Therms Usage by Regression -- Existing Excerpt:

Date	Time	Therms
1/1/2005	1:00	20.9
1/1/2005	2:00	22.7
1/1/2005	3:00	19.1
1/1/2005	4:00	17.4
1/1/2005	5:00	22.7
1/1/2005	6:00	10.4
1/1/2005	7:00	20.9
1/1/2005	8:00	12.1
1/1/2005	9:00	12.1
1/1/2005	10:00	5.1
1/1/2005	11:00	3.3
1/1/2005	12:00	1.6
1/1/2005	13:00	3.3
1/1/2005	14:00	5.1
1/1/2005	15:00	6.8
…	…	…

Existing NG Usage

Total Sum - Therms Monthly:	
Jan	23,724
Feb	18,635
Mar	11,175
Apr	5,874
May	2,062
Jun	434
Jul	52
Aug	323
Sep	1,021
Oct	6,884
Nov	8,575
Dec	18,249
Total	97,008

In a year of typical weather, existing system usage was estimated to be
97,008 therms

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 =	57	F
OAT below which condensing stops =	20	F

OAT	effic		
20	85%	m=	0.00243
58	94%	b=	0.80135

Therms Usage -- Proposed Excerpt:

		Biomass Boiler:		Condensing Boiler:		Total
Date	Time	Efficiency	Therms	Efficiency	Therms	Therms
1/1/2005	1:00	86%	11.4	89%	7.3	18.7
1/1/2005	2:00	86%	12.3	88%	8.0	20.3
1/1/2005	3:00	86%	10.4	89%	6.7	17.1
1/1/2005	4:00	86%	9.5	90%	6.1	15.5
1/1/2005	5:00	86%	12.3	88%	8.0	20.3
1/1/2005	6:00	86%	5.6	91%	3.5	9.2
1/1/2005	7:00	86%	11.4	89%	7.3	18.7
1/1/2005	8:00	86%	6.6	91%	4.2	10.7
1/1/2005	9:00	86%	6.6	91%	4.2	10.7
1/1/2005	10:00	86%	2.8	93%	1.7	4.5
1/1/2005	11:00	86%	1.8	93%	1.1	2.9
1/1/2005	12:00	86%	0.9	94%	0.5	1.4
1/1/2005	13:00	86%	1.8	93%	1.1	2.9
1/1/2005	14:00	86%	2.8	93%	1.7	4.5
...	...	...	...	...	...	...

Proposed Usage

Total Sum - Therms Monthly:		
	Biomass	Boiler
Jan	12,910	8,590
Feb	10,141	6,730
Mar	6,081	3,933
Apr	3,197	2,039
May	1,122	703
Jun	236	146
Jul	28	17
Aug	176	109
Sep	556	347
Oct	3,746	2,394
Nov	4,666	3,008
Dec	9,931	6,539
Totals	52,791	34,555

Savings Summary

System	Usage		Costs	
	Therms	Pellets (Tons)		*Fuel Switches:*
Existing:	97,008		$151,000	*#2 fuel oil*
Proposed:				
Biomass	52,791	329.94	$98,982	*pellets*
Cond boiler	34,555		$29,759	*natural gas*
Savings	**9,663**	**(329.94)**	**$22,258**	

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 Fuel Oil Boiler

Alternative: ECM 3 - Install Biomass Boiler with Condensing HHW Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCLEC\Utility Bills\BLCC5\BLCC5 - UCLEC v.2.xml
Date of Study:	Tue Sep 17 11:23:40 EDT 2019
Project Name:	Ulster County Law Enforcement Center
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	$440,200	-$440,200
Future Costs:			
Energy Consumption Costs	$3,989,428	$2,532,174	$1,457,254
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)	$3,989,428	$2,532,174	$1,457,254
Total PV Life-Cycle Cost	$3,989,428	$2,972,374	$1,017,054

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$1,457,254
- Increased Total Investment	$440,200

Net Savings	$1,017,054

Savings-to-Investment Ratio (SIR)

SIR = 3.31

Adjusted Internal Rate of Return

AIRR = 7.19%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 8

Discounted Payback occurs in year 9

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	9,701.0 MBtu	0.0 MBtu	9,701.0 MBtu	281,295.8 MBtu
Natural Gas	0.0 MBtu	3,456.0 MBtu	-3,456.0 MBtu	-100,212.2 MBtu
Coal	0.0 MBtu	5,279.0 MBtu	-5,279.0 MBtu	-153,072.9 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	9,701.0 MBtu	0.0 MBtu	9,701.0 MBtu	281,295.8 MBtu
Natural Gas	0.0 MBtu	3,456.0 MBtu	-3,456.0 MBtu	-100,212.2 MBtu
Coal	0.0 MBtu	5,279.0 MBtu	-5,279.0 MBtu	-153,072.9 MBtu

Emissions Reduction Summary

Energy Type	Average Base Case	Annual Alternative	Emissions Reduction	Life-Cycle Reduction
Distillate Fuel Oil (#1, #2)				
CO2	704,053.21 kg	0.00 kg	704,053.21 kg	20,415,133.58 kg
SO2	5,036.26 kg	0.00 kg	5,036.26 kg	146,034.40 kg
NOx	634.65 kg	0.00 kg	634.65 kg	18,402.71 kg
Natural Gas				
CO2	0.00 kg	182,554.01 kg	-182,554.01 kg	-5,293,441.63 kg
SO2	0.00 kg	1,473.27 kg	-1,473.27 kg	-42,719.74 kg
NOx	0.00 kg	153.16 kg	-153.16 kg	-4,441.16 kg
Coal				
CO2	0.00 kg	500,394.02 kg	-500,394.02 kg	-14,509,713.94 kg

SO2	0.00 kg	4,289.89 kg	-4,289.89 kg	-124,392.19 kg
NOx	0.00 kg	1,186.41 kg	-1,186.41 kg	-34,401.77 kg

