Ulster County 2021 Climate Smart Communities Recertification Documentation

PE4 Action: Renewable Energy Feasibility Studies

5 POINTS DOCUMENTED

Background: Ulster County has completed several feasibility studies at County-owned sites in the past 5 years.

- EPA Solar Screening Study at the Ulster County Quarryville site:

Renewable technologies assessed:	Study Level:
Solar PV	Screening study*

*Ulster County considers this study to be a feasibility study for solar PV as this site is currently in development. Additionally, a prior EPA screening study at multiple Ulster County landfills in 2014 led directly to development of one of the sites, which is currently operational. The only other feasibility work completed on that project was done by the developer prior to bidding on the project and by the County in the SEQR process.

- Heating and Cooling Master Plan at the Ulster County Office Building:
An energy audit was paired with feasibility studies of available heating and cooling technologies to develop a heating and cooling master plan.

Renewable technologies assessed:	Study Level:
Solar thermal DHW	Pre-feasibility study
Air source heat pumps	Pre-feasibility study
Cooling energy thermal storage	Pre-feasibility study
Biomass boiler	Feasibility study

- Heating and Cooling Master Plan at the Ulster County Law Enforcement Center (UCLEC):
An energy audit was paired with feasibility studies of available heating and cooling technologies to develop a heating and cooling master plan.

Renewable technologies assessed:	Study Level:
Solar thermal DHW	Pre-feasibility study
CHP	Pre-feasibility model
Cooling energy thermal storage	Pre-feasibility study
Biomass boiler	Feasibility study

- Geothermal Clean Energy Challenge study at the Ulster County Office Building:

Renewable technologies assessed:	Study Level:
Geothermal heating and cooling	Feasibility study

Documentation:

- EPA Solar Screening Study at the Ulster County Quarryville site
- Heating and Cooling Master Plans at the Ulster County Office Building and UCLEC
Available here: https://ulstercountyny.gov/environment/sustainability-energy/building-energy-benchmarking
- RFP for FlexTech Study at UC Office Building and UC Law Enforcement Center
- Geothermal Clean Energy Challenge study at the Ulster County Office Building
Available here: https://ulstercountyny.gov/environment/sustainability-energy/building-energy-benchmarking

United States Environmental Protection Agency

Solar Photovoltaic Screening Study - Siting Solar Photovoltaics at the Ulster County Former Tire Recycling Site, Saugerties, New York

Prepared by the Environmental Protection Agency, Region 2

October 2018

Acknowledgments:
We would like to thank Amanda LaValle, Coordinator of the Ulster County Department of the Environment, Nick Hvozda, Deputy Coordinator of the Ulster County Department of the Environment, and Ken Crannell, Deputy County Executive, for their assistance with facilitating the Ulster County Former Tire Recycling Site visit.

This report is to be used for screening purposes only.

Additional evaluations will need to be conducted to fully characterize the feasibility and economics of the Ulster County Former Tile Recycling Site for photovoltaic (PV) installation. Third party solar developers and local utility companies may have technical and financial interests in pursuing potential solar renewable energy projects and should perform additional solar assessments to determine if projects are economically viable.

While the Ulster County Former Tire Recycling Site has been screened for solar PV, the findings of this solar screening study should not be the sole basis for determining if a PV system at the site is viable. The results of this study are presented in an unbiased manner.

This study does not assess the environmental conditions at the site.

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I. Purpose of the Solar Screening Report

Through the U.S. EPA RE-Powering America's Land Initiative, EPA promotes the reuse of potentially contaminated properties, landfills, and mining sites for renewable energy generation. This initiative identifies the renewable energy potential of these sites and provides useful resources for communities, developers, industry, state and local governments or anyone interested in reusing these sites for renewable energy development. A list of RE-Powering America Initiative resources is provided at the end of this report (Section VIII) and can be found at http://www.epa.gov/oswercpa.

This solar screening report provides screening/preliminary information to assist the Ulster County officials in determining the potential for solar photovoltaic (PV) electricity generation at the Former Tire Recycling Site in Saugerties, New York. In general, the solar PV system represented in this report is a standalone system sized on proposed available area located at the Ulster County Former Tire Recycling Site. It should be noted that the viability of implementing a solar PV system is highly impacted by the available area for an array, solar resource, shading, operating status, distance to transmission lines, distance to major roads, favorable economic conditions, and community support.

II. Background

According the US Census, as of 2010, the town population in Saugerties is approximately 19,482 people. The Ulster County Former Tire Recycling Site is foreclosure eligible and the county is working through the necessary proceedings to obtain ownership of the land. The site is located off Quarry Road in Saugerties, New York (35 Quarry Road, Saugerties, 12477); it runs on either side of Quarry Road and is situated approximately a half of a mile north of New York Route 32. The site was operated as an illegal tire dump and stockpiles of waste tires were subsequently removed by New York State. A Phase II Environmental Site Assessment was completed in 2017 at the Site by The Chazen Companies, contracted by Ulster County. The assessment found no soil or groundwater contamination at the Site and recommended no further engineering or institutional controls be implemented. However, other site conditions (including burned building remnants) and environmental liens have proven to be significant barriers to any redevelopment of the Site. A copy of the report can be provided by the Ulster County Department of the Environment.

For more information about the Site and to obtain a copy of the Phase II assessment, contact Amanda LaValle, Coordinator of the Ulster County Department of the Environment, via email at environment@co.ulster.ny.us or via phone at (845) 388 – 7287.

III. Solar PV System Overview

Major System Components - A typical PV system is made up of several key components including:

- PV modules,
- Inverters and
- Balance-of-System components (including mounting racks, hardware for the panels, and wiring for electrical connections). Electrical connections (including wiring, disconnect switches, fuses, and breakers) are required to meet electrical code (e.g., NEC Article 690) for both safety and equipment protection.

In most traditional applications, wiring from the arrays to inverters and inverters to point of interconnection is generally run as direct burial through trenches or above ground using water/gas proof electrical conduits.

Additional information about solar PV systems can be reviewed in Attachment #3.

Figure 1. Town of Ulster Landfill, NY – Ulster County Executive Michael P. Hein
https://www.youtube.com/watch?v=likSbeKXrCY

Figure 2. Fixed Axis Solar PV Array on a ballasted concrete foundation at the Town of Beacon Landfill, NY.

IV. Solar PV Siting Considerations/Assessment

Siting Considerations

On March 28, 2018, the U.S. Environmental Protection Agency, Region 2 (EPA) team, in cooperation with Ulster County representatives from the Department of the Environment, visited and screened the site for potential solar photovoltaic (PV) renewable energy generation. In general, a minimum of 2 usable acres is recommended to site PV systems. Usable acreage is typically characterized as "flat to gently sloping" southern exposures that are free from obstructions and get full sun for at least a 6-hour period each day. Other considerations for siting land for solar PV generation include:

Table 1. Siting Considerations for Solar Photovoltaics

Siting Concerns	Looking for
Site topography	Existing flat area and surface stability for the PV Array.
Surface and vegetative conditions	Well maintained vegetative cover with minimum soil erosion concerns. Need to have existing storm water controls.
Shading/physical sunlight obstructions	Open area with minimum shading from trees and existing on-site buildings in order to maximize sunlight on each solar panel.
Available access roads and close distance to highways/developed roads	Developed roads and easy access for material shipment and to support heavy construction vehicles entering the site.
Distance to available electrical transmission lines	Nearby utility lines to interconnect with the proposed solar PV system. Longer distance will have cost and efficiency impacts.
Nearby natural resources	Nearby wetlands or streams/water bodies. Be aware of any potential flooding concerns and existing endangered species inhabiting the site.
Town restrictions	Any specific local codes requirements/restrictions and future land reuse established by the municipality.

During the site visit, the EPA solar team screened for available flat and open area, free from sunlight obstruction and suitable to support solar panels. The EPA solar team also used a Solmetric SunEye[1] solar path calculator to assess shading at particular locations by analyzing the sky view where solar panels can be potentially located. By finding the solar access, the instrument can determine if the area is appropriate for solar energy generation.

For information about the Solmetric SunEye and the SunEye annual solar access summary for the Ulster County Former Tire Recycling Site see Attachment #1.

[1] More information on this tool can be found at: http://www.solmetric.com/

Usable Acreage

Based on Geographic Information System (GIS) and on-site assessment, the total recommended usable area for solar PV generation is approximately 7.38 acres. This proposed usable area corresponds to a relatively flat open portion of the site. Figure 3 shows an aerial image of the Ulster County Former Tire Recycling Site with the recommended usable solar PV areas shaded in light blue, dark blue, green, and pink polygons. Although the EPA team recommends an estimated 7.38 acres for the proposed solar PV usable area, this acreage can be reassessed and adjusted by the town or a potential third-party solar developer working with the county.

The yellow sun icons in Figure 3 represent the locations where SunEye data points were taken to measure solar potential. More information about SunEye data can be found in Attachment #1. **Overall, the solar access yields averaged 96% annual solar exposure for the site, which is within the favorable annual solar access range for solar PV systems.** More SunEye data can be found in Attachment #2.

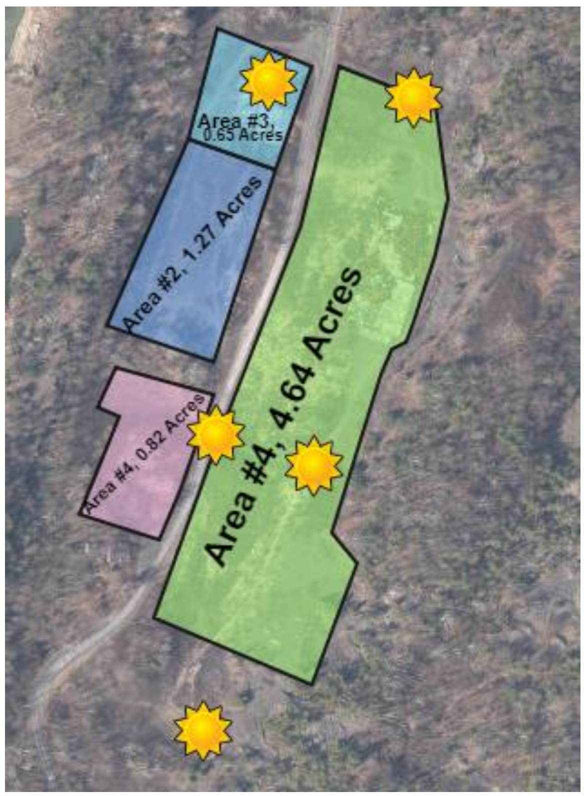

Figure 3. Aerial view of the feasible area for PV on the Ulster County Former Tire Recycling Site (taken with the GIS Platform)

Site observations:

- Heavy tree lines exist along the western and eastern borders of the site.
- An access road (Quarry Road) runs through the middle of the site. Other minor access roads are located throughout the property.
- A 3-Phase electrical transmission line runs half a mile south of the site along Route 32.
- The south west area of the site is not being proposed for solar because it is heavily vegetated and there is a heavy rock formation running along the southwest portion of the site.
- Other areas are available but are not being recommended in this analysis because they need to be properly cleared and prepared.

The following photos of the Ulster County Former Tire Recycling Site were collected during the site visit and illustrate some of the potential usable PV solar areas:

Figure 4A. Looking east from Area #2.

Figure 4B. Looking south from Area #1.

Figure 4C. Looking north from Areas #2 and #4.

Figure 4D. Looking south west from Area #3.

Figure 4E. Looking east from Area #4.

Figure 4F. Looking south from Area #1.

Figures 4A – 4F - Images of the Ulster County Former Tire Recycling Site taken by EPA.

Transmission/Utility Resources

According to Central Hudson Gas and Electric, a 3-Phase electrical transmission line runs along Route 32, approximately 0.4 miles south of the site[2]. In general, the distance from the proposed solar PV system to the point of interconnection with electrical transmission should be within a half mile distance in order to yield more viable economic conditions.

It is highly recommended that Ulster County consult with the electric distribution company (EDC) serving the area to discuss the potential for a solar project. In general, a preliminary interconnection transmission study from the local EDC should be performed early in the process if the Ulster County officials decide to pursue PV solar generation. The EDC serving the Ulster County Former Tire Recycling Site is Central Hudson Gas and Electric[3]. While the interconnection to the local transmission line seems favorable, early coordination with Central Hudson Gas and Electric is required to ensure that installations of distributed generation systems are properly designed to safely operate in parallel to the utility system, and to provide for Value Stack crediting if applicable. In New York State, Value Stack crediting is allowed for non-residential solar PV generation systems less than 2 MWs in size and a bill has been drafted to increase this number to 5 MWs for non-residential solar. For more information about the Value Stack crediting system, go to section VII of the study or visit https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources.

The preliminary interconnection study will also help the EDC to determine the feasibility of interconnecting to the electrical grid, assess whether potential electrical upgrades are needed, and estimate the interconnection costs. The EDC will also evaluate the available capacity of the transmission line to accommodate the solar power generated from the site. All technical pertinent information about the proposed solar PV system should be provided to the EDC in accordance with the application requirements.

Potential Off-Takers of the Generated Solar PV

As part of the PV siting consideration, potential solar PV off-takers were also identified. According to the Ulster County Department of the Environment, Ulster County would be the primary off-taker of the electricity generated by solar PV system on the site.

V. PVWatts System Sizing and Performance Results

PVWatts Analysis

The PVWatts[4] calculator is an online tool developed by the Department of Energy - National Renewable Energy Laboratory (DOE-NREL) to estimate the electricity production of a grid-connected ground or roof-mounted photovoltaic system. It requires only a few inputs including the location of the system, system size, and basic design parameters such as whether the system will be a fixed tilt or a single-axis tracking. The design parameters have default values or users can adjust them according to their needs.

The DC system size required in PVWatts is determined with an acre-to-power conversion factor. Based on research done by NREL for ground mounted solar PV systems and other similar solar PV, a value of 5.74

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[2] Central Hudson Gas and Electric Solar PV Hosting Capacity: https://gis.cenhud.com/gisportal/apps/webappviewer/index.html?id=01feb87ec2d74be1a0d4ea805aca9264

[3] Central Hudson Gas and Electric: http://www.cenhud.com/dg

[4] https://pvwatts.nrel.gov/ PVWatts®

acres/MW has been used for a fixed-tilt system. However, based on recent discussions with solar developers involved with solar projects and improvements with solar technology and efficiency, a conversion value of 4 acres/MW was assumed for this study. For the Ulster County Former Tire Recycling Site, this study recommends 7.38 acres of the usable area for a system size of 1.85 MW DC.

The site location is used to connect to NREL's Typical Meteorological Year (TMY) data which is the closest weather data source. NREL has compiled TMY data for thousands of locations throughout the United States. This data includes the solar irradiance, which is a measurement of solar radiation on the surface of the earth and is measured by the power (Watts) per unit area (m^2), W/m^2. The solar radiation values represent the resource available to a flat plate collector, such as a photovoltaic panel, oriented due south at an angle from horizontal to equal to the latitude of the collector location. Solar radiation, or insolation (irradiance multiplied by time), is measured in units of Watt hours per unit area during a specific time interval. Solar radiation above 3.5 $kWh/m^2/day$, is considered favorable when considering PV siting locations**.**

For the Ulster County Former Tire Recycling Site, the TMY data is taken from the Hudson Valley Regional Airport in Poughkeepsie, New York (35 miles from the site) and the solar radiation level was measured at **4.57 $kWh/m^2/day$.** The weather station identification information, PV system specifications, energy specifications, and performance results for the Ulster County Former Tire Recycling Site are provided in Tables 2 and 3.

The monthly performance results for the proposed solar PV systems at the Ulster County Former Tire Recycling Site as calculated by PVWatts can be found in Attachment #2.

Table 2. PVWatts Site Identification Information for the Ulster County Tire Site

Weather and PV System Technical Specifications	
Weather Data Source:	Poughkeepsie, Dutchess County, New York
Latitude/Longitude:	41.63° N, -73.88° W
Array Type:	Fixed-Tilt
Solar Radiation Levels:	4.57 $kWh/m^2/day$
System Losses*:	14%
Array Tilt, Array Azimuth:	20°, 180° South

**Systems Losses is another input parameter for the PV Watts calculator. It is also referred to as the DC to AC Derate Factor and is calculated from all of the losses that the system experiences when converting DC power to grid-ready AC power. These include accuracy for PV module nameplate DC rating, conversion efficiency of the inverter and transformer, mismatch, diodes and connections (voltage drops), DC and AC wiring (resistive losses), soiling, system availability, shading, sun-tracking and age.*

Table 3. PV System Yearly Performance Results for the Ulster County Tire Site

Usable LF Area for Solar PV	Fixed-Tilt PV System			
	DC System Size*	AC Energy Based on PVWATTS	GHG Reduction** (metric tons CO_{2e})	GHG Emissions Equivalent to # of Vehicles Driven Yearly**
7.38 acres	1.85 MW DC	2,341,640 kWh/yr	1,743 $MTCO_{2e}$	373 Cars

**Assumes an area-to-power conversion of 4 Acres/MW based on historical data provided by NREL and other similar solar projects.*
*** EPA's Greenhouse Gas (GHG) Equivalencies Calculator (http://www2.epa.gov/energy/greenhouse-gas-equivalencies-calculator) was used to determine the GHG reductions based on the proposed AC energy.*

Cautions for Interpreting Results – Weather Variability
Monthly and yearly energy production is modeled using photovoltaic system selected parameters and weather data that is typical or representative of long-term averages. Because weather patterns vary from year to year, the values in Table 4 are better indicators of long-term performance than of performance for a specific month or year. Photovoltaic system performance is largely proportional to the amount of solar radiation received, which may vary from the long-term average by ±30% for monthly values and ±10% for annual values.

VI. Forecasted Economics

In general, the forecasted economics for the solar PV system should factor the PV arrays/tilt and orientation and balance of system (BOS) components including the inverter and electrical supply/equipment costs, as well as the installation cost. Other cost factors for a PV system will depend on the system size, geographic location, mounting structure, type of PV module, and other soft costs (permit fees, installation/interconnection labor costs, sales tax, installer/developer profit, customer acquisitions costs, and transaction costs). For more information about understanding and managing solar soft costs go to http://energy.gov/eere/sunshot/soft-costs.

Based on NREL's Solar PV Price and Cost Breakdown Study[5], significant cost reductions in 2016 show the average cost for commercial and utility-scale ground-mounted systems (includes the engineering, procurement, and construction (EPC) system hardware, other EPC direct/indirect costs, and developer costs) for different installed capacities. The actual cost declined from $3.76/W in the fourth quarter of 2010 to $1.42/W in the first quarter of 2016. However, this price is for systems 100 MW in size, much larger than the system that is being proposed for the Ulster County Former Tire Recycling Site. An interpolation was made using data from the NREL Prices and Cost Breakdown to estimate cost for a system of 2.475 MW DC. As a result, an installed capacity of 1.85 MW gives a cost of $2.03/W.

With an increasing demand and supply, potential cost reductions may be expected as market conditions continue to evolve. It should be emphasized that this is a very rudimentary estimation of the economics involved for this proposed area and a more detailed analysis will be necessary moving forward.

The projected cost only factors in initial installation costs and does not reflect the true cost of the system since available NYS incentives that may lower the costs are not included and the associated soft costs to develop the solar PV will vary for this project. Additional steps may be necessary to install PV panels at these sites, such as site preparation and assessment of the interconnection requirements, which can drive the overall cost. Table 4 provides the initial system costs for a fixed tilt PV system based on the above stated pricing assumptions. The project is expected to have an optimal 25-year lifespan, although the system can reasonably be expected to continue operation past this point.

Table 4. PVWatts Initial Economic Considerations

Fixed-Tilt PV System	
Initial installation system cost	$2.03 /W DC
Ulster County Site PV System Size (7.38 acres) *	1.85 MW DC
Projected Estimated System Cost (without financial incentives)	$3,755,500.00

**Assumes an area-to-power conversion of 4 Acres/MW.*

[5] http://www.nrel.gov/docs/fy16osti/67142.pdf U.S. Photovoltaic Prices and Cost Breakdowns: Q1 2016 Benchmarks for Residential, Commercial, and Utility Scale Systems

VII. Benefits

Many municipal lots are particularly well-suited for solar development because they are often:

- Located near critical infrastructure including electric transmission lines and roads;
- Located near areas with high energy demand (e.g., large population bases);
- Constructed in areas of low grade (0-10%) needed for siting of solar PV structures;
- Offered at lower land costs when compared to open space;
- May be adequately zoned for renewable energy;
- May have environmental conditions that are not well-suited for commercial or residential redevelopment;
- Are able to accommodate Value Stacked or utility scale projects; and

Other benefits with solar implementation:

- Can provide short and long-term job opportunities;
- May reduce the environmental impacts of energy systems (e.g., reduce greenhouse gas emissions).

The **New York State Energy Research and Development Authority (NYSERDA)** promotes energy efficiency and the use of renewable energy sources in New York. According to NYSERDA, solar PV generation offers the following key benefits:

- PV systems are gentle on the environment, in contrast with electricity generated by fossil fuels;
- PV-generated electricity creates no noise, air, or water pollution;
- PV systems provide long-term stabilization of electrical costs;
- When combined with a battery backup system, a PV unit can provide power when utility power is not available.

In addition, this study outlines various financial incentives (Section VI – Incentives) that could assist in financing the implementation of a solar PV system including incentives offered by NYSERDA.[6] To learn about programs and funding opportunities available through NYSERDA from the NY-Sun Initiative, go to http://www.ny-sun.ny.gov/ or https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun/Megawatt-Block-Dashboards.

Value Stack Crediting:

In New York State, another benefit to implementing a renewable energy system is **Value Stack crediting**. This system of reimbursement for electricity generation is allowed for non-residential solar PV generation systems less than 2 MWs in size. Although current New York State Laws limit non-residential solar producers to 2 MWs, a bill has been proposed to increase this number to 5 MWs. More information about the bill's status can be found at: wwww.nysenate.gov/legislation/bills/2017/s8273. In a conventional Value Stack situation, a **customer-sited renewable energy system** is connected to the utility grid through a customer's utility meter. This is known as "behind-the-meter generation." At any given moment, if the site is using more electricity than the system is producing, all the electricity produced by the system is used on-site and the site's electricity needs are supplemented from the grid. If the site is using less electricity than the system is producing, the excess electricity is exported to the grid and the customer receives a monetary credit based on the time and location of energy generation. This is typically recorded as negative use and is commonly referred to as the "meter spinning backwards." At the end of the billing cycle, the grid-supplied electricity and the credits for any exported electricity are reconciled, and any surplus credits can be carried forward to the next billing cycle. The specifics of Value Stack crediting are dependent on the customer's service classification. Additional information about Value Stack crediting can be found at: https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources.It is highly recommended that Ulster County consults with Central Hudson Gas and Electric to discuss Value Stack crediting opportunities.

[6] http://www.nyserda.ny.gov/

Power Purchase Agreements:

A number of municipalities that own underutilized properties have expressed interest in potential revenue flow from solar PV systems. In some cases, revenue can be generated by the use of PV on a site pending actual site conditions, financial incentives, economic conditions, and support from the utility companies. While the findings of this report do not recommend how a solar array will be financed, if the municipality decides that they do not want to invest their own funds to build the solar site, they can consider entering into a Power Purchase Agreement (PPA) with a solar developer who would assume the cost of development. To learn more about PPA structures, please go to the following PPA checklist for state and local governments link: http://www.nrel.gov/docs/fy10osti/46668.pdf or the Interstate Renewable Energy Council PPA toolkit for local governments: http://www.irecusa.org/solar-power-purchase-agreements-a-toolkit-for-local-governments/

Incentives:

The economics of a PV system will also depend on NYS financial incentives, available federal tax credit, the regional cost of electricity, the solar resource, solar panel tilt and orientation, site conditions, distance to the electrical interconnection, and other critical requirements highlighted in this report. Table 5 provides several possible financial incentives that can be considered by Ulster County officials to assist with financing the proposed solar PV systems.

Table 5. Summary of Applicable Incentives

Federal and State Solar Investment Tax Credit	As of December 2015, system owners may continue to qualify up to 30% Federal Investment Tax Credit which is expected to step down to 26 percent in 2020 and 22 percent in 2021. After 2023, the residential credit will drop to zero while the commercial and utility credit will drop to a permanent 10 percent. Always consult with your qualified tax professional or accountant to determine your eligibility for tax credits.
Modified Accelerated Cost Recovery System (MACRS)	MACRS depreciation is also considered another important financial incentive. The MACRS is a method of depreciation in which a business' investments in certain tangible property are recovered, for tax purposes, over a specified time period through annual deductions. Qualifying solar energy equipment is eligible for a cost recovery period of five years. More information about MARCS is available at: http://www.seia.org/policy/finance-tax/depreciation-solar-energy-property-macrs.
NY-Sun Commercial/Industrial Incentive Program (PON 3082)	For installations of Solar PV Systems greater than 200 kW, incentives are available on a rolling application first-come, first-served basis for eligible projects. More information is available at: http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-3082-NY-Sun-Commercial-Industrial-Incentive-Program.
NY-Sun Megawatt Block Program	In June 2018, NYSERDA's NY-Sun Megawatt Block program was redesigned to include larger solar projects and encourage development on landfills and brownfield sites. More information is available at: https://www.nyserda.ny.gov/About/Newsroom/2018-Announcements/2018-06-18-NYSERDA-Announces-Redesign-of-NY-Suns-Megawatt-Block-Program.
Clean Energy Financing Arrangements	The New York Green Bank invites private sector capital providers and other clean energy industry participants to propose partnership arrangements with the Green Bank that would facilitate the financing of clean energy projects (including energy generation and energy savings projects) in the State of New York. More information is available at: http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/RFP-1-Clean-Energy-Financing-Arrangements
Other Incentives	For other applicable incentives, go to the following website: http://programs.dsireusa.org/system/program?fromSir=0&state=NY

VIII. RE-Powering America's Land

Through the RE-Powering America's Land Initiative, the U.S. EPA promotes the reuse of potentially contaminated properties, landfills, and mining sites for renewable energy generation. This initiative identifies the renewable energy potential of these sites and provides useful resources for anyone interested in reusing these sites for renewable energy development. Various RE-Powering America Initiative resources are summarized below and can be found at **http://www.epa.gov/oswercpa.**

- **Mapping and Screening Tools -** Under Mapping and Screening tools, EPA's RE-Powering America's Land team screened more than 80,000 potentially contaminated sites and MSW landfills, assessing the suitability of nearly 43 million acres across the country for site renewable energy generation facilities, including utility-scale solar. Maps depicting the details of these EPA tracked sites can be found at **https://www.epa.gov/re-powering/re-powering-mapping-and-screening-tools**. These maps enable users to view screening results for various renewable energy technologies at each site.

- **Technical Assistance and Support** - As part of the RE-Powering America's Land Initiative, the EPA and the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) have evaluated the feasibility of developing renewable energy production on Superfund, brownfields, and former landfills or mining sites. This project paired EPA's expertise on contaminated sites with the renewable energy expertise of NREL. A list of feasibility studies for renewable energy production using various technologies, including solar, and can be found **at https://www.epa.gov/re-powering/re-powering-feasibility-studies**.

- **Redevelopment Tools and Resources –** Under Redevelopment Tools and Resources, EPA and NREL created the joint publication, "**Best Practices for Siting Solar PV on Municipal Solid Waste Landfills"** -**https://www.epa.gov/re-powering/best-practices-siting-solar-photovoltaics-municipal-solid-waste-landfills** to provide assistance in addressing common technical challenges of siting PV on MSW landfills (such as impacts to landfill settlement differentials and the PV solar performance, impacts to other landfill systems, understanding landfill cap integrity/characteristics, and understanding landfill post-closure requirements for solar PV design considerations) and provide other useful information for solar developers, landfill owners, and federal, state, and local government entities. Another document for stakeholder consideration is the "**RE-Powering Finance Fact Sheet" – https://www.epa.gov/re-powering/financing-renewable-energy-projects-contaminated-lands-landfills-and-mine-sites** and **"Revised Bona Fide Prospective Purchaser (BFPP) Provisions Enforcement Guidance for Tenants" -https://www.epa.gov/enforcement/guidance-treatment-tenants-under-cerclas-bona-fide-prospective-purchaser-bfpp-provision**.

- **Fact Sheets and Success Stories -** The RE-Powering team highlights numerous successful of renewable energy projects throughout the United States. The RE-Powering America team also maintains a list of completed renewable energy installations on contaminated sites and landfills. To date, the RE-Powering Initiative has identified 274 renewable energy installations on 261 sites, with a cumulative installed capacity over 1,450 megawatts (MW) and consistent growth in installations since the inception of the RE-Powering Initiative. For information, go to **https://www.epa.gov/re-powering/re-powering-tracking-matrix.**

IX. Conclusions

Overall, the Ulster County Former Tire Recycling Site appears to have favorable site conditions to support solar PV generation and economic viable use. The site offered relatively flat open vegetative area with minimal shading concerns (the western and eastern borders of the site have high density vegetation) and high solar access making it an ideal site to install solar panels. The land slopes towards the south and the recommended usable solar PV areas are depicted in Figure 3. The solar PV system size and performance for the site is based on the recommended usable areas (illustrated in Table 3). In general, the proposed usable area for solar PV amounted to 7.38 acres with an installed capacity of 1.85 MW DC. Electrical transmission lines are conveniently located near the site, however early coordination with Central Hudson Gas and Electric for interconnection studies will be required if county officials decide to move forward with a solar PV project. Although this assessment is only recommending the areas documented by Figure 3, there are other areas that could potentially be used, but which would require considerable land clearing and preparation. These areas may be considered by the county and subsequent solar developer.

While this solar screening study recommended a PV system size based on proposed usable areas, the actual system installation will need to factor the availability of funds, the amount of solar power needed, and amount of solar power that can be sold. As indicated earlier, a third-party developer power purchase agreement (PPA) is another feasible way for a system to be financed for this site. In exchange for access to a site through a lease arrangement, third-party solar developers can finance, develop, and operate the solar projects utilizing their own expertise and sources of financing. These private enterprises are also able to take advantage of the federal tax benefits that cannot be captured by municipalities (or other entities that do not pay corporate income taxes), which should lower the total system cost. If the county officials decide to proceed with a solar system installation and work with a third-party solar developer, the developer can sell the electricity to the site host (pending on the potential cost savings for local town facilities between current utility rates and the solar utility rate) or to the local utility via a PPA - which will sell the electricity at negotiated rate for a fixed period of time for a term typically varying from 20-25 years. Thus, economic benefits from solar generation on the site could include competitively priced electricity from the project, revenues via land lease payments from a solar developer, potentially reduced maintenance costs, job creation, and stimulation of the local economy during solar construction.

By using obtainable and accessible land that is unavailable for redevelopment allows for repurpose of land that would not otherwise be productive and reduces greenhouse gas emission from current power sources. In case county officials are interested in pursuing solar PV generation, additional options could be explored to make the solar PV generation more viable while understanding the economic impacts. The Ulster County officials should also coordinate early with representatives from the New York State Department of Environmental Conservation and share the proposed solar plans on the site. Furthermore, town officials or a potential third-party solar developer could reassess and expand the usable solar PV area proposed in this screening study. Based on EPA's screening and assessment of the existing physical conditions, EPA supports the potential of solar PV generation at the Ulster County Former Tire Recycling Site.

X. Next Steps

Early and proper planning with other key stakeholders is critical to the success of a solar PV system. The following stakeholders should be consulted in the early stages of a solar PV project:

New York State Department of Environmental Conservation (NYSDEC):

NYSDEC

Ulster County should coordinate early with the **NYSDEC** to ensure that the environmental conditions at the site are suitable for the proposed work. To that end, it will be necessary to provide all related information to NYSDEC for the proposed solar PV system including:

- Location of the site and the PV system size,
- Estimated usable area for the solar PV installation,
- The mounting foundation type placed on the site,
- Potential storm water management issues, and
- Any additional information requested by NYSDEC.

In general, NYSDEC regional representatives' names and contact information can be found at **http://www.dec.ny.gov/chemical/76718.html**.

Coordination with the Local Utility Provider:

Central Hudson Gas and Electric

Central Hudson Gas and Electric should be consulted early in the planning stages so that the municipality can be alerted to any potential transmission interconnection issues that might exist or equipment upgrades needed to facilitate the solar project. Ulster County officials may request a transmission interconnection study from Central Hudson Gas and Electric. As indicated earlier, all technical pertinent information about the proposed solar PV system should be provided to Central Hudson Gas and Electric in accordance with their application requirements.

Coordination with the NYSERDA, NY SUN:

NYSERDA NY SUN

In addition to the solar PV financial incentives from NYSERDA, the NY-Sun program offers additional resources to municipalities interested in developing solar in their community. Of particular interest, is the "Solar Guideline for Local Governments": https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun/Communities/Local-Government-Training-and-Resources/Solar-Guidebook-for-Local-Governments. Municipalities can also obtain technical assistance and learn more about the solar procurement process by visiting **https://training.ny-sun.ny.gov/resources-5**.

For more information and training offered under the NY-Sun program or any assistance needed with electrical interconnection, contact Houtan Moaveni at (518) 862-1090, ext. 3016, or Houtan.Moaveni@nyserda.ny.gov.

<u>Coordination with the New York Power Authority (NYPA):</u>

NYPA

The New York Power Authority (NYPA) is authorized, through New York Public Authorities Law 1005(17), to provide strategic, technical, and other assistance to its customers to support implementation of energy related projects including renewable energy initiatives. NYPA is uniquely positioned to procure vendors on behalf of its customers.

NYPA is committed to working with public entities to incorporate solar energy at their facilities by providing customized solar services. Through these services, NYPA acts as a trusted energy advisor to its customers and is well positioned to oversee both policy and technical aspects of their projects. NYPA can engage at any and all phases of a project from inception to operation of the system, including financial analysis, feasibility assessment and site design, development and solicitation of a request for proposals (RFP), and contract mechanism recommendation.

NYPA is in development of over 60 MW of distributed solar PV for customers ranging from the Cities, Counties and Town's to K-12 schools, State Universities and State Agencies. By 2020, NYPA aims to develop at least 125 MW of renewable energy for the state of New York located at public facilities.

For more about the services offered by the New York Power Authority and their associated costs, go to www.nypa.gov or contact Christina Iwaniw, Certified Energy Manager, at Christina.iwaniw@nypa.gov or call (914) 390-8031.

As a reminder, this report is to be used for screening purposes only.

Additional evaluations will need to be conducted to fully characterize the feasibility and economics of the Ulster County Former Tire Recycling Site for PV installation. Third party solar developers and local utility companies may have technical and financial interests in pursuing potential solar renewable energy projects and should perform additional solar assessments to determine if projects are economically viable.

This study does not assess the environmental conditions at the site.

Attachment #1 – <u>SunEye Solar Measurements</u>

The EPA solar assessment team used a Solmetric SunEye[7] solar path calculator to assess shading at particular locations by analyzing the sky view where solar panels will be located. By finding the solar access, the instrument can determine if the area is appropriate for solar panels. PV modules are very sensitive to shading. When shaded (either partially or fully), the panel is unable to optimally collect the high-energy beam radiation from the sun. PV modules are made up of many individual cells that all produce a small amount of current and voltage. These individual cells are connected in series to produce a larger current. If an individual cell is shaded, it acts as resistance to the whole series circuit, impeding current flow and dissipating power rather than producing it. By finding the solar access, it can be determined if the area is appropriate for solar power generation.

The assessment team collected five Solmetric SunEye data points (skyline views) at across the entire perimeter of the site in sections with adequate flat area as shown is Figure 3. Overall, **solar access yields averaged 96%** annual solar exposure, which is within the favorable annual solar access range for PV systems.

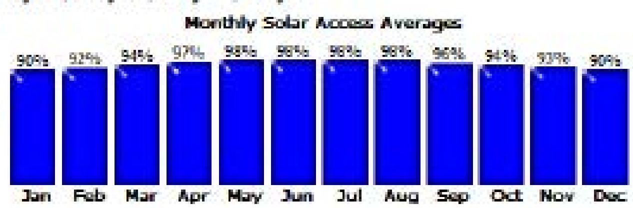
Session Properties

Name	Ulster County Former Tire Recycling Site
Creation Date	3/28/2018 8:50
Note	(none)
Location	42.1°N, 74.0°W Mag Dec: 13.3°W Time Zone: GMT-05:00

Solar access averages of 5 skylines in this session

Skylines Averaged: Sky01, Sky02, Sky03, Sky05, Sky06

Annual	May-Oct	Nov-Apr
96%	97%	93%



TSRF averages of 5 skylines in this session: 92%

Figure 5. Session properties for Solmetric SunEye

The Total Solar Resource Fraction (TSRF) is the ratio of insolation available accounting for both shading and Tilt and Orientation Factor (TOF), compared to the total insolation available at a given location at the optimum tilt and orientation and with no shading. TRSF is also expressed in percent. The TOF is the solar insolation at the actual tilt and orientation divided by the insolation at the optimum tilt and orientation, expressed in percent.

[7] More information on this tool can be found at: http://www.solmetric.com/

Attachment #2 – Monthly Performance Results for the Ulster County Former Tire Recycling Site

Performance Results 1,850 kW Fixed-Tilt PV System		
Month	**Solar Radiation* ($kWh/m^2/day$)**	**AC Energy (kWh)**
January	2.93	138,383
February	3.98	166,333
March	4.83	223,179
April	5.49	231,893
May	5.78	246,413
June	5.89	238,733
July	6.20	252,425
August	5.59	230,517
September	5.03	205,168
October	3.80	166,576
November	2.81	125,037
December	2.29	116,983
Total	**4.57* Monthly Average**	**2,341,640****

**Solar Radiation values above 3.5 $kWh/m^2/day$ are considered favorable when considering PV siting locations.*

***The solar photovoltaic performance degradation, a reduction in power generation due to long-term exposure, is under 1 % per year. Silicon modules have a lifespan range of 25–30 years but can keep producing energy beyond this range. For information about, a reduction in power generation due to long-term exposure, go to http://www.nrel.gov/docs/fy12osti/51664.pdf*

Attachment #3 – PV Systems Overview

Major System Components

A typical PV system is made up of several key components including:

- PV modules,
- inverters and
- balance-of-system components (including mounting racks, hardware for the panels, and wiring for electrical connections). Electrical connections (including wiring, disconnect switches, fuses, and breakers) are required to meet electrical code (e.g., NEC Article 690) for both safety and equipment protection.

In most traditional applications, wiring from the arrays to inverters and inverters to point of interconnection is generally run as direct burial through trenches. It is recommended that PV system vendors reflect these costs in the requests for proposals when costing out the overall system.

Figure 6. Ground mount array (source: NREL)

Solar PV cells are the electricity-generating component of a solar energy system. When sunlight (photons) strikes a PV cell, an electric current is produced by stimulating electrons (negative charges) in a layer in the cell designed to give up electrons easily. The existing electric field in the solar cell pulls these electrons to another layer. By connecting the cell to an external load, this current (movement of charges) can then be used to power the load, e.g., light bulb.

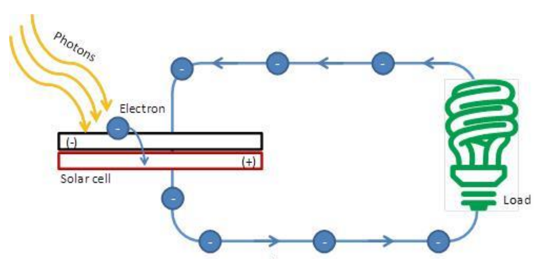


Figure 7. Generation of electricity from a PV cell (source: EPA)

PV cells are assembled into a PV panel or module. PV modules are then connected to create an array. The modules are connected in series and then in parallel as needed to reach the specific voltage and current requirements for the array. The direct current (DC) electricity generated by the array is then converted by an inverter to usable alternating current (AC) that can be consumed by adjoining buildings and facilities or exported to the electricity grid. PV system size varies from small residential (2-10 kilowatts (kW)), commercial (100-500 kW), to large utility scale (10+ megawatts (MW)). Central distribution plants are also currently being built in the 100 MW+ scale. Electricity from utility-scale systems is commonly sold back to the electricity grid.

The solar array has to be secured and oriented optimally to maximize system output. The structure holding the modules is referred to as the mounting system. The mounting systems can be ground mounted utilizing a ballast. For ground mount systems, the mounting system can be either directly anchored into the ground (via driven piers or concrete footers) or ballasted on the surface without ground penetration. Mounting systems must withstand local wind loads, which range from 90–120 mph range for most areas or 130 mph or more for areas with hurricane potential. Depending on the region, snow and ice loads must also be a design consideration for the mounting system.

PV Module

Module technologies are differentiated by the type of PV material used, resulting in a range of conversion efficiencies from light energy to electrical energy. The module efficiency is a measure of the percentage of solar energy converted into electricity. Two common PV technologies that have been widely used for commercial- and utility-scale projects are crystalline silicon and thin film.

Crystalline Silicon

Traditional solar cells are made from silicon. Silicon is quite abundant and nontoxic. It builds on a strong industry on both supply (silicon industry) and product side. This technology has been demonstrated for a consistent and high efficiency over 30 years in the field. The performance degradation, a reduction in power generation due to long-term exposure, is under 1% per year. Silicon modules have a lifespan in the 25-30-year range but can keep producing energy beyond this range.

Typical overall efficiency of silicon solar panels is between 12% and 18%. However, some manufacturers of mono-crystalline panels claim an overall efficiency nearing 20%. This range of efficiencies represents significant variation among the crystalline silicon technologies available. The technology is generally divided into mono- and multi-crystalline technologies, which indicates the presence of grain-boundaries (i.e., multiple crystals) in the cell materials and is controlled by raw material selection and manufacturing technique. Crystalline silicon panels are widely used based on deployments worldwide.

Figure 8 shows two examples of crystalline solar panels: mono- and multi-silicon installed on tracking mounting systems.


Figure 8. Mono- and multi-crystalline solar panels. Photos by (left) SunPower Corporation, NREL 23816 and (right) SunPower, NREL 13823

Thin Film

Thin-film PV cells are made from amorphous silicon (a-Si) or non-silicon materials such as cadmium telluride (CdTe). Thin-film cells use layers of semiconductor materials only a few micrometers thick. Due to the unique nature of thin films, some thin-film cells are constructed into flexible modules, enabling such applications as solar energy covers for landfills such as a geomembrane system. Other thin film modules are assembled into rigid constructions that can be used in fixed tilt or, in some cases, tracking system configurations.

The efficiency of thin-film solar cells is generally lower than for crystalline cells. Current overall efficiency of a thin-film panel is between 6% and 8% for a-Si and 11-12% for CdTe. Industry standard warranties of both crystalline and thin film PV panels typically guarantee system performance of 80% of the rated power output for 25 years. After 25 years, they will continue producing electricity at a lower performance level.

Mounting Systems

The array has to be secured and oriented optimally to maximize system output. The structure holding the modules is referred to as the mounting system. Typical ground mounted systems can be categorized as fixed-tilt or tracking. Fixed-tilt mounting structures consist of panels installed at a set angle, typically based on site latitude and wind conditions, to increase exposure to solar radiation throughout the year. Fixed-tilt systems are used at many sites. Fixed-tilt systems have lower maintenance costs but generate less energy (kWh) per unit power (kW) of capacity than tracking systems. The selection of mounting type is dependent on many factors including installation size, electricity rates, government incentives, land constraints, soil conditions, alignment and latitude requirements, and local weather.

The mounting system design will also need to meet applicable local building code requirements with respect to snow, wind, and seismic zones. Selection of mounting types should also consider frost protection needs especially in cold regions. Contaminated land applications may raise additional design considerations due to site conditions, including differential settlement. Selection of the mounting system is also heavily dependent on anchoring or foundation selection.

Inverters

Inverters convert DC electricity from the PV array into AC electricity, which can connect seamlessly to the electricity grid. Inverter efficiencies can be as high as 98.5%. Inverters also sense the utility power frequency and synchronize the PV-produced power to that frequency. When utility power is not present, the inverter will stop producing AC power to prevent “islanding,” a condition which could be dangerous to utility workers trying to fix a de-energized distribution system. This safety feature is built into all grid-connected inverters in the market.

Electricity produced from the PV system may also be fed to a step-up transformer to increase the voltage to match the grid. There are two primary types of inverters for grid-connected systems: string and micro inverters. Each type has strengths and weakness and may be recommended for different types of installations.

Wiring for Electrical Connections

Electrical connections, including wiring, disconnect switches, fuses, and breakers are required to meet electrical code (e.g., NEC Article 690) for both safety and equipment protection. In most traditional applications, wiring from (i) the arrays to inverters and (ii) inverters to point of interconnection is generally run as direct burial through trenches.

Attachment #4 – Glossary or Definition of Terms

Glossary or Definition of Terms	
PV	Photovoltaic energy
AC	Alternating current, which can be transmitted over power lines
DC	Direct current, which cannot be transmitted over power lines
Ballast	A footing on which a solar panel can be placed
Inverter	A machine which takes in direct current and converts it to alternating current, which can then be transmitted to an electrical substation for transmission to a utility company
Energy Density	The amount of energy available per a given region of space (per unit volume); this is impacted by the packing factor, which is the number of solar arrays that can be placed in a specific area
kW or kWh	Kilowatt or kilowatt hours
MW or MWh	Megawatt or megawatt hours
ITC	Investment tax credits
O&M	Operations and maintenance
PPA	Power purchase agreement, which is a legal contract between an electricity provider and a purchaser that defines all commercial terms for the sale of electricity
Transformer	An electrical device used to increase or decrease the alternating voltage in electrical power applications. A transformer on a solar power facility is primarily used to step-up the voltage to deliver the renewable energy to the utility grid.
EDC	Electric Distribution Company
GIS	Geographic information Systems

FLEXTECH STUDY AND HEATING/COOLING MASTER PLAN

For

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

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

Final Report: 09-17-2019

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

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

State of New York
Andrew Cuomo, Governor

New York State Energy Research and Development Authority

FlexTech Energy Study

Ulster County Office Building

244 Fair St.
Kingston, NY 12402

Prepared for:

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Ulster County Department of the Environment
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ABSTRACT

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

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

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

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

TABLE OF CONTENTS

PROJECT TEAM AND INFORMATION

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

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

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

Sincerely,

GPI

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

EXECUTIVE SUMMARY

DESCRIPTION OF STUDY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Figure 1

Ulster County Office Building

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

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

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

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

Base year costs - proposed annual cost savings	$141,425
% savings	4.7%

GENERAL NOTES:

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

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

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

ASSESSMENT OF SITE CONDITIONS

BUILDING OVERVIEW

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

Architectural Features

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

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

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

Heating, Air Conditioning, and Controls

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

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

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

Table 1

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

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

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

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

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

AC-4R is the only component of the distribution system analyzed as an ECM in this study. A VAV system will be evaluated as a replacement. This multi-zone unit was replaced in 1993 and includes a constant speed 7.5 HP fan motor, split DX cooling along with CHW and HW coils. The unit supplies conditioned air to the file vault that spans multiple floors. There is dedicated ductwork with reheat coils and zone dampers; electric reheat coils were recently replaced with hot water coils. An electric humidifier installed in the main ductwork has been inoperable for close to 5 years and is planned for replacement.

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

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

Electrical Systems

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

Process and Plug Loads

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

Building Control System

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

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

BUILDING BALANCE POINT TEMPERATURE AND LOAD COEFFICIENT

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

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

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

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

The results were as follows for the natural gas data:

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

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

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

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

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

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

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

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

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

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

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

PRELIMINARY ENERGY USE ANALYSIS (PEA)

Data and Building Characteristics for EPA Portfolio Manager

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

EPA Portfolio Manager Results

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

Figure 2

LEARN MORE AT energystar.gov

ENERGY STAR® Statement of Energy Performance

44

ENERGY STAR® Score[1]

Ulster County Office Building

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

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

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

Property & Contact Information

Property Address	**Property Owner**	**Primary Contact**
Ulster County Office Building 244 Fair Street Kingston, New York 12401	________________ , (____)____-______	____ ________ , (____)____-______ ________________

Property ID: 2352952
Ulster County ID: B222

Energy Consumption and Energy Use Intensity (EUI)

Site EUI
98.1 kBtu/ft²

Source EUI
192 kBtu/ft²

Annual Energy by Fuel

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

National Median Comparison

National Median Site EUI (kBtu/ft²)	91.8
National Median Source EUI (kBtu/ft²)	179.7
% Diff from National Median Source EUI	7%

Annual Emissions

Greenhouse Gas Emissions (Metric Tons CO2e/year)	281

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

TECHNOLOGY EVALUATION

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

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

<u>Supporting Information</u>

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

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

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

PFS-1: Install Solar Thermal DHW

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

EXISTING CONDITIONS:

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

ECM SPECIFICATIONS:

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

ACTION ITEMS:

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

PFS-2: Install Air Source Heat Pumps

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

EXISTING CONDITIONS:

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

ECM SPECIFICATIONS:

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

ACTION ITEMS:

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

PFS-3: Install Cooling Energy Thermal Storage

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

EXISTING CONDITIONS:

The existing chillers cool the building with no thermal storage.

ECM SPECIFICATIONS:

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

ACTION ITEMS:

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

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

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

EXISTING CONDITIONS:

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

ECM SPECIFICATIONS:

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

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

ACTION ITEMS:

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

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

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

EXISTING CONDITIONS:

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

ECM SPECIFICATIONS:

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

INCREMENTAL DIFFERENCES:

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

Table 2

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

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

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

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

EXISTING CONDITIONS:

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

ECM SPECIFICATIONS:

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

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

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

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

ACTION ITEMS:

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

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

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

ECM-3: Convert AC-4R to VAV

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

EXISTING CONDITIONS:

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

ECM SPECIFICATIONS:

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

ACTION ITEMS:

This measure is recommended.

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

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

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

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

HEATING/COOLING MASTER - FURTHER ANALYSIS (FA)

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

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

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

FA ECM-1: Install Two Condensing Natural Gas Boilers

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

COUNTY SELECTED COURSE OF ACTION:

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

EXISTING CONDITIONS:

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

COUNTY SOW SPECIFICATIONS:

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

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

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

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

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

COUNTY SELECTED COURSE OF ACTION:

Convert AC-4R to VAV.

EXISTING CONDITIONS:

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

COUNTY SOW SPECIFICATIONS:

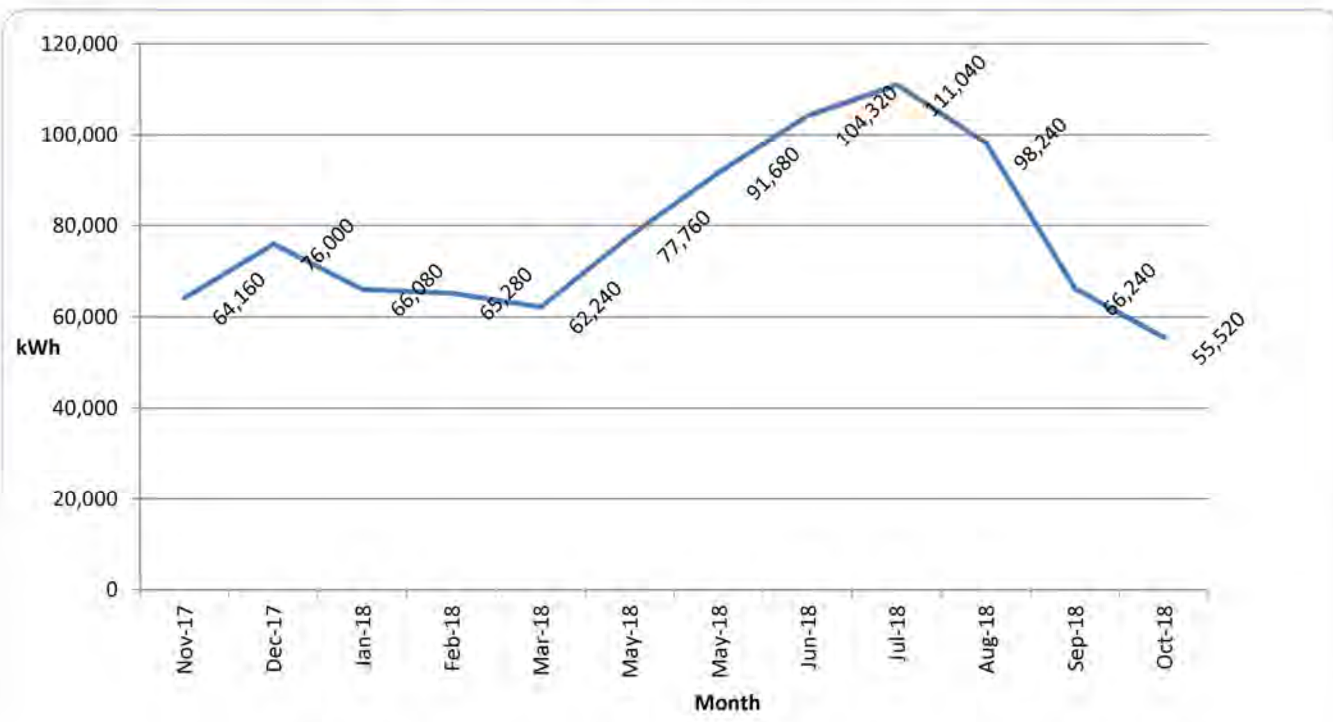
Work to include replacement of existing AC-4R with a VAV unit/system. This unit currently is a two-deck multizone unit with DX, chilled water and hot water coils. Reconfigure each existing zone as a VAV zone. DX and chilled water are there for redundancy. Maintain DX, chilled water and hot water functionality.

Appendix A – Utility Bill Summary

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

Utility Provider: Central Hudson Gas & Electric

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



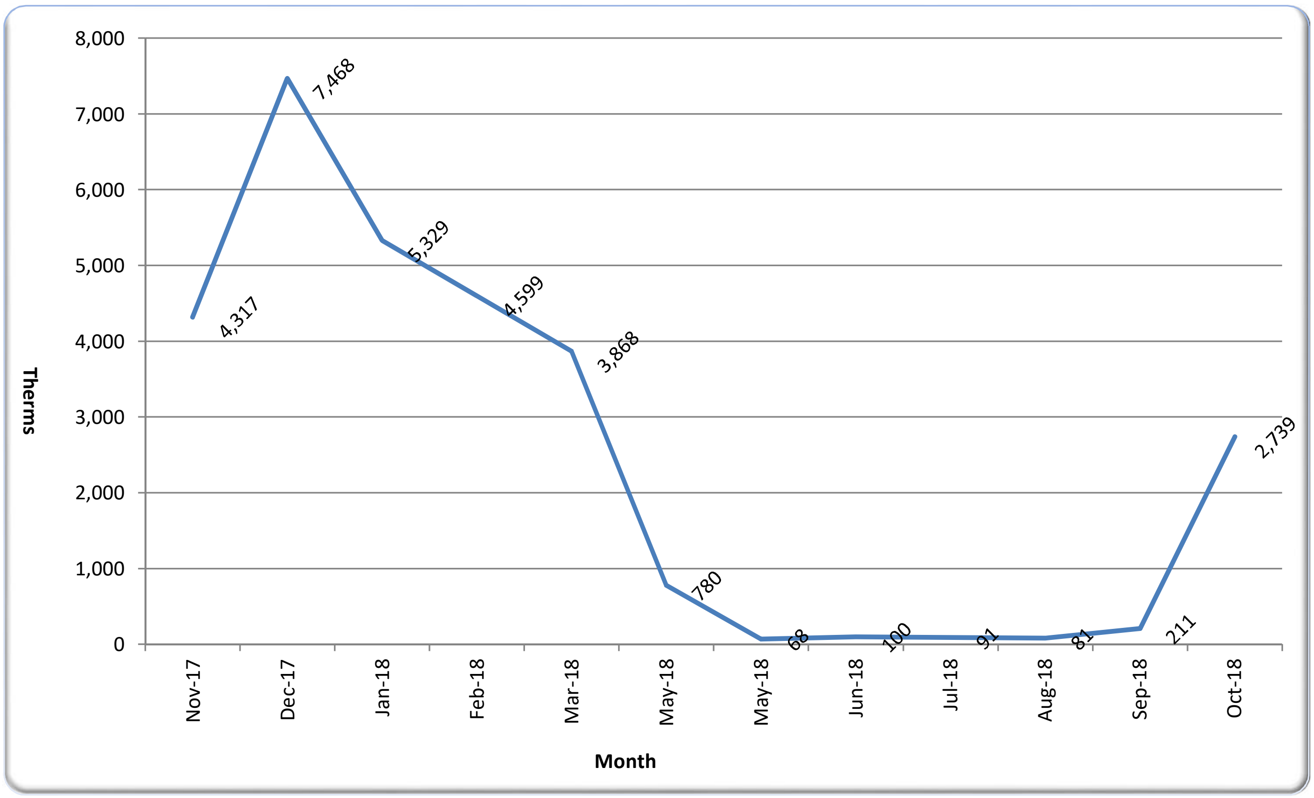
Facility: Ulster County Office Building
Address: 244 Fair St.
City: Kingston, NY
ZIP: 12402

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

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

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

$/MMBtu:	**$8.61**



ENERGY STAR® Data Verification Checklist

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ENERGY STAR ® Score[1]

Ulster County Office Building

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

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

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

Property & Contact Information

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

Property ID: 2352952
Ulster County ID: B222

Property Owner
____
,
(____)____-______

Primary Contact
____ ________
,
(____)____-______
____

1. Review of Whole Property Characteristics

Basic Property Information

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

Is this the official name of the property?

If "No", please specify: ____________________________________

2) Property Type: Office ☐ **Yes** ☐ **No**

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

3) Location: ☐ **Yes** ☐ **No**

244 Fair Street
Kingston, New York 12401

Is this correct and complete?

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

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

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

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

6) Number of Buildings: 1 ☐ Yes ☐ No

Does this number accurately represent all structures?

7) Whole Property Verification: ☐ Yes ☐ No

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

Notes:

Indoor Environmental Quality

1) Outdoor Air Ventilation ☐ Yes ☐ No

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

2) Thermal Environmental Conditions ☐ Yes ☐ No

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

3) Illumination ☐ Yes ☐ No

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

Notes:

2. Review of Property Use Details

Office: UCOB

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

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

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

2) **Weekly Operating Hours:** 60 ☐ **Yes** ☐ **No**

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

3) **Number of Workers on Main Shift:** 204 ☐ **Yes** ☐ **No**

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

4) **Number of Computers:** 173 ☐ **Yes** ☐ **No**

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

5) **Percent That Can Be Heated:** 100 ☐ **Yes** ☐ **No**

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

6) **Percent That Can Be Cooled:** 100 ☐ **Yes** ☐ **No**

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

Notes:

Parking: Parking Use

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

1) Open Parking Lot Size: 45,500 ft² ☐ **Yes** ☐ **No**

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

2) Partially Enclosed Parking Garage Size: 0 ft² ☐ **Yes** ☐ **No**

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

3) Completely Enclosed Parking Garage: 0 ft² ☐ **Yes** ☐ **No**

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

4) Supplemental Heating: No ☐ **Yes** ☐ **No**

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

Notes:

3. Review of Energy Consumption

Data Overview

Site Energy Use Summary		**National Median Comparison**	
Natural Gas (kBtu)	2,944,360.2 (48%)	National Median Site EUI (kBtu/ft²)	91.8
Electric - Grid (kBtu)	3,174,585.4 (52%)	National Median Source EUI (kBtu/ft²)	179.7
Total Energy (kBtu)	6,118,945.6	% Diff from National Median Source EUI	6.9%
Energy Intensity		**Emissions (based on site energy use)**	
Site (kBtu/ft²)	98.1	Greenhouse Gas Emissions (Metric Tons CO2e)	281.3
Source (kBtu/ft²)	192		
		Power Generation Plant or Distribution Utility:	
		Central Hudson Gas & Elec Corp	

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

Summary of All Associated Energy Meters

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

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

Total Energy Use ☐ **Yes** ☐ **No**

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

Additional Fuels ☐ **Yes** ☐ **No**

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

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

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

Notes:

Summary of Additional Meters

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

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

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

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

Notes:

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

Associated With: Ulster County Office Building

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

Total Energy Consumption for this Meter ☐ Yes ☐ No

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

Notes:

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

Associated With: Ulster County Office Building

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

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

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

Notes:

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

Associated With: Ulster County Office Building

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

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

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

Notes:

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

Associated With: Ulster County Office Building

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

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

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

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

Notes:

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

Associated With: Ulster County Office Building

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

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

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

Notes:

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

Associated With: Ulster County Office Building

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

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

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

Notes:

4. Signature & Stamp of Verifying Licensed Professional

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

Signature _______________________

Date _________

Licensed Professional

____ ________
,
(____)____-______
____

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

Professional Engineering Stamp

(if applicable)

Appendix B – ECM Calculation Data

UCOB PFS 1: SOLAR DHW SCREEN

Background Info

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

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

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

Third-Party Screening Tool

https://apps1.eere.energy.gov/femp/solar_hotwater_system/

ENERGY.GOV
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Federal Energy Management Program

EERE » Federal Energy Management Program

Solar Hot Water System Calculator

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

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

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

Step 1. Enter project and location information.

Project Name
UCOB

Select the nearest city/state
NY, ALBANY

ZIP Code
12402

Continue

Step 2. Calculate Hot Water Load and System Size

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

Building Type
Office

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

Number of person(s)
200

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

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

Calculate Load

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

Estimated System Size: 16.80 m²

Step 3. Estimate System Cost and Annual Savings

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

Water Heater Type
GAS: 0.43 - 0.86, assume 0.57

Efficiency
0.75

Energy Cost / 1,000 cu. ft.
8.61

Calculate Energy Savings

UCOB PFS 1: SOLAR DHW SCREEN

Final Report

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

SITE INFORMATION

Project Name	UCOB
Nearest City	NY, ALBANY
ZIP Code	12402

INPUT VALUES

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

CALCULATIONS

System Size	16.80 m^2
System Cost	$16,945.80
Annual Energy Savings	14,939.00 kWh/year
Annual Cost Savings	$427.33 based on $8.61/$1,000 cu. ft.
SIR	0.61
Simple Payback	39.66 years
Solar Fraction	79.00%
Annual Greenhouse Gas Reduction	5,961.26 lbs. of CO_2

Savings Summary

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

Solar mmBtu savings = 51

Natural gas cost savings:

$8.612 $/mmBtu natural gas (proposed)

Cost savings = $439

UCOB PFS 2: AIR SOURCE HEAT PUMP SCREENING CALCULATIONS

Existing Equipment

Heating

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

Cooling

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

Strategy for Screening: Heating

Issues

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

Strategy

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

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

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

Existing boiler usage base year (setup for savings calculation)
29,651 therms annual usage
3413 Btu/kWh
868,766 kWh equivalent heating usage (FYI)

Heat Pump Energy Usage Calculation: Heating

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

From above; use building load to get usage:
# of Units x (kBtuhout/unit) x EFLHheat = 22,482 therms x 100 kBtu/therm =
2,248,167 kBtu
COP = 3.3

Proposed kWh = 199,608 kWh

Strategy for Screening: Cooling

Issues

Need to estimate existing cooling energy usage & system efficiency

Strategy

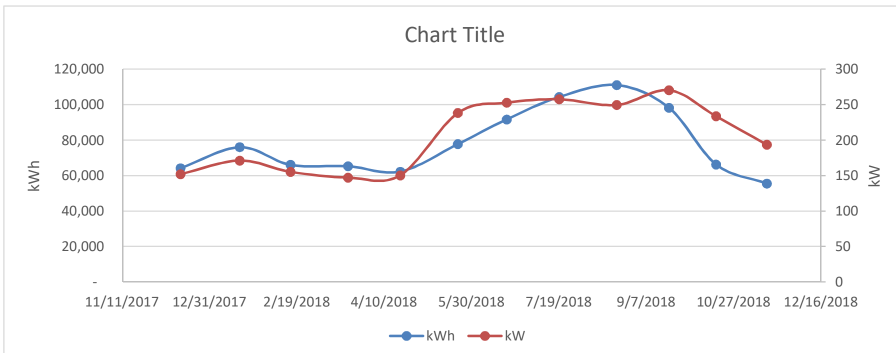
Rough estimates from base year utility data

UCOB PFS 2: AIR SOURCE HEAT PUMP SCREENING CALCULATIONS

Existing system analysis

Utility data for base year:

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



Re-order data for further analysis:

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

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

Existing operational parameters

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

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

UCOB PFS 2: AIR SOURCE HEAT PUMP SCREENING CALCULATIONS

Heat Pump Energy Usage Calculation: Cooling

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

where SEERee is for the proposed energy-efficient equipment

For the Mitsubishi PUMY unit referenced above, SEER ~ 15

Proposed kWh = 74,667

Energy and Cost Savings Summary

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

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

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

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

$10,575 net cost savings

Estimated Implementation Cost and Simple Payback

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

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

for 15 ton system

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

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

Simple Payback

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

UCOB PFS 3: THERMAL STORAGE SCREENING ANALYSIS

Cooling Demand Estimated from Utility Data

Starting Data (from utility data summary):

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

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

End Date	kW	kW - avg kW for non clg season	
5/22/2018	238.4	76.8	
6/19/2018	252.8	91.2	These values do not show a marked peak, take the average for analysis
7/19/2018	257.6	96	
8/21/2018	249.6	88	
9/20/2018	270.4	108.8	
10/17/2018	233.6	72	
		88.8	kW avg monthly peak demand increase attributed to cooling

Assumptions and Savings Estimates

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

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

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

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

Simple payback = 136.8 years

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

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

Determine Existing Boiler Heating Usage:

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

Assumptions and Approach:

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

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

4. Excerpts below are from 8760 model

TMY3 Data Excerpt:

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

Regression analysis results:

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

ECM 1 - Install Condensing Natural Gas Boiler

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Existing usage therms * Existing efficiency

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

Therms Usage by Regression -- Building Load Excerpt:

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

Building Load

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

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

Apply 8760 hour model to existing system usage in a year of typical weather:

Hourly usage = hourly load / existing efficiency (76%)

Therms Usage by Regression -- Existing Excerpt:

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

Existing NG Usage

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

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

ECM 1 - Install Condensing Natural Gas Boiler

Calculate Condensing Natural Gas Boiler Usage:

Hourly usage = hourly load / condensing boiler efficiency where:

Condensing Boiler Efficiency Parameters

Outdoor air temperature (OAT, deg F) selections:

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

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

Therms Usage -- Proposed Excerpt:

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

Proposed Usage

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

Savings Summary

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

NIST BLCC 5.3-18: Comparative Analysis

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

Base Case: Existing NG Boiler

Alternative: ECM 1 - Install Condensing Natural Gas Boiler

General Information

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

Comparison of Present-Value Costs

PV Life-Cycle Cost

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

Net Savings from Alternative Compared with Base Case

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

Net Savings -$32,698

Savings-to-Investment Ratio (SIR)

SIR = 0.70

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

Adjusted Internal Rate of Return

AIRR = 1.79%

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

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Discounted Payback never reached during study period.

Simple Payback occurs in year 27

Energy Savings Summary

Energy Savings Summary (in stated units)

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

Energy Savings Summary (in MBtu)

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

Emissions Reduction Summary

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

NIST BLCC 5.3-18: Comparative Analysis

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

Base Case: Existing NG Boiler

Alternative: FA ECM 1 - Install Condensing Natural Gas Boiler

General Information

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

Comparison of Present-Value Costs

PV Life-Cycle Cost

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

Net Savings from Alternative Compared with Base Case

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

Net Savings -$164,673

Savings-to-Investment Ratio (SIR)

SIR = 0.32

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

Adjusted Internal Rate of Return

AIRR = -0.86%

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

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback never reached during study period.

Discounted Payback never reached during study period.

Energy Savings Summary

Energy Savings Summary (in stated units)

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

Energy Savings Summary (in MBtu)

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

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Natural Gas				
CO_2	156,253.77 kg	135,029.75 kg	21,224.02 kg	615,423.86 kg
SO_2	1,261.02 kg	1,089.73 kg	171.28 kg	4,966.66 kg
NO_x	131.10 kg	113.29 kg	17.81 kg	516.34 kg
Total:				
CO_2	156,253.77 kg	135,029.75 kg	21,224.02 kg	615,423.86 kg
SO_2	1,261.02 kg	1,089.73 kg	171.28 kg	4,966.66 kg
NO_x	131.10 kg	113.29 kg	17.81 kg	516.34 kg

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

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

Determine Existing Boiler Heating Usage:

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

Assumptions and Approach:

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

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

4. Excerpts below are from 8760 model

TMY3 Data Excerpt:

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

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

ECM 1a - Install Condensing Natural Gas Boiler

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

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

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

Therms Usage by Regression -- Building Load Excerpt:

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

Building Load

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

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

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

Hourly usage = hourly load / code std efficiency where:

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

Therms Usage for Code Standard Excerpt:

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

Code Std NG Usage

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

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

ECM 1a - Install Condensing Natural Gas Boiler

Calculate Code-Minimum Natural Gas Boiler Usage:

Hourly usage = hourly load / condensing boiler efficiency where:

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

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

Therms Usage -- Proposed Excerpt:

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

Proposed Usage

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

Savings Summary

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

NIST BLCC 5.3-18: Comparative Analysis

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

Base Case: Code min boiler (ECM 1a)

Alternative: ECM 1 - Install Condensing Natural Gas Boiler

General Information

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

Comparison of Present-Value Costs

PV Life-Cycle Cost

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

Net Savings from Alternative Compared with Base Case

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

Net Savings $5,111

Savings-to-Investment Ratio (SIR)

SIR = 1.34

Adjusted Internal Rate of Return

AIRR = 4.01%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 17

Discounted Payback occurs in year 23

Energy Savings Summary

Energy Savings Summary (in stated units)

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

Energy Savings Summary (in MBtu)

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

Emissions Reduction Summary

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

UCOB Boiler Replacement		
Ulster County Office Building	244 Fair Street	Kingston, NY 12402
ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler		

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

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

Determine Existing Boiler Heating Usage:

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

Assumptions and Approach:

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

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

4. Excerpts below are from 8760 model

TMY3 Data

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

Regression analysis results:

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

ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler

Determine Existing Building Load:

Billing date range and Assumptions and Approach following approach above.

Load Therms = Existing usage therms * Existing efficiency

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

Therms Usage by Regression -- Building Load Excerpt:

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

Building Load

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

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

Apply 8760 model to existing system usage in a year of typical weather:

Hourly usage = hourly load / existing efficiency (76%)

Therms Usage by Regression -- Existing Excerpt:

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

Existing NG Usage

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

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

ECM 2 - Install Biomass Boiler with Condensing Natural Gas Boiler

Calculate Biomass Boiler and Condensing Natural Gas Boiler Usage:

Hourly usage = hourly load / proposed equipment efficiency

% Load Sharing:

Biomass	60%
Boiler	40%

Condensing Boiler Efficiency Parameters

Outdoor air temperature (OAT, deg F) selections:

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

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

Therms Usage by Regression -- Proposed Excerpt:

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

Proposed Usage

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

Savings Summary

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

NIST BLCC 5.3-18: Comparative Analysis

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

Base Case: Existing NG Boiler

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

General Information

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

Comparison of Present-Value Costs

PV Life-Cycle Cost

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

Net Savings from Alternative Compared with Base Case

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

Net Savings $56,719

Savings-to-Investment Ratio (SIR)

SIR = 1.18

Adjusted Internal Rate of Return

AIRR = 3.58%

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback occurs in year 17

Discounted Payback occurs in year 23

Energy Savings Summary

Energy Savings Summary (in stated units)

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

Note: Annual Alternative MBtu in coal row is Pellets

Energy Savings Summary (in MBtu)

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

Emissions Reduction Summary

Energy Type	-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Natural Gas				
CO_2	156,253.77 kg	54,010.84 kg	102,242.92 kg	2,964,694.92 kg
SO_2	1,261.02 kg	435.88 kg	825.13 kg	23,926.02 kg
NO_x	131.10 kg	45.31 kg	85.78 kg	2,487.36 kg
Coal				
CO_2	0.00 kg			
SO_2	0.00 kg			
NO_x	0.00 kg			
Total:				
CO_2	156,253.77 kg			
SO_2	1,261.02 kg			
NO_x	131.10 kg			

Note: Biomass boiler emissions not known, see report.

UCOB
ECM 3: AC-4R VAV Conversion

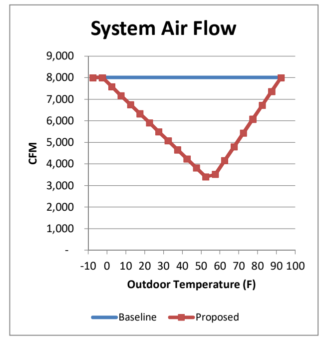
Convert AC-4R from constant volume to VAV by installing a Variable Frequency Drive

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

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

Occupied Period

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



Unoccupied Period

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

Peak Demand Savings

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

Formulas & Assumptions

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

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

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

NIST BLCC 5.3-18: Comparative Analysis

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

Base Case: Constant Air Volume - AC-4R

Alternative: ECM 3: AC-4R VAV Conversion

General Information

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

Comparison of Present-Value Costs

PV Life-Cycle Cost

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

Net Savings from Alternative Compared with Base Case

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

Net Savings -$29,749

Savings-to-Investment Ratio (SIR)

SIR = 0.38

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

Adjusted Internal Rate of Return

AIRR = -0.24%

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

Payback Period

Estimated Years to Payback (from beginning of Service Period)

Simple Payback never reached during study period.

Discounted Payback never reached during study period.

Energy Savings Summary

Energy Savings Summary (in stated units)

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

Energy Savings Summary (in MBtu)

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

Emissions Reduction Summary

Energy	-----Average	Annual	Emissions-----	Life-Cycle
Type	Base Case	Alternative	Reduction	Reduction
Electricity				
CO_2	5,240.83 kg	3,298.34 kg	1,942.50 kg	56,325.75 kg
SO_2	15.43 kg	16.62 kg	-1.19 kg	-34.64 kg
NO_x	5.56 kg	4.92 kg	0.64 kg	18.56 kg
Total:				
CO_2	5,240.83 kg	3,298.34 kg	1,942.50 kg	56,325.75 kg
SO_2	15.43 kg	16.62 kg	-1.19 kg	-34.64 kg
NO_x	5.56 kg	4.92 kg	0.64 kg	18.56 kg

Appendix C – ECM Cost Estimates

// L&S ENERGY SERVICES, INC.

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

Measure: PFS 1 - Install Solar Thermal DHW

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

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

// L&S Energy Services, Inc.

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

Measure: PFS 2 - Install Air Source Heat Pumps

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

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

L&S Energy Services, Inc.

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

Sheet No: 1 of 1
Date:
Date:

Measure: PFS 3 - Install Cooling Energy Storage

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

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

L&S Energy Services, Inc.

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

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

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

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

// L&S Energy Services, Inc.

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

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

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

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

L&S Energy Services, Inc.

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

Sheet No:	1 of 1
Date:	
Date:	

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

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

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

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

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

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

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

L&S Energy Services, Inc.

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

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

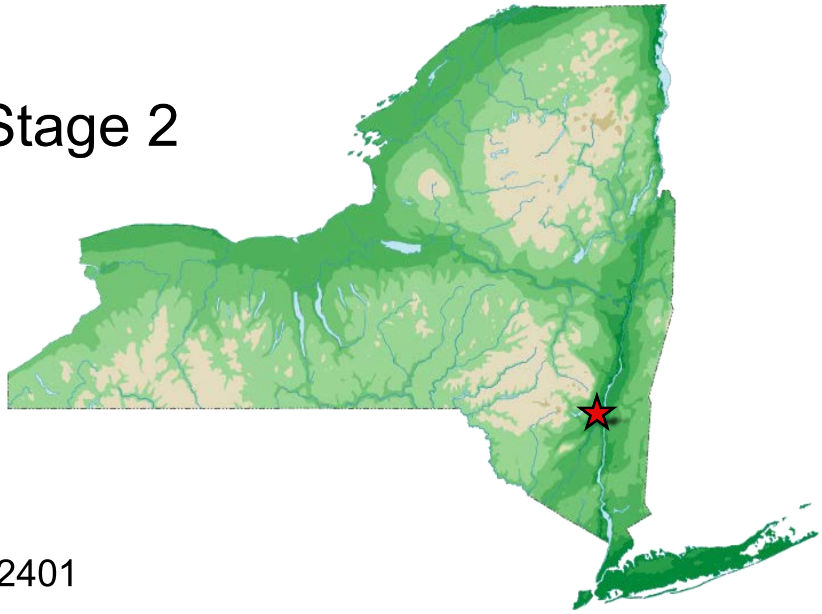
Div.	Description	Qty.	Unit	Unit Labor	Cost Material	Total Labor	Total Material	Total	Ref.
	Install new ~ 5124 MBH boiler	2	ea					$241,600	GPI
	including an allowance for demo								
	and new venting.								
	Total					$0	$0	$241,600	

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

Appendix D – NYSERDA/NYPA Geothermal Clean Energy Challenge

NEW YORK STATE OF OPPORTUNITY

Geothermal Clean Energy Challenge



Advanced Report – Stage 2

Applicant:	Ulster County
Address:	244 Fair St.
	Kingston, NY 12401
Site Name:	244 Fair St.

Project Summary

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

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

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

NY Power Authority | NYSERDA

Prepared by:
ICF

Energy, Financial, and Environmental Savings Opportunities from GSHP Implementation

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

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

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

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

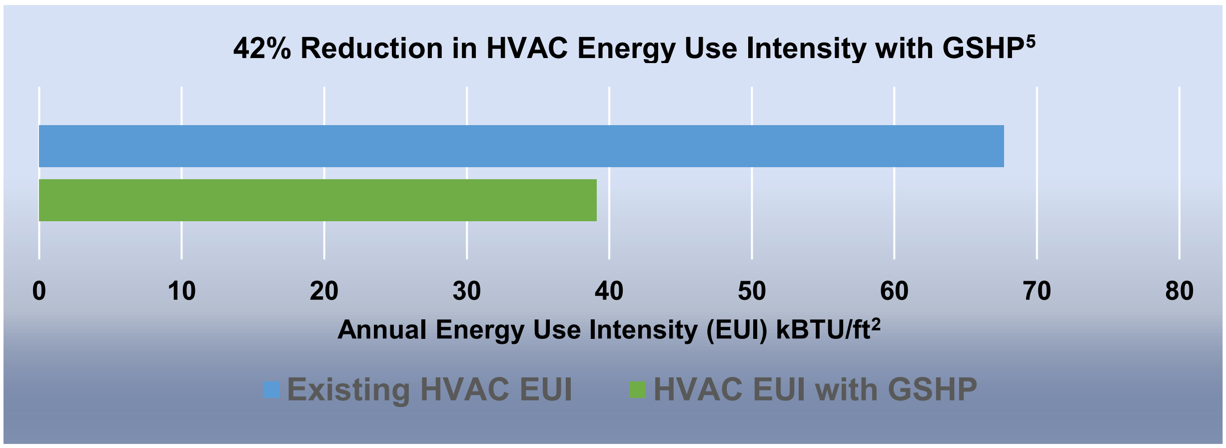
[1] The findings presented in this report are preliminary and should not be used as the sole basis for investment decisions.

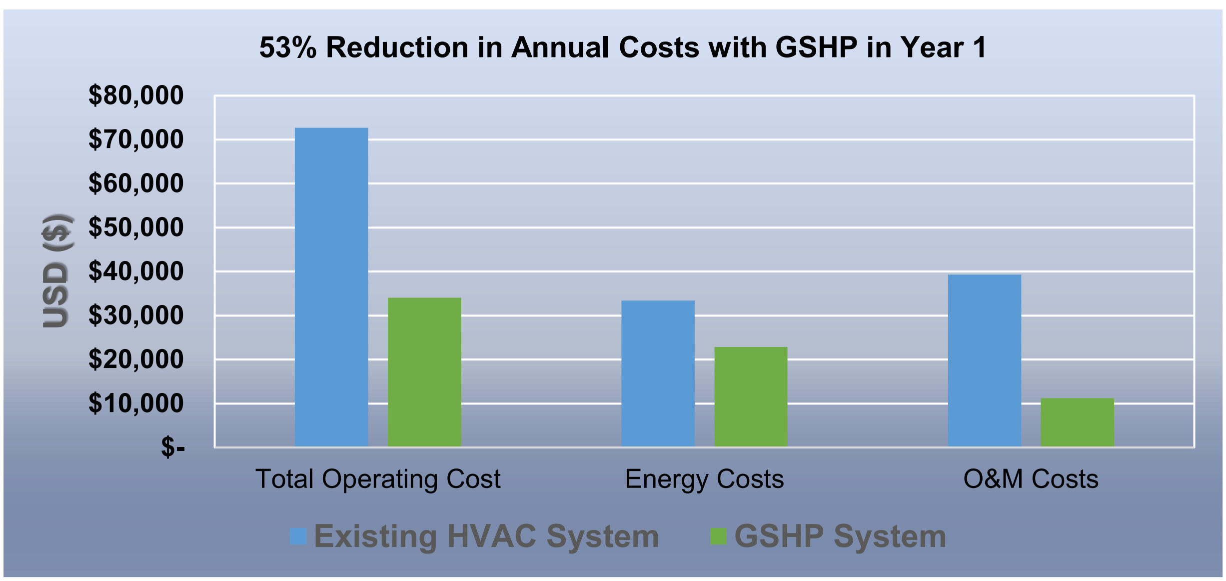
[2] O&M savings include the savings associated with the avoided use of cooling towers at the site.

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

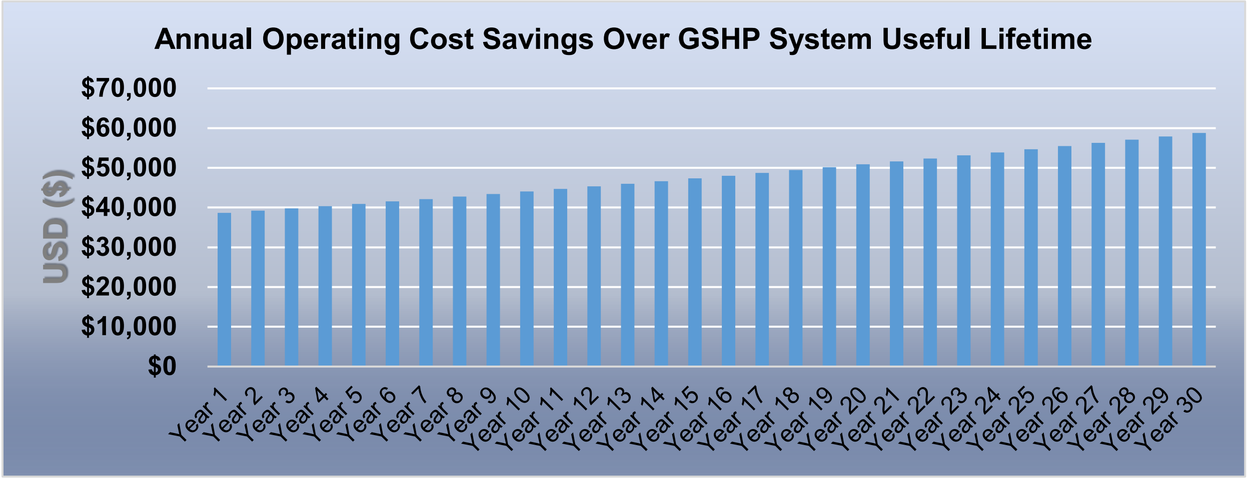
[4] Societal cost of carbon (30 year net present value) calculated using EPA 3% average data in 2017 dollars (https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html)

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





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



Annual Operating Cost Savings Over GSHP System Useful Lifetime

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]

129,393 Pounds of coal burned

18 Homes' electricity use for one year

25 Passenger vehicles driven for one year

3,958 Incandescent lamps switched to LEDs

[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:

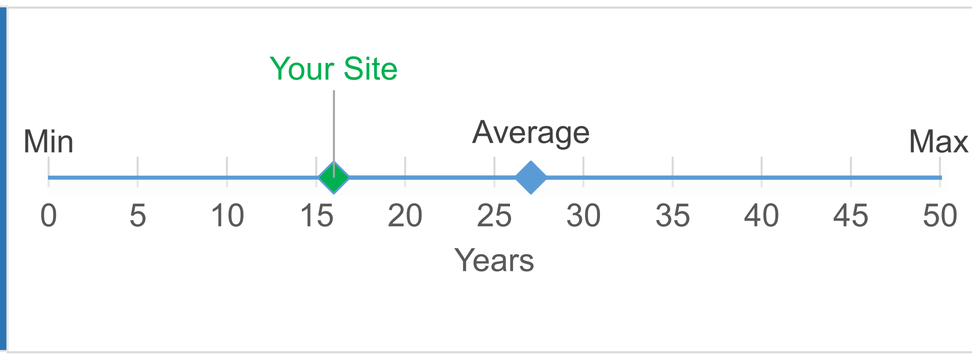
- NYPA's *Geothermal Clean Energy Challenge* website: https://www.nypa.gov/about/geothermalchallenge.
- NYSERDA's *Renewable Heating and Cooling Policy Framework*: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.

- 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.