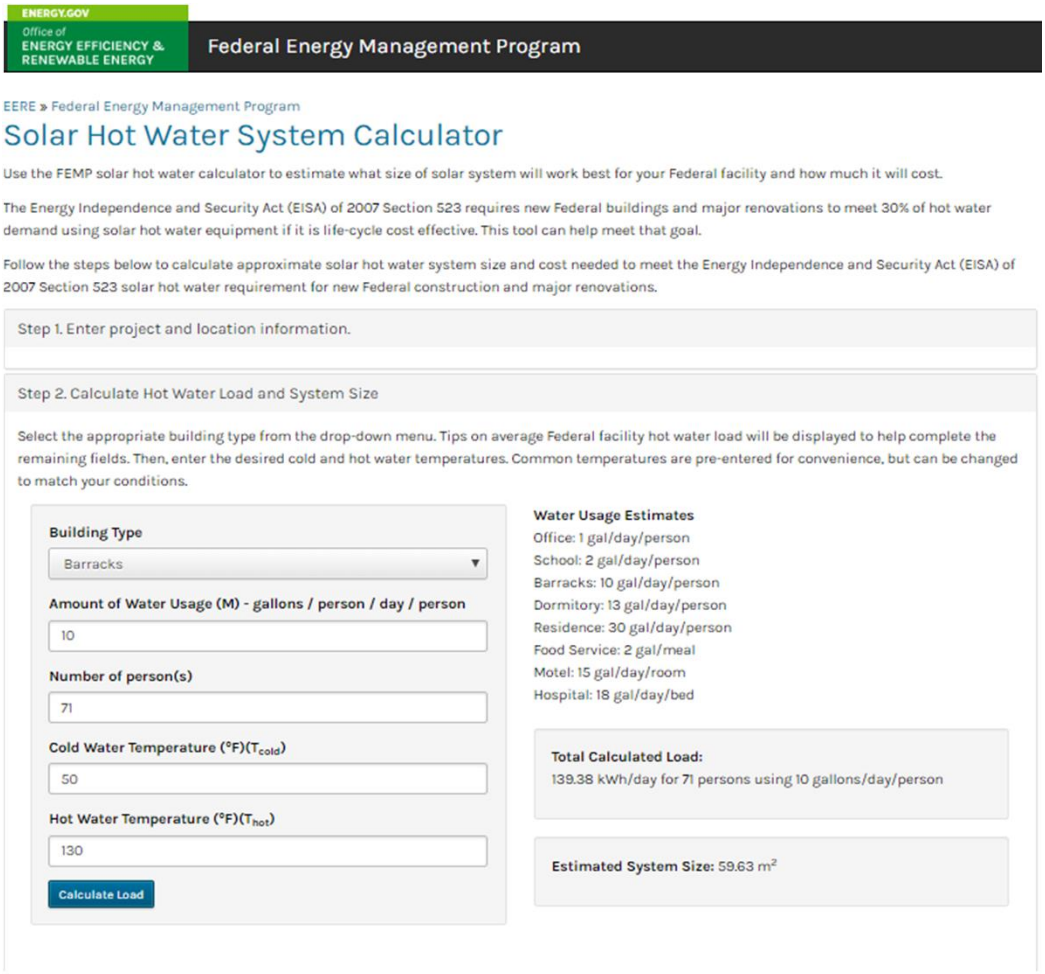
Total:

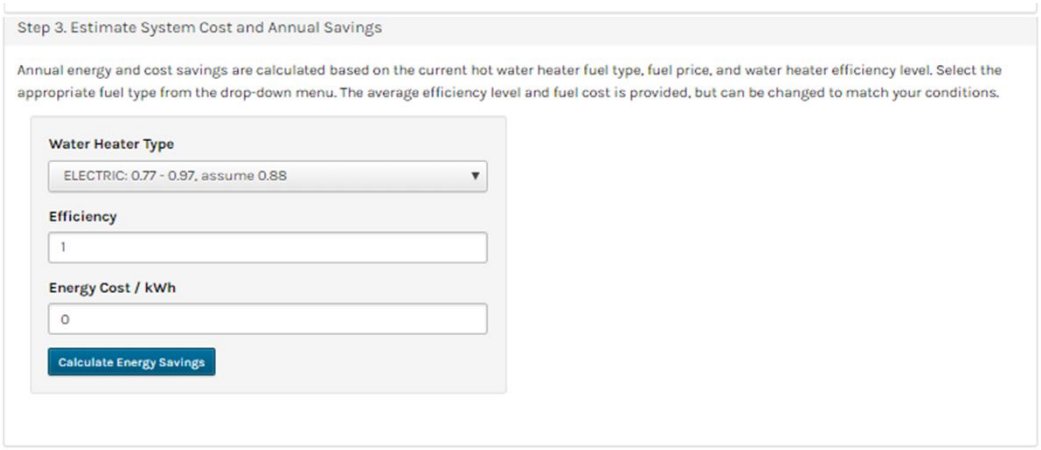
CO2	704,053.21 kg	682,948.03 kg	21,105.18 kg	611,978.00 kg
SO2	5,036.26 kg	5,763.16 kg	-726.90 kg	-21,077.54 kg
NOx	634.65 kg	1,339.57 kg	-704.92 kg	-20,440.23 kg

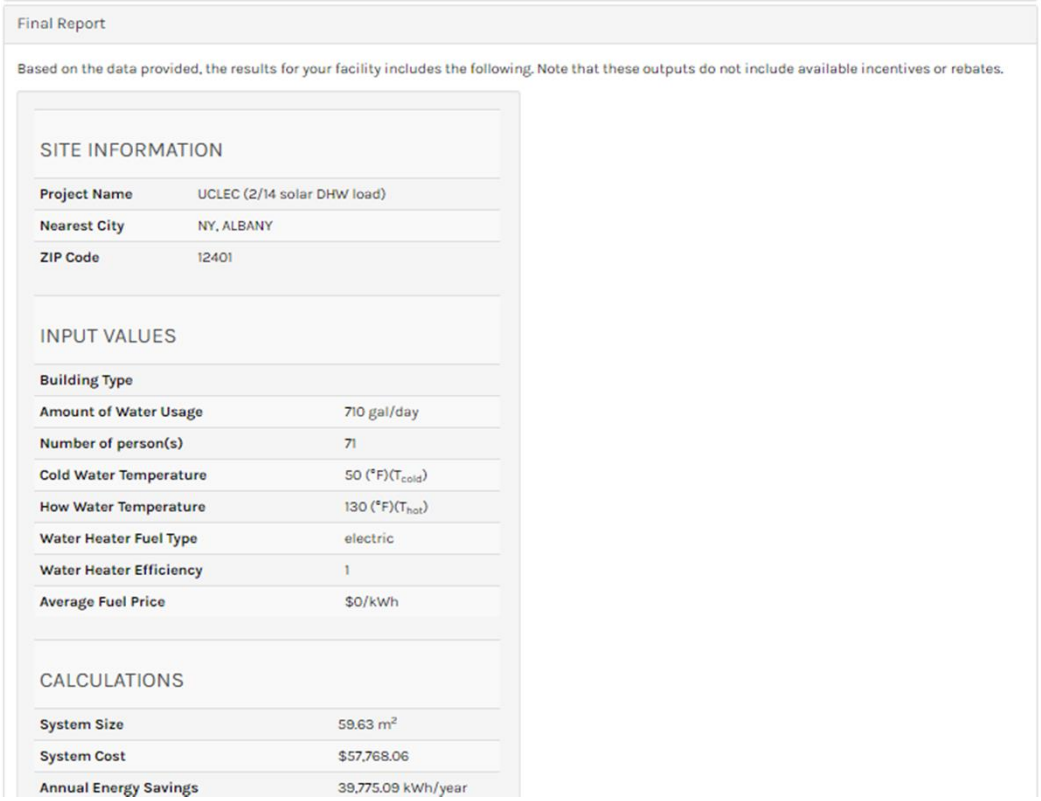
FA-PFS 1 - UCLEC SOLAR DHW SCREEN: REDUCED SOLAR LOAD