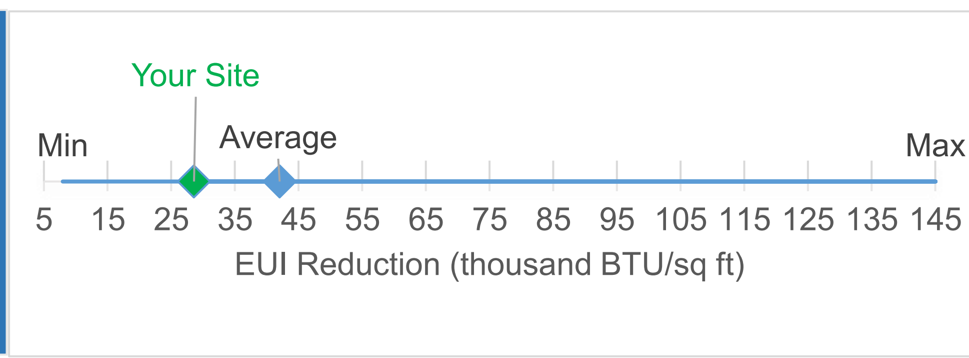
Site Specific Considerations and Selection Criteria

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.

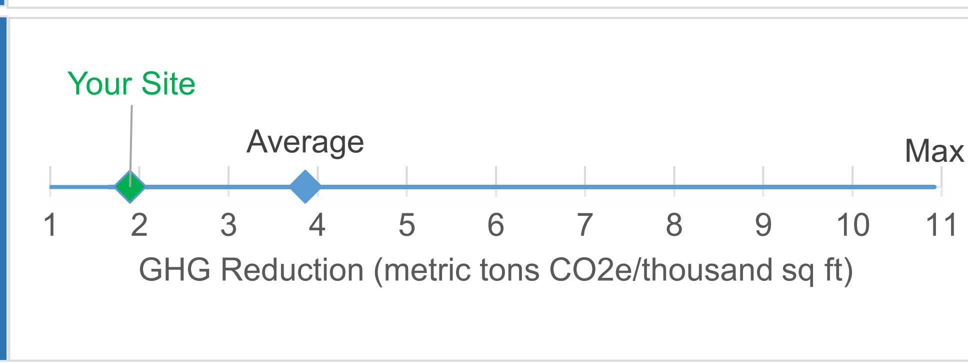
Simple Payback Comparison



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.

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:

Ulster County

Ulster County Department of the Environment
17 Pearl Street

Prepared by:

Greenman-Pedersen Inc. (GPI)

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L&S Energy Services

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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.

TABLE OF CONTENTS

PROJECT TEAM AND INFORMATION

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

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

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

Sincerely,

GPI

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

EXECUTIVE SUMMARY

DESCRIPTION OF STUDY

The focus of this Energy Study was to evaluate the replacement of boiler equipment, while simultaneously developing an implementable strategy for reducing energy use through the application of best-available clean heating and cooling technologies in both the near and long-term at the Ulster County 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 energy costs		
	Electric	$559,577
	#2 Fuel Oil	$212,015
		$771,592

Base year costs - proposed annual cost savings	$666,362
% savings	13.6%

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^o 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

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[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

LEARN MORE AT energystar.gov

ENERGY STAR® Statement of Energy Performance

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 CO_2 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^{o} F and 94% at outdoor temperature of 58^{o} 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:

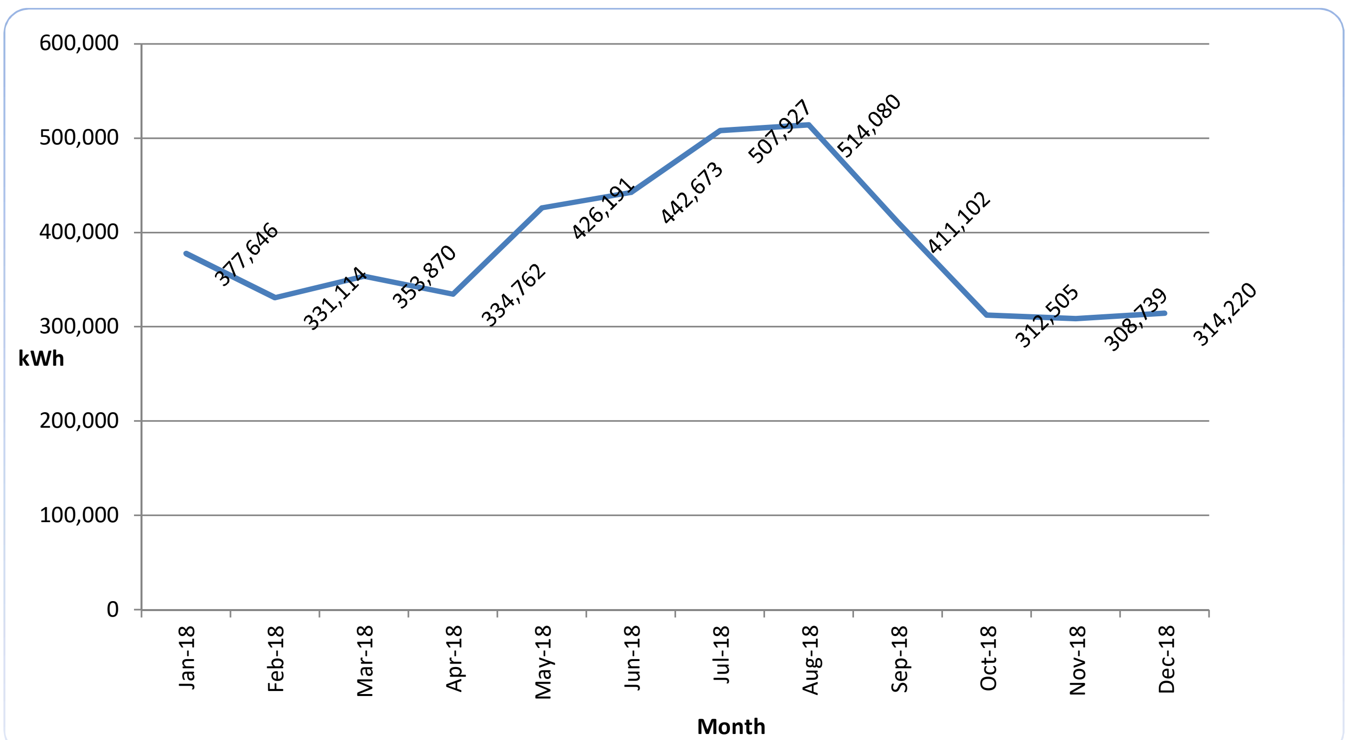
- Fuel switch: $83,015
- Efficiency improvement: $22,216

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

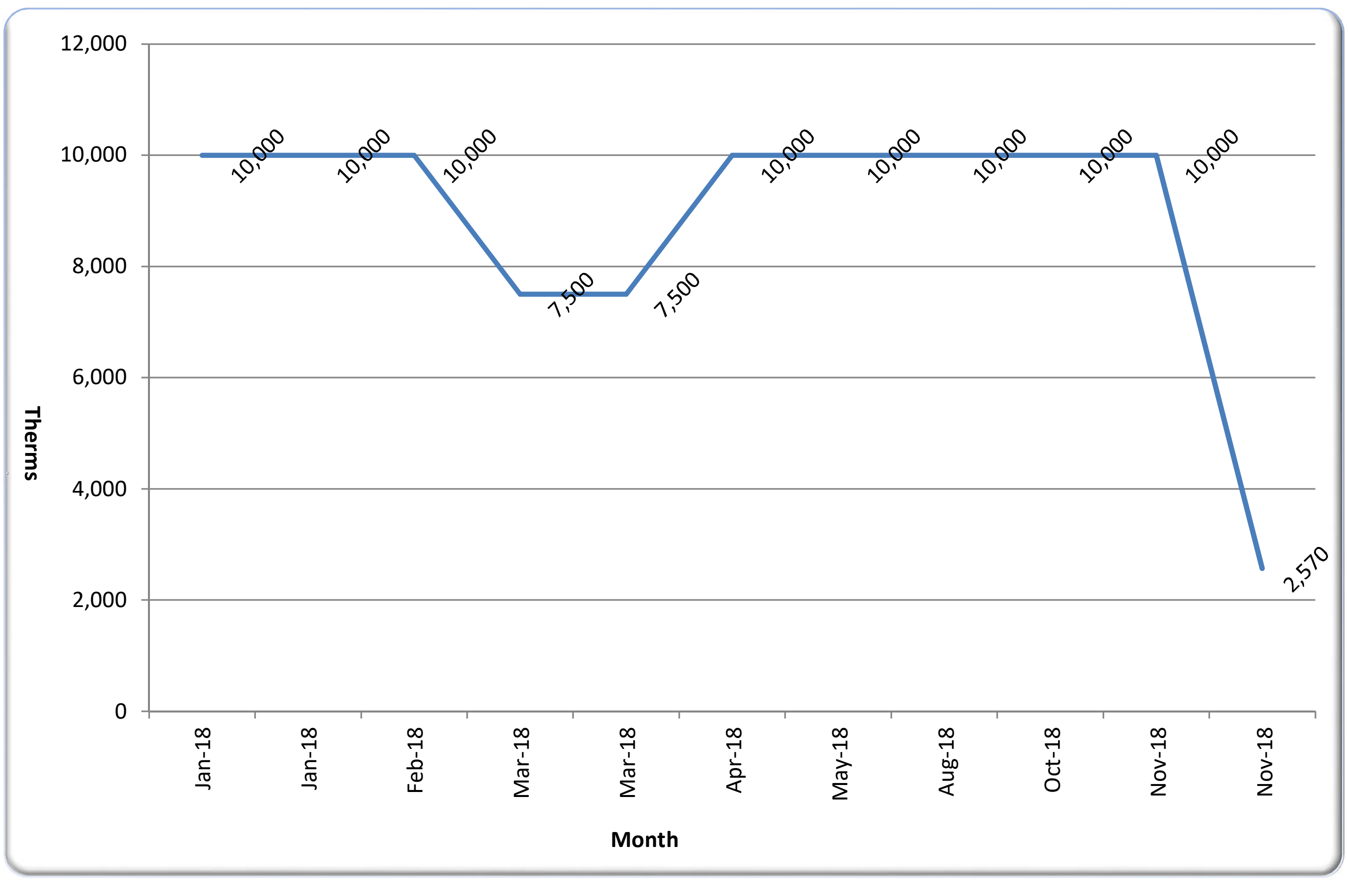
BTU Content (Btu/Gallon): 139,600

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

LEARN MORE AT energystar.gov

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

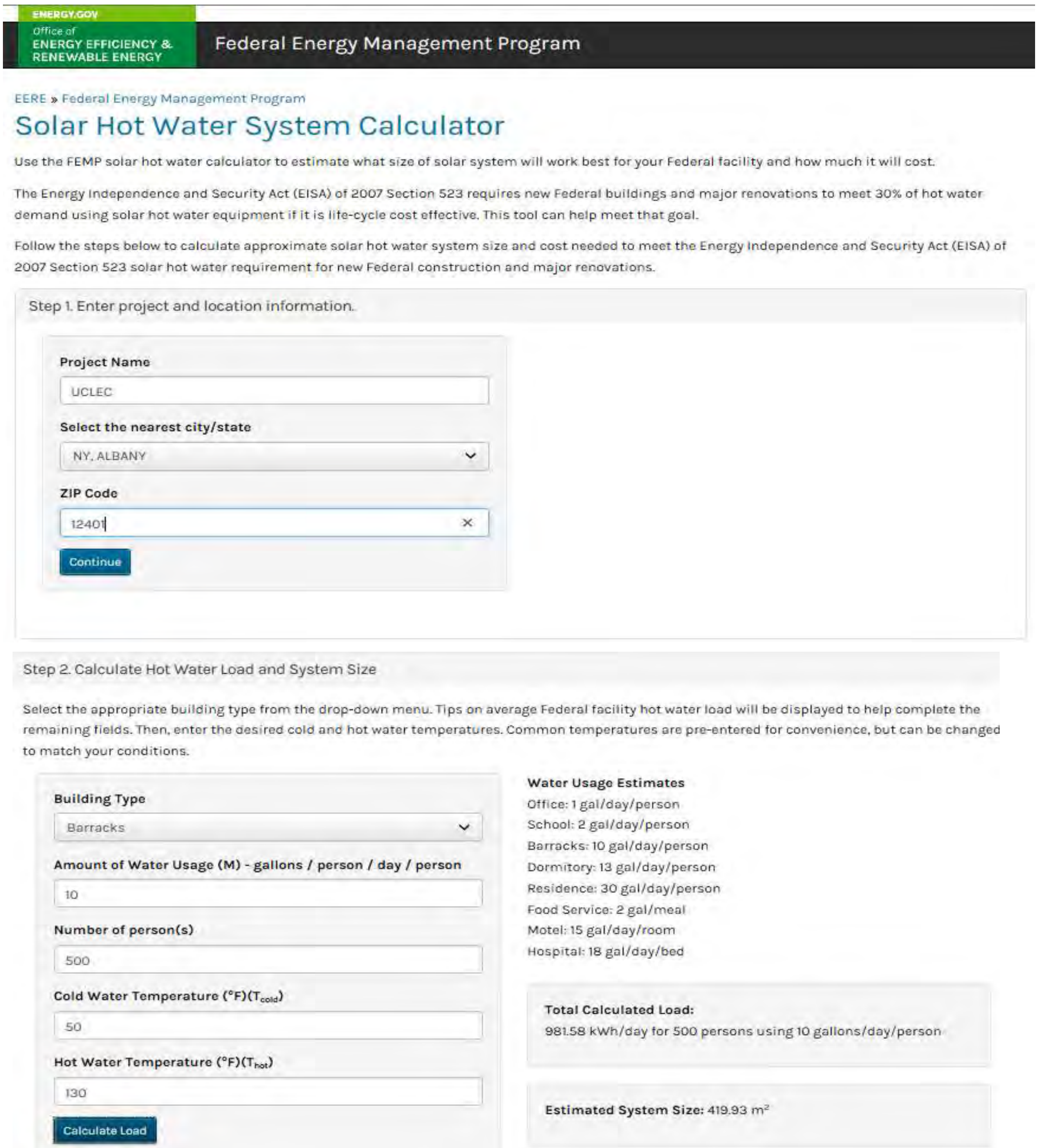
Background Info

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/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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 m^2

UCLEC PFS 1: SOLAR DHW SCREEN

Background Info

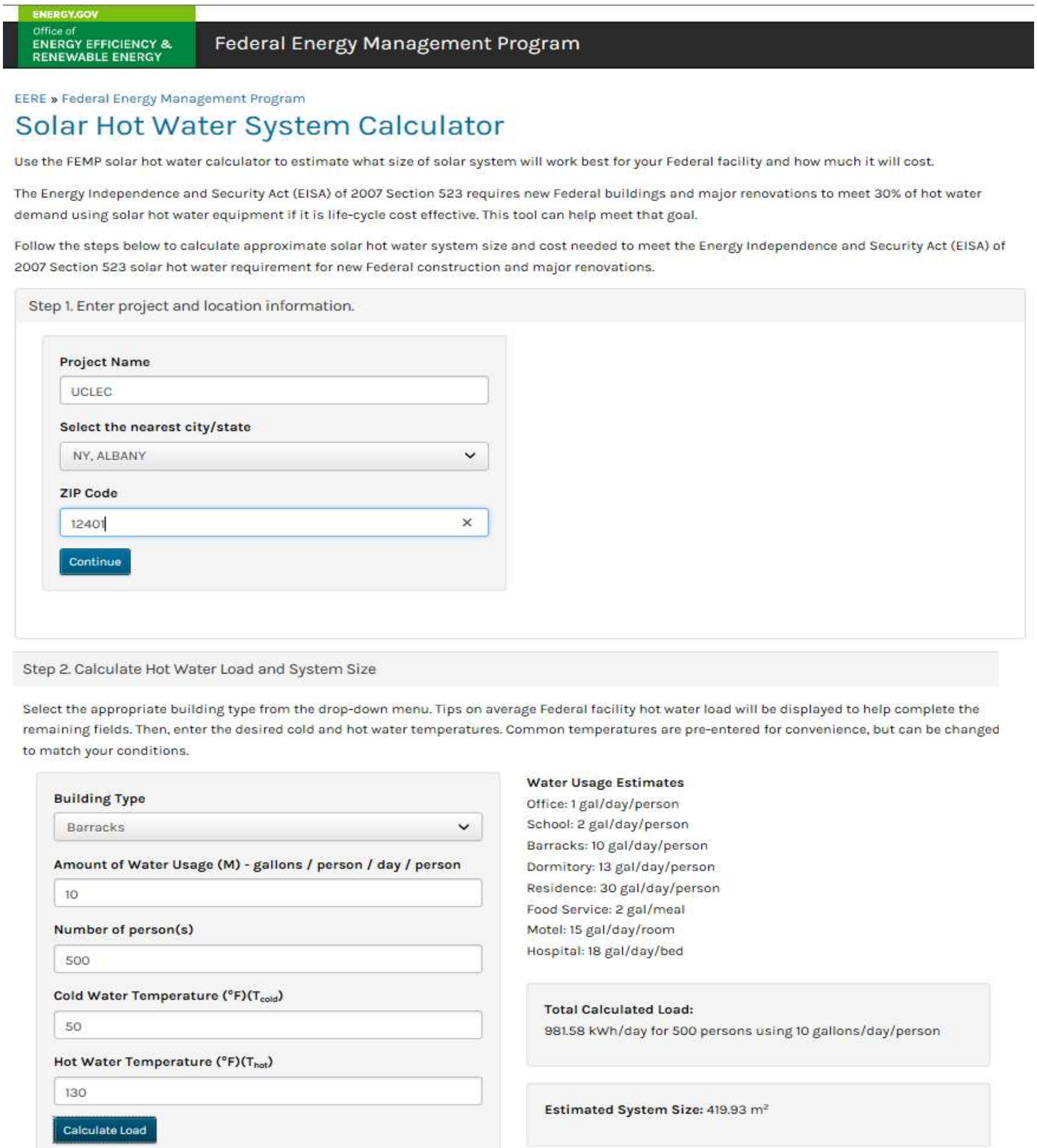
F:\Mike Stiles\Ulster Co Law Enforcement Center (UCLEC)\UCLEC
UCLEC Summary

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/



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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 m^2

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

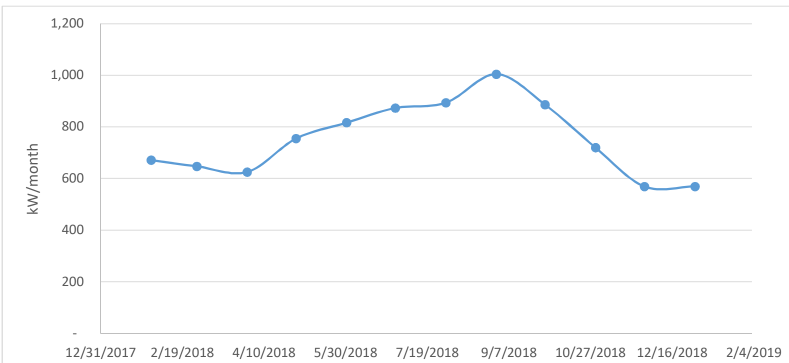
Calculator savings:	318,303	kWh		
Conversion factor:	3,413	Btu/kWh		
	0.003413	mmBtu/kWh		
Solar mmBtu savings =		1,086		
Existing # 2 fuel oil savings:				
$15.566	$/mmBtu #2 fuel oil			
Cost savings =			$16,910	#2 oil
	0.1396	mmBtu/gal #2 fuel oil		
7,782	gallons #2 fuel oil saved			
Natural gas (fuel 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:	
1/1/2005	1:00	Efficiency	Total Therms	Efficiency	Total Therms
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 Base Case	Annual Alternative	Consumption----- 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 Base Case	Annual Alternative	Consumption----- 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 Base Case	Annual Alternative	Emissions----- 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	-----Average	Annual	Consumption-----	Life-Cycle
Type	Base Case	Alternative	Savings	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	-----Average	Annual	Consumption-----	Life-Cycle
Type	Base Case	Alternative	Savings	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	-----Average	Annual	Emissions-----	Life-Cycle
Type	Base Case	Alternative	Reduction	Reduction
Distillate Fuel Oil (#1, #2)				
CO_2	403,308.33 kg	0.00 kg	403,308.33 kg	11,694,561.26 kg
SO_2	2,884.96 kg	0.00 kg	2,884.96 kg	83,654.03 kg
NO_x	363.55 kg	0.00 kg	363.55 kg	10,541.77 kg
Natural Gas				
CO_2	0.00 kg	258,565.36 kg	-258,565.36 kg	-7,497,510.65 kg
SO_2	0.00 kg	2,086.70 kg	-2,086.70 kg	-60,507.28 kg
NO_x	0.00 kg	216.93 kg	-216.93 kg	-6,290.36 kg
Total:				
CO_2	403,308.33 kg	258,565.36 kg	144,742.96 kg	4,197,050.61 kg
SO_2	2,884.96 kg	2,086.70 kg	798.26 kg	23,146.75 kg
NO_x	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

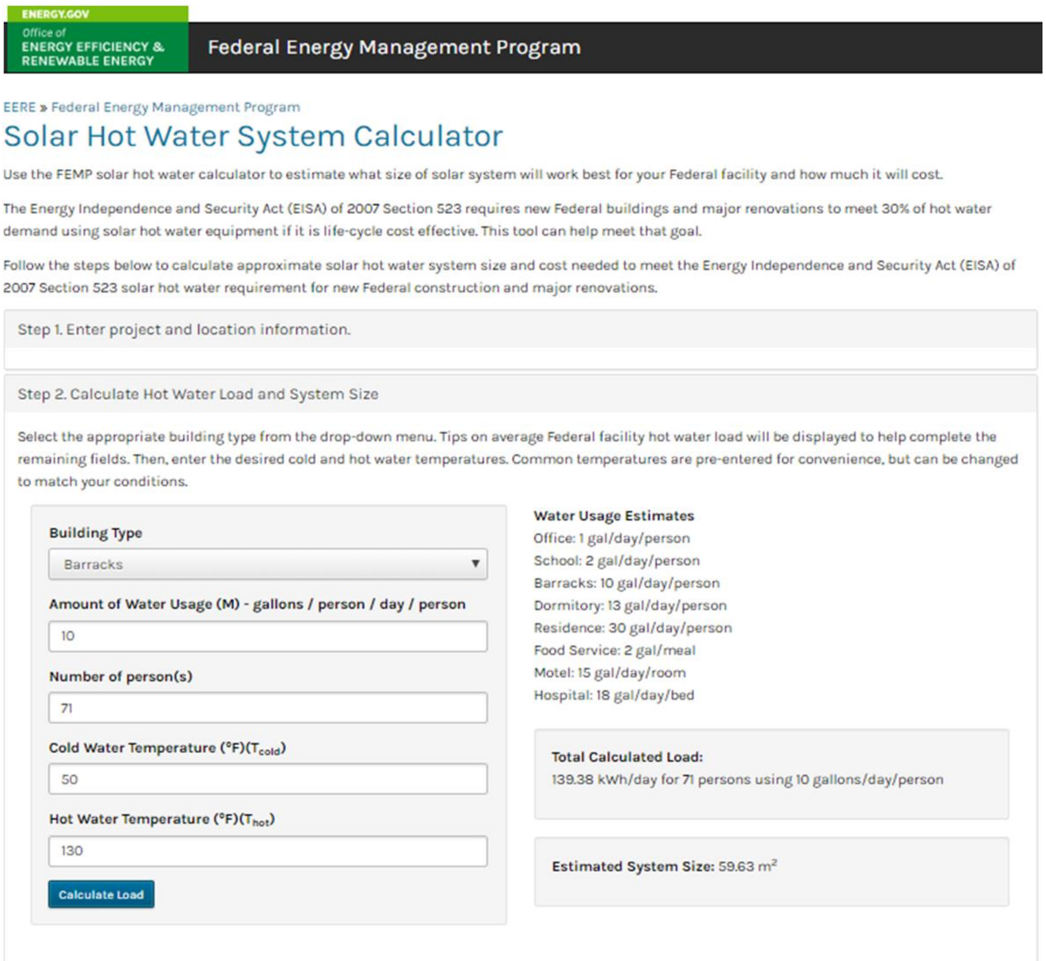
Energy Type		-----Average Base Case	Annual Alternative	Emissions----- Reduction	Life-Cycle Reduction
Distillate Fuel Oil (#1, #2)					
	CO_2	704,053.21 kg	0.00 kg	704,053.21 kg	20,415,133.58 kg
	SO_2	5,036.26 kg	0.00 kg	5,036.26 kg	146,034.40 kg
	NO_x	634.65 kg	0.00 kg	634.65 kg	18,402.71 kg
Natural Gas					
	CO_2	0.00 kg	182,554.01 kg	-182,554.01 kg	-5,293,441.63 kg
	SO_2	0.00 kg	1,473.27 kg	-1,473.27 kg	-42,719.74 kg
	NO_x	0.00 kg	153.16 kg	-153.16 kg	-4,441.16 kg
Coal					
	CO_2	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



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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.

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)
71

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:
139.38 kWh/day for 71 persons using 10 gallons/day/person

Estimated System Size: 59.63 m^2

Step 3. Estimate System Cost and Annual Savings

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

Water Heater Type

ELECTRIC: 0.77 - 0.97, assume 0.88

Efficiency

1

Energy Cost / kWh

0

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 (2/14 solar DHW load)
Nearest City	NY, ALBANY
ZIP Code	12401

INPUT VALUES

Building Type	
Amount of Water Usage	710 gal/day
Number of person(s)	71
Cold Water Temperature	50 (°F)(T_{cold})
How Water Temperature	130 (°F)(T_{hot})
Water Heater Fuel Type	electric
Water Heater Efficiency	1
Average Fuel Price	$0/kWh

CALCULATIONS

System Size	59.63 m²
System Cost	$57,768.06
Annual Energy Savings	39,775.09 kWh/year

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.: Sheet No: 1 of 1
Calculated by: MS Date:
Checked by: 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.: Sheet No: 1 of 1
Calculated by: MS Date:
Checked by: 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.:		Sheet No:	1 of 1
Calculated by:	MS	Date:	
Checked by:		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.: Sheet No: 1 of 1
Calculated by: MS Date:
Checked by: 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.:		Sheet No:	1 of 1
Calculated by:	MS	Date:	
Checked by:		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

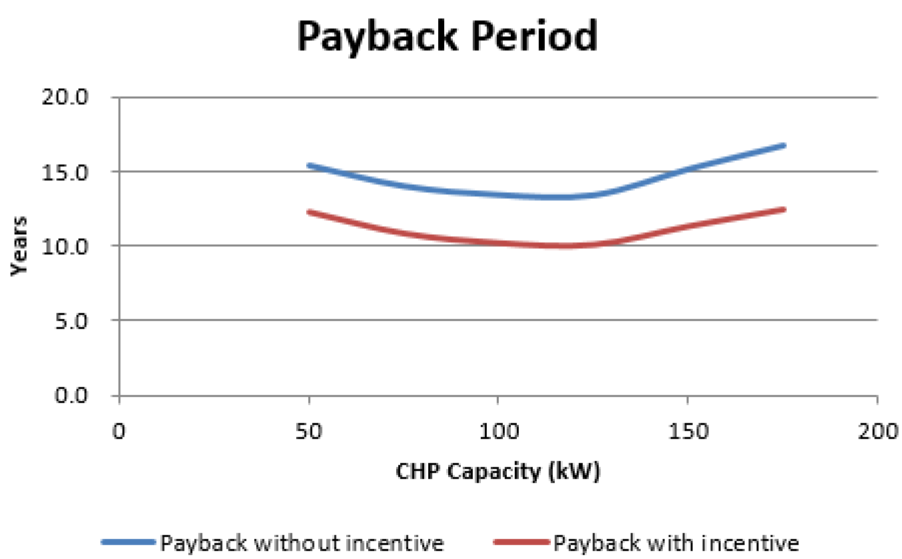
Facility	Variable Cost	Fixed Cost	Total Cost	kWh Rate	Summer kW Rate	Winter kW Rate	Gas Rate	CHP Gas Rate	Annual kWh	Peak Demand	Annual MMBtu	Optimal Size	Payback	Net annual cost savings	kWh savings	offset gas (MMBtu)	CO2 Savings
Ulster County Law Enforcement Center	$4,500	$100,000	$550,000	$0.083	$8.68	$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

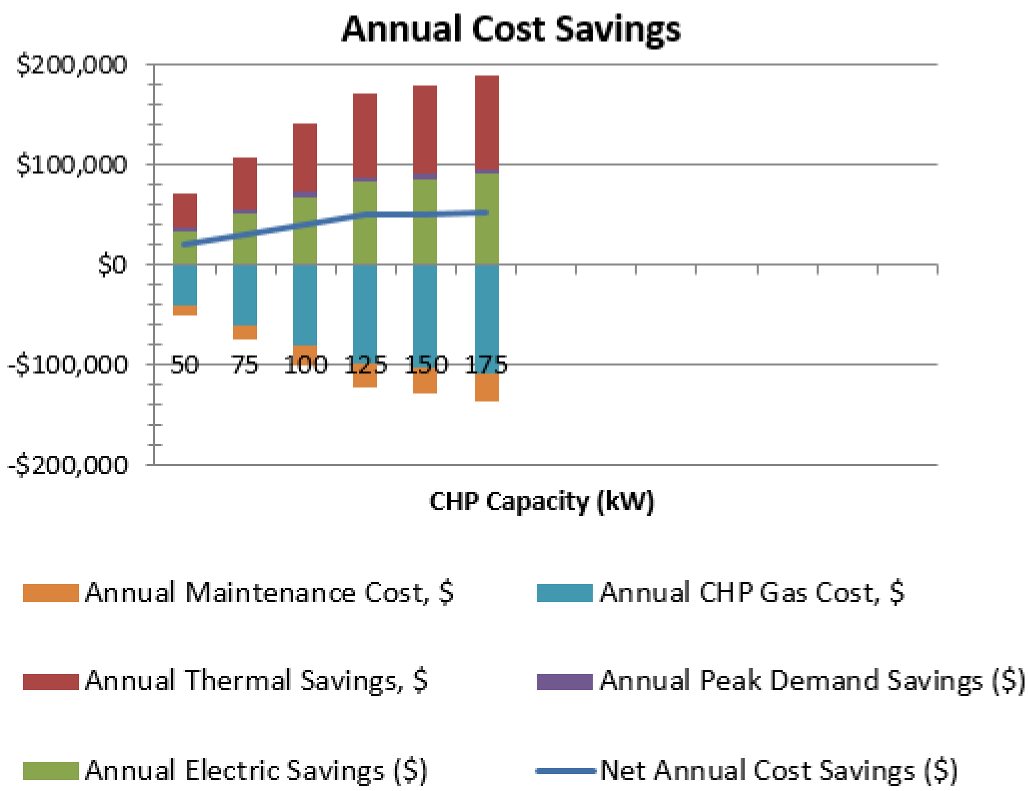
Option 1 Tables

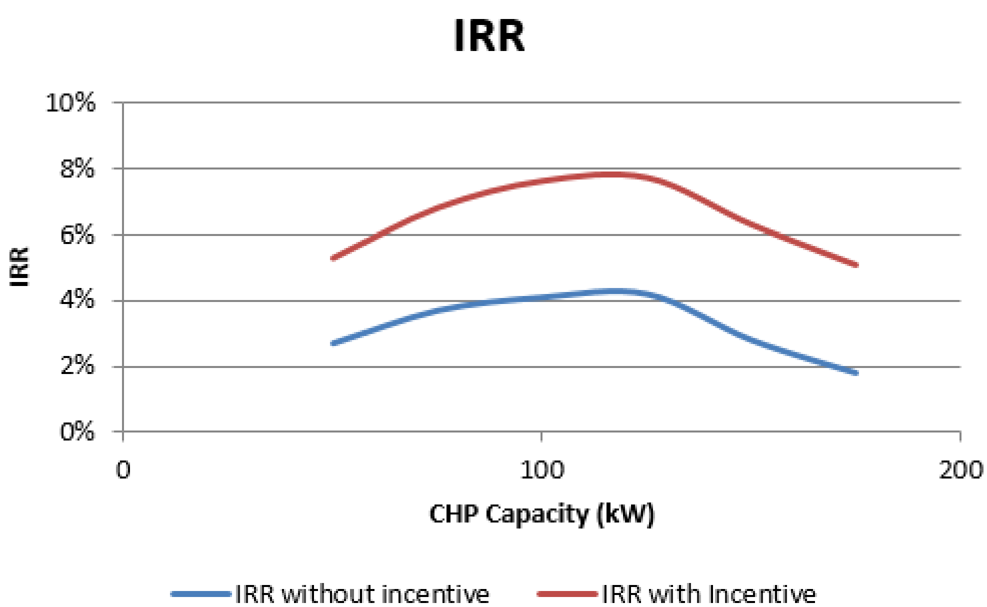
Memo Output	
Size min (kW)	75
Size max (kW)	150
Sample system size (kW)	100
System cost estimate	$550,000
Cost savings	$40,820
Payback period w/out Incentives (years)	13.5
NYSERDA incentive	$135,000
Payback period w/ incentives (years)	10.2

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.

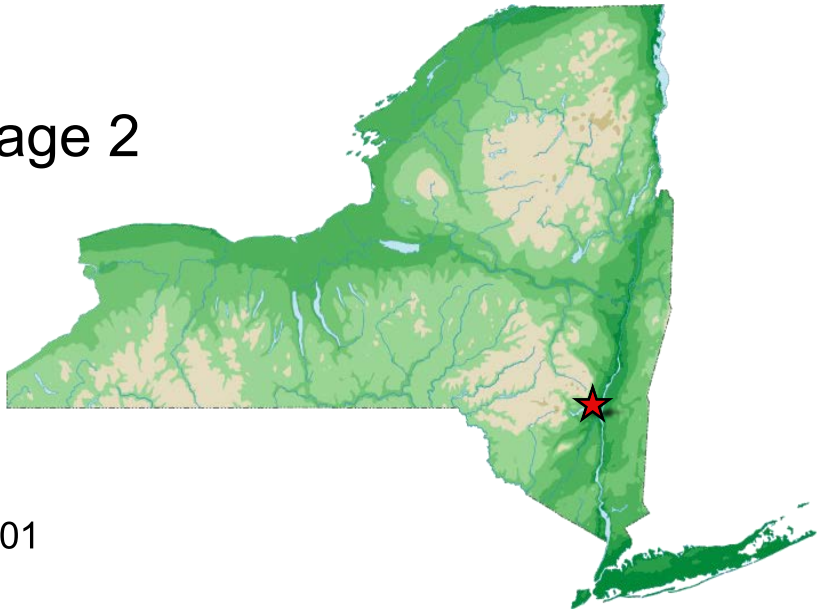



Annual Cost Savings
$200,000
$100,000
$0
-$100,000
-$200,000
50
75
100
125
150
175
CHP Capacity (kW)
Annual Maintenance Cost, $
Annual CHP Gas Cost, $
Annual Thermal Savings, $
Annual Peak Demand Savings ($)
Annual Electric Savings ($)
Net Annual Cost Savings ($)


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

Geothermal Clean Energy Challenge

NEW YORK STATE OF OPPORTUNITY



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

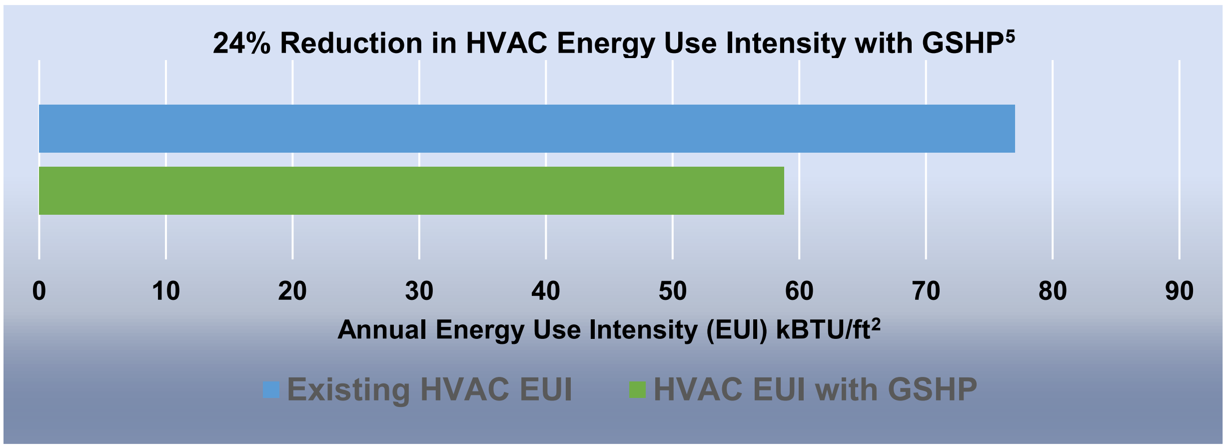
The tables below summarize the savings opportunities estimated for the site in terms of costs, energy and greenhouse gases when comparing the implementation of a ground source heat pump (GSHP) system to the existing (or planned) building HVAC systems.[1]

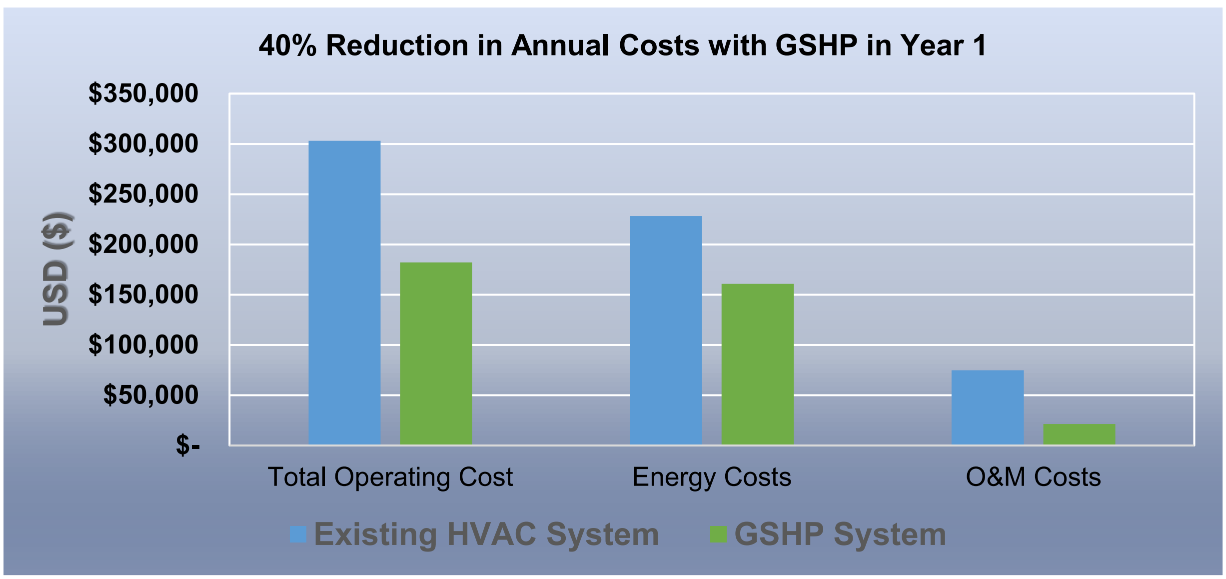
Note: the value of the carbon emissions included in the table is not directly monetizable by the applicant, but rather reflects the overall value to society provided by the reduced carbon emissions. The value is not used as a factor in the economic analysis in this report. However, the benefits to society 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

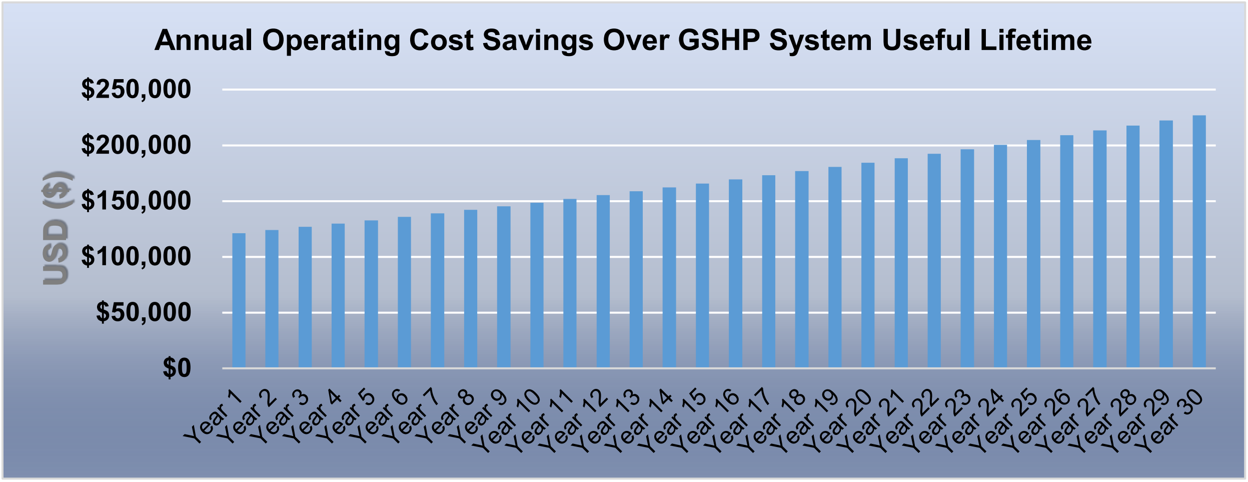
[1] The findings presented in this report are preliminary and should not be used as the sole basis for investment decisions.
[2] O&M savings include the savings associated with the avoided use of a cooling tower at the site.
[3] Estimated capital costs in this report reflect an expected range based on 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



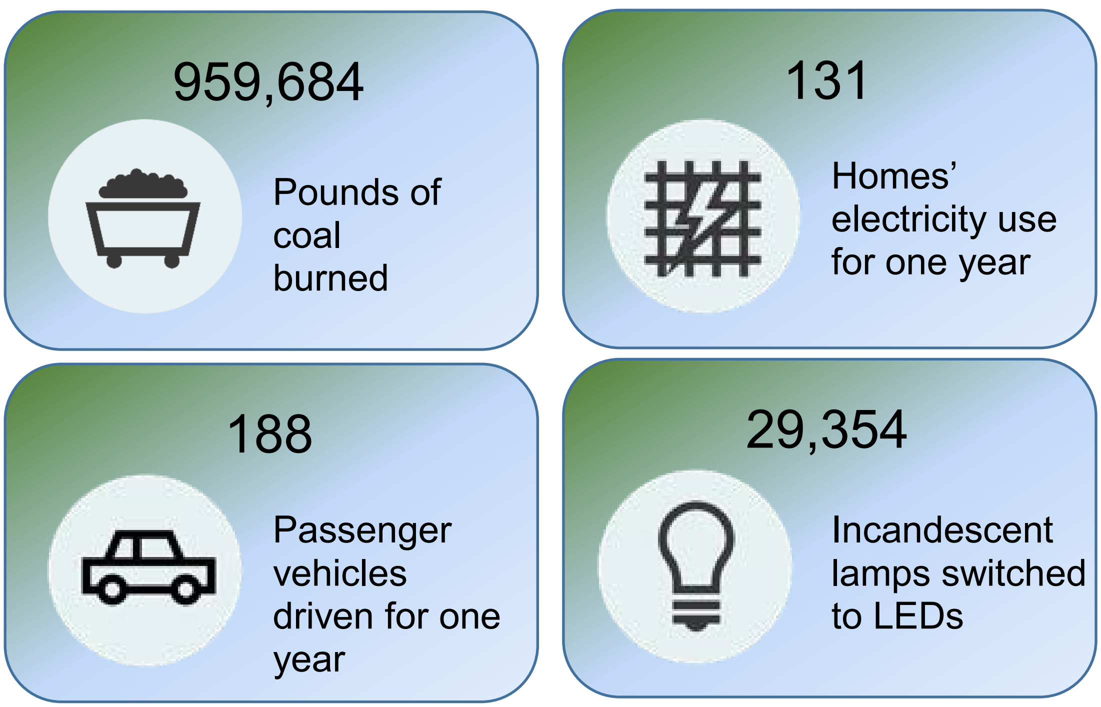


[5] Energy Use Intensity is calculated based on source energy and encompassing all the energy used in delivering energy to a site, including power generation, transmission and distribution losses. (https://www.governor.ny.gov/news/no-88-directing-state-agencies-and-authorities-improve-energy-efficiency-state-buildings)



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.