Goal: Re-run the analysis assuming the equivalent of only 4 of the 14 water heaters
% of usage = 4/14 = 14%

The on-line calculator estimates load based on gallons used/person/day
Original usage was 10 gallons/person/day
At 14% usage is equivalently reduced to 1.4 gallons/person/day
…rounded to 3 gallons/day (the calculator only inputs integers) -- 3 gallons crashes the calculator
…apply the reduction to the # of persons: 500 people * 14% = 71.4
or 71 people







Savings Summary

Calculator savings:	39,775	kWh
Conversion factor:	3,413	Btu/kWh
	0.003413	mmBtu/kWh

Solar mmBtu savings = 136

Gas interrupted 30% of time

2 fuel oil boiler savings:

Efficiency	85.15%	
	48 mmBtu's	
	$15.566 $/mmBtu #2 fuel oil	
Cost savings =	$744	#2 oil

Natural gas (fuel switch) savings:

Efficiency	85.15%	
	95 mmBtu's	
	$5.700 $/mmBtu natural gas	nat gas
Cost savings =	$542	

UCLEC Boiler Replacement		
Ulster County Law Enforcement Center	**380 Boulevard Kingston, NY 12402**	
FA ECM 1 - Install Condensing HHW Natural Gas Boiler		
Existing Boiler System Capacity (Plant):		**36,789**
Proposed Condensing Boiler Input Capacity (MBH ea.):		**10,000**
Proposed Non-Condensing Boiler Input Capacity (Remaining Plant):		**26,789**
Bin Temp at Which 100% Load Occurs (deg F)		**2.5**
Bin Temp for Balance Point		**57.5**
Boiler Availability:		**Year Round**
Btus per Therm Conversion Factor, Natural Gas:		**100,000**
Therms per Gallon #2 Fuel Oil		**1.396**
Existing Boiler Efficiency (assumed system)		**78%**
Proposed Condensing Boiler Efficiency (condensing above 50°F OSA)		**94%**
Proposed Boiler Efficiency (non-condensing below 50°F OSA)		**85%**
$/therm #2 fuel oil	**$**	**1.56**
$/therm natural gas (proposed) - assumed 30% interrupted	**$**	**0.57**
#2 Fuel Oil Savings (mmBtu)		**9,838**
Natural Gas Savings (proposed usage, mmBtu)		**(8,411)**
Net mmBtu Savings		**1,427**
#2 Fuel Oil Cost Savings	**$**	**153,138**
Natural Gas Cost (proposed)	**$**	**(47,907)**
Net Total Cost Savings ($)	**$**	**105,230**

Notes: For this example, heating and DHW loads are included and gas is interrupted 30% of the time, as per customer. Actual capacities to be determined at design.

Determine Existing Boiler Heating Usage:

Usage was analyzed using utility billing data from 1/9/2018 to 12/14/2018

Assumptions and Approach:

1. The model of heating energy usage is based on fuel oil delivery records and boiler room logs.
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 @57°F base
1/1/2005	1:00	35.6	21.4
1/1/2005	2:00	33.8	23.2
1/1/2005	3:00	37.4	19.6
1/1/2005	4:00	39.2	17.8
1/1/2005	5:00	33.8	23.2
1/1/2005	6:00	46.4	10.6
1/1/2005	7:00	35.6	21.4
1/1/2005	8:00	44.6	12.4
1/1/2005	9:00	44.6	12.4
1/1/2005	10:00	51.8	5.2
1/1/2005	11:00	53.6	3.4
1/1/2005	12:00	55.4	1.6
1/1/2005	13:00	53.6	3.4
1/1/2005	14:00	51.8	5.2
1/1/2005	15:00	50	7.0
…	…	…	…

FA ECM 1 - Install Condensing HHW Natural Gas Boiler

Regression analysis results:
therms/day = 23.4488 therms/HDD57 + 152.2483 therms/day
Note: Only the slope is used for the HHW boiler analysis; the intercept is for ECM 2 DHW

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Regression therms * Existing efficiency

Regression analysis results:
therms/day = 18.2900 therms/HDD57

Therms Usage by Regression -- Building Load Excerpt:

Date	Time	Therms
1/1/2005	1:00	21.3
1/1/2005	2:00	22.6
1/1/2005	3:00	19.9
1/1/2005	4:00	18.5
1/1/2005	5:00	22.6
1/1/2005	6:00	13.0
1/1/2005	7:00	21.3
1/1/2005	8:00	14.4
1/1/2005	9:00	14.4
1/1/2005	10:00	8.9
1/1/2005	11:00	7.5
1/1/2005	12:00	6.2
1/1/2005	13:00	7.5
1/1/2005	14:00	8.9
…	…	…

Building Load

Total Sum - Therms Monthly:	
Jan	22,186
Feb	17,860
Mar	12,398
Apr	8,149
May	5,285
Jun	3,901
Jul	3,722
Aug	3,934
Sep	4,359
Oct	9,051
Nov	10,251
Dec	17,916
Total	119,012

In a year of typical weather, existing system builidng load was estimated to be
119,012 therms

Apply 8760 hour model to existing system usage in a year of typical weather:
Hourly usage = hourly load / existing efficiency (78%)

Therms Usage by Regression -- Existing Excerpt:

Date	Time	Therms
1/1/2005	1:00	27.3
1/1/2005	2:00	29.0
1/1/2005	3:00	25.5
1/1/2005	4:00	23.7
1/1/2005	5:00	29.0
1/1/2005	6:00	16.7
1/1/2005	7:00	27.3
1/1/2005	8:00	18.5
1/1/2005	9:00	18.5
1/1/2005	10:00	11.4
1/1/2005	11:00	9.7
1/1/2005	12:00	7.9
1/1/2005	13:00	9.7
1/1/2005	14:00	11.4
1/1/2005	15:00	13.2
…	…	…

Existing NG Usage

Total Sum - Therms Monthly:	
Jan	28,444
Feb	22,898
Mar	15,895
Apr	10,448
May	6,775
Jun	5,001
Jul	4,772
Aug	5,043
Sep	5,588
Oct	11,604
Nov	13,142
Dec	22,969
Total	152,579

In a year of typical weather, existing system usage was estimated to be
152,579 therms

FA ECM 1 - Install Condensing HHW 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 =	57	F
OAT below which condensing stops =	50	F

Gas is assumed to be interrupted 30% of the time (switch to 85% of oil boiler).

OAT	effic		
50	85%	m=	0.01286
58	94%	b=	0.20714

Therms Usage -- Proposed Excerpt:

Date	Time	NG Condensing Boiler:		Oil Fired Boiler:	
1/1/2005	1:00	Efficiency	Total Therms	Efficiency	Total Therms
1/1/2005	2:00	85%	8.2	85%	16.8
1/1/2005	3:00	85%	8.2	85%	18.4
1/1/2005	4:00	85%	8.2	85%	15.2
1/1/2005	5:00	85%	8.2	85%	13.5
1/1/2005	6:00	85%	8.2	85%	18.4
1/1/2005	7:00	85%	8.2	85%	7.1
1/1/2005	8:00	85%	8.2	85%	16.8
1/1/2005	9:00	85%	8.2	85%	8.7
1/1/2005	10:00	85%	8.2	85%	8.7
1/1/2005	11:00	87%	7.1	85%	3.1
1/1/2005	12:00	90%	5.9	85%	2.7
1/1/2005	13:00	92%	4.7	85%	2.2
1/1/2005	14:00	90%	5.9	85%	2.7
1/1/2005	15:00	87%	7.1	85%	3.1
...	...	...	...	...	...

Proposed Boiler Usage

Total Sum - Therms Monthly:		
	NG Condensing	Oil Fired
Jan	6,072	20,023
Feb	14,700	6,304
Mar	10,157	4,376
Apr	6,589	2,876
May	4,130	1,865
Jun	2,944	1,377
Jul	2,776	1,314
Aug	2,961	1,388
Sep	3,344	1,538
Oct	7,334	3,194
Nov	8,358	3,618
Dec	14,745	6,323
Totals	84,110	54,197

Savings Summary

System	Usage	Costs	*Fuel Switch:*
	(Therms)		
Existing	152,579	$ 237,499	*#2 fuel oil*
Proposed:	84,110	$ 47,907	*natural gas*
	54,197	$ 84,361	*#2 fuel oil*
Savings	**14,272**	**$ 105,230**	

NIST BLCC 5.3-18: Comparative Analysis

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

Base Case: FA (3) Existing Fuel Oil Boilers

Alternative: FA ECM 1 - Install Condensing HHW Natural Gas Boiler

General Information

File Name:	C:\Users\Bkelly\Documents\Projectfiles\Projects\FlexTech\L&SReports\Ulster County\UCLEC\Utility Bills\BLCC5\BLCC5 - UCLEC v.2.xml
Date of Study:	Tue Sep 17 11:09:53 EDT 2019
Project Name:	Ulster County Law Enforcement Center
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	$1,010,200	-$1,010,200
Future Costs:			
Energy Consumption Costs	$6,274,641	$3,285,701	$2,988,940
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)	$6,274,641	$3,285,701	$2,988,940
Total PV Life-Cycle Cost	$6,274,641	$4,295,901	$1,978,740

Net Savings from Alternative Compared with Base Case

PV of Non-Investment Savings	$2,988,940
- Increased Total Investment	$1,010,200

Net Savings	$1,978,740

Savings-to-Investment Ratio (SIR)

SIR = 2.96

Adjusted Internal Rate of Return

AIRR = 6.79%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 7

Discounted Payback occurs in year 9

Energy Savings Summary

Energy Savings Summary (in stated units)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	15,257.9 MBtu	5,419.7 MBtu	9,838.2 MBtu	285,274.1 MBtu
Natural Gas	0.0 MBtu	8,411.0 MBtu	-8,411.0 MBtu	-243,890.2 MBtu

Energy Savings Summary (in MBtu)

Energy Type	Average Base Case	Annual Alternative	Consumption Savings	Life-Cycle Savings
Distillate Fuel Oil (#1, #2)	15,257.9 MBtu	5,419.7 MBtu	9,838.2 MBtu	285,274.1 MBtu
Natural Gas	0.0 MBtu	8,411.0 MBtu	-8,411.0 MBtu	-243,890.2 MBtu

Emissions Reduction Summary

Energy Type	Average Base Case	Annual Alternative	Emissions Reduction	Life-Cycle Reduction
Distillate Fuel Oil (#1, #2)				
CO2	1,107,347.02 kg	393,336.48 kg	714,010.54 kg	20,703,862.20 kg
SO2	7,921.12 kg	2,813.63 kg	5,107.49 kg	148,099.74 kg
NOx	998.19 kg	354.56 kg	643.63 kg	18,662.98 kg
Natural Gas				
CO2	0.00 kg	444,288.72 kg	-444,288.72 kg	-12,882,852.31 kg
SO2	0.00 kg	3,585.55 kg	-3,585.55 kg	-103,968.68 kg
NOx	0.00 kg	372.76 kg	-372.76 kg	-10,808.63 kg
Total:				
CO2	1,107,347.02 kg	837,625.20 kg	269,721.83 kg	7,821,009.88 kg
SO2	7,921.12 kg	6,399.18 kg	1,521.94 kg	44,131.06 kg
NOx	998.19 kg	727.32 kg	270.87 kg	7,854.35 kg

Appendix C – ECM Cost Estimates

L&S Energy Services, Inc.

Project Name: **Ulster County Law Enforcement Center**
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							$406,817	https://apps1.eere.energy.gov/femp/solar_hotwater_system/
	Total					$0	$0	$406,817	

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 Law Enforcement Center**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: PFS 2 - Install Cooling Energy Thermal 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 Law Enforcement Center**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: ECM 1 - Install a HHW Condensing Boiler

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demolition of existing heating equipment (1 boiler, keep the other two for backup)	1	ea	$24,100	$0	$24,100	$0	$24,100	RSMeans 2018 Mechanical 23 05 05.10 0390
	Install new 8000 MBH nat gas condensing boiler	1	ea					$195,000	Vendor quote for installed price
	Central Hudson Gas Service	1	ea					$220,000	Customer
	Total							$439,100	

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 Law Enforcement Center**
Project No.:
Calculated by: MS
Checked by:

Sheet No: 1 of 1
Date:
Date:

Measure: ECM 2 - Install Natural Gas DHW Boilers

Div.	Description	Qty.	Unit			Material Cost Each	Installed Cost Each	Total	Ref.
	Install natural gas high efficiency DHW boilers, 319 MBH each	7	ea			$24,800	$10,000	$243,600	vendor quote
	Total							$243,600	