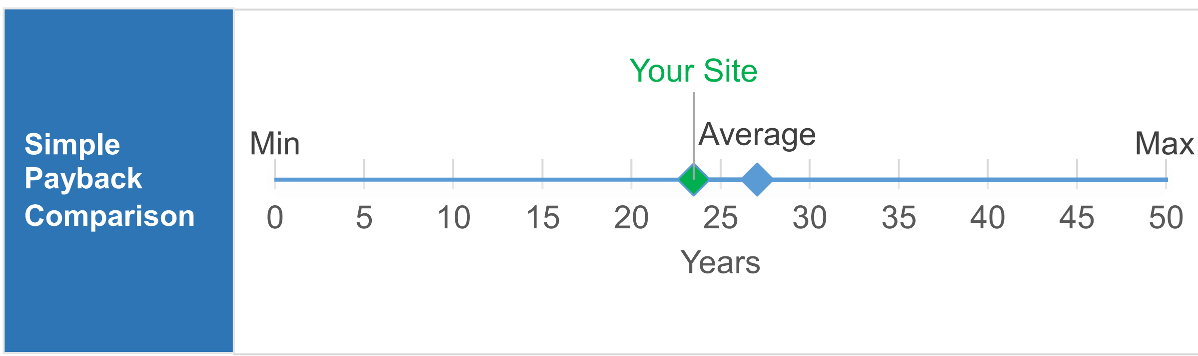
For more information on different types of GSHP loop fields and on environmental factors in GSHP system construction and operations, please see:

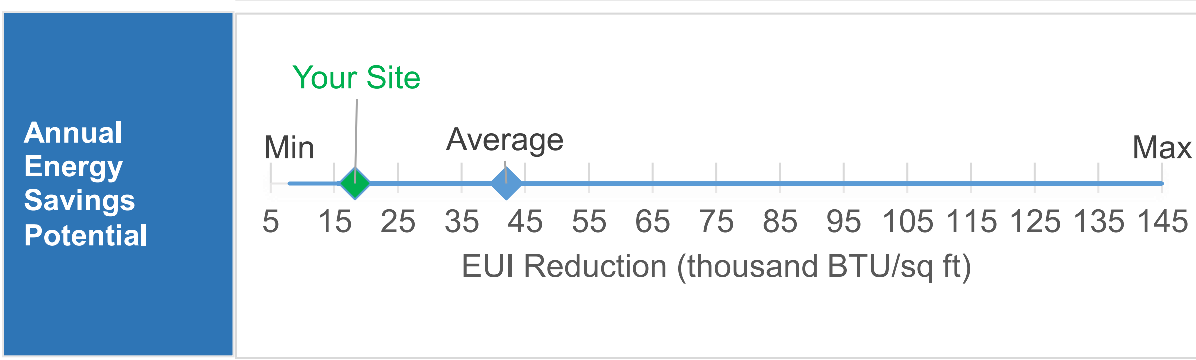
- NYPA's *Geothermal Clean Energy Challenge* website: https://www.nypa.gov/about/geothermalchallenge.
- NYSERDA's *Renewable Heating and Cooling Policy Framework*: https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.

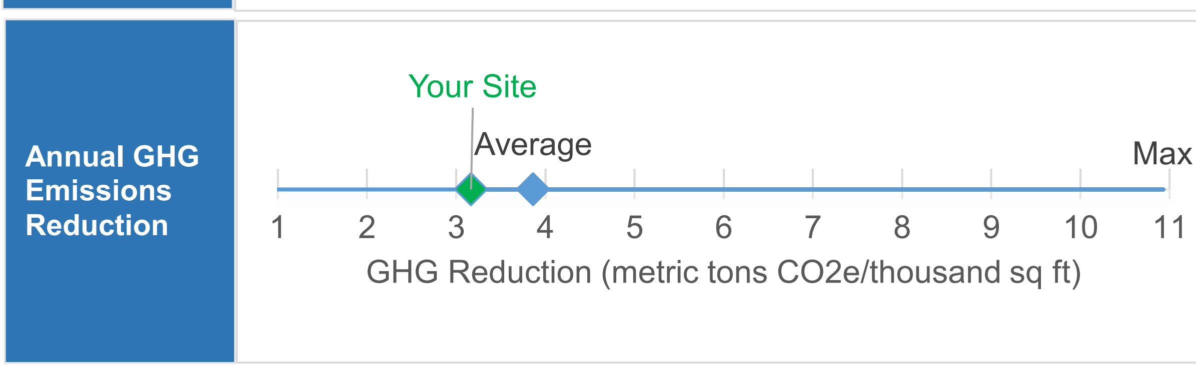
- NY-GEO, a nonprofit trade association dedicated to geothermal heating and cooling: https://ny-geo.org/pages/frontpage.
- U.S. Environmental Protection Agency's *Renewable Heating and Cooling* website: https://www.epa.gov/rhc/geothermal-heating-and-cooling-technologies.

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.







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 CO_2 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.

COUNTY OF ULSTER

REQUEST FOR PROPOSALS

RFP-UC18-045

FLEXTECH ENERGY STUDY

ULSTER COUNTY PURCHASING DEPARTMENT
MARC RIDER
DIRECTOR OF PURCHASING
244 FAIR STREET 3RD FLOOR
PO BOX 1800
KINGSTON, NY 12402

RECEIPT CONFIRMATION FORM

PLEASE COMPLETE AND RETURN THIS CONFIRMATION FORM WITHIN 5 WORKING DAYS OF RECEIVING BID PACKAGE TO:

Michael Maphis; Buyer
Ulster County Purchasing Department
244 Fair Street, 3rd Floor Kingston, NY 12401
Telephone: (845) 340-3999 Fax: (845) 340-3434
RFP-UC18-045: FLEXTECH ENERGY STUDY

Failure to return this form may result in no further communication or addenda regarding this Bid.

Company Name: ____

Address: ____

City: __________________________________ State: _________ Zip Code: ___________

Contact Person: ____

Phone Number: ____________________________EXT:_____ Fax Number**:** ____________________

Email: ____

I have received a copy of the above noted PROPOSAL.

_____ We will be submitting a PROPOSAL

_____ We will NOT be submitting a PROPOSAL **– (please indicate reason)**

____

____

____

Signature: ____

Title: ____

If a bidders meeting has been arranged for this Bid, please indicate if you plan to attend: **Yes / No**

REQUEST FOR PROPOSAL

DATE: **May 17, 2018**

NOTICE IS HEREBY GIVEN THAT SEALED PROPOSALS ARE SOUGHT AND REQUESTED FOR THE FOLLOWING:

RFP NAME: FLEXTECH ENERGY STUDY

RFP NUMBER: RFP-UC18-045

MAIL PROPOSAL TO: Ulster County Purchasing,
Ulster County Office Building
244 Fair St 3rd Floor
PO Box 1800
Kingston, NY 12402

SUBMISSION DATE: Friday, June 15th, 2018 at 4:00 P.M.

Proposals received after the time specified will not be opened.

CONTACT PERSON: **Michael Maphis; Buyer**
Ph: (845) 340-3999 **Email:** mmap@co.ulster.ny.us

PROPOSALS **MUST** BE SUBMITTED IN A **SEALED** ENVELOPE OR PACKAGE.

PRINT (ON THE FACE OF ENVELOPE): 1) NAME & ADDRESS OF COMPANY
2) RFP NAME & NUMBER

It is the responder's responsibility to read the attached RFP Specifications.

By: **Marc Rider**
Director of Purchasing

1.0 INTRODUCTION

The Ulster County Department of the Environment (hereafter referred to as the "County") requests written proposals from interested and qualified Firms (hereafter referred to as the "Consultant") for engineering services to conduct a heating and cooling technology evaluation in two County-owned properties. The County intends to utilize cost-share funding from the NYSERDA FlexTech program (PON 1746) for this project.

A. Project Background

Ulster County has a strong track record of being a leader in green power use and environmental sustainability. 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.

Additionally, 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.

Through this project, Ulster County is seeking to evaluate a stated need to replace boiler equipment at both properties, while simultaneously developing an implementable strategy for reducing the energy use intensity of these properties through the application of best-available clean heating and cooling technologies in both the near and mid-term.

B. Project Locations

Ulster County Law Enforcement Center: 380 Boulevard, Kingston, NY.
Currently planning replacement of (2) of (3) 10,044 MBtu/hr Sellers Model SY-300-W boilers with new dual-fuel boilers and associated components and installation of a natural gas main to the building. Currently, only ULSD fuel oil is available on site. However, Ulster County is working with the local utility, Central Hudson, for extension of natural gas distribution infrastructure to the site. The facility is 277,000 sq. ft. and the Site Energy Use Intensity is 121.3 kBtu/sq. ft.

Ulster County Office Building: 244 Fair Street, Kingston, NY.
Currently planning replacement of (2) of (2) 5,124 MBtu/hr Weil-McClain Model 1688 natural gas boilers, valving and controls. The facility is 62,396 sq. ft. and the Site Energy Use Intensity is 97.7 kBtu/sq. ft.

C. Project Goal

These two facilities, the Ulster County Office Building and the Ulster County Law Enforcement Center, contribute 45% to the total building energy usage within the County. Together, they require a combined annual energy expenditure of approximately $842,500. The County is devoting resources to reduce the energy use, cost and emissions impacts at these facilities.

Prior to committing to a long-term fuel commitment by selecting natural gas combustion equipment, Ulster County is seeking to assess clean alternatives to these technologies to fit with this long-term energy reduction plan and requires objective and customized information, specific to these sites, to make decisions regarding energy projects. A successful proposal should allow the County to reach a result where near-term heating needs (i.e. boiler replacement) are met in an energy efficient manner *and* a larger strategy for deployment of clean heating and cooling technologies at these locations is presented.

D. Proposal Requirements

Proposing firms should have the experience and staff capacity to both 1) evaluate the existing building loads and mechanical systems, and 2) assess and recommend clean heating and cooling and/or energy-efficient options.

Proposals should include a scope of work, schedule and budget to complete an energy efficiency technical analysis and evaluation of advanced technologies through the FlexTech program. Proposals should be written to comply with FlexTech program requirements. Proposed amendments/additions to the scope of work provided below will be considered. Please reference Attachment A-1 of the FlexTech Program (PON 1746) for more information, available at https://nyserda.ny.gov.

During contract development, the contractor will provide administrative support for the FlexTech program, providing information as needed for County staff to finalize the FlexTech application to NYSERDA for approval, including the project scope of work, Schedule and Budget; and consultation on any NYSERDA revisions to the submitted scope of work.

2.0 PROPOSAL/SUBMITTAL RETURN DATE

2.1 RETURN CONFIRMATION FORM

Receipt Confirmation Form which follows the cover page of this RFP should be completed and faxed (845-340-3434) to the Ulster County Purchasing Department **immediately** if planning on submitting a proposal. Failure to file this form with Ulster County Purchasing may result in no further communications regarding this RFP. In order to better evaluate the County's procedures, those deciding not to respond to the RFP are asked to return the sheet with a short explanation of the reason(s) they will not be submitting.

2.2 RETURN DATE

One unbound original, six (6) photocopies, and one electronic copy (CD or thumb drive) of the proposal and other required documents containing the entire proposal must be submitted, sealed in an opaque envelope/package clearly marked on the outside with the name and number of the RFP, and the name and address of the responder. All copies and the original document must be clearly identified as such. **The Original Document is defined as the copy containing the original ink signed signature pages.**

Proposals must be received no later than 4:00 P.M. Friday, June 15, 2018 at the following address:

Ulster County Purchasing
Marc Rider, Director of Purchasing
PO Box 1800
244 Fair St 3rd Floor
Kingston, NY 12401

2.3 SUBMISSION CONDITIONS

The Proposal submitted by the individual Responder(s) is the document upon which Ulster County will make its initial judgment regarding the Responders qualifications, understanding of the County's scope and objectives, methodology, and ability to perform services under the contract.

Those submitting Proposals do so entirely at their expense. There is no express or implied obligation by County of Ulster to reimburse any firm or individual for any costs incurred in preparing or submitting Proposals, preparing or submitting additional information requested by the County, or for participating in any selection interviews.

Submission of a proposal indicates acceptance of the conditions contained in this RFP, unless clearly and specifically noted otherwise in the proposal.

Proposals will remain valid until the execution of a contract by Ulster County, unless otherwise rejected consistent with this RFP.

Oral, faxed, or telephoned submittals, or modification thereof, will not be accepted. The County of Ulster reserves the right to waive any and all informalities and to disregard all nonconforming, non-responsive or conditional Proposals. Ulster County reserves the right to reject any or all proposals.

The County of Ulster may, at any time by written notification to all Responders, change any portion of the RFP described and detailed herein.

2.4 GENERAL GUIDELINES

This section of the RFP provides general guidance for preparing proposals. Specific instructions on the format and content of the proposal are contained in Section **9.0 SUBMITTAL CONTENT AND FORMAT.** . The responder's proposal must include all data and information requested by the RFP and must be submitted in accordance with these instructions. The proposal shall be compliant with the requirements as stated in the General Specifications specified in this RFP. Nonconformance with the instructions provided in the RFP may result in an unfavorable proposal evaluation.

The proposal shall be clear, concise and shall include sufficient detail for effective evaluation and for substantiating the validity of stated claims. The proposal should not simply rephrase or restate the RFP requirements, but rather shall provide convincing rationale to address how the responder intends to meet these requirements. Responders shall assume that the County (1) has no prior knowledge of their facilities and experience, and (2) will base its evaluation on the information presented in the responder's proposal.

Elaborate brochures or documentation, binding, detailed artwork, or other embellishments are unnecessary and are not desired. Similarly, for oral presentations, elaborate productions are unnecessary and not desired.

All submitted proposals become the property of Ulster County. The County Purchasing Department will retain one copy of all unsuccessful proposals and will destroy extra copies of such unsuccessful proposals.

2.5 QUESTIONS/CLARIFICATIONS

No oral interpretations as to the meaning of the RFP or revisions to the RFP will be made for any responder.

Requests for clarification or interpretation shall be made in writing and directed to

Marc Rider, Director of Purchasing,
Ulster County Purchasing,
244 Fair St 3rd Floor
Kingston, NY 12402
Email mrid@co.ulster.ny.us or Fax 845-340-3434

At least seven (7) calendar days before the date established for submitting proposals. Inquiries will not be considered after that date. Transmittal of questions via facsimile is acceptable.

Any interpretation deemed necessary by Ulster County will be in the form of an addendum to the RFP and, when issued, will be delivered as promptly as is practicable to all responders. All addenda shall become part of the RFP. Responders shall not rely upon any oral statements or conversations they may have with Ulster County employees or third parties regarding the RFP whether at any pre-proposal conference or otherwise.

3.0 QUALIFICATION OF RESPONDENT

Each responder shall provide a statement of qualifications as required by these specifications.

The County of Ulster may make such investigations it deems necessary to determine the ability of the responder to perform the work. The responder shall furnish to the County, within five (5) days of a request, all such information and data for this purpose as may be requested. The County reserves the right to reject any proposal if the information submitted by, or investigation of, such responder fails to satisfy the County that such responder is properly qualified to carry out the obligations ser forth in this RFP and/or the resulting contract and to complete the work contemplated therein. Conditional proposals will not be accepted.

4.0 PRE-PROPOSAL MEETING (VENDOR’S CONFERENCE)

A pre-proposal meeting is not scheduled at this time.

5.0 METHOD OF AWARD

It is the intention of the County that the award of this project shall be made to the responder whose total proposal, in the opinion of Ulster County, best meets the established criteria listed herein. All aspects of evaluation will be taken into consideration in awarding the project.

It is understood by the parties that the contract resulting from this RFP shall be executed only to the extent of the monies available to the County of Ulster. In addition, the County desires to maximize NYSERDA funding to the extent practicable, and as such this project will rely on NYSERDA commitment to cost-sharing as well as being guided by cost-share limits placed on the project at NYSERDA’s discretion.

A notice of award shall not be binding upon the County until the contract has been fully executed by both parties.

6.0 CONTRACT PERIOD

The term of the contract will be for a period of six (6) months commencing on September 1, 2018 through February 28, 2019.

The successful Responder shall execute a contract with the County of Ulster in substantial conformance with this RFP and the attached sample County of Ulster **AGREEMENT FOR PROFESSIONAL SERVICES (ATTACHMENT A).**

A Notice of Award shall not be binding upon the County until the contract has been fully executed by both parties and approved by the County Executive and Ulster County Legislature

7.0 EVALUATION CRITERIA

Only those proposals that contain complete information and required certifications will be considered. All proposals will be evaluated and examined by a committee of Ulster County representatives using multiple criteria. The project may be awarded to a qualified responder that, based on the committee's evaluation, submits the proposal that best meets the County's needs.

The submitted proposals will be evaluated based on the following criteria:

OVERALL PLAN TO PROVIDE REQUIRED SERVICES (30 POINTS)

- Completeness of responder 's proposed plan to provide a FlexTech energy efficiency technical analysis and report for the identified Ulster County properties.
- Demonstrated capability of the responder to satisfactorily meet not only the requirements outlined in this document but all necessary phases of the program.
- Plan to accomplish all required tasks.

FEE/PRICING PROPOSAL (25 POINTS)

- Cost of proposal
- Reasonableness of fees and budget
- Reasonableness of optional fees

QUALIFICATIONS AND EXPERIENCE (15 POINTS)

- Responder's experience with projects of similar size and scope
- Personnel qualifications and experience
- Responder's business history and viability
- References

UNDERSTANDING OF COUNTY'S GOALS AND OBJECTIVES (25 POINTS)

- Responder understands and proposal addresses the needs of the County and offers a program that will meet or exceed the County's objectives.

LOCAL ECONOMIC DEVELOPMENT (5 POINTS)

- Vendors located within Ulster County will receive five points.
- Vendors located within a contiguous county will receive three points.
- Vendors located within New York State will receive one point.

8.0 INTERVIEWS

If the Evaluation Committee determines necessary, interviews may be scheduled with selected responders as soon as possible after the initial evaluation. This will permit further evaluation and to allow the Evaluation Committee to inquire further into the experience the responder has had on similar projects, willingness and ability to work closely with Ulster County staff and others, thorough understanding of the various aspects of the requirements, and ability to maintain a schedule and complete the services on time and other matters deemed pertinent.

9.0 SUBMITTAL CONTENT AND FORMAT

In order for the County to conduct a uniform review process of all proposals, proposals must be submitted in the format set forth below. Failure to follow this format may be cause for rejection of the proposal because adherence to this format is critical for the County's evaluation process:

SECTION I

Title Page: Showing RFP number, closing date and time, responder's name, address, telephone and fax number of the company. Responder must also clearly identify the name(s) of the contact person responsible for inquiries regarding the RFP submission and the person responsible to bind the company contractually. Along with the names of these individuals, responder must provide their phone and fax numbers and email address for each.

Table of Contents- The Table of Contents must indicate the material included in the proposal by section and page number.

SECTION II: QUALIFICATIONS AND EXPERIENCE

Each responder will provide the history of the company, describe their professional qualifications, prior experience in similar projects, demonstrated capabilities, including demonstrated ability to work effectively with other service and system providers (eg, County government), history of regulatory compliance, fiscal solvency and budget performance; contract compliance; accuracy and timeliness of reporting; management structure and ability to support projects of this scope; ability to recruit and retain staff; and commitment to staff development.

Provide examples of how changes implemented to other programs managed by the company improved operations and resulted in cost savings.

Identify all personnel assigned to the project. (Attach resumes)

Provide a minimum of three (3) references, excluding Ulster County, for similar projects completed. Include contact name, telephone number, date of contract, dollar value of contract and brief description of the program. Specific emphasis should be placed on similar work preformed in the previous five years.

SECTION III: PROPOSED PLAN

In a narrative format, describe in detail how the program will be structured explaining how each of the requirements of the scope of work and other tasks will be accomplished. Include any other additional services, enhancements and/or options that will be provided to the County.

Explain what steps will be necessary to implement services.

Describe what information will be provided to the County effectively capturing required data. Attach samples of all reports to be used.

Describe the plan to work with the County.

Detail methods to be employed which will result in cost savings for the County. Give examples and where possible provide a realistic estimate cost savings.

Include any additional services or information seen beneficial to this program that the evaluation committee should consider.

SECTION IV: FEE/COST PROPOSAL

Cost Proposal – One (1) copy of the Responder's fee shall be submitted in a **separate envelope marked "COST PROPOSAL" with the RFP name and number and shall be included in the original copy of the proposal submitted (do not include this information with any of the copies).** The fee quoted will include all items of labor, materials, travel, equipment and other costs necessary to fully provide the service.

The responder's name must appear on all cost proposal sheets**.**

In addition, a line by line budget must be included to support and justify the annual fee.

SECTION V: RETURN DOCUMENTS

Complete and sign all Return Sheets as indicated at the end of this RFP document.

10.0 SCOPE OF WORK

Task 1: Data Collection:

a) Gather information on building mechanical systems and building energy use. The County will provide equipment make/model, specifications and as-built schematics as available.

b) Access to a minimum of 5 years of historical energy use data and metrics will be provided to the Consultant through the EPA ENERGY STAR Portfolio Manager application.

c) Reports from Level 3 energy audits conducted in 2007 and 2010 will be provided.

d) Additional information may be provided upon request.

Task 2: Site Visits:

a) Conduct site visits as needed. Access to mechanical rooms, roof and basement will be provided.

b) Access to building management software systems will be provided.

c) Interviews with County personnel and building management contracts will be arranged as requested.

Task 3: Preliminary Energy Use Analysis:

a) Analyze existing site conditions, equipment specifications/configuration and energy-use data.

b) Develop building heating and cooling load estimates as needed.

Task 4: Technology Evaluation and Heating/Cooling Master Plan

a) Investigate best-available clean heating & cooling technologies and recommend alternative system/equipment options. Technologies assessed should include, but are not limited to:

-High-efficiency natural gas combustion with combined heat and power (CHP) capability
-Air source heat pumps (ASHP)
-Ground-source heat pumps (GSHP)
-Solar Heating and Cooling
-Renewable combustion fuels (biomass, renewable fuel oil)
-Thermal storage technologies

b) The analysis should be conducted at the pre-feasibility study level for all assessed options and the feasibility study level for a recommended course of action, upon discussion with the County.
c) Incorporate consideration of available incentives into economic evaluation of technologies, including consideration of Federal and State tax credits (if project were to be completed by a commercial entity through a thermal energy purchase agreement). Quantify potential energy savings and greenhouse gas emissions reductions using life-cycle cost methodology.
d) Integrate results and insights from NYSERDA/NYPA Geothermal Clean Energy Challenge Stage 1 summary screening, which is currently in progress for both sites. This screening report will be provided by the County when available (expected May/June 2018).
e) Integrate CHP pre-feasibility model results for the Ulster County Law Enforcement Center completed for the County by ERS, Inc, which will be provided by the County.
f) Provide progress reports as required by NYSERDA.

Task 5: Report Development
a) Generate draft FlexTech report per program requirements. The report should include technical, economic and environmental comparisons of the assessed options and should address all tasks listed in the scope of work.
b) Address comments from NYSERDA and the County on the draft report.
c) Generate the final report for the FlexTech study.
d) Provide technical support for County decision making, including the decision to proceed with planned boiler equipment replacement and natural gas service extension. Assist in developing a scope of work for an RFP to solicit engineering services for design of the selected system/technology. Offerors may propose additional services for consideration.

Please provide an anticipated schedule for completing tasks. Schedule should be in a format referencing number of weeks from NYSERDA approval for completion of each task. The County is wishes to complete this study as quickly as practicable, and welcomes considerations within the proposal to fast-track the project. The following is a suggested schedule:

Task		**Time (in weeks from NYSERDA notice to proceed)**
1.	Data Collection	0-2
2.	Site Visits	1-3
3.	Preliminary Energy Use Analysis	3-5
4.	Technology Evaluation / Master Plan	6-10
5.	Report Development	10-14

a. Draft report to NYSERDA	10
b. NYSERDA review and comment	11-13
c. Final report to NYSERDA	14
d. Technical support for RFP development	14-16

If you wish to schedule an inspection of the facilities, please contact Nick Hvozda, Deputy Coordinator, Department of the Environment, at (845) 340-4298 or email at nhvo@co.ulster.ny.us.

11.0 TERMINATION

The County reserves the right to terminate any part of or the entire contract resulting from this Request for Proposal if the Successful Responder fails to carry out any item, promise, or condition of the contract. The County will issue a written ten (10) day Notice of Default to the Successful Responder if in the opinion of the County, the Successful Responder:

- Provides services that do not meet the requirements of the contract or if he/she attempts to impose service or workmanship that is of unacceptable quality;

- Fails to complete the required work or fails to perform required services within the time frame stipulated;

- Fails to make progress to perform the contract requirements and/or gives the County an indication that he/she will not or cannot perform the requirements of the contract
- Failure of the Successful Responder to remedy the problems noted or to otherwise bring performance to satisfactory levels that are within the requirements of the contract shall give the County cause to cancel this contract. The Successful Responder will be provided with a written cancellation notice that specifies the effective date of the cancellation. After receipt of the Notice of Cancellation, the Successful Responder agrees to perform the terms and conditions of this contract up to and including the date of cancellation as though no cancellation has been made.

- In case of Default and/or Cancellation, the County reserves the right to purchase this service from the open market or to complete any actual excess costs by (1) deduction from the unpaid balance due or (2) other remedies as provided by law.

- Conflict of interest: The Director of Purchasing may cancel any contract(s) resulting from this request within the life of the contract, without penalty or further obligation, if any person significantly involved in initiating, securing, drafting, or creating the contract for the County of Ulster becomes an employee or agent of the Successful Responder.

- Termination for convenience: The County of Ulster reserves the right to terminate any resulting order or contract upon ten (10) days written notice. The County will be responsible only for those standard items that have been delivered or accepted.

In addition to termination or in the alternative, the County may pursue any or all other legal and equitable remedies and rights it may have under the circumstances.

12.0 RETENTION OF RECORDS AND AUDIT ACCESS

12.1 Retention of Records

The Successful Responder shall maintain books, records and documents of its performance under the contract in accordance with generally accepted accounting principles including proof of any expenses claimed for reimbursement. The provider shall report to the County as required and allow records to be subject to inspection by the County upon reasonable notice. The Successful Responder shall maintain and retain for a period of not less than three years after the date of termination of the contract all financial information, data and records used to prepare and support the Successful Responder's final proposal and all records pertaining to the revenues, performance of the work and incurrence of costs under the contract. The Successful Responder shall ensure that its sub-contractors and suppliers maintain and retain for no less than three years all similar records.

12.2 Audit Access

Ulster County and its authorized representatives and designees shall have access to all records maintained and retained by the Successful Responder and its subcontractors for the purpose of inspection, cost/price analysis, audit or other reasonable purposes related to the contract. Ulster County and its representatives and designees shall have access to records and be able to copy such records during the Successful Responder's normal business hours. The Successful Responder shall provide proper facilities for such access, inspection and copying.

13.0 ALTERNATE PROPOSALS

Ulster County reserves the right to consider alternatives submitted by Responders that provide enhancements beyond the RFP requirements. Proposal alternatives may be considered if deemed to be in the best interest of Ulster County's. Responders shall clearly identify and explain in detail where such alternatives deviate from or qualify the terms of the proposal and specifications as issued.

14.0 COMPLIANCE WITH LAWS, LICENSES AND PERMITS

The responder(s) agree that they will fully comply with all applicable Federal, State and County policies, procedures, standards and laws, rules and regulations.

15.0 PERSONNEL IDENTIFICATION

All personnel must carry on their person photo identification (e.g. employee identification badge, valid driver's license, etc) while on Ulster County property and must promptly show such identification when requested to do so by any Ulster County employee. Representatives of the County reserve the right to reject and bar from the facility, for good and sufficient reason, in the sole discretion of the County, any employee hired by the Contractor.

16.0 INSURANCE

The successful responder shall, at their own expense, maintain in effect at all times during the performance of the work under this contract, if any, resulting from this RFP, at least the insurance coverage specified in Schedule C “Insurance Requirements” that is part of the sample Contract Agreement for Professional Services which is included in this RFP. The successful responder shall file with the Ulster County Purchasing Department, within ten (10) days of notice of award, evidence of insurance certifying the required coverage.

17.0 DISQUALIFICATION

The County reserves the right to refuse to issue an award to responders that fails to comply with any pre-qualification regulations of the County, if any such regulations or requirements are cited, or otherwise included in the Request for Proposal.

Proposals received from responder who have previously failed to complete contracts within the time required, or who have previously performed similar work in an unsatisfactory manner, may be rejected. A proposal may be rejected if the responder cannot show that it has the necessary ability, resources and qualified employees to commence the work at the time prescribed and thereafter to perform and complete the work at the rate or within the time specified. A proposal may be rejected if the responder is already obligated for the performance of other work that would delay the commencement, performance or completion of the work described in this RFP.

18.0 PAYMENT

PAYMENT PROCESSING: Payments cannot be processed by the County until an invoice referring to the Contract Number and are mailed to the proper departmental address. The County will pay the proper amounts due the vendor within sixty (60) days of receipt by the County of the vendor’s invoice with the requested supporting documentation and approval of the vendor’s invoice by the Department Head and the Ulster County Comptroller.

If the Contractor is a NYSERDA FlexTech Consultant, NYSERDA will contribute its share of the actual study cost, not to exceed the amount agreed upon in the Purchase Order towards the allowable FlexTech Consultant fees, directly to the FlexTech Consultant per the approved scope of work.

19.0 FREEDOM OF INFORMATION

The responder agrees to comply with the Freedom of Information Law (FOIL) and such rules and regulations as the County and the State may from time to time make, including, but not limited to, such rules as may be devised governing access to public documents pursuant to Article 6 of the Public Officers Law, popularly known as the Freedom of Information Law.

Proposals submitted in response to this RFP shall be considered public documents and, with limited exceptions, all proposals, including proposals that are recommended for award, will be available for inspection and copying by the public.

If a Responder considers any portion of its proposal to be protected under the law, the Responder shall clearly and distinctly identify each such portion with words such as "CONFIDENTIAL, “or “PROPRIETARY". If a request is made for disclosure of such portion, Ulster County will determine whether the material should be made available under the law. If the material is not exempt from public disclosure law, Ulster County will notify the Responder of the request and allow the Responder five days to take whatever action it deems necessary to protect its interests. If the Responder fails or neglects to take such action within said period, Ulster County will release portions of the proposal deemed subject to disclosure. By submitting a proposal, the Responder assents to the procedure outlined in this paragraph and shall have no claim against Ulster County on account of actions taken under such procedure.

20.0 AFFIDAVIT OF NON- COLLUSION

The completion AND submission of the Affidavit of Non-Collusion, which is included with this RFP and is required with the submittal, certifies that the prices in the submitted proposal have been arrived at independently without collusion, consultation, communication, or agreement for the purpose of restricting competition, as to any matter relating to such prices with any other responder with or any competitor.

21.0 SUSPENSION AND DEBARMENT

By submitting a proposal in response to this RFP, each responder warrants that neither it nor any of its officers, employees, subcontractors, or agents is excluded or in any other manner barred from doing business with any federal, state, or local agency, municipality, or department. Any misrepresentation or false statement related to a responder's status in this regard will result in rejection of such responder's submission.

In addition, if the successful responder or any of its officers, employees, subcontractors, or agents become excluded or barred in any manner from doing business with any federal state, or local agency, municipality, or department, during the period in which goods and/or services are provided pursuant to this RFP, the successful responder agrees to immediately notify the County Attorney of such status. Any misrepresentation or false statement related to the successful responder's status in this regard, or any failure by the successful responder to immediately notify the County Attorney of any change in such status, shall result in immediate termination of County's business relationship with the successful responder in addition to such other remedies as may be provided by law, in equity, pursuant to the terms and conditions of this RFP document, or the conditions of the contract, if any, resulting from this RFP.

22.0 IMPLIED REQUIREMENTS

Products and services which are not specifically requested in this RFP, but which are necessary to provide a complete program/project as described herein, shall be included in the submitted proposal.

23.0 TIME TABLE FOR REQUEST FOR PROPOSAL

Listed below are specific and estimated dates and times of actions related to this request for proposal (RFP). In the event, it is necessary to change the return date for the RFP a supplemental addendum to this RFP shall be issued by the County.

June 8, 2018	Last day to submit written inquiries
June 15, 2018	Due Date for Proposals
Week of: June 22, 2018	Selection Committee evaluates Proposals
Week of: June 29, 2018	Oral Interviews By Invited Companies
Week of: July 6, 2018	Notice of Intent to Award
September 1, 2018	Contract Start Date

(Rev. 7.18.16)

County Contract No.: ___________

AGREEMENT FOR PROFESSIONAL SERVICES

THIS AGREEMENT is entered into by and between the **COUNTY OF ULSTER**, a municipal corporation and a county of the State of New York, with principal offices at 244 Fair Street, Kingston, New York 12401 (the "**County**"), and **[ENTER FIRM NAME HERE]**, a [to be completed by Contract Management] with principal offices at [Enter Firm's business address] (the "**Firm**"), (each, a "Party;" together, the "Parties").

RECITALS

WHEREAS, the County's [Enter County's Dept. Name] desires to enter into an agreement for [state basic description of services to be performed]; and

WHEREAS, the County solicited, through its RFP____________, proposals for [state brief description of RFP services]; and

WHEREAS, the Firm was a successful proposer; and

WHEREAS, the County has agreed to engage the Firm, and the Firm has agreed to contract with the County, to [state brief description of services to be provided] [pursuant to Bid No. _____________ and the Firm's Response to Bid No. _____________] in accordance with the terms and conditions set forth in this Agreement.

NOW THEREFORE, in consideration of the promises and covenants set forth below, the County and the Firm hereby agree as follows:

ARTICLE 1 - SCOPE OF SERVICES

The Firm agrees to perform the services identified in Schedule A, the Scope of Services (the "Services"), which is attached hereto and is hereby made a part of this Agreement. The Firm agrees to perform the Services in accordance with the terms and conditions of this Agreement. It is specifically agreed to by the Firm that the County will not compensate the Firm for any services not included in Schedule A without prior authorization, evidenced only by a written Change Order, Amendment, or Addendum to this Agreement, which is executed by the Ulster County Executive (the "Executive") or the Ulster County Director of Purchasing (the "Purchasing Director"), after consultation with the head of the County Department responsible for the oversight of this Agreement (the "Department Head"), and upon review by the County Attorney's Office.

ARTICLE 2 - TERM OF AGREEMENT

The Firm agrees to perform the Services **beginning [Enter Start Date], 20__, and ending [Enter Completion Date], 20_____**. In accordance with the Bid, the County, at its sole discretion, may with written notice to the Firm, extend the Term of this Agreement for up to [two (2)] additional [one (1) year] periods under the same terms, prices, and conditions contained herein.

If, owing to the actions or neglect of the County, the Firm is prevented from completing the Services within the Term of this Agreement, then the Firm's sole and exclusive remedy will be to request that a Change Order, Amendment, or an Addendum to this Agreement be issued by the Executive or the Purchasing Director, permitting an extension of time to perform the Services, equal to the time lost due to such delay. Such request must be based upon written notice only, delivered to the Department Head promptly, but not later than thirty (30) days after the initial occurrence of the event giving rise to such claim, and stating the specific nature of the claim. An extension of time to perform the Services may only be granted by a written Change Order, Amendment, or Addendum to this Agreement, signed by the Executive or the Purchasing Director. In no event will the County be liable to the Firm, its subcontractors, agents, assignees, or any other person or entity, for damages arising out of or resulting from any such delays.

ARTICLE 3 - COMPENSATION

For satisfactory performance of the Services, or as such Services may be modified by a mutually agreed upon written Change Order, Amendment, or Addendum to this Agreement, the County agrees to compensate the Firm in accordance with Schedule B, “Fees, Expenses, and Submissions for Payment,” which is attached hereto and is hereby made a part of this Agreement. As directed in Schedule B, the Firm shall submit invoices to the County for the Services rendered. Each invoice must be prepared in such form and supported by such documentation as the County may reasonably require. The County will remit payment to the Firm within sixty (60) days of approval of the invoice by the Department Head and County Comptroller. The County will notify the Firm in writing of its reasons, if any, for objecting to all or any portion of the Firm’s invoice and/or supporting documentation.

A **[CHOOSE ONE- fixed fee OR not-to-exceed]** amount of **[WRITE OUT DOLLAR AMOUNT IN CAPS HERE] AND __/100 ($.) DOLLARS** has been established for the Services to be rendered by the Firm. Costs in excess of the above amount may not be incurred without the prior written authorization of the Executive or the Purchasing Director, after consultation with the Department Head, and evidenced only by a written Change Order, Amendment, or Addendum to this Agreement. It is specifically agreed to by the Firm that the County will not be responsible for any additional costs, or costs in excess of the above cost, if authorization by the Executive or the Purchasing Director is not given in writing prior to the performance of any services giving rise to such excess or additional costs.

In the event that the Firm receives payments, from any source whatsoever, in consideration for the same Services provided to the County under this Agreement, the monetary obligation of the County hereunder will be reduced by an equivalent amount, provided, however, that nothing contained herein will require such reimbursement where additional similar services are provided and no duplicative payments are received.

If this is an Agreement for which Firm will, in whole or in part, be compensated with New York State funds, Firm agrees to comply with Executive Order Number 38, which sets limits on state-funded administrative costs and executive compensation contracts. Executive Order Number 38 can be found at the following website address: https://www.governor.ny.gov/executiveorder/38.

ARTICLE 4 - EXECUTORY CLAUSE

The County will have no liability under this Agreement to the Firm or to anyone else beyond funds appropriated and available for this Agreement. The County may terminate this Agreement at the end of any fiscal year if funds are not appropriated and available for this Agreement for the following fiscal year.

The Firm understands and agrees that the dollar amounts identified in this Agreement are based upon funding allocations from the State of New York and/or the Federal Government, which are the basis for any payments made by the County hereunder. In the event that the anticipated amount of funding changes, or is reduced or denied, in part or in full, the County, where appropriate, will not be liable to the Firm for the difference. If the full state and/or federal aid in reimbursement to the County for any payment made under this Agreement, by the County to the Firm, is not approved for any reason whatsoever, then the County may (i) deduct and withhold from any future payment(s) an amount equal to the reimbursement denied, or (ii) otherwise recover from the Firm the amount denied. It is understood that based upon changes in state aid and/or the federal funding process, the actual amounts in this Agreement may change throughout the Term. The amounts in this Agreement will be amended to reflect the actual approved aid amounts upon notification to the County by the state and/or Federal Government, as necessary.

ARTICLE 5 – PROCUREMENT OF AGREEMENT

The Firm represents and warrants that no person or selling agent has been employed or retained by the Firm to solicit or secure this Agreement upon a separate agreement, or upon an understanding for a commission, percentage, brokerage fee, contingent fee, or any other compensation. The Firm further represents and warrants that no payment, gift, or thing of value has been made, given, or promised to obtain this or any other agreement between the Parties. The Firm makes such representations and warranties to induce the County to enter into this Agreement and the County relies upon such representations and warranties in the execution hereof.

For a breach or violation of such representations or warranties, the County will have the right to annul this Agreement without liability, entitling the County to recover all monies paid hereunder, and the Firm shall neither make claim for, nor be entitled to recover any sum or sums otherwise due under this Agreement. This remedy, if effected, will not constitute the sole remedy afforded to the County for such breach or violation, nor will it constitute a waiver of the County's right to claim damages or otherwise refuse payment, or to take any other action provided for by law, in equity, or pursuant to this Agreement.

ARTICLE 6 - CONFLICT OF INTEREST

The Firm represents and warrants that neither it, nor any of its directors, officers, members, partners, or employees, have any interest, nor will they acquire any interest, directly or indirectly, which would or may conflict in any manner or degree with the performance or rendering of the Services to be provided pursuant to this Agreement. The Firm further represents and warrants that in the performance of this Agreement, no person having such interest or possible interest will be employed by it, and that no elected official or other officer or employee of the County, nor any person whose salary is payable, in whole or in part, by the County, or any corporation, partnership, or association in which such official, officer, or employee is directly or indirectly interested, will have any such interest, direct or indirect, in this Agreement, or in the proceeds thereof, unless such person (i) is required by the Ulster County Ethics and Disclosure Law, as amended from time to time, to submit a disclosure form to the County's Board of Ethics, and amends such disclosure form to include their interest in this Agreement, or (ii) if not required to complete and submit such a disclosure form, either voluntarily completes and submits said disclosure form, disclosing their interest in this Agreement, or seeks a formal opinion from the County's Board of Ethics, as to whether or not a conflict of interest exists.

For a breach or violation of such representations or warranties, the County will have the right to annul this Agreement without liability, entitling the County to recover all monies paid hereunder, and the Firm must not make claim for, nor be entitled to recover any sum or sums otherwise due under this Agreement. This remedy, if effected, will not constitute the sole remedy afforded to the County for such breach or violation, nor will it constitute a waiver of the County's right to claim damages or otherwise refuse payment, or to take any other action provided for by law, in equity, or pursuant to this Agreement.

ARTICLE 7 – REPRESENTATIONS BY THE FIRM

The Firm represents that it is fully licensed (to the extent required by law), experienced, and properly qualified to perform the Services to be provided under this Agreement, and that it is properly permitted, equipped, organized, and financed to perform such Services.

The Firm understands that it may become necessary for the County to submit to governmental agencies and/or authorities, or to a court of law, part or all of the data, analyses, and/or conclusions developed as a result of its performance of these Services. The Firm is aware that there are significant penalties for submitting false information to governmental agencies, including the possibility of fines and imprisonment. The Firm shall be responsible for such penalties resulting from false information submitted to the County by the Firm.

By signing this Agreement, Firm is attesting to that fact that neither it nor any of its employees, agents, representatives, officers, subcontractors, or any other entity or individual providing Services pursuant to this Agreement has been sanctioned, excluded, or in any other manner barred from doing business with any federal, state, or local agency, municipality, or department. If Firm or any of its officers, employees, subcontractors, or agents become excluded or barred in any manner from doing business with any federal, state, or local agency, municipality, or department during the Term of this Agreement, the Firm agrees to provide immediate and detailed notice to the County Attorney regarding such status. Any misrepresentation or false statement related to Firm's status in this regard, or any failure by Firm to immediately notify the County Attorney of any change in such status will result in immediate termination of this Agreement, in addition to such other remedies as may be provided by law, in equity, or pursuant to this Agreement.

ARTICLE 8 – CORPORATE COMPLIANCE

The Firm agrees to comply with all federal, state, and local laws, rules, and regulations governing the provision of goods and/or Services under this Agreement. In particular, the Firm agrees to comply with the laws, rules and regulations of Ulster County, as well as with its Compliance Plan (the "Plan"). The Plan can be viewed at www.co.ulster.ny.us/downloads/UlsterCountyCompliancePlan.pdf. Alternatively, a hard copy of the Plan will be provided upon Firm's request. The Plan relates to the County's compliance with relevant federal and state fraud and abuse laws. The Firm represents and warrants that it has read and understands the Plan and agrees to abide by its terms when delivering Services under this Agreement. The Firm shall ensure that each individual who provides such Services under this Agreement is provided with a copy of the Plan or given access to the Plan. The County strongly encourages all healthcare providers contracting with the County to implement their own compliance programs that address each of the elements of compliance recommended by the Office of the Inspector General, as well as the elements as recommended and/or mandated by the New York State Office of the Medicaid Inspector General.

The County will conduct appropriate screening of providers, independent contractors, vendors, and agents to ensure and verify that they have not been sanctioned and/or excluded by any federal or state law enforcement, regulatory, or licensing authority. The County will also verify that entities and businesses that provide and/or perform Services for the County have not been the subject of adverse governmental actions and/or excluded from the federal healthcare programs.

Firm understands that the County has established and implemented a Corporate Compliance Program and has developed “Standards of Conduct for Ulster County Vendors and Contractors” (the “Standards”). The Standards can be accessed electronically at any time by going to www.co.ulster.ny.us/downloads/compliance.pdf. The Firm represents that it has read, understands and agrees to comply with the Standards with respect to its performance pursuant to this Agreement. The hotline for reporting violations of the Standards is (877) 569-8777.

ARTICLE 9 - FAIR PRACTICES

The Firm, and each person signing on behalf of the Firm, represents, warrants and certifies under penalty of perjury, that to the best of their knowledge and belief:

A. The prices in this Agreement have been arrived at independently by the Firm without collusion, consultation, communication, or agreement with any other bidder, proposer, or with any competitor, as to any matter relating to such prices which has the effect of, or has as its purpose, restricting competition; and

B. Unless otherwise required by law, the prices that have been quoted in this Agreement and on the proposal or quote submitted by the Firm have not been knowingly disclosed by the Firm prior to the communication of such quote to the County, or prior to the proposal opening, directly or indirectly, to any other bidder, proposer, or to any competitor; and

C. No attempt has been made or will be made by the Firm to induce any other person, partnership, corporation, or other entity to submit or not to submit a proposal or quote for the purpose of restricting competition.

The fact that the Firm (i) published price lists, rates, or tariffs covering the Services and/or items being procured, (ii) informed prospective customers of proposed or pending publication of new or revised price lists for such Services and/or items, or (iii) provided the same Services and/or items to other customers at the same prices being bid or quoted, does not constitute, without more, a disclosure within the meaning of this Article 9.

ARTICLE 10 - INDEPENDENT CONTRACTOR

In performing the Services and incurring expenses under this Agreement, the Firm shall operate as and have the status of an independent Firm, and must not act as agent for or on behalf of the County, nor will the Firm represent the County, or bind the County in any manner. As an independent contractor, the Firm shall be solely responsible for determining the means and methods of performing the Services, and shall have complete charge and responsibility for the Firm’s personnel engaged in the performance of the same.

In accordance with such status as independent Firm, the Firm covenants and agrees that neither it, nor its employees or agents, will proclaim themselves to be officers or employees of the County, or of any department, agency, or unit thereof, by reason hereof, and that the Firm’s employees or agents will not, by reason hereof, make any claim, demand, or application to or for any right or privilege applicable to an officer or employee of the County including, but not limited to, Workers’ Compensation coverage, health insurance coverage, Unemployment Insurance benefits, Social Security benefits, or employee retirement membership or credit.

Nothing contained in this Agreement will be construed to create the relationship of employer and employee, principal and agent, partnership, or joint venture, or any other fiduciary relationship.

ARTICLE 11 - ASSIGNMENT

The Firm must not assign any of its rights, interests, or obligations under this Agreement, or assign any of the Services to be performed by it under this Agreement, without the prior express written consent of the Executive or the Purchasing Director, upon review by the Ulster County Attorney’s Office. Any such assignment, transfer, conveyance, or other disposition without such prior consent will be void, and any Services provided thereunder will not be compensated. Any assignment properly consented to by the Executive or the Purchasing Director will be subject to all of the terms and conditions of this Agreement.

Failure of the Firm to obtain any required consent to any assignment will be grounds for termination for cause at the option of the County, and if this Agreement be so terminated, the County will thereupon be relieved and discharged from any further liability and obligation to the Firm, its assignees, or transferees; and all monies that may become due under this Agreement shall be forfeited to the County, except so much thereof as may be necessary to pay the Firm's employees for past Services.

The provisions of this clause must not hinder, prevent, or affect any assignment by the Firm for the benefit of its creditors made pursuant to the laws of the State of New York, except where the Federal Supremacy Clause requires otherwise.

This Agreement may be assigned by the County to any corporation, agency, municipality, or instrumentality having authority to accept such assignment.

ARTICLE 12 – SUBCONTRACTING

Firm agrees to include the following provisions in any and all subcontract agreements for Services to be performed pursuant to this Agreement:

A. That the work performed by the subcontractor must be in accordance with the terms and conditions of this Agreement between the County and the Firm, including, but not limited to, the insurance requirements set forth in Schedule C; and

B. That nothing contained in the subcontractor agreement will impair the rights of the County; and

C. That nothing contained in the subcontractor agreement, or under this Agreement between the County and the Firm, will create any contractual relation in law or equity, between the subcontractor and the County; and

D. That the subcontractor specifically agrees to be bound by the confidentiality provision as set forth in Article 14 of this Agreement between the County and the Firm.

Upon signing this Agreement, Firm shall provide the Department Head with the names and scope of work of any and all subcontractors to be used in the performance of Firm's obligations pursuant to this Agreement. Furthermore, upon the County's request, Firm shall provide copies of any and all subcontract agreements for Services to be performed pursuant to this Agreement.

The Firm agrees that it is fully responsible to the County for the acts and omissions of its subcontractors and of persons either directly or indirectly employed by them to the same extent as it is for the acts and omissions of persons employed by the Firm. The Firm will not in any way be relieved of any responsibility under this Agreement by any subcontract.

The Firm must not subcontract any of its obligations under this Agreement.

ARTICLE 13 - PERFORMANCE

The Firm shall perform the Services using its own equipment and facilities wherever and whenever possible. In performing the Services, the Firm shall assign qualified personnel and perform such Services in accordance with the professional standards and with the skill, diligence and quality control/quality assurance measures expected of a reputable company performing Services of a similar nature. The Firm is hereby given notice that the County will be relying upon the accuracy, competence, and completeness of the Firm's performance in using the results achieved by Firm's performance of these Services. The Firm shall at all times comply with all applicable federal, New York State, and local laws, ordinances, statutes, rules, and regulations.

<u>Health Insurance Portability & Accountability Act of 1996 ("HIPAA")</u>. Under certain circumstances, federal law and regulations governing the privacy of certain health information requires a "Business Associate Agreement" (a "BAA") between the County and the Firm [45 C.F.R. Section 164.504(e)]. If HIPAA is applicable to this Agreement, the County and the Firm agree to enter into a separate BAA that complies with HIPAA, as that law may be amended from time to time. Unless Firm has previously executed a compliant BAA that is in effect and on file with the County, the BAA referenced in this provision must be executed simultaneously with this Agreement.

ARTICLE 14 - CONFIDENTIALITY

For purposes of this Article:

A. The term "Confidential Information" as used herein, means all material and information, whether written or oral, received by the Firm from or through the County or any other person connected with the County, or developed, produced, or obtained by the Firm in connection with its performance of Services under this Agreement. Confidential Information will include, but not be limited to: samples, substances and other materials, conversations, correspondence, records, notes, reports, plans, drawings, specifications and other documents in draft or final form, including any documentation or data relating to the results of any investigation, testing, sampling in laboratory or other analysis, and all conclusions, interpretations, recommendations, and/or comments relating thereto.

B. The term "Firm" as used herein includes all officers, directors, employees, agents, subcontractors, assignees, or representatives of the Firm.

The Firm shall keep all Confidential Information in a secure location within the Firm's offices. The County will have the right, but not the obligation, to enter the Firm's offices in order to inspect the arrangements of the Firm for keeping Confidential Information secure. The County's inspection, or its failure to inspect, will not relieve the Firm of its responsibilities pursuant to this Article 14.

The Firm shall hold Confidential Information in trust and confidence, and must not disclose Confidential Information, or any portion thereof, to anyone other than the County without the prior written consent of the Executive or the Purchasing Director, and must not use Confidential Information, or any portion thereof, for any purpose whatsoever except in connection with its performance of the Services under this Agreement.

The Firm shall notify the County immediately upon its receipt of any request by anyone other than the County for, or any inquiry related to, Confidential Information. The Firm is not prohibited from disclosing portions of Confidential Information if and to the extent that: (i) such portions have become generally available to the public other than by an act or omission of the Firm, or (ii) disclosure of such portions is required by subpoena, warrant, or court order; provided, however, that in the event anyone other than the County requests all or a portion of Confidential Information, the Firm shall oppose such request and cooperate with the County in obtaining a protective order or other appropriate remedy, unless and until the Executive or the Purchasing Director, upon consultation with the Ulster County Attorney, in writing, waives compliance with the provisions of this Article 14, or determines that disclosure is legally required. In the event that such protective order or other remedy is not obtained, or the County waives compliance with this Article 14, or determines that such disclosure is legally required, the Firm shall disclose only such portions of Confidential Information that, in the opinion of the County, the Firm is legally required to disclose, and the Firm shall use its best efforts to obtain from the party to whom Confidential Information is disclosed, written assurance that confidential treatment will be given to any such Confidential Information disclosed, to the extent permitted by law.

Prior to the performance of any of the Services in connection with this Agreement, Firm shall obtain from each of its subcontractors, a confidentiality agreement running to the benefit of the County that is substantively identical to this Article 14. Further, at any time, if requested by the County, Firm shall obtain such an agreement from the officers, directors, agents, representatives, or employees of the Firm and/or any of its subcontractors.

ARTICLE 15 – OWNERSHIP OF CONFIDENTIAL INFORMATION

Notwithstanding any other provision herein to the contrary:

A. All Confidential Information, as defined in Article 14, including all copies thereof, is the exclusive property of the County regardless of whether or not it is delivered to the County. The Firm shall deliver Confidential Information and all copies thereof to the County upon request.

B. To the extent that copies of Confidential Information are authorized by the County to be retained by the Firm, such information shall be retained in a secure location in the Firm's office for a period of six (6) years after completion of the Services, or termination of this Agreement, whichever occurs later, and thereafter disposed of at the County's direction.

ARTICLE 16 – INTENTIONALLY LEFT BLANK

ARTICLE 17 – PUBLICITY

The prior written approval of the County is required before the Firm or any of its employees, representatives, servants, agents, assignees, or subcontractors may, at any time either during or after completion or termination of this Agreement, make any statement to the media or issue any material for publication bearing on the Services performed or data collected in connection with this Agreement.

If the Firm, or any of its employees, representatives, servants, agents, assignees, or subcontractors desires to publish a work dealing with any aspect of this Agreement, or of the results or accomplishments attained by its performance, they must first obtain the prior written permission of the Executive or the Purchasing Director which, unless otherwise agreed to in said written permission, will entitle the County to a royalty fee and a non-exclusive and irrevocable license to reproduce, publish, or otherwise use, and to authorize others to use, such publication.

ARTICLE 18 – BOOKS AND RECORDS

The Firm agrees to maintain separate and accurate books, records, documents, and other evidence, and to employ accounting procedures and practices that sufficiently and properly reflect all direct and indirect costs of any nature expended in the performance of this Agreement.

ARTICLE 19 - RETENTION OF RECORDS

The Firm agrees to retain all books, records, and other documents relevant to this Agreement for six (6) years after the final payment or termination of this Agreement, whichever occurs later. The County, any New York State and/or federal auditors, and any other persons duly authorized by the County, will have full access and the right to examine any of said materials during said period.

ARTICLE 20 – AUDITING AND REPORTS

All forms or invoices presented for payment to be made hereunder, and the books, records, and accounts upon which said forms or invoices are based, are subject to audit by the County. The Firm shall submit any and all documentation and justification in support of expenditures or fees under this Agreement as may be required by the County so that it may evaluate the reasonableness of the charges, and the Firm shall make its records available to the County upon request. All books, forms, records, reports, cancelled checks, and any and all similar material may be subject to periodic inspection, review, and audit by the County, the State of New York, the Federal Government and/or other persons duly authorized by the County. Such audits may include examination and review of the source and application of all funds, whether from the County, the State of New York, the Federal Government, private sources, or otherwise. The Firm will not be entitled to any interim or final payment under this Agreement if any audit requirements and/or requests have not been satisfactorily met.

ARTICLE 21 – NO DISCRIMINATION

As required by Article 15 of the New York State Executive Law (also known as the Human Rights Law) and all other state and federal statutory and constitutional non-discrimination provisions, including the Civil Rights Act, the Firm must not discriminate against any employee or applicant for employment because of race, creed, color, sex, national origin, sexual orientation, age, disability, genetic predisposition, carrier status, military status, domestic violence victim status, or marital status.

If this Agreement provides for a total expenditure in excess of $25,000.00, Firm shall make and document its conscientious and active efforts to employ and utilize minority group members and women in its work force on County contracts, and will undertake or continue existing programs of affirmative action to ensure that minority group members and women are afforded equal employment opportunities without discrimination. Affirmative action will mean recruitment, employment, job assignment, promotion, upgrade, demotion, transfer, layoff, termination, and rates of pay or other forms of compensation.

Furthermore, in accordance with New York State Labor Law Section 220-e, if this is an Agreement for the construction or alteration of any public building or public work, or for the manufacture, sale or distribution of materials, equipment or supplies, and to the extent that this Agreement will be performed within the State of New York, the Firm agrees that neither it, nor its subcontractors, will, by reason of race, creed, color, disability, sex, or national origin: (i) discriminate in hiring against any New York State citizen who is qualified and available to perform the Services, or (ii) discriminate against or intimidate any employee hired for the performance of Services under this Agreement. If this is a building service agreement as defined in the New York State Labor Law Section 230, then in accordance with New York State Labor Law Section 239, the Firm agrees that neither it, nor its subcontractors, will by reason of race, creed, color, national origin, age, sex or disability: (i) discriminate in hiring against any New York State citizen who is qualified and available to perform the Services, or (ii) discriminate against or intimidate any employee hired for the performance of Services under this Agreement. The Firm is subject to (i) a fine of Fifty and 00/100 ($50.00) Dollars per person, per day, for any violation of the New York State Labor Law Sections 220-e or 239, and/or (ii) possible termination of this Agreement and forfeiture of all moneys due hereunder for a second or subsequent violation.

ARTICLE 22 - INSURANCE

For provision of the Services set forth herein and as may be hereinafter amended, the Firm shall maintain or cause to be maintained in full force and effect during the term of this Agreement, at its expense, insurance with stated minimum coverage as set forth in Schedule C, which is attached hereto and is hereby made a part of this Agreement. Such policies are to be in the broadest form available on usual commercial terms and must be written by insurers who have been fully informed as to the nature of Services to be performed by the Firm pursuant to this Agreement. Such insurers must be of recognized financial standing, satisfactory to the County. The County must be named as an additional insured on all commercial general liability policies with the understanding that any obligations imposed upon the insured (including, without limitation, the obligation to pay premiums) will be the sole obligation of the Firm and not those of the County. Notwithstanding anything to the contrary in this Agreement, the Firm irrevocably waives all claims against the County for all losses, damages, claims, or expenses resulting from risks commercially insurable under the insurance described in Schedule C and this Article 22. The provision of insurance by the Firm will not in any way limit the Firm’s liability under this Agreement.

At the time Firm submits two (2) original executed copies of this Agreement, Firm shall include certificates of insurance evidencing its compliance with these requirements and those set forth in Schedule C.

Each policy of insurance must contain clauses to the effect that (i) such insurance shall be primary, without right of contribution of any other insurance carried by or on behalf of the County, with respect to its interests, (ii) it must not be cancelled or materially amended without thirty (30) days prior written notice to the County, except in the case of cancellation for non-payment of premium which requires fifteen (15) days prior written notice, directed to the County’s Insurance Department and the Department Head, and (iii) the County will have the option to pay any necessary premiums to keep such insurance in effect, and charge the cost back to the Firm.

To the extent it is commercially available, each policy of insurance must be provided on an “occurrence” basis. If any insurance is not so commercially available on an “occurrence” basis it must be provided on a “claims made” basis, and all such “claims made” policies must provide that:

A. Policy retroactive dates coincide with or precede the Firm’s start of the performance of Services (including subsequent policies purchased as renewals or replacements); and

B. The Firm shall maintain similar insurance for a minimum of three (3) years following final acceptance of the Services; and

C. If the insurance is terminated for any reason, the Firm agrees to purchase for the County an unlimited, extended reporting provision to report claims arising from the Services performed under this Agreement; and

D. The Firm must give immediate notice to the County, through the Department Head, the Ulster County Attorney’s Office, and the County’s Insurance Department, of circumstances or incidents that might give rise to future claims with respect to the Services performed under this Agreement.

ARTICLE 23 - INDEMNIFICATION

The Firm agrees to defend, indemnify, and hold harmless the County, including its officials, employees, and agents, against all claims, losses, damages, liabilities, costs, or expenses (including without limitation, reasonable attorney fees and costs of litigation and/or settlement), whether incurred as a result of a claim by a third party or any other person or entity, arising out of the Services performed by the Firm, its employees, representatives, subcontractors, assignees, or agents pursuant to this Agreement, which the County, or its officials, employees, or agents may suffer by reason of any negligence, fault, act, or omission of the Firm, its employees, representatives, subcontractors, assignees, or agents. The Firm agrees to investigate, handle, respond to, provide defense for, and defend any such claims, demands, or suits at its sole expense, and agrees to bear all other costs and expenses related thereto, even if such claims, demands, or suits are groundless, false, or fraudulent.

In the event that any claim is made or any action is brought against the County arising out of the negligence, fault, act, or omission of the Firm or an employee, representative, subcontractor, assignee, or agent of the Firm, either within or without the scope of the respective employment, representation, subcontract, assignment, or agency, or arising out of the Firm's negligence, fault, act, or omission, then the County will have the right to withhold further payments hereunder for the purpose of set-off in sufficient sums to cover said claim or action. The rights and remedies of the County provided for in this clause will not be exclusive and are in addition to any other rights and remedies provided by law, in equity, or pursuant to this Agreement.

ARTICLE 24 - RESPONSIBILITY TO CORRECT DEFICIENCIES

The Firm shall be responsible to correct, in a timely fashion and at the Firm's sole expense, any deficiencies in its Services resulting from the Firm's failure to act in accordance with the standards set forth in Article 13 (Performance) and Schedule A, provided such deficiencies are reported to the Firm within one hundred-twenty (120) days after completion and final acceptance of the Services. If the Firm fails to correct such deficiencies in a timely and proper manner, the County may elect to have others perform such corrections, and the County may charge any related cost of such corrections to the Firm and/or set-off such amount against any sums otherwise due to the Firm. These remedies, if effected, will not constitute the sole or exclusive remedies afforded to the County for such deficiencies, nor will they constitute a waiver of the County's right to claim damages or otherwise refuse payment, or to take any other action provided for by law, in equity, or pursuant to this Agreement.

ARTICLE 25 - CURRENT OR FORMER COUNTY EMPLOYEES

The Firm represents and warrants that during the Term of this Agreement and for a period of one (1) year after its expiration or termination, it shall not retain the services of any County employee or former County employee in connection with this Agreement, or any other agreement that said Firm has or may have with the County, without the express written permission of the Executive or the Purchasing Director.

For a breach or violation of such representations or warranties, the County will have the right to annul this Agreement without liability, entitling the County to recover all monies paid hereunder, and the Firm must neither make claim for, nor be entitled to recover, any sum or sums otherwise due under this Agreement. This remedy, if effected, will not constitute the sole remedy afforded to the County for such breach or violation, nor will it constitute a waiver of the County's right to claim damages or otherwise refuse payment, or to take any other action provided for by law, in equity or pursuant to this Agreement.

ARTICLE 26 - PROTECTION OF COUNTY PROPERTY

The Firm assumes the risk of and shall be responsible for any loss or damage to the County's property and equipment, whether owned, leased, or otherwise possessed by the County, used in the performance of this Agreement. Any such loss or damage caused, either directly or indirectly, by the acts, conduct, omissions, or lack of good faith of the Firm, its officers, directors, members, partners, employees, representatives, or assignees, or any person, firm, company, agent, or others engaged by the Firm as an expert, consultant, specialist, or subcontractor hereunder, will be the responsibility of the Firm.

In the event that any such County property is lost or damaged, except for normal wear and tear, then the County will have the right to withhold further payments hereunder for the purposes of set-off in sufficient sums to cover such loss or damage.

The Firm agrees to defend, indemnify, and hold the County harmless from any and all liability or claim for loss, cost, damage, or expense (including without limitation, reasonable attorney fees and costs of litigation and/or settlement) due to any such loss or damage to any such County property described in this Article 26.

The rights and remedies of the County provided herein will not be exclusive and are in addition to any other rights and remedies provided by law, in equity, or pursuant to this Agreement.

ARTICLE 27 – FORCE MAJEURE

Neither Party hereto will be considered in default in the performance of its obligations hereunder, to the extent that performance of any such obligation is prevented and/or delayed by any cause, existing or future, beyond the control of such Party, and which by that Party's exercise of due diligence and foresight could not reasonably have been avoided.

Upon removal of such cause, the Party affected shall resume its performance as soon as reasonably possible. The Firm's financial inability to perform will not be deemed to be an event of Force Majeure regardless of the source causing such financial inability. If the Firm is so delayed in the timely performance of the Services, the Firm's sole and exclusive remedy is to request that a Change Order, Amendment, or Addendum to this Agreement be issued by the County and signed by the Executive or the Purchasing Director, permitting an extension of time to perform the Services in an amount equal to the time lost due to such delay. Such request shall be based upon written notice only, stating the specific nature of the claim, delivered to the Department Head promptly, but not later than thirty (30) days after the initial occurrence of the event giving rise to such claim. An extension of time to perform the Services may only be granted by a written Change Order, Amendment, or Addendum to this Agreement, signed by the Executive or the Purchasing Director. In no event will the County be liable to the Firm or to its subcontractors, agents, assignees, or any other person or entity for damages arising out of, or resulting from, any such delays.

ARTICLE 28 - TERMINATION

The County may, by written notice to the Firm, effective upon mailing, terminate this Agreement in whole or in part at any time (i) for the County's convenience, (ii) upon the failure of the Firm to comply with any of the terms or conditions of this Agreement, or (iii) upon the Firm becoming insolvent or bankrupt.

Upon termination of this Agreement, the Firm shall comply with any and all County closeout procedures, including but not limited to:

A. Accounting for and refunding to the County within ten (10) days, any unearned and/or unexpended funds that have been paid to the Firm pursuant to this Agreement; and

B. Furnishing to the County within ten (10) days, an inventory of all equipment, appurtenances, and property purchased by the Firm through, or provided under this Agreement, and carrying out any County directive concerning the disposition thereof; and

C. In the event that this Agreement is terminated for the convenience of the County, the Firm will be paid for all Services rendered through the date of termination in accordance with Schedule B.

In the event the County terminates this Agreement, in whole or in part, as provided in this Article 28, the County may procure upon such terms and in such manner as deemed appropriate, Services similar to those so terminated, and the Firm shall continue the performance of this Agreement to the extent not terminated hereby. If this Agreement is terminated in whole or in part for reasons other than the convenience of the County, the cost and expense of any Services procured by the County to complete the Services herein will be charged to the Firm and/or set off against any sums due to the Firm.

Notwithstanding any other provisions of this Agreement, the Firm will not be relieved of liability to the County for damages sustained by the County by virtue of the Firm's breach of this Agreement, or failure to perform in accordance with applicable standards. The County may withhold payments due to the Firm for the purposes of set-off until such time as the exact amount of damages due to the County from the Firm is determined.

The rights and remedies of the County provided herein will not be exclusive and are in addition to any other rights and remedies provided by law, in equity, or pursuant to this Agreement.

ARTICLE 29 - SET-OFF RIGHTS

The County will have all of its common law, equitable, and statutory rights of set-off. These rights shall include, but are not limited to, the County's right to withhold for the purposes of set-off any monies otherwise due to the Firm (i) under this Agreement, (ii) under any other agreement or contract with the County, including any agreement or contract for a term commencing prior to or after the Term of this Agreement, or (iii) from the County by operation of law. The County will also have the right to withhold any monies otherwise due under this Agreement for the purposes of set-off against any amounts due and owing to the County for any reason whatsoever, including without limitation, tax delinquencies, fee delinquencies and/or monetary penalties or interest relative thereto.

ARTICLE 30 - NO ARBITRATION

Any and all disputes involving this Agreement, including the breach or alleged breach thereof, may not be submitted to arbitration unless specifically agreed to in writing by the Executive or the Purchasing Director, after consultation with the Ulster County Attorney, but must instead only be heard in the Supreme Court of the State of New York, with venue in Ulster County, or if appropriate, in the Federal District Court, with venue in the Northern District of New York, Albany Division.

ARTICLE 31 - GOVERNING LAW

This Agreement is governed by the laws of the State of New York except where the Federal Supremacy Clause requires otherwise. The Firm shall render all Services under this Agreement in accordance with applicable provisions of all federal, state, and local laws, rules, and regulations as are in effect at the time such Services are rendered.

ARTICLE 32 – PREVAILING WAGE

In accordance with New York State Labor Law Section 220-d, if this is an Agreement for the construction, reconstruction, maintenance and/or repair of any public work, the Firm agrees that all laborers, workers, or mechanics employed by the Firm and/or its subcontractors in contemplation of the performance of this Agreement will be paid not less than such hourly minimum rate of wage and shall be provided supplements not less than the prevailing supplements as designated by the New York State Commissioner of Labor.

ARTICLE 33 - WAIVER AND SEVERABILITY

The failure of either Party to enforce at any time, any provision of this Agreement, does not constitute a waiver of such provision in any way or waive the right of either Party at any time to avail itself of such remedies as it may have for any breach or breaches of such provision. None of the conditions of this Agreement will be considered waived by the County unless such waiver is explicitly given in writing by the Executive or the Purchasing Director. No such waiver shall be a waiver of any past or future default, breach, or modification of any of the terms or conditions of this Agreement, unless expressly stipulated in such waiver as executed by the Executive or the Purchasing Director.

The invalidity or invalid application of any provision of this Agreement will not affect the validity of any other provision, or the application of any other provision of this Agreement.

ARTICLE 34 - GENERAL RELEASE

Acceptance by the Firm or its assignees of the final payment under this Agreement, whether by voucher, judgment of any court of competent jurisdiction, administrative, or other means, will constitute and operate as a general release to the County from any and all claims of the Firm arising out of the performance of this Agreement.

ARTICLE 35 - NO CLAIM AGAINST OFFICERS, AGENTS OR EMPLOYEES

No claim whatsoever shall be made by the Firm against any officer, agent, or employee of the County, for or on account of any act or omission in connection with this Agreement.

ARTICLE 36 - ENTIRE AGREEMENT

The rights and obligations of the Parties and their respective agents, successors and assignees will be subject to and governed by this Agreement, including Schedules A, B, and C, which supersedes any other understandings or writings between or among the Parties to this Agreement.

ARTICLE 37- SURVIVING OBLIGATIONS

The Firm's obligations and those of the Firm's employees, representatives, agents, subcontractors, successors, and assignees, assumed pursuant to Article 7 (Representations by the Firm), Article 8 (Corporate Compliance), Article 13 (Performance), Article 14

(Confidentiality), Article 15 (Ownership of Confidential Information), Article 16 (Intellectual Property), Article 17 (Publicity), Article 19 (Retention of Records), Article 23 (Indemnification), Article 24 (Responsibility to Correct Deficiencies), and Article 26 (Protection of County Property), will survive completion of the Services and/or the expiration or termination of this Agreement.

ARTICLE 38 - NOTICES

Except as expressly provided otherwise in this Agreement, all notices given to any of the Parties pursuant to or in connection with this Agreement will be in writing, will be delivered by hand, by certified or registered mail, return receipt requested, or by Federal Express, Express Mail, or other nationally recognized overnight carrier. Except where otherwise specifically defined within this Agreement, notices will be effective when received. Notice addresses are as follows:

Firm:
[Insert Firm Name Here]
Attention: [Insert Appropriate Information]
[Insert Firm Address]
[Insert Firm City, State & Zip Code]

County:
Ulster County [Insert Department Name]
Attention: [Insert Dept. Head Title Here]
[Insert Department's Physical Address]
Kingston, New York 12401

Any communication or notice regarding indemnification, termination, litigation, or proposed changes to the terms and conditions of this Agreement will be deemed to have been duly made upon receipt by both the County's Department of [Insert your Department here] and the Ulster County Attorney's Office at the addresses set forth herein, or such other addresses as may have been specified in writing by the County:

Mailing Address:
County of Ulster
Attention: County Attorney
Post Office Box 1800
Kingston, New York 12402

Physical Address:
County of Ulster
Attention: County Attorney
244 Fair Street, 5th Floor
Kingston, New York 12401

Either Party may, by written notice to the other Party given in accordance with the foregoing, change its address for notices.

ARTICLE 39 - MODIFICATION

No changes, amendments, or modifications of any of the terms and/or conditions of this Agreement shall be valid unless reduced to writing and signed by the Parties to this Agreement, and no payment will be due in connection therewith, unless prior to the performance of any such Services, the Executive or the Purchasing Director, after consultation with the Department Head, executes an Addendum, Amendment, or Change Order to this Agreement. The aforesaid Addendum, Amendment, or Change Order must specifically set forth the scope of such extra or additional services, the amount of compensation, and the extension of time for performance, if any, for any such extra or additional services. Unless otherwise specifically provided for therein, the provisions of this Agreement will apply with full force and effect to the terms and conditions contained in such Addendum, Amendment, or Change Order.

ARTICLE 40 - HEADINGS AND DEFINED TERMS

The Article headings used in this Agreement are for reference and convenience only, and will not in any way limit or amplify the terms, conditions, and/or provisions hereof. All capitalized terms, acronyms, and/or abbreviations will have the meanings ascribed to them by this Agreement.

IN WITNESS WHEREOF, the Parties hereto have caused their duly authorized representatives to enter into this Agreement as of the dates set forth below, effective as of the beginning date set forth in Article 2 above.

[INSERT DEPARTMENT NAME HERE]
(Approved as to content)

By: ______________________________
NAME: [Dept Head]
TITLE: [Dept Head]
DATE: ____________________________

COUNTY OF ULSTER

By: ______________________________
NAME: Marc Rider
TITLE: Director of Purchasing
DATE: ____________________________

[INSERT FIRM NAME]

By: ______________________________
NAME: [If known]
TITLE: [If known]
DATE: ____________________________

**Note: Inter-municipal agreements (including, but not limited to agreements with Agencies of NYS [DOT, DOH, DCJS, etc.], towns, cities, villages, school districts, BOCES, etc.), and agreements affecting real property (e.g., deeds, leases, etc.) generally require a Legislative resolution, <u>which should be drafted by the Department</u>. Check with Contract Management if you are unsure whether a resolution is required.

* PRIOR to submitting your document to Contract Management for review, please remove all directions and drafting guidance from the document.

SCHEDULE A
SCOPE OF SERVICES

*__Please number all paragraphs.__

***Please explain the following in individual paragraphs (one idea/point per paragraph):**

1. State that the Firm will be performing the Services for the County. (Example: *The Firm shall perform engineering design Services for the County's Department of Public Works.)*

2. Provide a detailed description of ***WHAT*** Services the Firm shall perform for the County.

3. State ***WHERE*** the Services shall be performed by the Firm.

4. State ***HOW*** the Services are to be performed by the Firm.

5. State ***WHEN*** the Services shall be performed by the Firm.

6. Provide a detailed description of ***WHAT*** outcomes/products/deliverables are expected upon completion of the Services.

7. State ***WHEN*** the work products/reports/deliverables are due.

8. State ***WHERE and to WHOM*** the work product/reports/deliverables are to be delivered.

SCHEDULE B
FEES, EXPENSES, AND SUBMISSIONS FOR PAYMENT

DIRECTIONS - How to draft the contents of this Schedule:

- **If the Firm's invoices/payments for this Agreement are approved, directed, authorized, and/or made by NYS, and are processed through the County's Department of Finance rather than the County Comptroller's Office, please contact Contract Management for specific language.**

- **Please number all paragraphs.**

- **Contracts should have a not-to-exceed or fixed fee dollar amount.**

- **Paragraph 2 may be modified to reflect the specific details of this Agreement; for example, to include hourly rates, or to be billed on a weekly basis, or a fixed fee with equal monthly payments, etc.**

1. The Firm's fee for Services must not exceed the amount of **[ENTER WRITTEN DOLLAR AMOUNT HERE] AND ___/100 ($ .00) DOLLARS** for the Term of this Agreement.

2. The Firm shall invoice the County's [Enter Department Name here] on a [weekly/monthly/quarterly] basis for the Services provided, at a rate of **[ENTER WRITTEN DOLLAR AMOUNT HERE] AND ___/100 ($ .00) DOLLARS** per [hour/day/week/month], which must not exceed the amount of **[ENTER WRITTEN DOLLAR AMOUNT HERE] AND ___/100 ($ .00) DOLLARS** per [week/month/quarter].

3. The Firm shall submit to the County original invoices for payment.

4. The Firm shall submit its invoices by the [write out: first, tenth, etc.] (__th) day of each [month/quarter], for the Services provided during the previous [month/quarter].

- **You may also choose to use a chart similar to the example below for quarterly or semi-annual invoices/payments.**

[4. The Firm shall submit its invoices to the County according to the schedule below:

Dates of Services Provided:	**Invoice submitted no later than:**
January 1, 20XX – March 31, 20XX	April 20, 20XX
April 1, 20XX – June 30, 20XX	July 20, 20XX
July 1, 20XX– September 30, 20XX	October 20, 20XX
October 1, 20XX – December 31, 20XX	January 30, 20XY

5. The Firm's invoices must contain, or have attached, sufficient supporting detail, as reasonably required by the County, to verify the claim.

6. In no event shall claims be submitted in advance or accrued prior to expenditure.

7. The Firm's final invoice under this Agreement shall be submitted by the [write out: tenth, thirtieth, etc.] (__th) day of the month following the ending date contained in Article 2 (Term of Agreement).

8. The County will remit payment to the Firm within sixty (60) days of approval of the invoice by the [Dept. Head Title] of the County's Department of [Dept. name] and the Ulster County Comptroller.

9. Notwithstanding any other term or provision of this Agreement, including this Schedule B, Firm's invoices, together with all documentation required, must be promptly and timely submitted. The County reserves the right to reject payment of invoices that are submitted more than one hundred twenty (120) days after the required submission date set forth above, <u>regardless of whether the service, work, or delivery was rendered</u>.

10. The Firm agrees to meet any additional invoicing requirements that the County may from time to time require, with reasonable notice to the Firm.

(Rev. 8.01.17)

PLEASE BRING THESE INSURANCE REQUIREMENTS TO YOUR INSURANCE AGENT TO ASSURE PROPER COVERAGE AND LIMITS ARE IN PLACE. FAILURE TO PROVIDE CERTIFICATE(S) OF INSURANCE EVIDENCING REQUIREMENTS BELOW, SHALL RESULT IN DELAY OF CONTRACT EXECUTION.

SCHEDULE C
COUNTY OF ULSTER STANDARD CONTRACT INSURANCE REQUIREMENTS
(PROFESSIONAL SERVICES INCLUDING LOW RISK CONTRACTS WITH INDIVIDUALS)

CONDITIONS OF INSURANCE

Unless otherwise authorized by the Ulster County Insurance Officer, strict adherence to this schedule is required. Any deviation without prior authorization from the County's Insurance Department will result in a delay in the finalization of this Agreement.

The VENDOR shall submit copies of any or all required insurance policies as and when requested by the County.

CERTIFICATES OF INSURANCE

The VENDOR shall file with the County's Insurance Department, prior to commencing work under this Agreement, all proper Certificates of Insurance.

The Certificates of Insurance shall include:

a. Name and address of Insured
b. Issue date of certificate
c. Insurance company name
d. Type of coverage in effect
e. Policy number
f. Inception and expiration dates of policies included on the certificate
g. Limits of liability for all policies included on the certificate
h. "Certificate Holder" shall be the County of Ulster, P.O. Box 1800, Kingston, New York 12402-1800.

If the VENDOR'S insurance policies should be non-renewed or canceled, or should expire during the life of this Agreement, the County shall be provided with a new certificate indicating the replacement policy information as requested above. The County requires thirty (30) days prior written notice of cancellation [fifteen (15) days for non-payment of premium] from the Insurer, its agents or representatives.

The contractor/vendor agrees to indemnify the County of Ulster for any applicable deductibles and self-insured retentions.

WORKERS' COMPENSATION AND DISABILITY INSURANCE

The VENDOR shall take out and maintain during the life of this Agreement, Workers' Compensation (WC) Insurance and Disability Benefits (DB) Insurance, for all of its employees employed at the site of the project, and shall provide Certificates of Insurance evidencing this coverage to the County's Insurance Department.

If the VENDOR is not required to carry such insurance, the Firm must submit form CE-200 attesting to the fact that it is exempt from providing WC and/or DB Insurance coverage for all of its employees.

The manner of proof related to WC and DB Insurance is controlled by New York State Laws, Rules and Regulations. "ACORD" forms are not acceptable proof of WC and/or DB Insurance.

WORKERS' COMPENSATION REQUIREMENTS

To assist the State of New York and municipal entities in enforcing WCL Section 57, a business entity (the Firm) seeking to enter into a contract with a municipality (the County) must provide one of the following forms to the municipal entity it is entering into a contract with. The VENDOR should contact their insurance agent to obtain acceptable proof of WC coverage:

- Form C-105.2 – "Certificate of NYS Workers' Compensation Insurance" **or**
- Form U-26.3 – "Certificate of Workers' Compensation Insurance" issued by the New York State Insurance Fund **or**
- Form SI-12 – "Affidavit Certifying that Compensation has Been Secured" issued by the Self-Insurance Office of the Workers' Compensation Board if the VENDOR is self-insured **or**
- Form GSI-105.2 – "Certificate of Participation in Workers' Compensation Group Self-Insurance" issued by the Self-Insurance administrator of the group **or**
- Form GSI-12 – "Certificate of Group Workers' Compensation Group Self-Insurance" issued by the Self-Insurance Office of the Workers' Compensation Board if the VENDOR is self-insured.

If the VENDOR is not required to carry WC coverage, it must submit Form CE-200, "Certificate of Attestation of Exemption" from New York State Workers' Compensation and/or Disability Benefits Insurance Coverage. This form and the instructions for completing it are available at http://www.wcb.ny.gov

DISABILITY BENEFITS REQUIREMENTS
To assist the State of New York and municipal entities in enforcing WCL Section 220(8), a business entity (the VENDOR) seeking to enter into a contract with a municipality (the County) must provide one of the following forms to the municipal entity it is entering into a contract with. The VENDOR should contact their insurance agent to obtain acceptable proof of DB Insurance Coverage:

- Form DB-120.1 – "Certificate of Insurance Coverage Under the NYS Disability Benefits Law" **or**
- Form DB-155 – "Compliance with Disability Benefits Law" issued by the Self-Insurance Office of the Workers' Compensation Board if the VENDOR is self-insured.

If the VENDOR is not required to carry DB Insurance coverage, it must submit Form CE-200, "Certificate of Attestation of Exemption" from New York State Workers' Compensation and/or Disability Benefits Insurance Coverage. This form and the instructions for completing it are available at http://www.wcb.ny.gov

COMMERCIAL GENERAL LIABILITY INSURANCE:
The VENDOR shall take out and maintain during the life of this Agreement, such bodily injury liability and property damage liability insurance as shall protect it and the County from claims for damages for bodily injury including accidental death, as well as from claims for property damage that may arise from operations under this Agreement, whether such operations be by the Firm, by any subcontractor, or by anyone directly or indirectly employed by either of them.

It shall be the responsibility of the VENDOR to maintain such insurance in amounts sufficient to fully protect itself and the County, but in no instance shall amounts be less than the minimum acceptable levels of coverage set forth below:

- Bodily Injury Liability and Property Damage Liability Insurance in an amount not less than **ONE MILLION AND 00/100 ($1,000,000.00) DOLLARS** for each occurrence, and in an amount not less than **TWO MILLION AND 00/100 ($2,000,000.00) DOLLARS** general aggregate.