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 Law Enforcement Center**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: ECM 3 - Install Biomass Boiler with HHW Condensing Boiler

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demolition of existing equipment	2	ea	$24,100	$0	$48,200	$0	$48,200	Mechanical 23 05 05.10 0390
	Install a 4430 MBH pellet boiler	1	ea					$307,000	Vendor installed cost
	Install an ancillary condensing natural gas boiler, 3600 MBH	1	ea					$85,000	Vendor installed cost
	Total							$440,200	

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 Law Enforcement Center**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: FA PFS 1 - Install Solar Thermal DHW

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Solar DHW - Capacity to offset WH-7 and WH-7A							$58,117	https://apps1.eere.energy.gov/femp/solar_hotwater_system/
	Total					$0	$0	$58,117	

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 Law Enforcement Center**
Project No.:
Calculated by: MS
Checked by:
Sheet No: 1 of 1
Date:
Date:

Measure: FA ECM 1 - Install a HHW Condensing Boiler

Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Demo of Existing boilers	3	ea	$6,000		$18,000		$18,000	GPI
	Install new 300 HP nat gas condensing boiler	1	ea					$211,200	GPI
	Install new 300 HP dual fuel non-condensing boilers	2	ea					$558,000	GPI
	Venting	3	ea		$1,000		$3,000	$3,000	GPI
	including an allowance for demo and new venting.								
	Central Hudson Gas Service	1	ea					$220,000	Customer
	Total							$1,010,200	

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

Appendix D – CHP pre-feasibility Model and NYSERDA/NYPA Geothermal Clean Energy Challenge Results

CHP Pre-Feasibility Model Results

Summary of Savings

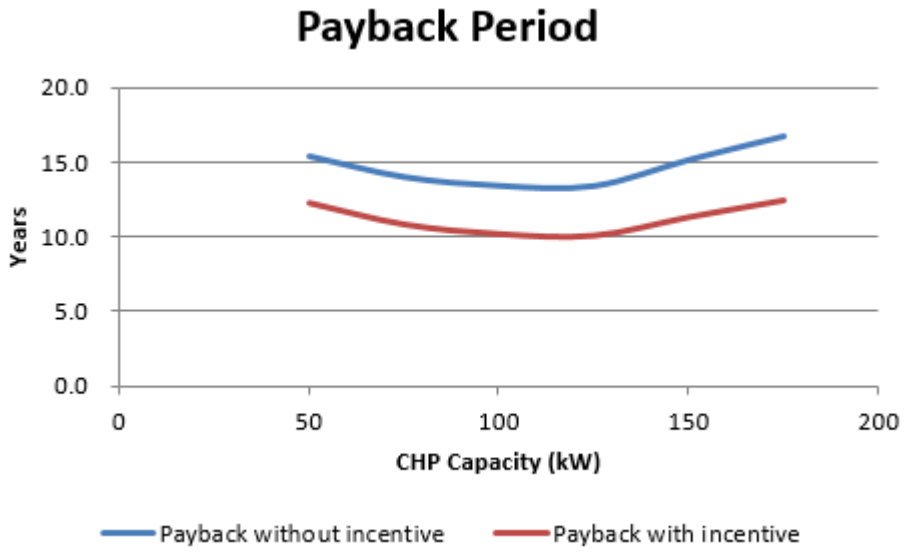
Facility	Variable Cost	Fixed Cost	Total Cost	kWh Rate	Summer kW Rate	Winter kW Rate	Gas Rate	CHP Gas Rate	Annual kWh	Peak Demand	Annual MMBtu	Optimal Size	Payback	Net annual cost savings	kWh savings	offset gas (MMBtu)	CO2 Savings
Ulster County Law Enforcement Center	$4,500	$100,000	$550,000	$0.083	$8.68	$8.49	$11.84	$7.50	4,929,057	948	16,311	100-125	13.5	$40,820	809,048	5,805	164,646
	$4,000	$75,000	$475,000										11.6	$40,820	809,048	5,805	164,646
Ulster County Law Enforcement Center	$4,500	$100,000	$550,000	$0.083	$9.16	$9.16	$9.77	$7.00	4,929,057	948	16,311	100-125	16.0	$34,474	809,048	5,805	164,646
	$4,000	$75,000	$475,000										13.9	$34,256	809,048	5,805	164,646
Ulster County Law Enforcement Center	$4,500	$100,000	$550,000	$0.090	$9.50	$9.50	$10.50	$7.00	4,929,057	948	16,311	100-125	12.4	$44,353	809,048	5,805	164,646
	$4,000	$75,000	$475,000										10.7	$44,353	809,048	5,805	164,646