Other Conditions of Commercial General Liability Insurance:

a. Coverage shall be written on Commercial General Liability form.
b. Coverage shall include:
   1. Contractual Liability
   2. Independent Contractors
   3. Products and Completed Operations
c. "Additional Insured" status shall be granted to "County of Ulster, P.O. Box 1800, Kingston, New York, 12402-1800", shown on the Commercial General Liability policy, further stating that this insurance shall be primary and non-contributory with any other valid and collectable insurance.

AUTOMOBILE LIABILITY INSURANCE
Automobile Bodily Injury Liability and Property Damage Liability Insurance shall be provided by the VENDOR, with a minimum Combined Single Limit (CSL) of **ONE MILLION AND 00/100 ($1,000,000.00) DOLLARS.**

Coverage shall include:

a. All owned vehicles
b. Any hired automobile
c. Any non-owned automobile

PROFESSIONAL LIABILITY INSURANCE (e.g. MALPRACTICE INSURANCE)

[✓] If this box is checked, Professional Liability Insurance shall be provided by the VENDOR in an amount not less than **ONE MILLION AND 00/100 ($1,000,000.00) DOLLARS for each occurrence, and in an amount not less than TWO MILLION AND 00/100 ($2,000,000.00) DOLLARS** general aggregate.

CYBER LIABILITY INSURANCE:

[ ] If this box is checked, Cyber Liability Insurance shall be provided by the VENDOR in an amount not less than **FIVE MILLION AND 00/100 ($5,000,000) DOLLARS** for each occurrence and in an amount of not less than **FIVE MILLION AND 00/100 ($5,000,000) DOLLARS** general aggregate. **Copies of policy must be submitted with certificate of insurance.**

SEXUAL ABUSE & MOLESTATION COVERAGE:

[ ] If this box is checked, Sexual Abuse & Molestation Coverage must be provided.

THE FOLLOWING SHEETS MUST BE COMPLETED AND RETURNED WITH YOUR PROPOSAL

RESPONSE RETURN FORM

VENDOR NAME: ____

TITLE: ____

PHONE NUMBER: ____

E-MAIL: ____

ADDRESS: ____

AUTHORIZED SIGNATURE: ____________________________________

RESPONDER'S NAME: ______________________________

ASSUMED NAME CERTIFICATION

***If the responder's business is conducted under an assumed name, a copy of the certificate required to be filed under the New York general business law must be attached.**

ASSUMED NAME:____

If the responder is an individual, the proposal must be signed by that individual; if the responder is a corporation, by an officer of the corporation, or other person authorized by resolution of the board of directors, and in such case a copy of the resolution must be attached; if a partnership, by one of the partners or other person authorized by a writing signed by at least one general partner and submitted with the proposal or previously filed with the Director of Purchasing.

The submission of this proposal constitutes a certification that no County Officer has any interest therein. (Note: In the event that any County Officer has any such interest, the full nature thereof should be disclosed below.)

____

____

____

INSURANCE STATEMENT

Responder agrees as follows - please mark appropriate box(es):

Insurance Certificate as requested is attached ☐

OR

I certify that I can supply insurance as specified if awarded the contract ☐

Insurance Certificate filed on __________________
DATE

FAILURE TO PROVIDE SPECIFIED INSURANCE SHALL DISQUALIFY RESPONDER

____
AUTHORIZED SIGNATURE

ORGANIZATION INFORMATION FORM

RESPONDER NAME: ____

TYPE OF ENTITY: CORP.____ PARTNERSHIP: ______ INDIVIDUAL: ________ OTHER: ______

FEDERAL EMPLOYER ID #:_________________ OR SOCIAL SECURITY #:_____________________

DATE OF ORGANIZATION:__________________________________

IF APPLICABLE: DATE FILED: ______________ STATE FILED: _______________________

If a non-publicly owned corporation:

CORPORATION NAME: ___________________________________

LIST PRINCIPAL STOCKHOLDERS: (owning 5% or more of outstanding shares)

_______________________________ ____

_______________________________ ____

LIST OFFICERS AND DIRECTORS:

NAME	TITLE
_______________________________	____
_______________________________	____

****
****

If a partnership:

PARTNERSHIP NAME: ____

LIST PARTNERS NAME(S):

____________________________________ ______________________________________

____________________________________ ______________________________________

____________________________________ ______________________________________

____________________________________ ______________________________________

CERTIFICATION AND SIGNATURE FORM

AFFIDAVIT OF NON-COLLUSION

NAME OF RESPONDER: ______________________________ PHONE NO.: _________________________EXT:_________

BUSINESS ADDRESS: ____FAX NO.: ____________________________

I hereby attest that I am the person responsible within my firm for the final decision as to the prices(s) and amount of this proposal or, if not, that I have written authorization, enclosed herewith, from that person to make the statements set out below on his or her behalf and on behalf of my firm.

I further attest that:
1. The price(s) and amount of this proposal have been arrived at independently, without consultation, communication or agreement for the purpose of restricting competition with any other contractor, responder or potential responder.
2. Neither the price(s), nor the amount of this proposal, have been disclosed to any other firm or person who is a responder or potential responder on this project, and will not be so disclosed prior to proposal opening.
3. No attempt has been made or will be made to solicit, cause or induce any firm or person to refrain from responding to this RFP, or to submit a proposal higher than the proposal of this firm, or any intentionally high or non-competitive proposal or other form of complementary proposal.
4. The proposal of my firm is made in good faith and not pursuant to any agreement or discussion with, or inducement from any firm or person to submit a complementary proposal.
5. My firm has not offered or entered into a subcontract or agreement regarding the purchase of materials or services from any other firm or person, or offered, promised or paid cash or anything of value to any firm or person, whether in connection with this or any other project, in consideration for an agreement or promise by an firm or person to refrain from responding to this RFP or to submit a complementary proposal on this project.
6. My firm has not accepted or been promised any subcontract or agreement regarding the sale of materials or services to any firm or person, and has not been promised or paid cash or anything of value by any firm or person, whether in connection with this or any project, in consideration for my firm's submitting a complementary proposal, or agreeing to do so, on this project.

7. I have made a diligent inquiry of all members, officers, employees, and agents of my firm with responsibilities relating to the preparation, approval or submission of my firm's proposal on this project and have been advised by each of them that he or she has not participated in any communication, consultation, discussion, agreement, collusion, act or other conduct inconsistent with any of the statements and representations made in this affidavit.

8. By submission of this proposal, I certify that I have read, am familiar with, and will comply with any and all segments of these specifications.

The person signing this proposal, under the penalties of perjury, affirms the truth thereof.

____
Signature & Company Position

____
Print Name & Company Position

____
Company Name

____
Date Signed

____
Federal I.D. Number

RESPONDER'S NAME: ________________________________

CERTIFICATION OF COMPLIANCE WITH THE IRAN DIVESTMENT ACT

Pursuant to State Finance Law §165-a, on August 10, 2012 the Commissioner of the Office of General Services (OGS) posted a prohibited entities list of "persons" who are engaged in "investment activities in Iran" (both are defined terms in the law) on the OGS website at: http://www.ogs.ny.gov/about/regs/docs/ListofEntities.pdf

By submitting a bid in response to this solicitation or by assuming the responsibility of a Contract awarded hereunder, each Bidder/Contractor, any person signing on behalf of any Bidder/Contractor and any assignee or subcontractor and, in the case of a joint bid, each party thereto, certifies, under penalty of perjury, that once the Prohibited Entities List is posted on the OGS website, that to the best of its knowledge and belief, that each Bidder/Contractor and any subcontractor or assignee is not identified on the Prohibited Entities List created pursuant to SFL § 165-a(3)(b).

Additionally, Bidder/Contractor is advised that once the Prohibited Entities List is posted on the OGS Website, any Bidder/Contractor seeking to renew or extend a Contract or assume the responsibility of a Contract awarded in response to this solicitation must certify at the time the Contract is renewed, extended or assigned that it is not included on the Prohibited Entities List.

During the term of the Contract, should the County receive information that a Bidder/Contractor is in violation of the above-referenced certification, the County will offer the person or entity an opportunity to respond. If the person or entity fails to demonstrate that he/she/it has ceased engagement in the investment which is in violation of the Act within 90 days after the determination of such violation, then the County shall take such action as may be appropriate including, but not limited to, imposing sanctions, seeking compliance, recovering damages or declaring the Bidder/Contractor in default.

The County reserves the right to reject any bid or request for assignment for a Bidder/Contractor that appears on the Prohibited Entities List prior to the award of a contract and to pursue a responsibility review with respect to any Bidder/Contractor that is awarded a contract and subsequently appears on the Prohibited Entities List.

I, ______________________________________, being duly sworn, deposes and says that he/she is the
______________________________________ of the ______________________________________

Corporation and that neither the Bidder/Contractor nor any proposed subcontractor is identified on the Prohibited Entities List.

____
SIGNED

SWORN to before me this

____________ day of __________________________

201 ____

Notary Public: ________________________________

RESPONDER'S NAME: ___________________________________

MACBRIDE FAIR EMPLOYMENT PRINCIPLES

Ulster County Resolution 108 of March 8, 2001, in an attempt to prevent discrimination in all forms, provides the requirement that vendors who do business with Ulster County read, initial and return the attached statement as part of their official document.

Please read and initial **either** Statement #1 or Statement #2.

DO NOT INITIAL BOTH STATEMENTS.

___1. The Bidder, and any individual or legal entity in which the Bidder holds a 10% or greater ownership interest and any individual or legal entity that holds a 10% or greater ownership interest in the Bidder, has no business operations in Northern Ireland.

___2. The Bidder, and any individual or legal entity in which the Bidder holds a 10% or greater ownership interest and any individual or legal entity that holds a 10% or greater ownership interest in the Bidder shall take lawful steps in good faith to conduct any business operations they have in Northern Ireland in accordance with the MacBride Fair Employment Principles and shall permit the independent monitoring of their compliance with such principles.

____
AUTHORIZED SIGNATURE

____
PRINT NAME:

ALL QUESTIONS PERTAINING TO THIS RFP **MUST** BE SUBMITTED IN WRITING 7 DAYS PRIOR TO SUBMITTAL RETURN DATE.

(This form can be used and faxed to 845-340-3434 to the attention of Marc Rider, Director of Purchasing. Or questions can be submitted by email to mrid@co.ulster.ny.us with a cc to the contact person listed on page1. We will respond as soon as possible.)

Date: ______________________________

Company Name: ______________________________

Contact Name: ______________________________

Telephone No.: ______________________________

Fax No.: ______________________________

E-mail: ______________________________

The New York Power Authority

In Cooperation with

Arcadis

Geothermal Clean Energy Challenge Stage 3 Report

for

Ulster County Office Building

October 27, 2020

TABLE OF CONTENTS

TITLE **PAGE**

Section 1
Executive Summary

EXECUTIVE SUMMARY

The Geothermal Clean Energy Challenge (Challenge) is a joint venture between the New York Power Authority (NYPA) and the New York State Energy Research and Development Authority (NYSERDA) to provide technical support, financial assistance, and implementation services to stimulate and finance the installation of best-in-class, large-scale geothermal systems, known as Ground Source Heat Pump (GSHP) systems. These systems reduce energy costs and greenhouse gas emissions. Increasing the use of these systems will play a major role in achieving Gov. Andrew M. Cuomo's Renewing the Energy Vision (REV) goal to reduce New York State's greenhouse gas emissions 40 percent by 2030. Stages 1 and 2 of the Challenge have been completed for the Ulster County Office Building (Office Building). Stage 3 of the Challenge 'Targeted Geothermal Audit & Conceptual Design' involves the production of audit-grade detailed design studies and business planning reports before large-scale geothermal systems are deployed.

Arcadis performed a detailed energy and geothermal audit for the Ulster County Office Building on January 21, 2020. The Office Building is located at 240 Fair Street, Kingston, New York. The purpose of the audit was to identify and evaluate cost-effective energy savings opportunities in conjunction with identifying the feasibility of implementing a GSHP system to provide heating and cooling at the Office Building.

As a result of the energy audit, ten ECMs were identified and recommended for the implementation. Of the identified ECMs, two have low or no implementation costs and eight have larger capital expenditures. The most substantial ECM analyzed was the ECM 8b, which included the replacement of the existing boilers and chiller with a hybrid GSHP system. The analysis included a geothermal test well, thermal conductivity test, review of existing mechanical systems, load reduction measures, existing mechanical system upgrades, and four bore field options. The test concluded that the office building has an average conductivity of 1.49 Btu/(hr-ft-F) based on the national range of soil thermal conductivity. Analyses of the geothermal test well thermal conductivity test results and the typical heating and cooling loads were completed to estimate a conceptual GSHP loop design. Other ECMs were identified to reduce the Office Building's energy use, but none were determined to have a substantial effect on reducing the size of the GSHP system. A geothermal heat exchanger grid of 5x12 boreholes (60 total) at 499 feet deep will meet the required design inlet water temperatures required during heating and cooling operations. In order to implement the new GSHP system, the GSHP would need to be integrated into the existing core mechanical systems providing heating and cooling for the building. Based on the loop capacity, preliminary estimates for design includes one 200-ton mag chiller, one 40-ton heat pump chiller, and a closed-circuit cooling tower to meet all of the building's cooling loads and two 800 MBH condensing boilers to meet the building's heating loads. The overall estimated cost of the GSHP system including

NYPA CPC project implementation fees would be $2,663,804, or $44,397 per well, with a simple payback period of 127 years.

Table 1: ECM Summary Table

ECM #	Measure Description	Energy Saved (kWh)	Demand Saved (kW)	Fuel Savings (therms)	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback Period (years)	CO2e Reduction (tonnes)
1	Stairwell fin tube radiation adjustment	0	0.0	84	$78	$0	0	0.499
2	Replace CFL with LED	1,881	0.3	-36	$157	$502	3	0.254
3	Install control to reduce run time on EF-3	1,096	0.0	1,034	$1,153	$6,638	6	6.411
4	Install control to reduce run time on EF-5	6,127	0.7	0	$656	$3,361	5	1.523
5	Install VFD on AHU HW Loop Pump	6,282	0.0	0	$598	$8,907	15	1.526
6	Replace existing drive on AC-1 and convert to DCV	39,360	11.4	0	$4,252	$70,525	17	9.787
7	Convert AC-4 to VAV with DCV	22,372	0.0	421	$2,167	$101,885	47	8.062
8.a.1	Replace existing boilers	0	0.0	6,359	$5,938	$550,750[9]	93	37.750
8.b.1	Replace existing chiller	11,248	13.4	0	$7,520	$570,806	76	2.797
8b	GSHP System with Upgraded Chillers and Boilers	41,773	0.0	18,470	$20,942	$2,663,804[8]	127	120.035
9	Controls Upgrade	71,066	0.0	7,112	$12,277	$58,220	5	59.891
10	Building Envelope Upgrade	27,968	0.0	5,347	$7,211	$677,935	94	38.697

Notes:

1. Assuming average energy values of $0.07929/kWh (not including demand charges), demand value of $8.30/kW, and a natural gas value of $0.9338/therm from the most recent year of utility data.
2. There is not a summer peak demand savings for ECM8b but shoulder seasons provide savings.
3. ECMs were calculated independent of one another. Further measure interactions will be analyzed at the 60% design stage.
4. Project costs include NYPA CPC project implementation costs. Project costs were estimated using vendor quotes, driller quotes, and 2020 RS Means.
5. Refer to the Energy Conservation Measures section of the report for additional measure details.
6. The Simple Payback Periods were rounded to the nearest year in this Summary Table.
7. Currently available NYSERDA incentives of $279,600 were included in this cost. There is no guarantee that these incentives will be available.
8. Currently available NYSERDA incentives of $5,475 were included in this cost. There is no guarantee that these incentives will be available.

Section 2
Facility Description

FACILITY DESCRIPTION

The Office Building is in the Stockade District of historic Kingston approximately two miles west of the Hudson River. The surrounding area is primarily commercial and residential, with many buildings being preserved as historic landmarks.

Figure 1: Ulster County Office Building

Ulster County Office Building

The office building was constructed in 1964 and is 6-stories with a basement which total up to 62,396 square feet. These office spaces are occupied by a variety of County departments including the DMV, a records storage vault, financial offices and legislative spaces. The 6th floor houses a county executive meeting room with infrequent occupancy and other specialty offices. Many of these spaces have been renovated and reconfigured since its original construction which includes upgrades to the mechanical and electrical systems.

OCCUPANCY SCHEDULE

Typical occupancy is between 250 and 300 people. The building is typically occupied from 8:00 AM to 5:00 PM Monday through Friday. Employees can work outside of these windows as needed from 6:00AM to midnight. When the building is armed by security a midnight, general lighting is deactivated, and HVAC equipment is in unoccupied mode for the evening. When security disarms the building at 6:00AM, these systems are reenergized for the day. Specific controls and schedules for each type of equipment is noted in their respective sections.

LOCAL CLIMATE CONDITIONS

Since there are minimal internal heat loads in the Office Building, local climate has the largest impact on the Building's energy consumption. The building envelope is comprised of a curtain wall style system which is inherently inefficient, resulting in substantial heat loss and gains. Site weather patterns determine a typical meteorological year (TMY) and peak design conditions calculated by ASHRAE. These both have a large effect on energy calculations utilizing weather bin analysis and the peak loads that HVAC systems are designed for. The following are the ASHRAE design day conditions for the Poughkeepsie, New York and were used as the basis for the energy calculations. The design parameters are:

Cooling Season Design Day: 88.4 degree F Dry Bulb / 72.3 degree F Wet Bulb

Heating Season Design Day: 8.4 degree F Dry Bulb

HEATING, VENTILATION AND AIR CONDITIONING

The Office Building is maintained between 70- and 74-degrees Fahrenheit (F) depending on the zone during occupied hours. During unoccupied hours in the heating season, a typical temperature setback of 65-degrees F is used. During the cooling season a typical temperature setback of 75-degrees F is used. Humidity is only actively controlled for AC-4 as it serves the vault area. Dehumidification is controlled by regulation of the chilled water flow that supplies the chilled water coils in each AHU.

During the summer, the boilers are shut off to eliminate stand-by system losses and to prevent the building from unintentional simultaneous heating and cooling. Similarly, chilled water is shut off during the heating season. Even with these schedules, simultaneous heating and cooling does occur during the shoulder season when the systems overlap. Exact dates of when these systems are shut off annually are dependent on weather conditions, but the changeover periods are typically in October and May.

HEATING SYSTEM

Heating hot water (HHW) is provided by two natural gas fired Weil-McLain sectional cast iron boilers which were installed in 1988. The boilers are on an annual maintenance plan. They are at the end of their useful life and facility staff reported that the burners need continuous adjustments and excess air has become a greater issue. Two boilers are required to operate to meet the heating building load during times when the outdoor air temperature is 10 degrees F or lower. The boilers are controlled through the BMS and are enabled when the OA DB temperature drops below 58 degrees F and are in constant operation anytime the temperature is below 40 degrees F. During periods of lighter loads, the boilers are manually changed from lead to lag to balance hours of operation. The hot water supply (HWS) temperature is linearly reset based on OAT. At 0 degrees F the HWS is 180 degrees F and at 60 degrees F the HWS is at 120 degrees F.

Table 2: Boiler Plant Schedule

Tag	Manufacturer	Year Installed	Boiler Gas Input (MBH)	Boiler Water Output (MBH)	Description
No.1	Weil-McLain	1988	5,124	3,557	Gas Fired – Model 1688
No.2	Weil-McLain	1988	5,124	3,557	Gas Fired – Model 1688

Figure 2: Weil-McLain Boilers

The hot water produced by the boilers is supplied via three hot water pumps (HWP). One pump provides hot water to the AC units which utilize 3-way valves. The other two pumps provide hot water to the perimeter fin tube radiation which have 2-way valves. It is reported that the flow to Floor 5 and 6 is inadequate. The perimeter fin tube radiation units are controlled by unitary thermostats. Some areas are over or under heated due to a thermostat now being in a different room due to renovations. The northeast stairwell is in the corner of the building and contains fin tube radiation at intermediate landings between floors to maintain a setpoint temperature of approximately 70 degrees F. The units utilize self-contained thermostats with manual control via a dial on the enclosure. It was recognized that each unit was operating during the inspection and the upper portions of the stairwell were warmer than required as they are not typically occupied.

Table 3: Hot Water Pump Schedule

Tag	Manufacturer	Motor HP	Pump Flow (GPM)	Location	Serves
P3-1	B&G	7.5	390	Basement	AHU
P4-1	B&G	2	84	Basement	South Fin Tube
P5-2	B&G	3	106	Basement	North Fin Tube

COOLING SYSTEM

Chilled water (CHW) is provided by a singled water-cooled York variable speed drive (VSD) centrifugal chiller which is approximately 15 years old and not yet at the end of its useful life. The chiller is located in the basement and the cooling tower is located on the roof. The Frick counterflow cooling tower is original to the building but is currently operating without issue as reported by the building engineer. The cooling tower utilize two fans and operate to maintain a set return condensing water temperature back to the chiller. It is drained and cleaned at the end of each cooling season.

Table 4: Chiller Plant Schedule

Tag	Manufacturer	Model	Year Installed	Size (tons)	Description
CH-1	York	YT	2005	300 (est)	Variable Speed Drive

Figure 3: York Chiller

CHW is supplied to the AC units via a loop by means of two constant speed pumps. Control is accomplished by 3-way valves. Condenser water is circulated between the chiller sand cooling tower by means of two constant speed condenser water pumps (CWP). Pumps for both systems operate in a lead/lag sequence and a spare pump is available for redundancy.

Table 5: Chilled Water System Pump Schedule

Tag	Manufacturer	Motor HP	Pump Flow (GPM)	Location	Serves
P1-1	B&G	15	740	Basement	Chiller
P1-2	B&G	15	740	Basement	Chiller
P2-1	B&G	15	700	Basement	Cooling Tower
P2-2	B&G	15	700	Basement	Cooling Tower

AIR DISTRIBUTION

All air handing units contain chilled water (CHW) and hot water (HW) coils for cooling and heating, respectively. AC-1, 2, 3, and 5 were replaced in 1987. When replaced, AC-1, 3 and 5 were upgraded to include economizers and reheat coils. Each floor is separated into 4 major zones, with a cooling coil in the supply air duct of each zone which is supplied by a dedicated supply air ductwork that was originally designed as a hot/cold-deck multi-zone system, but these systems were retrofitted in 2003 to remove the hot/cold decks. As a result, only the cooling coils are used to for final tempering of zone supply air for cooling only.

AC-1 is in the basement and serves Floors 1 through 5. There is a manually operated variable speed drive on the supply fan motor that is used for balancing purposes and is typically manually adjusted between heating and cooling seasons to provide the proper airflow required. AC-2 is in the basement and serves the main lobby vestibule. The ductwork supplies air to the vestibule through floor discharges between the doors. This unit does not have outside air (OA) since it only recirculates air within the vestibule which receives OA via the doors. AC-3 is in the mechanical room behind the maintenance office and serves the basement. This unit has its own dedicated OA duct and has economizing capabilities that is manually operated by staff. AC-4R is in the basement next to AC-1 and shares a common OA plenum. This unit serves the document vault area that spans from the basement to Floor 3 and contains 3 coils; one direct expansion (DX), one CHW, and one HW. The DX coils are backups for when the chilled water system is off during the shoulder season. There are four condensing units that serve each of the DX coils. The unit utilizes hot water reheat coils for each zone, these reheat coils were previously electric. Each zone's ductwork has an independent electric steam generator for humidification. These are not currently being used as they have the tendency to over humidify and cause alarms. AC-5 is the only unit located on the rooftop and is dedicated to Floor 6. There is both a hot water and chilled water heat exchanger located on Floor 6 which separate the house's hydronic loops and the rooftop unit's glycol loops. Each glycol loop has its own dedicated circulation pump. The intent of this design is to avoid freezing but the glycol CHW is drained when the chiller is deenergized for the winter.

Table 6: Air Handling Unit Schedule

Tag	Manufacturer	Model	Location	Area Served	Cooling System Type	Heating System Type
AC-1	Unknown	Unknown	Basement	Floors 1-5	CHW	HHW
AC-2	Unknown	Unknown	Basement	Vestibule	CHW	HHW
AC-3	Carrier	39BA060D15	Basement	Basement	CHW	HHW
AC-4	Trane	MCCA021SDE	Basement	Vault	CHW/DX	HHW
AC-5	Unknown	Unknown	Roof	Floor 6	CHW	HHW

Note: AC units designated as "Unknown" did not had nameplates or other identifiable markings

Exhaust fans are integrated into the building's security system. When the security system is activated at night, exhaust fans are deactivated and vice versa in the morning when the security system is deactivated. No identifiable markings were located on the exhaust fan housings.

Table 7: Exhaust Fan Schedule

Tag	Location	Area Served
EF-1	Roof	Lavatories
EF-2	Roof	6th Floor Legislative Conference Room
EF-3	Roof	Storage Riser
EF-4	1st Floor	Generator Room
EF-5	Basement	Chiller Vault
EF-6	Roof	Janitor Closets

CONTROLS

The buildings HVAC system is controlled by a Johnson Controls Metasys Building Automation System (BAS) and the workstation is located in the basement maintenance office. The system has the capability to trend data but is not utilized to its full capabilities. A 3-degree F deadband has been programmed to reduce overlapping heating and cooling during the shoulder season. EmTech has taken over the maintenance of the system and has reported inaccuracies in some of the monitoring points. It appears that the system may not have been reconfigured accurately since the last renovation.

Figure 4: Johnson Controls Metasys Building Automation System

There are a mixture of direct digital controls (DDC) and pneumatic controls in operation throughout the building. A 1.5 HP, 80-gallon DeVilbiss compressed air system is located in the mechanical equipment room in the basement. The air compressor serves the pneumatic thermostats and control valves. It was observed to run for long periods of time and cycled frequently.

Figure 5: 1.5 HP DeVilbiss air compressor

BUILDING ENVELOPE

WALLS

The Building's exterior is curtain wall construction, consisting of glass windows and aluminum mullion framing members which make up the curtain wall. This is supported by a steel framed structure. The windows are single pane with insulated glazing and have not been upgraded since the original construction.

Due to the curtain wall's construction, maintaining comfort within the building around the perimeter is difficult due to the high conductive heat losses and gains due to thermal bridging through the aluminum framing and high infiltration rates.

Figure 6 shows the exterior view of the Documentation Vault area. This area spans from the basement to Floor 3 and is separated from the windows by concrete masonry unit (CMU) block. The first 2 floors appear to be cooler in color temperature than the 3rd floor since this floor is standard office space without a CMU barrier. The spandrel panels are also cooler in color temperature as they are more insulated than the single pane windows. Thermal bridging is apparent along all the aluminum framing.

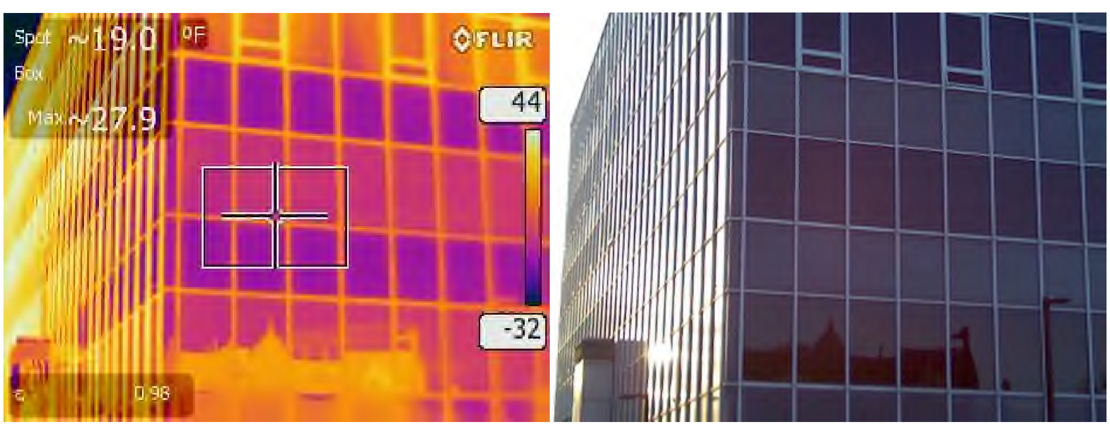


Figure 6: Southeast Envelope - Exterior View of Vault Area

Both main entrances have vestibules and are located on opposite ends of the building. The front entrance uses standard push/pull doors and the exterior doors were reported to break frequently due to the wind. The rear entrance uses automatic sliding doors without air curtains. These automatic doors were observed to stay open for a longer period of time than necessary once activated. Due to frequent pedestrian traffic for the DMV at the front vestibule, both vestibule doors are often open at the same time allowing a large volume of unconditioned outside air to enter the 1st floor during occupied times creating an uncomfortable environment and increased loading of the HVAC system.

Figure 7 shows the front vestibule area which is cooler than the main lobby located to the right of the photo. The vestibule is functioning as a barrier to the outside air but there are still large losses through the standard lobby window assemblies.

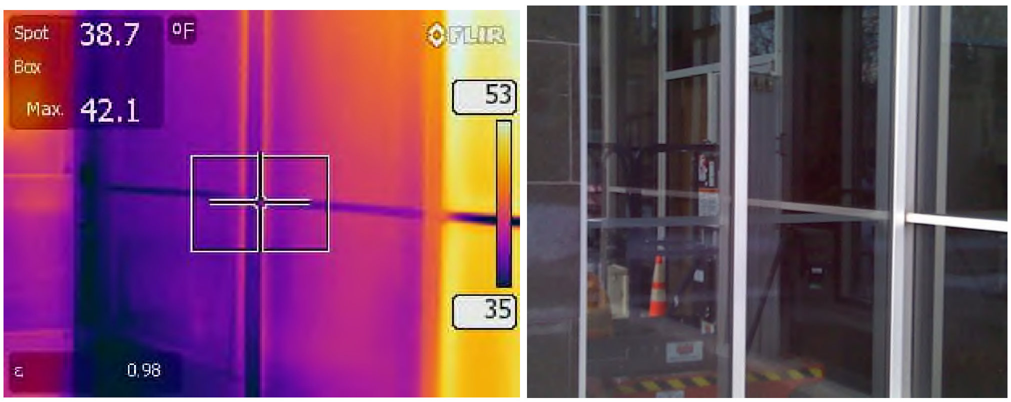


Figure 7: Northwest Envelope - Exterior View of Front Vestibule

ROOF

The existing black membrane rubber roof which is approximately 40 years old. The cooling tower, AC-5, and most of the exhaust fans are located on the rooftop. Funding has been approved for the replacement of the roof membrane. It is not known when the replacement will take place.

LIGHTING

INTERIOR

The light fixtures were recently upgraded to light emitting diode (LED) technology through a program with the building's utility provider, Central Hudson. Almost all the T8 linear fluorescent fixtures in offices, stairwells, mechanical rooms, and common areas were replaced with plug and play Philips InstaFit lamps. Many of the offices also utilize A/B switching which allows the occupancy to choose to only use half the number of lamps in their fixtures. This was observed to be commonly used by the occupants as the upgraded lamps have a higher lumen output. A small number of compact fluorescent light (CFL) cans and T8 fixtures were observed during the walkthrough. Exterior pole mounted lighting has been upgraded to Cree LED fixtures.

Hallway lighting is integrated into the building's security system. When the system is activated at night, all hallway lighting is deactivated and vice versa in the morning when the system is deactivated. Independent office areas are switch controlled and some areas have been upgraded to utilize occupancy sensors. Bathrooms also have ceiling mounted occupancy sensors. Staff are vigilant as almost all offices observed during the inspection had their lights off when they were unoccupied.

Figure 8: Typical LED Fixtures Located in Office Areas

EXTERIOR

Perimeter exterior lighting is present in the form of cobra head style LED streetlights and LED can style fixtures over the front entrance.

Figure 9: LED Streetlight in Parking Lot

DOMESTIC HOT WATER

An 80-gallon Bradford White water heater is located in the basement and is responsible for supplying domestic hot water (DHW) to the building. The hot water is delivered to each floor by a supply and return distribution loop with an aquastat.

Figure 10: 80-gallon Bradford White DHW Tank

MISCELLANEOUS

Typical office spaces contain computers, printers, task lighting, and vending machines. Printers are centralized and there is typically one per department. Due to the exterior wall construction, there is excessive heat loss at the perimeter zones and personal electric unit heaters are being used. There is approximately one kitchenette per department which typically contain a refrigerator, microwave, toaster oven, and coffee pot. There is a DMV data closet and telecom closet which are both cooled by dedicated split DX systems.

Section 3
Energy Baseline

ENERGY BASELINE

UTILITY ACCOUNTS AND BILLING

ELECTRICITY

The electric utility provider is Central Hudson Gas and Electric (CHG&E). The building is listed under Service Classification No. 2 (E200-E290) for General Service Commercial/Industrial with demand less than 1,000 kW. While delivery is charged by CHG&E, the building is supplied through Constellation Energy for with fixed supply rate of $0.05844/kWh. Area (parking) lights are segregated from the other electric energy charges but on the same monthly bill. They are categorized as Service Classification No. 5 (E500) – Area Lighting Service. Since area lights are typically on during sundown, there are no demand charges for this service classification.

There are no opportunities to change rate class after a review of CHG&E's Summary of Proposed Monthly Electric Base Delivery Rates.

Table 8: Average Electricity Rates

Average Building Demand Rate ($/kW)	Blended Building Rate ($/kWh)	Non-Blended Rate Used for ECM Savings Calculations ($/kWh)	Blended Area Lights Consumption Rate ($/kWh)
8.30	0.106	0.07929	0.241

NATURAL GAS

Natural gas is charged on the same CHG&E bill as the electric charges. The building is listed under Service Classification No. 2 (G250-G450) Commercial and Industrial Rate for commercial and industrial heating, water heating, and cooking customers.

Table 9: Average Natural Gas Consumption Rate

Average Natural Gas Rate ($/therm)
0.9338

ANNUAL ENERGY USE

The total energy use and energy baseline for the Office Building over the past two years is shown in Table 10.

Table 10: Annual Energy Use Summary

Bill Date Range	Annual Electricity Use (kWh)	Natural Gas Use (therms)	Annual Energy (MMBtu)	Energy Use Intensity (kbtu/sqft)	Energy Cost Intensity ($/sqft)
November 2017 – October 2018	946,740	27,929	6,023	96.5	$2.08
November 2018 – October 2019	875,860	27,130	5,701	91.4	$1.89

Notes:
MMBtu = Million British thermal units
Kbtu = Thousand British thermal units
Sqft = square foot

ENERGY END USE BREAKDOWN

ENERGY

Figure 11 on the following page, displays the breakdown of energy (electricity and natural gas) by end user within the Office Building. Due to the lack of granularity for disaggregating loads like air compressors, office equipment, and data centers in eQuest, the energy end use breakdown was completed using ASHRAE Procedures for Commercial Building Energy Audits as well as data output from the eQuest energy model for accuracy. The top five energy intensive systems are space heating, lighting, cooling, and ventilation. The 2012 Commercial Building Energy Consumption Survey (CBECS) lists the top five systems based on energy intensity to be space heating, ventilation, computing, other, and lighting. Cooling may be higher on the list for this facility compared to CBECS due to the curtainwall envelope which allows more heat gain during the cooling season.

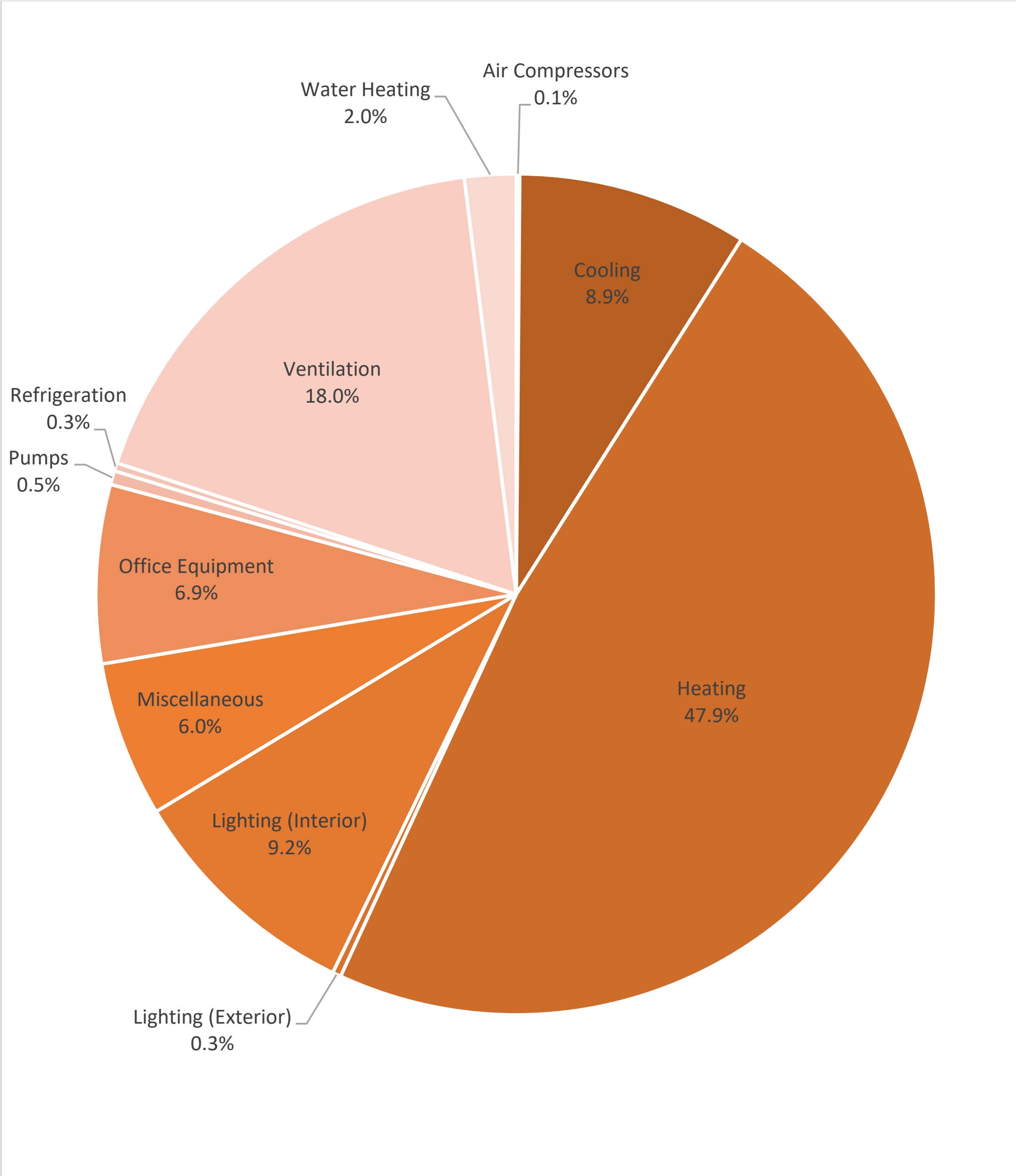


Figure 11: Estimated Annual MMBtu Usage by System Type

ELECTRIC ENERGY CONSUMPTION

The appropriate cooling degree days (CDD) were found by trial and error using regression analysis. The utility bills are invoiced mid-month which required the CDD to be customized to match that timeframe. The highest correlation to for electricity consumption and weather was at 61 degrees F. The building typically consumes between 55,000 and 76,000 kWh at baseload with the remaining spikes corresponding to temperature due to the large envelope load.

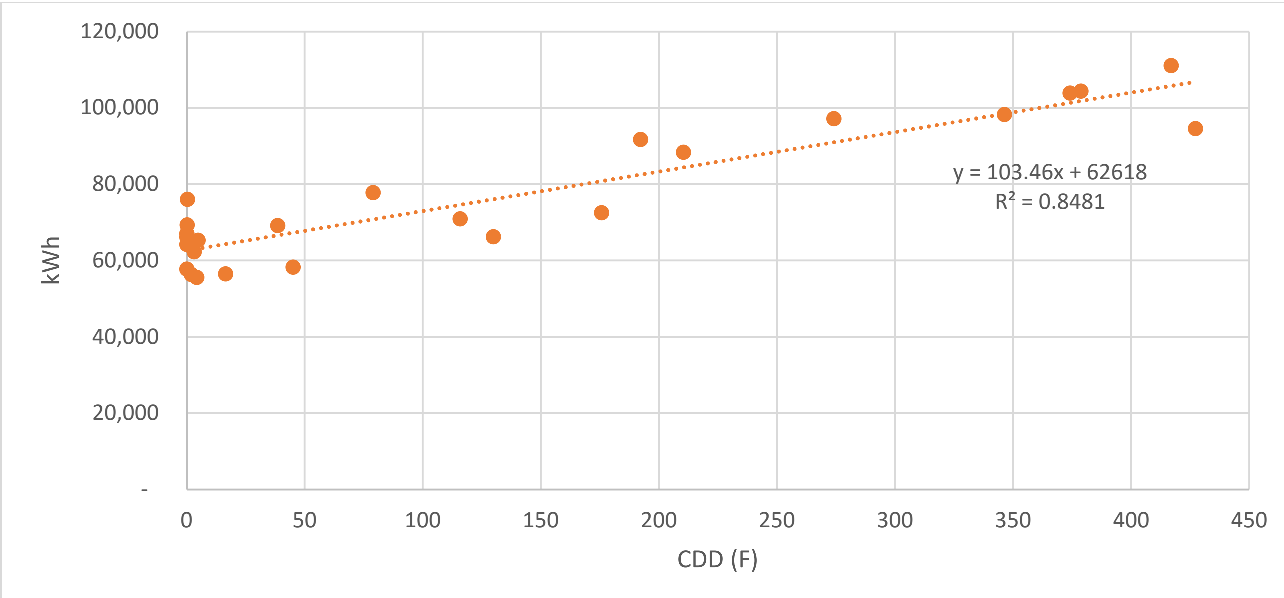


Figure 12: Regression Analysis for Electric Consumption and CDD

As cooling is provided by a chilled water system the electric energy consumption spikes during the summer. 2018 had a larger spike than 2019 but this is explained by the increase in the CDD for that timeframe. There are small spikes in December of each year which are likely due to the electric duct heaters for AC-4 and personal electric unit heaters in the office areas.

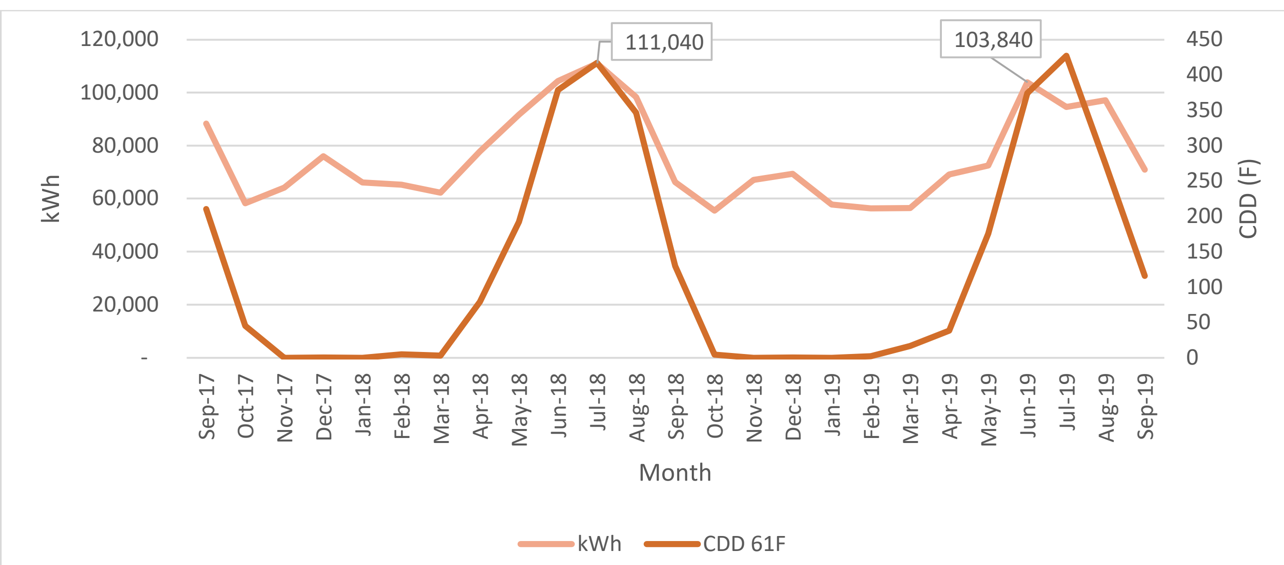


Figure 13: Past 2 Years of Electricity Consumption with CDD

ELECTRIC DEMAND

Understanding the demand portion of the electric bill is important since the demand cost for the building ranges from 17 to 28 percent of the total energy cost. The Office Building's peak demand profile ranges between 136 kW and 270 kW between November 2017 and October 2019, as shown in Figure *14*. Small spikes are present in the winter which is likely due to the electric duct heaters on AC-4 and personal electric unit heaters throughout the building.

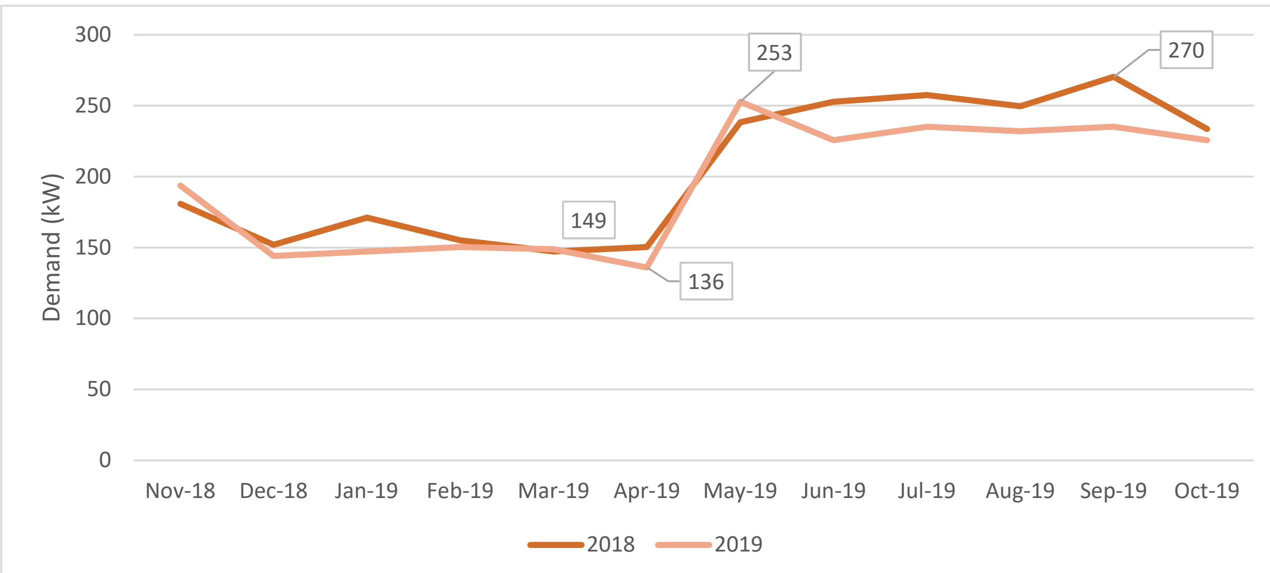


Figure 14: Peak Demand Profile

Table 11: Office Building Estimated Peak Demand Breakdown

End Use	kW	Percent (%)
Air Compressors	1.0	0.37%
Cooling	111.3	41.56%
Data Center/IT	1.0	0.37%
Lighting (Interior)	47.0	17.55%
Lighting (Exterior)	1.5	0.56%
Miscellaneous	32.7	12.21
Pumps & Aux.	16.5	6.16%
Ventilation	56.5	21.10%
Total Estimated	**267.8**	**100%**
Historical Billing	**253.0**	
Percent of Billing	**105%**	
Total per 1000 x sqft.	**4.3**	

NATURAL GAS CONSUMPTION

The appropriate heating degree days (HDD) were found by trial and error using regression analysis. Like with the CDD, the utility bills are invoiced mid-month which required the HDD to be customized to match that timeframe. The highest correlation to for natural gas consumption and weather was at 58 degrees F. The building typically consumes a very small amount of natural gas for hot water with most consumption corresponding to temperature due to the envelope, infiltration, and ventilation loads.

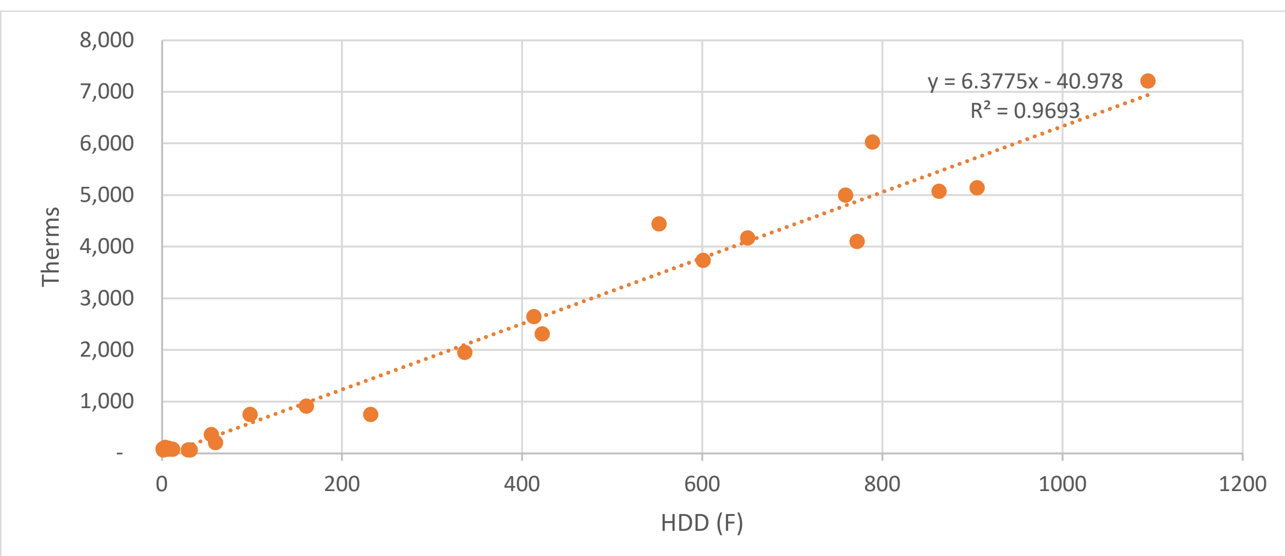


Figure 15: Regression Analysis for Natural Gas Consumption and HDD

As heating is provided by the hot water boilers the natural gas consumption spikes during the winter. 2018 had a larger spike than 2019 but this is explained by the increase in the HDD for that timeframe. The summer trends for domestic hot water consumption are consistent as this is only used for lavatory sinks and kitchenettes.

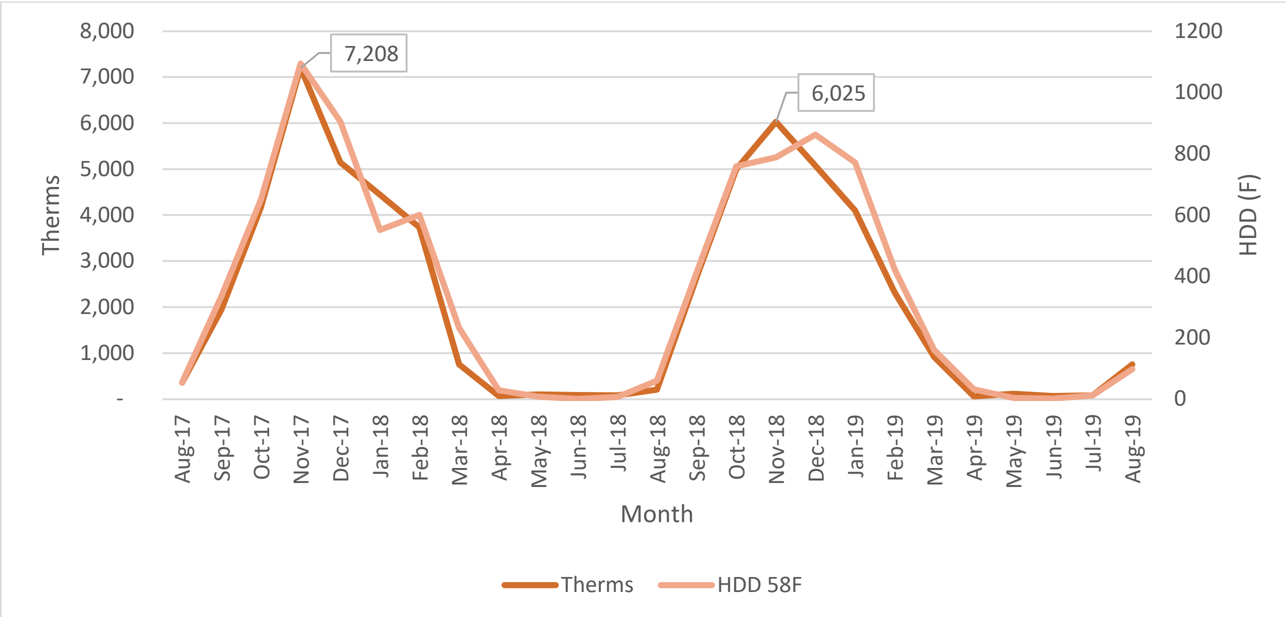


Figure 16: Past 2 Years of Natural Gas Consumption with HDD

Section 4
Energy Modeling Analysis

ENERGY MODELING ANALYSIS

The modeling program used for this analysis was eQuest, which was designed by James J. Hirsch & Associates. eQuest is a building energy use analysis tool that allows users to perform detailed comparative analyses of building designs and technologies using typical meteorological year (TMY3) data from the National Renewable Energy Laboratory (NREL). The program utilizes a combination of user inputs and software defaults to allow users to generate an accurate model of the building of study and provide estimates of energy consumption based on building envelope constructions, occupancy schedules, internal and external loads, and HVAC system operations and setpoints.

MODEL CREATION AND CALIBRATION

The baseline model was developed using eQuest's Schematic Design Wizard. The Schematic Design Wizard is intended for early-stage model development. Computer-aided design (CAD) drawings were imported into the program to accurately utilize the Office Building's exact layout. High level inputs including envelope constructions, interior finishes, windows and exterior doors, occupancy schedules, and HVAC equipment specifications and operations were entered into the model to establish a basic building footprint and building systems.

eQuest's Detailed Data Edit Mode was used to further refine the model's inputs. The Detailed Data Edit Mode allows users increased freedoms to revise operating schedules for fans, cooling, heating, occupancy, lighting, and miscellaneous equipment. Additionally, the Detailed Data Edit Mode allows further adjustment of envelope constructions for windows and skylights, doors, and building façade exteriors. The Detailed Data Edit Mode was utilized for the Office Building to provide greater detail on HVAC systems, building setpoints, building schedules, and sources of internal loads.

A model of the Office Building was generated based on data provided by Ulster County staff as well as data gathered during the site walkthrough. Where data was available, inputs were provided to eQuest, and where data was unavailable, ASHRAE and building code estimates or program defaults were used to generate an accurate model of the Office Building's operation and energy consumption. Calculated energy consumption was calibrated with utility bill data and ASHRAE's Procedures for Commercial Building Energy Audits tool to ensure the accuracy of the generated model.

PEAK LOAD CALCULATION

Simulation of the Office Building using eQuest provides a multitude of reports concerning energy consumption, heating and cooling loads for each zone, heating and cooling load components such as conduction through windows, ventilation, and internal heat gains, and HVAC loads. Peak heating loads were calculated for just the hot water circulation loop that serves the heating coils assuming typical operation at the Office Building, as shown in Table 12.

Table 12: eQuest peak heating loads for the boiler during normal Office operation

Month	Heating Energy (MMBtu)	Maximum Heating Load (kBtu/h)
Jan	486	1,956
Feb	401	1,966
Mar	242	1,482
Apr	150	1,171
May	22	459
Jun	0	0
Jul	0	0
Aug	0	0
Sep	0	0
Oct	26	1,156
Nov	194	1,391
Dec	384	1,632

Similarly, peak cooling loads were calculated assuming typical operation at the Office Building, as shown in Table 13.

Table 13: eQuest peak cooling loads for during normal office operation

Month	Cooling Energy (MMBtu)	Maximum Cooling Load (kBtu/h)
Jan	0	0
Feb	0	0
Mar	0	0
Apr	0	0
May	77	1,488
Jun	226	1,936
Jul	247	1,725
Aug	291	1,712
Sep	89	1,516
Oct	22	1,538
Nov	0	0
Dec	0	0

Section 5
Energy Conservation Measures

ENERGY CONSERVATION MEASURES

ECMs were developed to support the Office Building in reducing overall energy consumption resulting in the reduction of heating and cooling loads in conjunction with design and construction of a GSHP system. In order to model energy consumption and calculate energy savings throughout the year, Microsoft Excel Bin analyses methods was performed for each measure, where appropriate. Of all the ECMs considered, seven had attractive payback periods, additional maintenance savings, or would be a reference for future projects when pricing becomes more reasonable. Project cost estimates were determined using manufacturer and distributor quotes as well as the 2020 RS Means handbook, with contingency added, as appropriate. Estimated accuracy of implementation costs is based on The Association for the Advancement of Cost Engineering's (AACE) Class 3 cost estimate. The expected accuracy range with a Class 3 cost estimate is between -10 percent and 30 percent of the calculated cost for implementation of each measure. A summary is provided in Table 14 below.

Table 14: ECM Summary Table

ECM #	Measure Description	Energy Saved (kWh)	Demand Saved (kW)	Fuel Savings (therms)	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback Period (years)	CO2e Reduction (tonnes)
1	Stairwell fin tube radiation adjustment	0	0.0	84	$78	$0	0	0.499
2	Replace CFL with LED	1,881	0.3	-36	$157	$502	3	0.254
3	Install control to reduce run time on EF-3	1,096	0.0	1,034	$1,153	$6,638	6	6.411
4	Install control to reduce run time on EF-5	6,127	0.7	0	$656	$3,361	5	1.523
5	Install VFD on AHU HW Loop Pump	6,282	0.0	0	$598	$8,907	15	1.526
6	Replace existing drive on AC-1 and convert to DCV	39,360	11.4	0	$4,252	$70,525	17	9.787
7	Convert AC-4 to VAV with DCV	22,372	0.0	421	$2,167	$101,885	47	8.062
8.a.1	Replace existing boilers	0	0.0	6,359	$5,938	$550,750[9]	93	37.750
8.b.1	Replace existing chiller	11,248	13.4	0	$7,520	$570,806	76	2.797
8b	GSHP System with Upgraded Chillers and Boilers	41,773	0.0	18,470	$20,942	$2,663,804[8]	127	120.035
9	Controls Upgrade	71,066	0.0	7,112	$12,277	$58,220	5	59.891
10	Building Envelope Upgrade	27,968	0.0	5,347	$7,211	$677,935	94	38.697

Notes:

1. Assuming average energy values of $0.07929/kWh (not including demand charges), demand value of $8.30/kW, and a natural gas value of $0.9338/therm from the most recent year of utility data.
2. There is not a summer peak demand savings for ECM8b but shoulder seasons provide savings.
3. ECMs were calculated independent of one another. Further measure interactions will be analyzed at the 60% design stage.
4. Project costs include NYPA CPC project implementation costs. Project costs were estimated using vendor quotes, driller quotes, and 2020 RS Means.
5. Refer to the Energy Conservation Measures section of the report for additional measure details.
6. The Simple Payback Periods were rounded to the nearest year in this Summary Table.
7. Currently available NYSERDA incentives of $279,600 were included in this cost. There is no guarantee that these incentives will be available.
8. Currently available NYSERDA incentives of $5,475 were included in this cost. There is no guarantee that these incentives will be available.

ECM 1: STAIRWELL FIN TUBE RADITIATION ADJUSTMENT

The northeast stairwell is heated by hot water fin tube radiation units located on the landings in between each floor. During the inspection it was noticed that the 6th floor was unnecessarily warmer than the floors below due to stratification. Most pedestrian traffic is through the elevators and the stairwells are not commonly used by staff. As each unit has a self-contained manual dial thermostatic control mounted on it, it is proposed to turn down the setpoints of units located on the upper floors. This is a no-cost measure so it can be done in small increments to test the changes and ensure satisfactory heating of all floors.

ECM 2: REPLACE CFLs WITH LEDs

Facility staff is in the process of upgrading the remaining CFL fixtures to LED technology. During the inspection a total of 32 can downlight fixtures were identified have 2 pin type CFL bulbs each. These 13W CFL lamps can easily be replaced by a comparable 8W LED lamp upon failure or before failure. No additional modifications to the fixture will be required. The calculations were completed assuming that all lamps were replaced at once.

ECM 3: INSTALL CONTROL TO REDUCE RUN TIME ON EF-2

EF-2 serves the 6th Floor Legislative Conference Room and is in operation even when meetings are not taking place. Since this fan is scheduled to run on a set schedule it is proposed to revise the schedule to make the existing occupied periods unoccupied which will be activated by ceiling mounted occupancy sensors within the space. Once the occupancy sensors are triggered, EF-2 will stay on for an hour from the last detected motion in the room. This will greatly reduce the amount of exhaust air from the space, saving on heating and cooling energy supplied from AC-5.

ECM 4: INSTALL CONTROL TO REDUCE RUN TIME ON EF-5

EF-5 serves the chiller vault in the basement to ventilate the space for safety. There is a refrigerant alarm in the space to alert the building engineer if there is a leak but the fan itself is manually controlled and currently kept in the ‘on’ position. The fan was found to be operating during the audit in heating season even though the chiller was not in use. If the fan is controlled by the refrigerant sensor instead of the manual switch, it will still be code compliant. The fan control integration into the refrigerant sensor will allow the fan to run only when a refrigerant leak is detected. Staff will still have the ability to override the fan control if work is being completed in the chiller vault. This retrofit will greatly reduce the ventilation within the space saving heating and cooling energy supplied from basement unit AC-3.

ECM 5: INSTALL VFD ON AHU HOT WATER LOOP PUMP

All AC units are served by the boiler by a hot water distribution loop, utilizing three-way control valves on the heating coils of the AC units. It is proposed to either convert the three-way valves to two-way valves or replace the three-way valves at each unit with a two-way valve and install a VFD on the HWP that serves the loop. The VFD will allow the pump to respond to unit demand based on system static pressure utilizing static regain controls. Due to the limited capabilities of the existing BMS system, the VFD will not be integrated into the system. It will be controlled locally at the panel, as required.

ECM 6: REPLACE EXISTING DRIVE ON AC-1 AND CONVERT TO DCV

AC-1 is the largest unit in the building and serves floors 1 through 5 except for the Vault areas. The outside air damper is maintained at 10 percent open during typical operation and only opens further when economizing. It is recommended to monitor CO2 through each floor's return air plenum and adjust outside air to maintain the minimum required by ASHRAE 62.1. This will allow for ventilation savings during early morning and evening periods when occupancy is typically at its lowest.
As the existing drive on AC-1 was installed to manually balance the supply air fan. It is sometimes adjusted by facility staff seasonally to accommodate changes in pressurization. It is recommended to replace this drive with a variable frequency drive which will be able to adjust based on the demand from each floor.

ECM 7: CONVERT AC-4 TO VAV WITH DCV

The vault area is served by AC-4 and typically has low occupancy due to the nature of the space. Each floor has its own dedicated supply air duct. It is recommended to retrofit the existing constant air volume (CAV) system to variable air volume (VAV) with additional DCV controls. This will allow the system to greatly reduce the volume of air it is currently delivering to the space which will reduce cooling and heating loads. Additionally, less ventilation air will require less dehumidification during the summer as well as less humidification in the winter.

ECM 8.a.1: REPLACE EXISTING BOILERS

The existing heating system is original to the Office Building's construction. Staff expressed interest in replacing the two existing boilers. Since these units are past their end of useful life, the baseline scenario for this ECM assumed replacement of the boilers with modular condensing boiler units. Modular condensing boilers are able to operate at a much higher efficiency than the existing boilers and would be more appropriately sized to the building load. This ECM assumed that the associated equipment like circulation pumps would be maintained but should be assessed for potential upgrades in design.

ECM 8.a.2: REPLACE EXISTING CHILLER

The existing chiller is approximately 15 years old but based on the buildings cooling appears to be oversized, therefore operates outside its optimal efficiency. As a result, the chiller was evaluated to be replaced with a high efficiency variable speed chiller. The savings for this ECM came from the increased efficiency of the new chiller but additional chiller plant optimization strategies should be assessed once in design. The other associated equipment like circulation pumps will be maintained but should also be assessed for potential upgrades in design.

ECM 8b: GSHP SYSTEM WITH UPGRADED CHILLERS AND BOILERS

GEOTHERMAL SAMPLE WELL AND TESTING RESULTS

The geothermal test well in the Ulster County Office Building parking lot was initiated on January 31, 2020 and completed on February 3, 2020. The test well was drilled to 126-feet at a diameter of 8 inches and to 499-feet at a diameter of 6 inches. The test loop piping utilized 1.25-inch DR11 high-density polyethylene (HDPE). The formation makeup at the test well site consisted of sand from 0 to 110-feet and gray shale from 110 to 499-feet. The grout mixture was composed of 100-pounds TG Lite, 32-pounds of PowerTEC, and 30-gallons of water.

After sufficient curing of the grout, the thermal conductivity (TC) test was completed for 70.3 hours to determine ground thermal properties. The TC test was performed by injecting a known and constant heat power into the borehole heat exchanger and measuring the temperature response of the surrounding formation. This method is used to determine the undisturbed formation ground temperature, the TC, the borehole thermal resistance, and an estimate of thermal diffusivity (TD). In the test borehole, an average heat flux of 20.1 W/ft was injected into the heat exchanger.

Geothermal Resource Technologies Inc. (GRTI) completed the analysis of the TC test results. The loop temperature and input heat rate data were plotted against the natural log of elapsed time are shown below in Figure *17*. The temperature versus time data was analyzed using the line source method in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 48 hours. The slope of the curve fit was found to be 3.69 which was then used to calculate the TC.

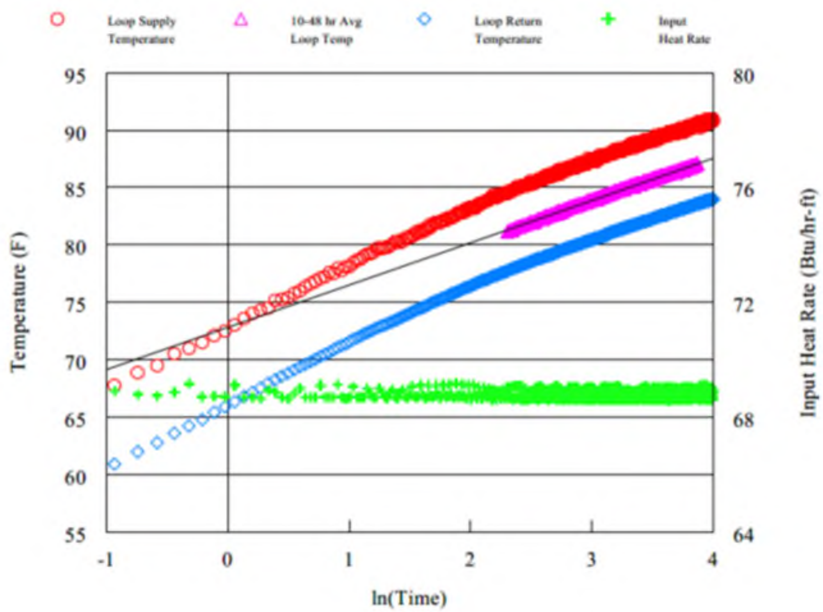


Figure 17: Thermal Conductivity Test Results

The resulting TC value of 1.49 Btu/hr-ft-°F calculated is considered average as the typical values range between 0.6 to 2.5 Btu/hr-ft-°F across the United States. A heat capacity value for shale was calculated from specific heat and density values for the formation. A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 30.8 Btu/ft^3 -°F . A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be 1.16 ft^2/day. TD is more of a determining factor than TC for the balance of heating and cooling loads. Results of the thermal conductivity test are shown in Table *15*.

Table 15: Thermal Conductivity Test Results

Parameter	Result	Unit
Thermal Conductivity	1.49	Btu/hr-ft-°F
Thermal Diffusivity	1.16	(ft^2/day)
Borehole Average Heat Capacity	30.8	Btu/ft^3-°F
Undisturbed Ground Temperature	54.3 - 55.5	°F

GEOTHERMAL SYSTEM CONCEPTUAL DESIGN

Based on the site area restrictions and the existing constraints of the parking lot area, it is recommended to implement a vertical, closed-loop U-bend geothermal heat exchanger system. Four types of vertical, closed-loop options were assessed as part of the preliminary design. The primary difference between each option was bore depth, piping configuration and or piping material. Each option was analyzed to understand the best thermal transfer efficiency with the least implementation cost, resulting in the best return on investment. These options offered a unique perspective on how the various combinations impacts the thermal efficiency and ultimately the quantity of bore holes required to meet a predetermined build heating and cooling load.

The four options analyzed were;

1. Single HDPE 1-1/4" U-Bend 499 foot depth: This is a typical option for vertical wells and does not require permitting due to the depth of the well. The test well was also drilled to 499 feet, so the well test results did not have to be extrapolated to estimate available resource. This option was selected due to cost, driller availability, and simplicity of the system.
2. Double 1-1/2" U-Bend 900 foot depth: This option utilizes a high-density polyethylene filled with highly conductive carbon-type nanoparticles which gives the material up to 75% higher thermal conductivity than the conventional HDPE option above. Since the material can improve drilling efficiency and provide additional savings over HDPE, it is proposed to drill to 900 feet which will require 21 bores which the parking lot can accommodate. The TD value used during analysis was conservative to account for any changes in thermal properties as the bore holes will be 400 feet deeper than the test well. It was ultimately not recommended due to the extrapolation in the available resource from the thermal conductivity report for the depth of the wells required, experienced drillers to install a system this depth, and the anticipated performance of the system.
3. Concentric 5"x3" Piping System - 1,610 foot depth: This option was analyzed as it would require only 11 bores. It was ultimately not recommended due to the extrapolation in the available resource from the thermal conductivity report for the depth of the wells required, experienced drillers to install a system this depth, and the anticipated performance of the system.
4. Concentric 7"x4" Piping System - 2,270 foot depth: This option was analyzed as it would require only 6 bores. It was ultimately not recommended due to the extrapolation in the available resource from the thermal conductivity report for the depth of the wells required, experienced drillers to install a system this depth, and the anticipated performance of the system.

There are four main types of geothermal configurations utilized for thermal heat transfer for the heating and cooling of commercial buildings, they are:

1. Vertical, closed loop system – vertical bore holes at varying depths utilizing u-bend piping in the bore hole connected by horizontal manifolds placed in horizontal trenches to connect the bore hole vertical piping system to the indoor mechanical systems. Since depth can be increased to accommodate additional load, less surface area is required for the bore field than other system types.
2. Horizontal, closed-loop system – horizontal piping which lays in shallow trenches connected by horizontal manifolds placed in the trenches to connect the bore field piping system to the indoor mechanical systems. As shallow trenches are cheaper than drilling vertical bore holes, a horizontal loop requires significantly more land area than is available at the Office Building.

3. Pond/lake, closed-loop system – thermal piping is submersed in a nearby body of water which is used as a thermal source and sink instead of the ground like Options 1 and 2. This is cheaper than the other options but was not considered for application at the Office Building due to the lack of access to a nearby body of water.
4. Open-loop system – instead of utilizing thermal piping to maintain a barrier between thermal sources and sinks like with the closed-loop systems, this system circulates the heat exchange fluid (typically water) that is already contained in the source. Expensive thermal piping is not required which saves on the initial capital cost for these project types and additional savings can be achieved using a surface body of water. This option was not considered at the Office Building as it requires the use of well or surface body water as the heat exchange fluid which is not available nearby the Office Building.

GEOTHERMAL DESIGN PARAMETERS

Due to the low amount of domestic hot water consumed on site the geothermal system will only be used to provide space conditioning for the building. The following table outlines the annual energy requirements of the building organized by heating and cooling. The system was sized using a combination of building demand and energy requirements so that the bore field would not be greatly oversized which would substantially increase the project cost and area required.

Table 16: Annual Building Energy Requirements

	Building Annual Cooling Requirement	Building Annual Heating Requirement
Space Conditioning Energy (kBtu)	1,129,481	2,498,473
Hot Water Generation Energy (kBtu)	---	0
Total Energy (kBtu)	1,129,481	2,498,473

Since the building is in a heating dominate climate, the ground energy will become unbalanced over time as more heat will be extracted from the ground then what is put back in. Due to this imbalance and cost of adding additional bores to only handle peak loads, a hybrid heat pump system is the most cost-effective arrangement to supplement peak loads and maintain bore field health. Due to the dominance of the heating season the hybrid arrangement will consist of two supplemental condensing hot water boilers which are sized to handle 20 percent of the load. The cooling season is not at risk for overheating the bore field as the cooling season is much shorter than the heating season, but during large cooling demands the bore field may have difficulty keeping up with peak cooling demand heat rejection capacity. As a result, it is proposed to use a cooling tower as a supplement for heat rejection during the cooling season which will work in conjunction with the bore field in the hybrid arrangement. Additional details about the operation of these systems during heating, cooling, and shoulder seasons are provided later in this report. The following table describes how the annual energy use requirements of the Office Building are distributed between the GSHP, boilers, and cooling tower. The net ground energy is negative as the amount of heat extracted from the ground during the heating season is greater than the amount deposited during the cooling season.

Based on the calculated loads for heating and cooling, and to maintain bore field health the geothermal heat exchange grid will be installed to maintain an average spacing between bores of 20.0 feet on-center (OC). It is proposed that boreholes be drilled to approximately 499 feet deep to maintain the design inlet water temperatures described above. Upon further review with GRTI, the estimated TD is conservative and will potentially decrease (improve) as depth is increased.

The system geometry consists of 12 rows, with 5 bores per row, totalling in 60 bores for the field. The average column to column spacing is 20.0 feet for a single u-bend configuration. The bores will have a total one way length of 29,940 feet. The bores will be 5 inches in diameter with and the high TC HDPE piping will have a nominal diameter of 1.25 inches.

Due to land availability at the Office Building the only location for the bore field is the asphalt parking lot. The parking lot's total footprint is approximately 20,000 square feet which most will be utilized for the 60 bores. Due to the layout of the parking lot, a symmetrical grid will be difficult to achieve but the 20-foot spacing will be maintained. Using the same method prior to drilling the test well, the proposed conceptual heat exchange grid layout is predicated on the existing location of underground utilities. The is a small tolerance for bore locations that can be adjusted within a few feet to accommodate interferences. An overflow area was identified if underground utilities or other restrictions require boreholes to be relocated outside of the tolerance area. A conceptual layout of the proposed geothermal heat exchange grid with 60 bores is shown in Figure *18*.

Figure 18: Heat Exchanger grid layout

The geothermal heat exchanger system selected was the single HDPE 1-1/4" U-Bend with 499-foot bores due to its cost, larger selection of available drillers, and simplicity of the system. To ensure that the geothermal heat exchanger design does not become too unbalanced, conservative spacing in the bore field was maintained based on industry standards. The system was designed based on the results of the thermal conductivity test and calculated heating and cooling loads which were estimated using a combination of eQuest building energy modelling software and spreadsheet calculations. Geothermal delivery supply water temperatures required for proper equipment operation and what the system design was predicated on are:

1. 40.0 degrees F minimum from the bore field to the heat recovery chillers in heating mode, and;
2. 80.0 degrees F maximum from the bore field to the heat recovery chillers in cooling mode.

The system design day was calculated first to compare the existing and proposed systems. It is the aggregated load for heating and cooling seasons including all constituent zones and hot water elements in the building. This is the loading profile for which the entire system is sized and is based on the worst-case season (heating or cooling) to ensure a conservative system design. The total capacity of the system is listed in the table below. Note that the existing heating capacity is for two boilers which are oversized and only at part load during peak conditions.

Table 17: Comparison of Existing and Proposed Systems

	Existing Cooling	Proposed Cooling	Existing Heating	Proposed Heating
Total Capacity (kBtuh)	3,600.0	2,050.4	7,114.0	1,745.0
Efficiency	0.582 IPLV (est.)	18.9 EER	80% (est.)	2.7 COP
Demand (kW)	180.1	108.2	<10	175.4

The circulating fluid for the loop would be 25 percent propylene glycol which gives the mixture a freezing temperature of approximately 14 degrees F. The system controls will ensure that the loop is kept above the freezing temperature. After system models were completed, final operating temperatures and flowrates for the system were established. Since the interior building loop is separated from the exterior loop, flows can be different based on demand within the building which can also save pump energy. Over a 5-year analysis period the long term soil temperatures will reach equilibrium temperature of 54.7 degrees F between the heating and cooling seasons. Temperature penalty describes the change in the deep earth temperature immediately surrounding the installed bore field after extended periods of system operation.

Table 18: Design Day Ground Loop Temperatures

Cooling Mode	Heating Mode
Unit Inlet 80.8 °F	Unit Inlet 41.6 °F
Unit Outlet 90.2 °F	Unit Outlet 36.6 °F

Calculations for peak flow were based on a block flow of 3 gpm per ton. The total bore field flow was calculated using the flow per path for 60 bores, with one path entering the bore field and one path leaving, for a total of 120 paths. Using the velocity and pipe characteristics, the head loss of the bore field was calculated to appropriately size the geoexchange source/sink pump located on the supply side loop. Operational system pressures in the heat exchanger loop will be between 20 and 30 psi and utilize a heat exchanger fluid with a mixture of 25 percent propylene glycol and 75 percent deionized or distilled water.

CONSIDERATIONS FOR MECHANICAL EQUIPMENT

Multiple layout options for new mechanical equipment were evaluated to be in either the existing mechanical space or in a new dedicated mechanical space located on the ground level outside. After evaluation, it was concluded that the new mechanical equipment will fit in the existing mechanical space in the basement. The proposed magnetic bearing chiller will be installed in the existing chiller vault. Since the existing chiller vault is located under the front lawn, it will be excavated so it can be easily removed in one piece. Once all the large equipment is removed through the opening, all new mechanical equipment will be lowered into the basement including the new chiller and other large equipment.

BUILDING SYSTEM DESCRIPTION

The exterior heat exchange loops from the bore field will enter the building on the southwest side of the building into the existing chiller vault. The manifold will tie together the multiple loops and will be constructed for a low head design to reduce pump energy. The manifold will consist of digital temperature sensors, flow meters to assist in system balancing, and shut off valves. Specific manifold will be detailed during the 60 percent design. The existing HW and CHW piping systems serving the AC units and boilers will be re-piped as required to accommodate the new piping configuration for the heat pump system and will be sized to minimize system head loss The new piping system will connect to the HW and CHW piping systems that leaves the mechanical room to serve the building will be maintained to reduce project cost.

The existing 300-ton chiller will be removed from the vault as it is being replaced with a new magnetic bearing (mag) chiller with heat recovery as a part of the new heat pump system. The associated chilled water pumps will be replaced from the adjacent space as well. In order to add supplemental heat rejection to the system, the current open evaporative cooling tower (the cooling tower is not adequate for this service) will be replaced with a closed-circuit cooling tower. This will provide a closed loop and not allow the condenser water loop to be exposed to the atmosphere. The intent is to utilize the associated condenser water pumps as a part of the hybrid system configuration.
Through preliminary sizing based on dimensions known at this stage, the vault will be able to house the equipment listed below.

Table 19: Chiller Vault New Equipment List

Type	Quantity	Make	Size
GSHP Manifold	1	TBD	TBD
Centrifugal Mag Bearing Chiller	1	TBD	200-tons

The remainder of the large equipment as noted below will be installed in the basement of the building after the existing 3,350 MBH boilers are removed. For the purposes of this 30 percent design, the proposed equipment will not require an expansion of the existing electric service as new equipment size is comparable.

Table 20: Remaining Basement Mechanical Room Equipment

Type	Quantity	Make	Size
Heat Pump Scroll Chiller	1	TBD	40-tons
Chiller Pumps	4	TBD	Varies
Pumps	4	TBD	Varies
Condensing Boilers	2	Camus	800 MBH
Boiler Pumps	2	TBD	TBD

Table 21: Design Chiller Heat Pump Inlet Load Temperatures

Cooling Mode (WB)	Heating Mode (DB)
Water to Air 67 °F	Water to Air 70 °F
Water to Water 55 °F	Water to Water 100 °F

The existing fan coil units (FCUs) and perimeter fin tube radiation (FTR) throughout the building are designed to utilize 180 degree F water to maintain temperature during a design heating day. As a result, these units will be maintained and will be on a 180 degree F hot water loop supplied by the supplemental condensing gas boilers during the heating season. The geothermal system itself is only capable of producing a maximum of 130-degree F water. The existing AC Units heating coils are designed to utilize 180 degree F hot water during the heating season and the cooling coils are designed to utilize 45-50 degree F chilled water during the cooling season to temper the AHU supply air to the spaces. Therefore, the heating coils do not have enough heating capacity at the lower heat pump loop temperature of 135 degree F. As a result, and to minimise system capital cost, the cooling coils will be re-piped for changeover duty so they can be used during the heating season for the low temperature hot water. This will expand the heat coil capacity and will work in conjunction with the existing hot water coils in the AHUs. Then during the cooling season, the cooling coils will be used for cooling service. As there was limited data available for the existing AC Units, airflows were estimated using coil temperature rise, and terminal unit airflow data.

SEASONAL OPERATION

OVERVIEW

The outdoor air temperature and the heating or cooling requirement of the building will determine if the GSHP system is either in the heating mode, cooling mode or simultaneous (heating and cooling) mode. The HVAC water side systems sequence of operation (SOO) will include a revised SOO for the core heating and cooling infrastructure which includes operation of the new GSHP system and integration into the existing hot water boiler and chilled water systems. The detailed SOO will need to be further developed and will be included as part of the 60 percent design documents.

The current water side operation of the buildings end terminal devices such as FTR, FCUs and Zone Cooling Coils will not change and will continue to be controlled as is by the existing controls and thermostats.

The HVAC's air side systems distribution and control will remain the same as is currently controlled. All outside air dampers on the AC units will be maintained under current sequencing based on building occupancy schedule. There may be minor adjustments in the control strategy as a result of the integration of the new GSHP system into the existing HVAC system.

HEATING SEASON

Based on an outdoor air temperature (OAT) of 50 degF +/- the GSHP will in a predominantly heating mode, where the new gas fired condensing boilers will be energized developing HW to serve the buildings FTR and FCU system on each floor. Based on the internal building temperature, the AC Units will be supplying 90 degree F +/- supply air to each floor. The GSHP will be in full heat mode, where heat will be extracted from the ground at a temperature of 36.6 degree F and distributed to the chiller heat recovery unit where the heat pump supply water temperature will be increased to the optimal temperature (max of 135 degree F) and distributed to each AC Unit coils. In this mode the AC Units heating and cooling coils will be used for heating the return air to the desired temperature based on the building requirements. energized and the heating or cooling requirement of the building. As the OAT drops to below 15 degree F +/- the heating requirements of the building will increase to the point where the new condensing boiler will not only provide 180 degree F HW for the FTR, etc, but also will supplement the heat pump loop to maintain a loop temperature of around 135 degree F to the AHU's as the bore field will not be able to maintain the required loop temperature required for heating. The 180 degree F heating loop will be on a temperature reset schedule, where the loop temp will be set on a sliding scale proportional to a corresponding OAT.

TRANSITIONAL OPERATION (HEATING & COOLING) – SHOULDER SEASON

As the season changes from Winter to Summer, the OAT rises and/or the buildings internal heat load increases there will be a need to provide both heating and cooling at the same time. In this scenario, there will be a small chiller that will be energized that provides chilled water to the cooling loop while the heat pump loop is still in the heating mode along with the 180 degree F loop which will allow for both heating and cooling to occur at the same time.

As the season changes from Summer to Winter, the OAT decreases and/or the buildings internal heat load decreases there will be a need to provide both heating and cooling at the same time. In this scenario, the main chiller will be deenergized and the small chiller will be energized to provide chilled water to the cooling loop which will allow for both heating and cooling to occur at the same time. The heat pump loop will operate in heating mode along with the 180 degree F loop for FTR operation.

COOLING SEASON

As the OAT rises above 65 degree F +/- and becomes a cooling only operation, the heating boilers are deenergized and the chiller generates chilled water a distributes to the AC Units cooling coil and interior zone cooling coils to maintain zone cooling setpoints. The heat from the chiller condenser is rejected to the GSHP loop which is maintained at 90.2 degree F and rejected to the ground through the bore field. In this mode, the control strategy is more in-line with a traditional chilled water system, except heat is rejected to the ground as opposed to the evaporative cooling tower. The one caveat to this is that we have incorporated a closed-circuit cooler (replaces the open cooling tower), where this will be used for heat rejection during peak cooling design periods working in parallel with the GSHP heat rejection system. This strategy will reduce the bore field heat saturation over the course of the cooling season.