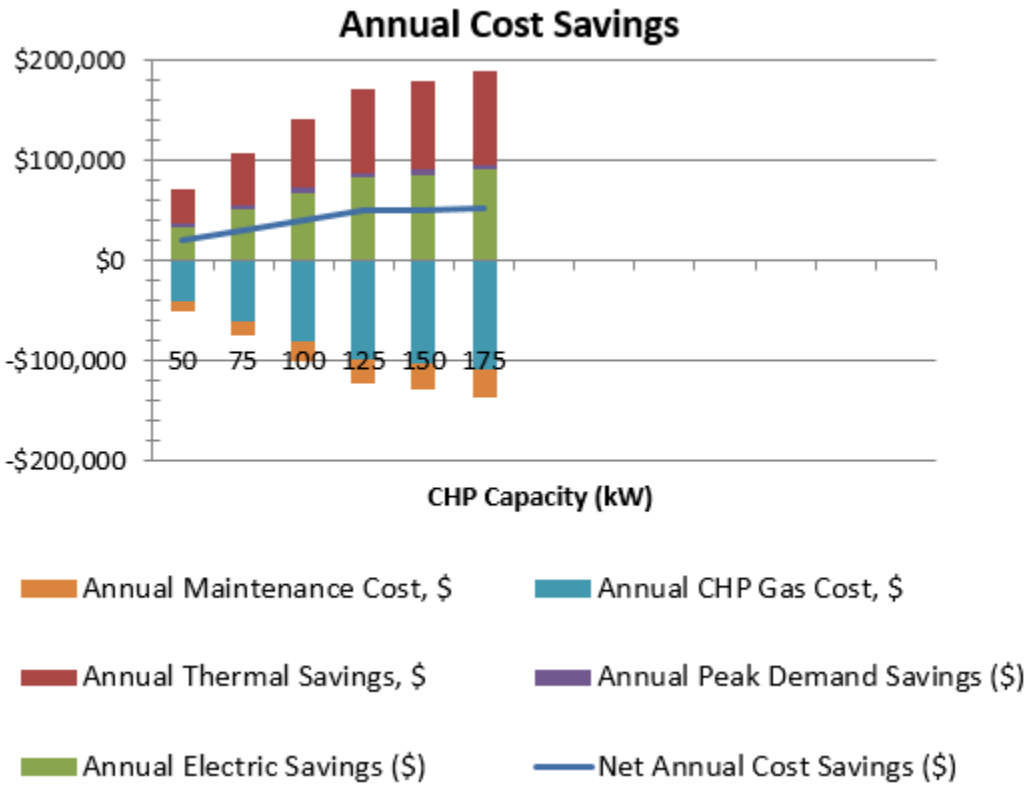
Option 1 Tables

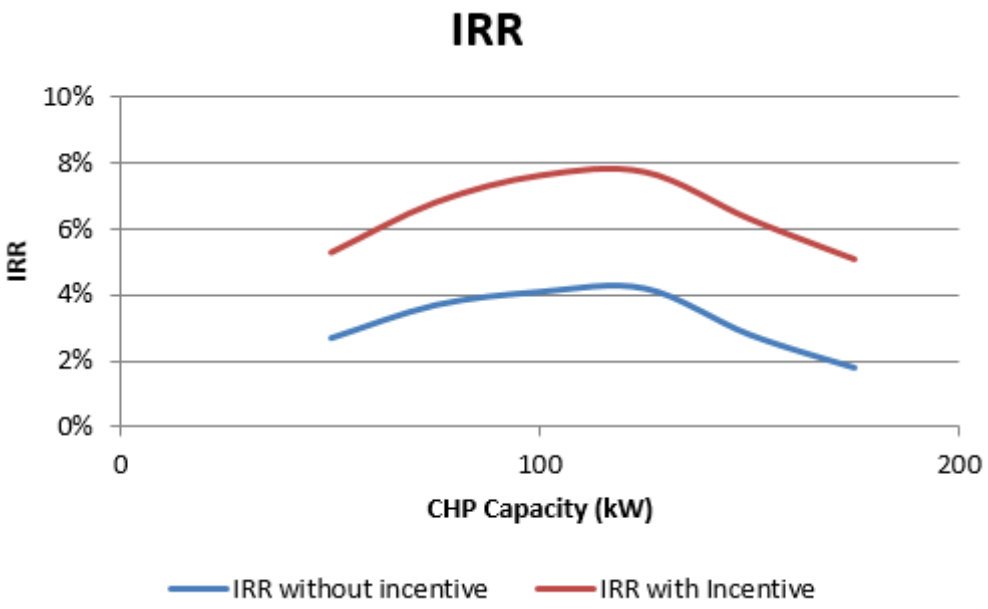
Memo Output	
Size min (kW)	75
Size max (kW)	150
Sample system size (kW)	100
System cost estimate	$550,000
Cost savings	$40,820
Payback period w/out Incentives (years)	13.5
NYSERDA incentive	$135,000
Payback period w/ incentives (years)	10.2

Summary Information of Selected System Size	
Estimated electric savings (kWh)	809,048
Estimated offset gas savings (MMBtu)	5,805
Estimated CHP gas consumption (MMBtu)	10,667
Estimated maintenance cost	$20,226
Annual hours of operation	8,516
Average summertime non-holiday weekday reduction in peak demand (9pm)	94
Average monthly demand reduction, kW	48
Annual electric demand savings	$4,941
Annual overall system efficiency	77.6%
Electrical efficiency	25.9%
Annual dump hours	0

Note: Incentive no longer available as discussed in "Discussion of CHP pre-feasibility model results" section above.



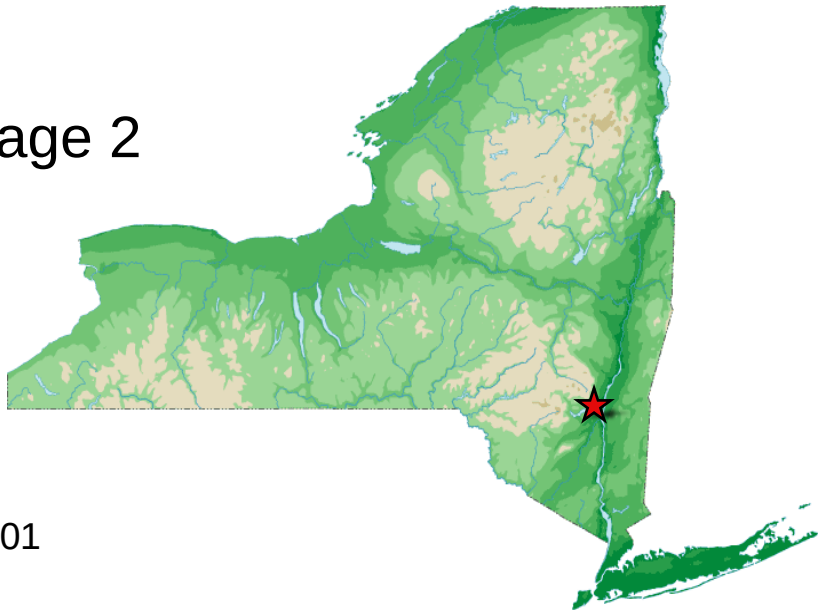

Annual Cost Savings
$200,000
$100,000
$0
-$100,000
-$200,000
50
75
100
125
150
175
CHP Capacity (kW)
Annual Maintenance Cost, $
Annual CHP Gas Cost, $
Annual Thermal Savings, $
Annual Peak Demand Savings ($)
Annual Electric Savings ($)
Net Annual Cost Savings ($)


IRR
10%
8%
6%
4%
2%
0%
IRR
0
100
200
CHP Capacity (kW)
IRR without incentive
IRR with Incentive

NEW YORK STATE OF OPPORTUNITY.

Geothermal Clean Energy Challenge

Advanced Report – Stage 2



Applicant: Ulster County

Address: 380 Boulevard
Kingston, NY 12401

Site Name: 380 Boulevard

Project Summary

This potential project was modeled as a single closed loop ground source heat pump (GSHP) system with 758 tons of cooling capacity that will serve the building listed on the next page with a total conditioned area of 277,000 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. Compared to the Stage 1 report, this fine-tuning led to a larger GSHP system being required (758 tons in Stage 2 vs. 632 tons in Stage 1), slightly lower annual energy cost savings, and higher capital costs for traditional HVAC that would be avoided with a GSHP system. The net effect of these changes was an approximately three-year increase in the period needed to pay back the GSHP investment in the Stage 2 report compared to Stage 1, primarily due to the higher capital costs necessitated by the larger GSHP system in Stage 2.

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 Law Enforcement Center (UCLEC)	Prison and Sheriff's Office	277,000

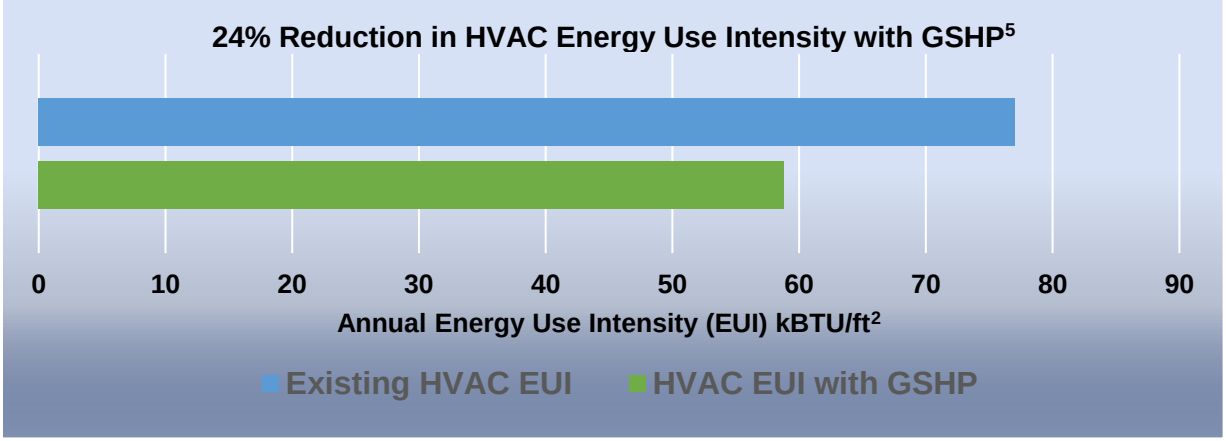
The tables below summarize the savings opportunities estimated for the site in terms of costs, energy and greenhouse gases when comparing the implementation of a ground source heat pump (GSHP) system to the existing (or planned) building HVAC systems.[1]

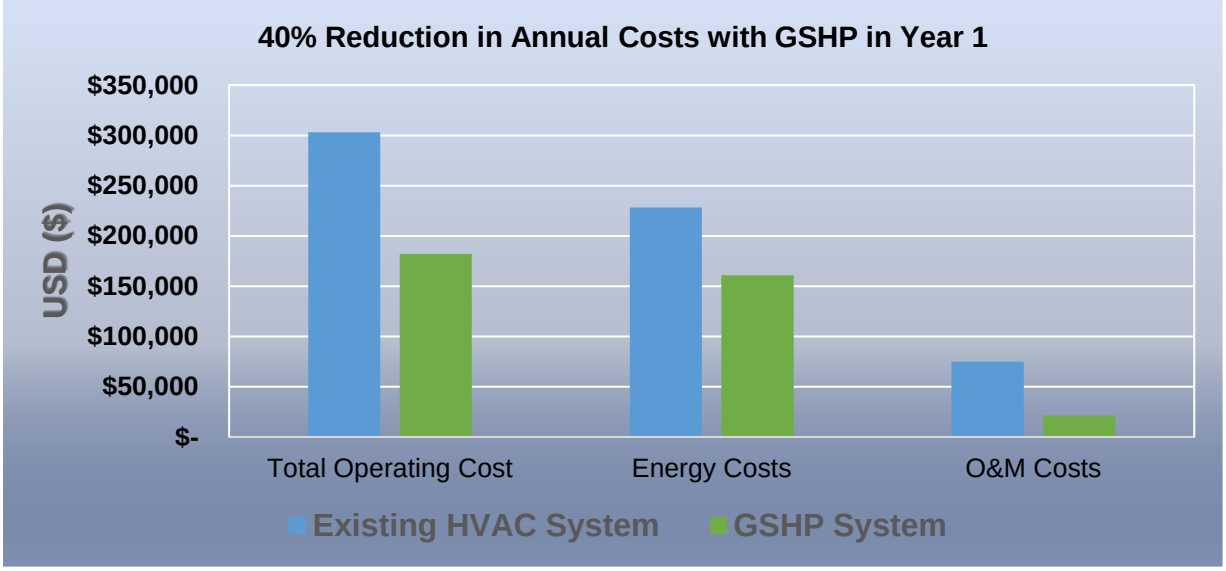
Note: the value of the carbon emissions included in the table is not directly monetizable by the applicant, but rather reflects the overall value to society provided by the reduced carbon emissions. The value is not used as a factor in the economic analysis in this report. However, the benefits to society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

Volumetric Savings / Increases	
Annual Propane Savings	0 gallons
Annual Fuel Oil Savings	107,348 gallons
Annual Natural Gas Savings	0 [1000 ft3]
Annual Electricity Increase	944,795 kWh
Annual GHG Emissions Reduction	877 metric tons (CO2e)
Cost Savings ($)	
Annual Energy Bill Savings	$ 67,599
Annual O&M Savings[2]	$ 53,475
Investments & Incentives[3] ($)	
Installed GSHP System Capital Costs (Est. Range)	$ 4,963,384 - $ 5,509,356
Avoided Capital Costs for Traditional HVAC System	$ 937,486
NYSERDA Incentive Payment for GSHP System	$ 500,000
Societal Value of Reduced Carbon Emissions[4]	$ 1,638,469

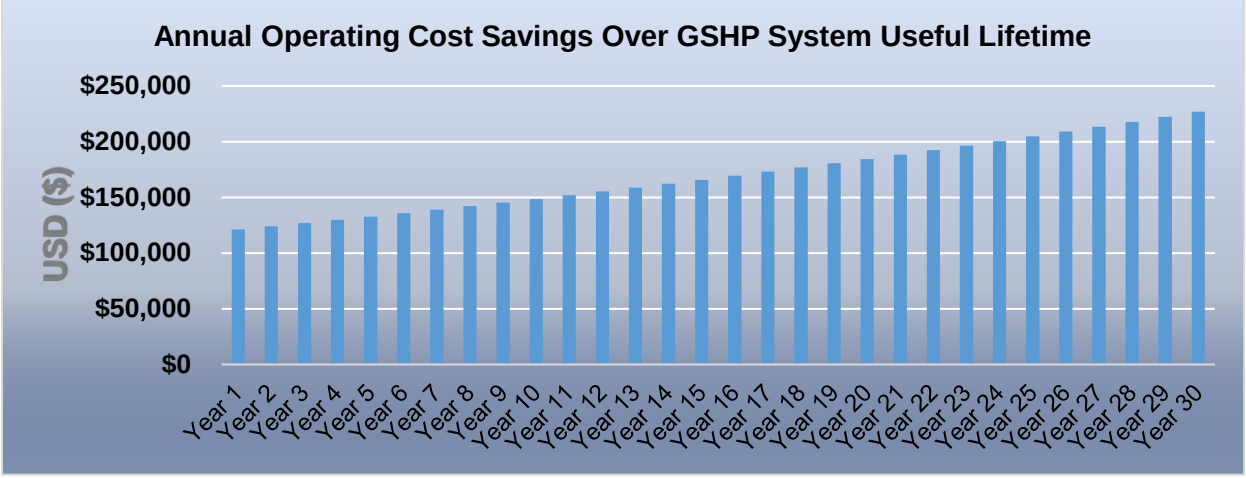
[1] The findings presented in this report are preliminary and should not be used as the sole basis for investment decisions.
[2] O&M savings include the savings associated with the avoided use of a cooling tower at the site.
[3] Estimated capital costs in this report reflect an expected range based on 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)	
25 - 27 years	22 – 25 years
GSHP Net Present Value (Estimated Range over 30-year life)	
(-$ 1,814,102) – (-$ 1,268,130)	(-$ 1,314,102) – (-$ 768,130)
GSHP Savings to Investment Ratio (Estimated Range)	
0.67 - 0.74	0.74 - 0.83



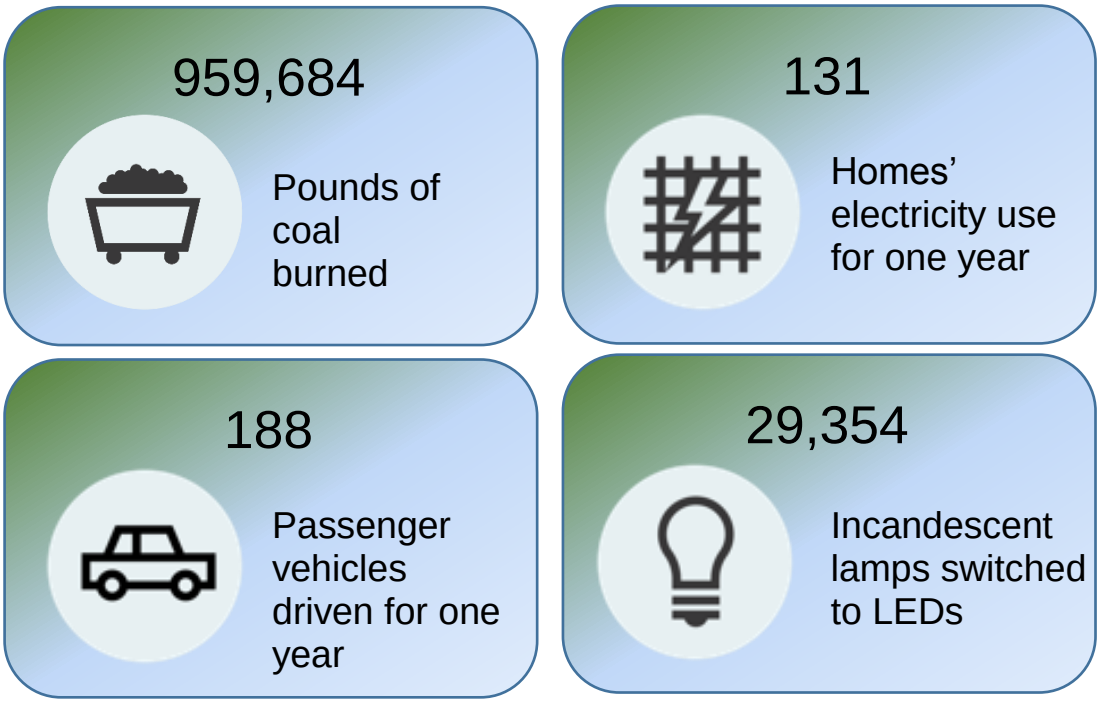


[5] Energy Use Intensity is calculated based on source energy and encompassing all the energy used in delivering energy to a site, including power generation, transmission and distribution losses. (https://www.governor.ny.gov/news/no-88-directing-state-agencies-and-authorities-improve-energy-efficiency-state-buildings)



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:

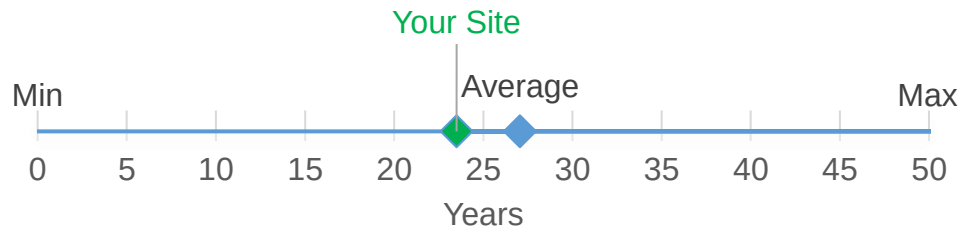
- NYPA's *Geothermal Clean Energy Challenge* website: https://www.nypa.gov/about/geothermalchallenge.
- NYSERDA's *Renewable Heating and Cooling Policy Framework*: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.

- 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.

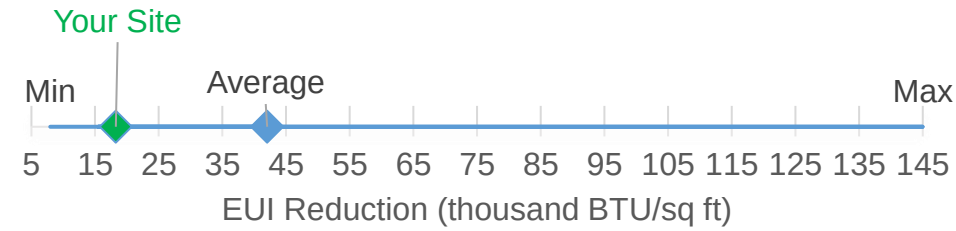
Site Specific Considerations and Selection Criteria

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.

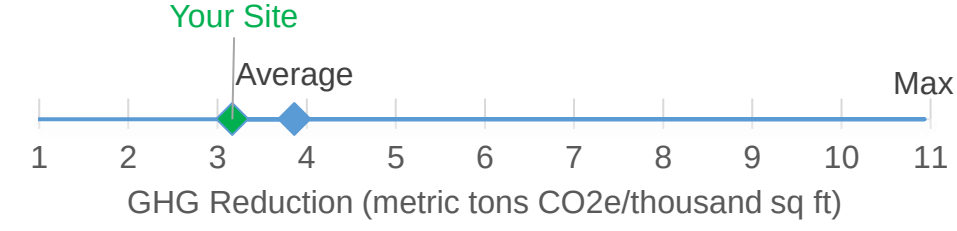
Simple Payback Comparison



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.