DETAILED COST ESTIMATE

Material costs were estimated to +/- 20% based on vendor quotes and 2020 RS Means and labor costs were estimated as a percentage of the material cost. Separate cost estimates were provided for the GSHP system's source-side and supply-side. On the source-side cost estimates were provided for drilling 60 boreholes to 499-feet deep, casing for each borehole, all associated HDPE looping, grouting for each borehole, and tie-in of all boreholes together and tie-in to the mechanical equipment. Additional costs were estimated for excavation and trenching as well as pumps to pump the heat exchange fluid.

On the supply-side cost estimates were provided for the installation of two new high temp heat pump units with a heat pump coil for the chilled water or hot water operation as well as pumps to circulate the chilled water or hot water between the AHUs and the heat pumps. Based on existing loads and capacity of the GSHP loop, preliminary estimates determined that the installation of one 200-ton magnetic bearing multi-stack chiller, one 40-ton multi-stack scroll heat pump chiller, and a closed circuit cooling tower would meet the cooling loads of the Building. Additionally, two 800 MBH condensing boilers would meet the heating loads of the Building. An adder for a new mechanical space to house new equipment was included in the implementation cost, but based on the existing mechanical room layout, it appears use of the existing mechanical could be viable (see Mechanical Room Plan).

Including all required work for the GSHP measure (ECM 8b), the final cost per well for 60 wells is $47,886. Costs were estimated using a combination of driller and vendor estimates as well as RS Means.

Table 22: ECM8b - GSHP Summary

Summary of Estimated System Costs	
Source-Side	$ 820,000
Supply-Side	$ 813,144
Demolition	$ 95,000
Total	$ 1,728,144
% Markup	10%
Project Cost	$ 1,900,958
Net Project Cost*	**$ 2,873,187**
Cost/Well	**$ 47,886**

*Note: Net Project Cost includes all NYPA CPC costs, before financing

LIFE CYCLE COST ANALYSIS

A 20-year life-cycle cost analysis (LCCA) was completed by NYPA and is included here for reference. The LCCA compared the base case ECMs 8.a.1 – Boilers and 8.a.2 – Chillers to the alternative ECM 8.b. – GSHP. This analysis assumed that the boilers in ECM 8.a.1 were replaced immediately at Year 0, and the chillers would be replaced at Year 10 (assumes 10 years of useful life remaining). ECM 8.b.1 was assumed to be fully installed at Year 0 and there would no major component replacements over the 20-year analysis period. The energy cost was escalated at based on the Energy Information Administration's (EIA) energy price projects for NYS over the 20-year period. The BLCC analysis uses a 2.5% discount rate provided by the Federal Energy Management Program (FEMP) to account for inflation for renewable energy projects. The analysis also uses a variable energy escalation rate provided by the Department of Energy (DOE). There were no operation and maintenance (O&M) savings credited in the analysis, assuming that comparable O&M is required in the base case and alternate scenarios. Due to the substantially higher initial capital cost of the GSHP and low cost of natural gas, the total present value life-cycle cost was negative $242,176.

	Base Case	Alternative	Savings from Alternative
Initial Investment Costs Paid By Agency:			
Capital Requirements as of Base Date	$985,795	$3,456,022	-$2,470,227
Future Costs:			
Recurring and Non-Recurring Contract Costs	$0	$0	$0
Energy Consumption Costs	$1,392,236	$1,155,660	$236,576
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	-$77,529	-$2,069,004	$1,991,475
	------------	------------	------------
Subtotal (for Future Cost Items)	$1,314,707	-$913,344	$2,228,051
	------------	------------	------------
Total PV Life-Cycle Cost	$2,300,503	$2,542,678	-$242,176

Figure 19: Life Cycle Comparison of Present-Value Costs

ECM 9: CONTROLS OPTIMIZATION

Original commissioning documentation could not be obtained, and it is uncertain if commissioning was originally completed for the Office Building. If the hybrid GSHP system is installed, the entire system will be commissioned to ensure that is functioning according to the design intent. If it is decided to not proceed with the hybrid GSHP system, it is still recommended to optimize the existing controls and retro-commission the existing building systems for the following reasons:

- Energy savings
- Restoring equipment function to original operation
- Reduction of occupant complaints
- Increased equipment life
- Improved indoor air quality
- Updated O&M requirements

This will also result in an updated baseline for the Office Building's operation that can be utilized for ongoing commissioning as well as future energy audit and design projects. Energy savings and cost estimates for this measure were based on studies completed by ASHRAE, PNNL, and Energy Star using a dollar per square foot metric.

ECM 10: BUILDING ENVELOPE UPGRADE

Due to the Building's curtain wall construction, maintaining comfort within the building around the perimeter is difficult due to the high conductive heat losses and gains due to thermal bridging through the aluminum framing and high infiltration rates. The windows are single pane with insulated glazing and have not been upgraded since the original construction. It is proposed to install a curtainwall retrofit window system that will reduce convective and conductive heat transfer from the windows. This type of system was selected due to its simplicity to install and lower capital cost compared to completely overhauling the existing envelope. The system can be installed during normal operating hours with minimal disruption to daily activities and does not change the exterior appearance of the building as it is installed from the inside. Although this will not solve all the comfort issues reported by staff, it will reduce them along with reducing the heating and cooling loads served by mechanical equipment.

Section 6
Next Steps

REVIEWED BUT NOT RECOMMENDED CAPITAL IMPROVEMENTS

A number of potential ECMs were not currently recommended due to high cost, low savings, or installation difficulty.

IMP 1: BUILDING LIGHTING CONTROL RETROFIT

The common area hallway lighting for each floor is integrated into the building's security system. The security system is deactivated at 6AM turning the lights on and deactivated at midnight turning all of the lights off. If the system is deactivated at any point after midnight, it forces all of the common area lighting back on in the building no matter what floor the individual is accessing. It is proposed to install an occupancy sensor control at the light panel relay of each floor so that the fixtures are energized only when an occupant is present. The length of time that the fixtures stay active during occupied periods can be adjusted so they do not turn off prematurely. This will also allow the light schedule to be adjusted to an earlier time as there is infrequent occupancy on most floors after typical business hours. However, due to the high cost of replacement and a recent LED fixture retrofit, this measure is not recommended for implementation.

IMP 2: STAIRWELL LIGHT SENSOR RETROFIT

There are two linear LED fixtures per floor, one at the floor entrance and the other at the landing between floors. To comply with lighting code, these fixtures are energized 24/7 for emergency egress purposes. A minimum level of illumination can be maintained with once fixture energized at a time during unoccupied periods of time. It is proposed to install an occupancy sensor on the landing fixtures to deenergize them when the building is unoccupied. The fixtures at the floor level will remain unchanged. However, due to the high cost of replacement and a recent LED fixture retrofit, this measure is not recommended for implementation.

IMP 3: FRONT ENTRANCE VESTIBULE MODIFICATIONS

The front entrance experiences a high volume of foot traffic as it is the main entrance for the DMV. There are two sets of double swinging doors to enter the vestibule and an additional two sets to enter the lobby. It was reported by facility staff that the outermost doors are frequently damaged due to wind and have difficulties closing, allowing more air into the vestibule. Additionally, the three supply air diffusers from AC-2 are located on the floor of the vestibule in between the doors and the four return air registers are located toward the ceiling on the opposite side. It is proposed to reconfigure the supply air diffusers so that they are above the doors to act as an air curtain to keep unconditioned air from entering the vestibule. The existing diffusers will have to be replaced for an option that will increase the velocity and direct the supply air appropriately.

Due to the cost of this measure it was not recommended for implementation. Any modifications to these areas should be completed to satisfy occupant comfort and O&M purposes. Other modifications such as revolving doors were investigated but are not recommended due to the expense as well.

IMP 4: REAR ENTRANCE AIR CURTAIN

The rear entrance has a small vestibule with double automatic sliding doors on each end. Since they are timed to close, they are often both open at the same time as the vestibule is short. This allows outside air to enter the building. Outside air infiltrates at a faster rate when the front doors are open at the same time. To counteract this, air curtains should be installed above the sliding doors to reduce the amount of infiltration.

Like the front vestibule, this measure is cost and savings prohibitive. Other modifications such as revolving doors were investigated but are not recommended due to the expense as well.

IMP 5: INSTALL VFD ON CHILLED WATER PUMP

All AC units are served by the chiller via a chilled water loop and three-way valves. It is proposed to replace the three-way valves at each unit with a two-way valve and install a VFD on the CHWP that serves the loop. The VFD will allow the pump to respond to unit demand based on system pressure. The chiller manufacturer was contacted in order to assess the required pressure and flows in the evaporator of the unit. There was only a small amount of room to reduce the flow and the chiller already has VSD capability. Due to these reasons, the pump turn down using a VFD would be minimal thus the savings would be minimal.

BEST PRACTICE OPPORTUNITIES

REPLACE AC-4 STEAM GENERATORS WITH ULTRASONIC TECHNOLOGY

The existing electric steam generators on AC-4 are not active as there are issues with over humidifying the vault spaces. Instead, the humidity can float during the winter as less humidity is preferred compared to too much. It is proposed that the existing steam generators be removed and that ultrasonic humidifiers be installed in each floor of the vault. It is recommended that these units be supplied with deionized water to reduce future O&M cost but at a higher initial cost. These units will allow for humidity to be controlled independently within each space which can differ based on occupancy and stratification at the common stairwell. Since the steam generators are not currently in operation, there will be no energy savings for this measure, and it is considered a best practice.

Manufacturers report that ultrasonic humidifiers use as little as 1/10th the energy of comparable steam generators.

AC UNIT SCHEDULE REVISIONS

The AC units have an occupied schedule from 6AM to midnight during weekdays and it was reported that county staff sometimes occupy the facility during the evening hours. It is recommended to take a work hour survey of all employees to judge if schedule revisions can be implemented. Since this is a no cost ECM, any revisions to the building schedules will result in immediate energy savings.

ROOF REPLACEMENT

Funding has also been secured to replace the roof which is original to the building. It is recommended to consider any upgrading the roof type at this stage as it will be cost prohibitive to retrofit before the next future replacement. All components of the roof should be inspected, and insulation should potentially be replaced.

COMPRESSED AIR

The existing air compressor serving the pneumatic controls is past the end of its useful life and should be replace as a part of a future capital cost project. The associated air dryer was replaced recently. Additionally, staff should use ultrasonic leak detection equipment to tag the location of compressed air leaks. Regularly checking for and repairing leaks located within the compressed air system can provide electricity savings and reduce operation of the air compressors. Lower compressor operation also results in lower maintenance costs.

TURN OFF COMPUTER EQUIPMENT OVERNIGHT

If computers are left on overnight, they will continue to draw power. The Office Building can utilize the built-in Task Scheduler program on Microsoft Windows computers to set up a daily repeating task of shutting down the computer overnight. This will reduce the overnight phantom load as well as reduce the run time of the computer, resulting in less wear-and-tear on computer components.

MAINTAIN CLEAN AIR FILTERS AND INTAKES

Regularly cleaning the intake screen and providing clean filters to each AC unit could reduce the overall system pressure drop and decrease the load on the supply fans.

Section 7
Measurement and Verification Procedure

MEASUREMENT AND VERIFICIATION PROCEDURE

Measurement and verification for GSHP systems is recommend to use Option D—Calibrated Computer Simulation in the "M&V Guidelines: Measurement and Verification for Performance-Based Contracts". Option D recommends the use of computer simulation software to establish baseline energy consumption of the existing facility's operation by calibrating model outputs with monthly utility data. A separate simulation with the GSHP retrofit measure can be completed to establish energy savings compared to the existing baseline. The GSHP simulation should be calibrated with spot measurements of equipment during the performance period to ensure that actual operating parameters conform to the original design operating parameters. If the actual operation differs from the design operation, the GSHP simulation should be adjusted to reflect actual operation. Example of spot measurements to be logged during the performance period attempt to ascertain equipment efficiency, system performance, and bore field performance and might include:

1. Water temperatures entering and leaving the heat pump
2. Ambient outdoor temperature
3. Supply and return load water temperatures for water-to-water GSHP systems
4. Heat pump unit input kW

Section 8
Energy Analysis Methodology

ENERGY ANALYSIS METHODOLOGY

The basic methodology behind the energy analysis in this report follows the following steps.

1. Annual bills were reviewed and aggregated into a final number. This number was compared with similar building types to understand the relative efficiency of the building. The monthly use was plotted for the two years to understand annual trends. As there were no major anomalies identified, the utility bills were an accurate means of annual energy consumption for the Office Building.
2. Electric and natural gas utility bills were disaggregated through equipment runtime estimation. Lighting counts and runtime were used to establish lighting use. Hot water heating consumption was determined as the sole source of natural gas consumption onsite. Office equipment was counted and noted for utilization during the energy audit to develop use estimates.
3. ECMs savings were then developed through Microsoft Excel® Bin Analysis, percentage-based estimates, and equipment literature. ECM savings were then vetted by comparing them to disaggregated energy use by system and adjusted if necessary, to provide a reliable result.

Appendix A

Project #:	30040573					
Project Name:	Ulster County Office Building					
Engineer:	Arcadis Consulting					
Measure:	Proposed Chiller Design to Alternate Chiller Design					
Alternate Design:						
Location:	**Description:**	**Qty:**	**Material:**	**Labor:**	**Unit Price:**	**Ext. Price:**
Supply-Side	200-ton Mag Bearing Multi-Stack Chiller	1	$264,000.00	$ 79,200.00	$343,200.00	$343,200.00
Supply-Side	40-ton Multi-Stack VME Scroll Heat Pump Chiller	1	$106,500.00	$ 31,950.00	$138,450.00	$138,450.00
					Total Cost:	$481,650.00
					Mark-Up 10%	$ 48,165.00
					Project Cost:	$529,815.00

Ground Loop Design

Borehole Design Project Report - 7/2/2020

Project Name:	**Ulster County Office Bldg**		
Designer Name:	Brian Urlaub		
Date:	7/1/2020	**Project Start Date:**	7/1/2020
Client Name:	**Arcadis**		
Address Line 1:			
Address Line 2:			
City:		**Phone:**	
State:		**Fax:**	
Zip:		**Email:**	

Calculation Results

Design Method: ***Design Day***	**COOLING**	**HEATING**
Total Bore Length (ft):	**29940.0**	**29940.0**
Borehole Number:	**60**	**60**
Borehole Length (ft):	**499.0**	**499.0**
Ground Temperature Change (°F):	**-0.3**	**-0.3**
Unit Inlet (°F):	**80.8**	**41.6**
Unit Outlet (°F):	**90.2**	**36.6**
Total Unit Capacity (kBtu/Hr):	**2050.4**	**1745.0**
Peak Load (kBtu/Hr):	**2050.4**	**1643.2**
Peak Demand (kW):	**108.2**	**175.4**
Heat Pump EER/COP:	**18.9**	**2.7**
System EER/COP:	**18.9**	**2.7**
System Flow Rate (gpm):	**512.6**	**410.8**

Input Parameters

Fluid		**Soil**	
Flow Rate	3.0 gpm/ton	Ground Temperature:	55.0 °F
Fluid:	25.0% Propylene Glycol	Thermal Conductivity:	1.49 Btu/(h*ft*°F)
Specific Heat (Cp):	1.01 Btu/(°F*lbm)	Thermal Diffusivity:	1.16 ft^2/day
Density (rho):	62.4 lb/ft^3		

Piping

Pipe Type:	1 1/4 in. (32 mm)
Flow Type:	Turbulent - SDR11
Pipe Resistance:	0.104 h*ft*°F/Btu
U-Tube Configuration:	Single
Radial Pipe Placement:	Average
Borehole Diameter:	5.00 in
Grout Thermal Conductivity:	1.20 Btu/(h*ft*°F)
Borehole Thermal Resistance:	0.198 h*ft*°F/Btu

Input Parameters (Cont.)

Pattern		Modeling Time Period	
Vertical Grid Arrangement:	12 x 5		
Borehole Number:	60	Prediction Time:	5.0 years
Borehole Separation:	20.0 ft	Long Term Soil Temperatures:	
Bores Per Circuit	1	*Cooling:*	54.7 °F
Fixed Length Mode	On	*Heating:*	54.7 °F
Grid File	None		

Default Heat Pumps

Manufacturer: Chillit Chillers LLC
C6H-40T Series

Design Heat Pump Inlet Load Temperatures:

	Cooling (WB)	*Heating (DB)*
Water to Air:	67 °F	70 °F
Water to Water:	55 °F	100 °F

Optional Hybrid Loads

	Cooling	Heating
Geo Peak (%)	80%	79%
Geo Total (%)	80%	79%
Hybrid Peak (%)	20%	21%
Hybrid Total (%)	20%	21%

Extra kW

Pump Power	0.0 kW
Cooling Tower Pump:	0.0 kW
Cooling Tower Fan:	0.0 kW
Additional Power	0.0 kW

Loads File

Ulster Co Load Profile 7.1.20.zon

Loads

Design Day Loads

Time of Day	*Heat Gains (kBtu/Hr)*	*Heat Losses (kBtu/Hr)*
8 a.m. - Noon	27.7	1643.2
Noon - 4 p.m.	2050.4	691.7
4 p.m. - 8 p.m.	27.7	691.7
8 p.m. - 8 a.m.	27.7	691.7

Annual Equivalent Full-Load Hours
COOLING 551 *HEATING* 1520

Days Occupied per Week: 5.0

Monthly Loads on Next Page

Monthly Loads Data

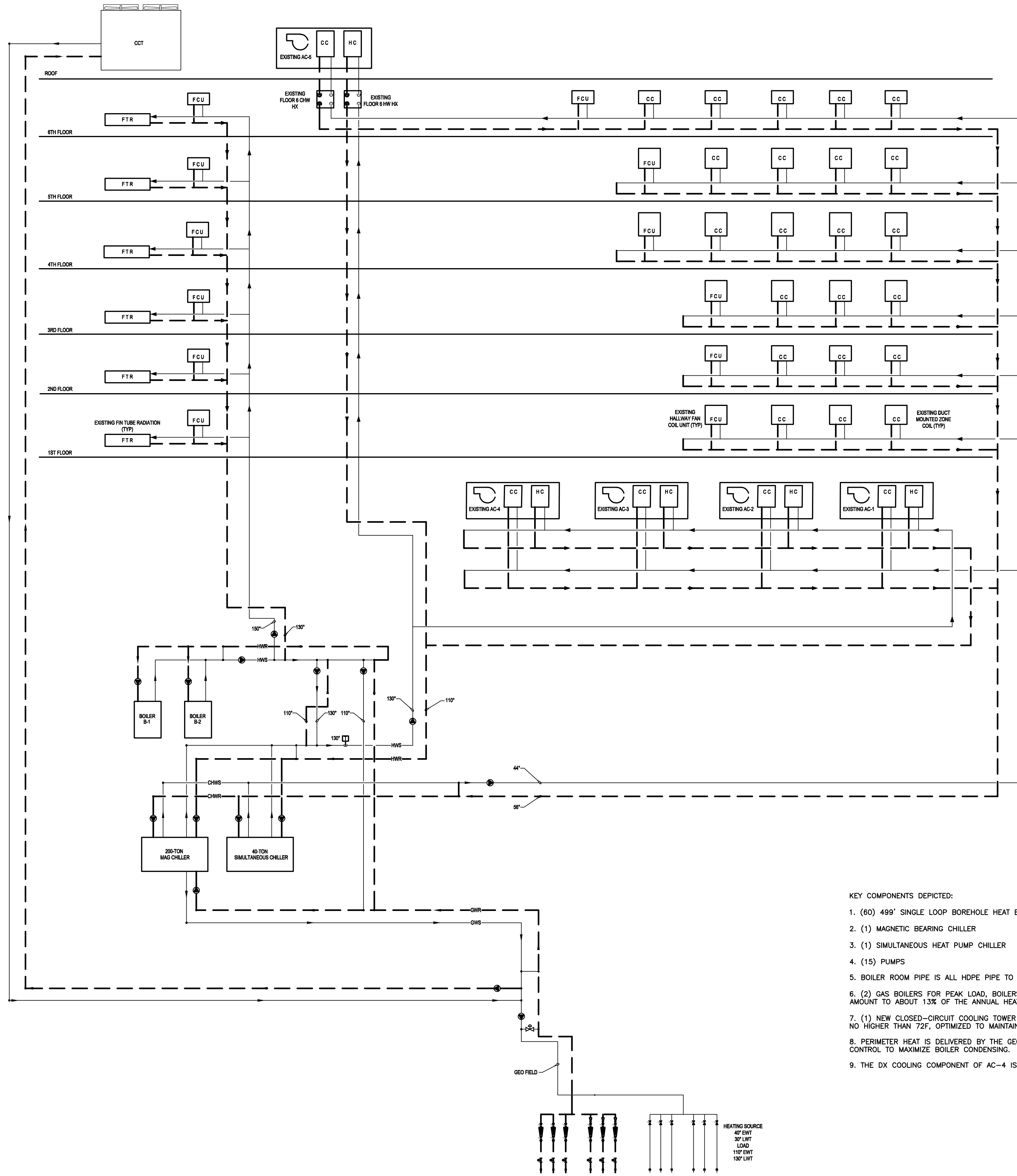
	Cooling		Heating	
	Total (kBtu)	Peak (kBtu/hr)	Total (kBtu)	Peak (kBtu/hr)
January	0	0	542533	1643
February	0	0	451165	1643
March	0	0	379697	1292
April	0	0	245760	989
May	106334	1874	43839	628
June	259331	2050	0	0
July	282596	2050	0	0
August	317724	2050	0	0
September	128110	1992	0	0
October	35386	1936	90547	1283
November	0	0	304595	1125
December	0	0	440337	1643
Total	**1129481**		**2498473**	
Hours at Peak		**3.0**		**3.0**

Hourly Loads Data

Included: None

Filename: None

PRELIMINARY DESIGN - SUBJECT TO CHANGE



KEY COMPONENTS DEPICTED:

1. (60) 499' SINGLE LOOP BOREHOLE HEAT EXCHANGERS
2. (1) MAGNETIC BEARING CHILLER
3. (1) SIMULTANEOUS HEAT PUMP CHILLER
4. (15) PUMPS
5. BOILER ROOM PIPE IS ALL HDPE PIPE TO ALLOW LARGER PIPE SIZES WITH LOWER PUMP HEAD LOSS. LONG LIFE LOW MAINTENANCE PIPING.
6. (2) GAS BOILERS FOR PEAK LOAD, BOILERS ARE INTENDED TO REMOVE ABOUT 20% OF THE PEAK MBH HEATING REQUIREMENT, BUT OPERATION SHOULD ONLY AMOUNT TO ABOUT 13% OF THE ANNUAL HEATING ENERGY DUE TO THE LOW BIN HOURS OF OPERATION.
7. (1) NEW CLOSED-CIRCUIT COOLING TOWER IS EMPLOYED IN A HYBRID CONFIGURATION TO KEEP GROUND WATER MAXIMUM HEAT TO AN EWT AT THE CHILLERS NO HIGHER THAN 72F, OPTIMIZED TO MAINTAIN 65F EWT UNDER MOST CONDITIONS.
8. PERIMETER HEAT IS DELIVERED BY THE GEOEXCHANGE SYSTEM DOWN TO ABOUT 29F OUTSIDE THEN SWITCHED OF TO BOILERS WITH AN OUTDOOR RESET CONTROL TO MAXIMIZE BOILER CONDENSING.
9. THE DX COOLING COMPONENT OF AC-4 IS A REDUNDANT BACK UP COOLING SYSTEM AND SHALL BE MAINTAINED.

ARCADIS

LEGAL ENTITY:
ARCADIS U.S., INC.

CONSULTANTS

SEALS

**30% SUBMITTAL
DO NOT USE FOR
CONSTRUCTION**

KINGSTON, NY
ULSTER COUNTY

GEOTHERMAL CLEAN ENERGY CHALLENGE STAGE 3 REPORT FOR ULSTER COUNTY OFFICE BUILDING

ARCADIS PROJ. NO. 30040573

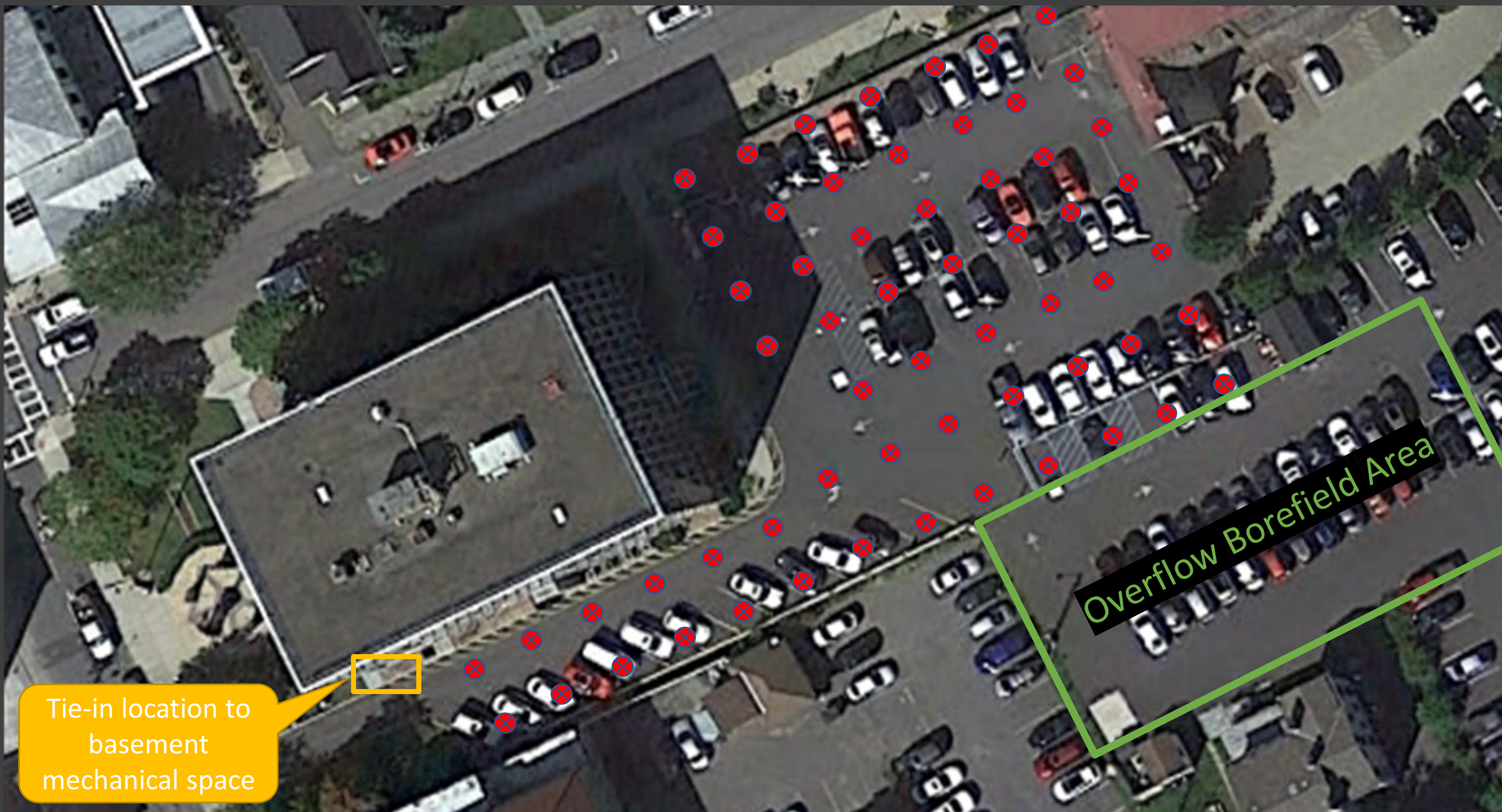
NO.	DATE	ISSUED FOR	BY

DATE: JULY 2020
PROJECT NO.: 30040573
FILE NAME: ULSTER GSHP ONE-LINE
DESIGNED BY:
DRAWN BY:
CHECKED BY:

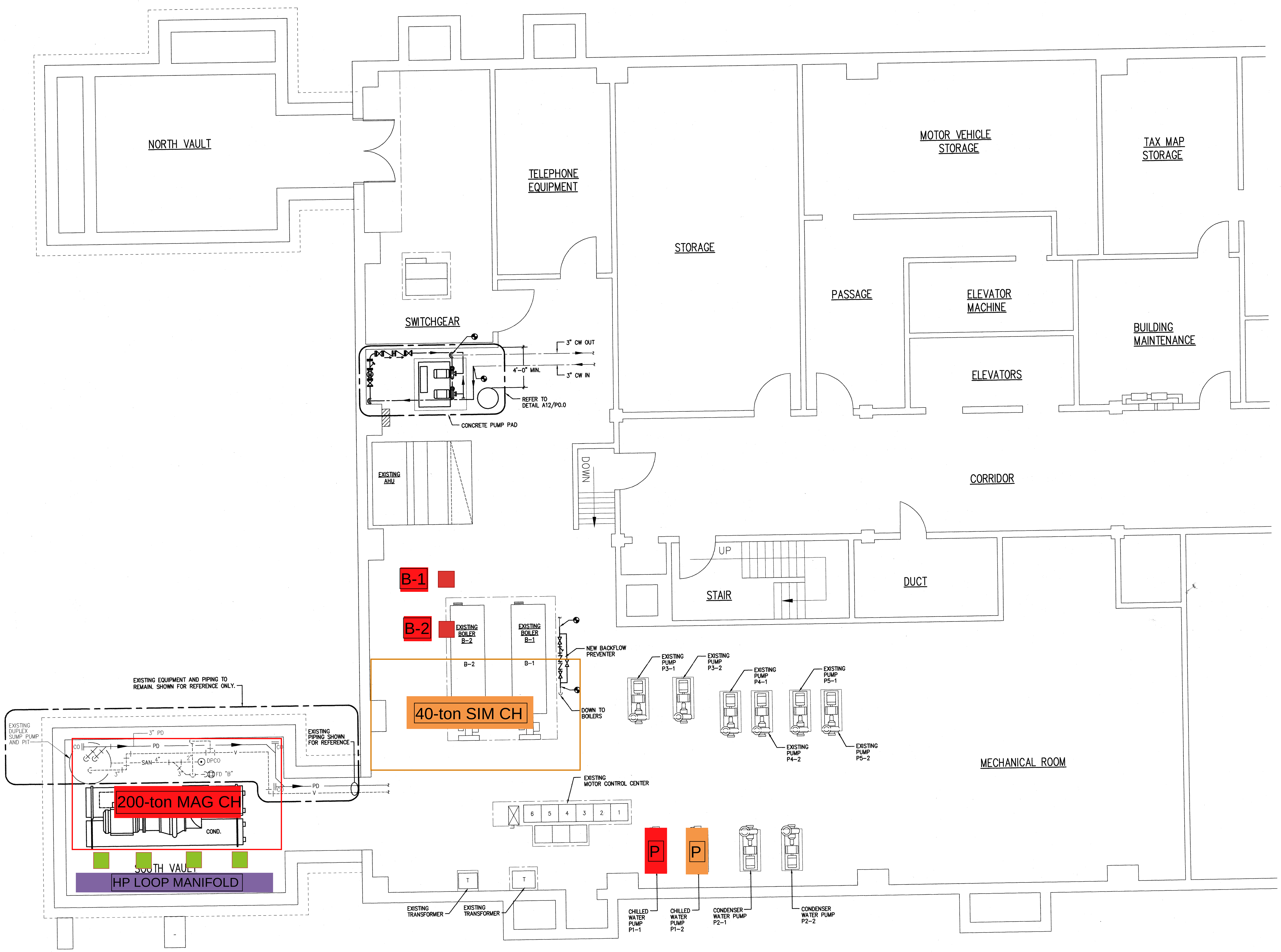
SHEET TITLE

SCALE: NO SCALE

SHEET ______ OF XXX


Overflow Borefield Area
Tie-in location to basement mechanical space

TENTATIVE MECHANICAL ROOM EQUIPMENT LAYOUT



A1/P1.0 *PLUMBING PIPING BASEMENT PLAN*

SCALE: 1/4"=1'-0"

IT IS A VIOLATION OF THE LAW FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DRAWING IN ANY WAY. ALTERATIONS MUST HAVE THE SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

CONTRACTOR SHALL VERIFY ALL DIMENSIONS AT SITE. UNAUTHORIZED ALTERATIONS OR ADDITIONS TO THIS DOCUMENT IS A VIOLATION OF THE NEW YORK STATE EDUCATION LAW.

No.	REVISIONS/SUBMISSIONS	Date

0 1" 2" 3"

ULSTER COUNTY OFFICE BUILDING
CHILLER REPLACEMENT
244 FAIR STREET
KINGSTON, NEW YORK

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KENNETH HEWES BARRICKLO ARCHITECT, P.C.
173 GREEN STREET
KINGSTON, NEW YORK 12401
PHONE (845) 339-0058 FAX (845) 339-7380

Drawing Title
PLUMBING PIPING BASEMENT PLAN

Seal		
	Designed RRS	Project No. 2315
	Drawn MEH	CAD File No. M:\DWG\2003\2315\2315P\2315PP\2315P1.0
	Checked RRS	Drawing No.
	Scale 1/4"=1'-0"	P1.0
	Date SEPTEMBER 19, 2003	3 OF 3

Appendix B

Project #: 30040573
Project Name: Ulster County Geothermal
Engineer: Chris Muller
Measure: ECM 18a and 18b

ECM 8a. - Baseline

Location	Item	Qty	Material	Labor	Unit Price	Cost
Supply-Side	Condensing Boilers	2	$ 70,000	$ 46,000	$ 116,000	$ 232,000
	Variable Speed Chiller	1	$ 175,000	$ 66,000	$ 241,000	$ 241,000
					Total	**$ 473,000**
					% Markup	10%
					Project Cost	**$ 520,300**
					Boiler Only	$ 255,200

ECM 8b. Proposed

Location	Description	Qty	Material	Labor	Unit Price	Ext. Price
Source-Side Opt #1	HDPE 1-1/4" UBend500 FT	0			$ 1,017,775	$ -
Source-Side Opt #2	GeoperformX Double 1-1/2" U-Bend 900 FT	0			$ 759,107	$ -
Source-Side Opt #3	Concentric 5"x3"GeoperformX, 1610FT	0			$ 673,682	$ -
Source-Side Opt #4	Concentric 7"x4"GeoperformX, 2270FT	0			$ 651,829	$ -
Source-Side Opt #5	500' Drilled bores, 80' casing, looping, grouting, bore tie-in	1			$ 700,000	$ 700,000
	Excavation	1			$ 100,000	$ 100,000
	Source Side Pumps	1			$ 20,000	$ 20,000
Supply-Side	200-ton Mag Bearing Multi-Stack Chiller	1	$ 264,000	$ 79,200	$ 343,200	$ 343,200
	40-ton Multi-Stack VME Scroll Heat Pump Chiller	1	$ 106,500	$ 31,950	$ 138,450	$ 138,450
	Closed-Circuit Cooling Tower	1	$ 160,000	$ 20,000	$ 180,000	$ 180,000
	Supply Side Pumps/Piping	1	$ 20,200	$ 5,700	$ 25,900	$ 25,900
	800MBH Gas Boilers	2	$ 16,732	$ 5,020	$ 21,752	$ 43,503
	Camus Boiler Pumps	2	$ 804	$ 241	$ 1,045	$ 2,090
	Mechanical Room Adder	1	$ 40,000	$ 20,000	$ 60,000	$ 60,000
Cx	Commissioning	1	$ -	$ 20,000	$ 20,000	$ 20,000
Demo	Boilers	2	$ -	$ 20,000	$ 20,000	$ 40,000
	Chiller	1	$ -	$ 30,000	$ 30,000	$ 30,000
	Cooling Tower	1	$ -	$ 25,000	$ 25,000	$ 25,000
	Chiller Salvage	1	$ -	$ -	$ -	$ -
					Total	$ 1,728,144
					% Markup	10%
					Project Cost	**$ 1,900,958**
					Cost/Well	**$ 31,683**

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Project #: '30040573
Project Name: Ulster County Geothermal
Engineer: Chris Muller
Measure: ECM 8b - GSHP Compared to Baseline ECM8a

Savings Type	Peak Baseline	Peak Proposed	Savings
kW*	134.0	-69.2	$ 394.25
kWh	187,398	-145,625	$ 3,312.17
therms	23,272	-4,802	$ 17,247.09
		Total	**$ 20,953.51**

*kW cost savings calculated separetely as monthly savings vary

Load Reductions	
Cooling (MMBtu)	**Heating (MMBtu)**
143	1,847

Incremental Cost Analysis				
		Baseline[1]	Proposed[2]	Incremental Cost Difference
$	Implementation Cost	$ 520,300.00	$ 1,900,957.96	**$ 1,380,657.96**

Summary of Incremental Cost Savings	
Total Implementation Incremental Cost	$ 1,380,657.96
Annual Cost Savings	$ 19,793.94
Simple Payback Period	69.8

Notes:

1. The Baseline Implementation Cost assumes the replacement of both boilers and the chiller, including labor.
2. The Proposed Scenario Implementation Cost assumes the replacement removal of the existing boilers and chiller, as well as the installation of all GSHP components, including all costs associated with the loop as well as the mechanical equipment

Appendix C

Formation Thermal Conductivity
Test & Data Analysis

Test Location: **Ulster County Office Building**
Kingston, NY

Test Date: January 31 – February 3, 2020

Analysis For: Wragg Well Drilling & Pump Service LLC
172 Baker Road
Roxbury, CT 06783
Phone: (860) 354-1989

Test Performed By: Wragg Well Drilling & Pump Service LLC

EXECUTIVE SUMMARY

A formation thermal conductivity test was performed on the geothermal bore at the Ulster County Office Building site at 244 Fair St. in Kingston, New York. The vertical bore was completed on January 20, 2020 by Wragg Well Drilling & Pump Service. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the afternoon of January 31, 2020.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 1.49 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

Formation Thermal Diffusivity ≈ 1.16 ft^2/day

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

Undisturbed Formation Temperature ≈ 54.3-55.5°F

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at www.grti.com.

TEST PROCEDURES

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below:

Grouting Procedure for Test Loops – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

Undisturbed Formation Temperature Measurement – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours**.**

Data Acquisition Frequency - Test data is recorded at five minute intervals.

Equipment Calibration/Accuracy – Transducers and datalogger are calibrated per manufacturer recommendations. Manufacturer stated accuracy of power transducers is less than ±2%. Temperature sensor accuracy is periodically checked via ice water bath.

Power Quality – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

Input Heat Rate – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

Insulation – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

Retesting in the Event of Failure – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

Data Analysis

Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. Applying the line source method to a u-bend grouted in a borehole, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In the analysis of the data from the formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger was plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear coefficients were calculated that produce a line that fit the data. This procedure was repeated for various time intervals to ensure that variations in the power or other effects did not produce inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

Contact: Galen Streich
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Elkton, SD
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Test Bore Details
(As Provided by Wragg Well Drilling & Pump Service LLC)

Site Name	Ulster County Office Building
Location	Kingston, NY
Driller	Wragg Well Drilling & Pump Service
Installed Date	January 20, 2020
Borehole Diameter	8 inches, 0-126 ft 6 inches, 126-499 ft
Casing	6 inch permanent steel casing to 126 ft
U-Bend Size	1 ¼ inch DR-11 HDPE
U-Bend Depth Below Grade	499 ft
Grout Type	GeoPro TG Lite/PowerTEC
Grout Mixture	100 lb TG Lite, 32 lb PowerTEC, 30 gal water
Grouted Portion	Entire bore

Drill Log

Formation Description	Depth (ft)
Sand	0'-110'
Gray shale	110'-499'

Note: Bore produced approx. 3 gpm water at 200 ft.

Thermal Conductivity Test Data

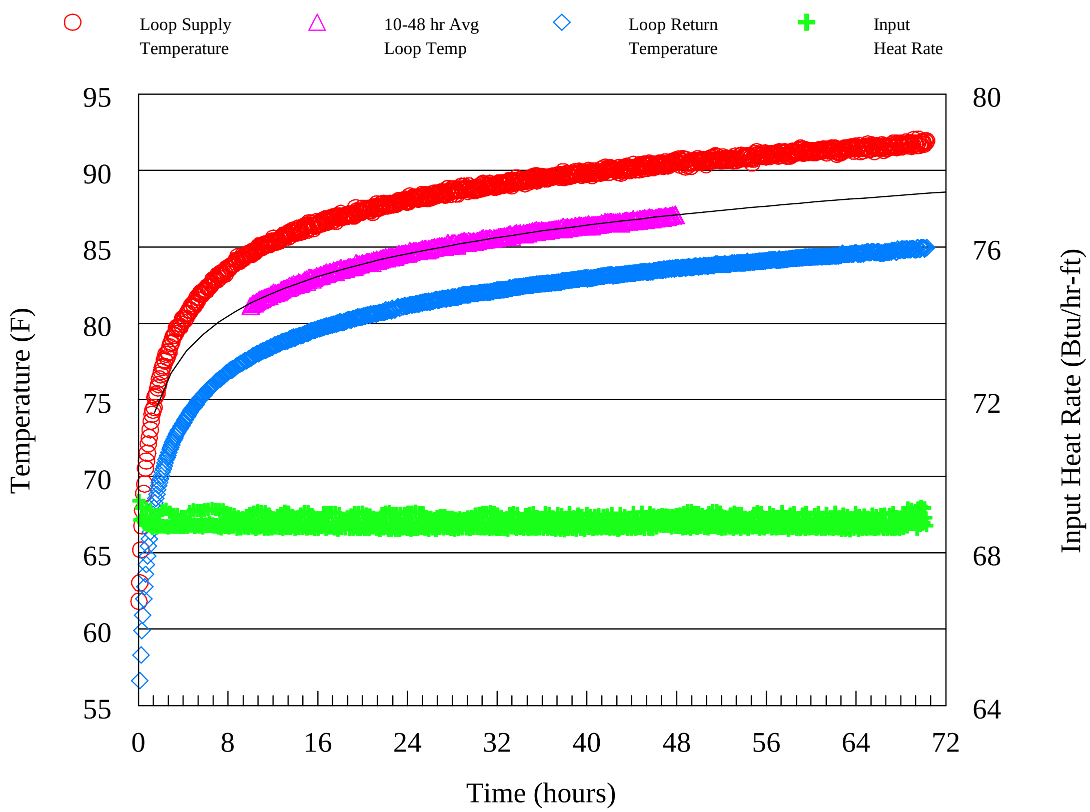

Fig. 1: Temperature & Heat Rate Data Vs Time

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on the left axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

Summary Test Statistics

Test Date	January 31 – February 3, 2020
Undisturbed Formation Temperature	Approx. 54.3-55.5°F
Duration	70.3 hr
Average Voltage	238.9 V
Average Heat Input Rate	34,316 Btu/hr (10,057 W)
Avg Heat Input Rate per Foot of Bore	68.8 Btu/hr-ft (20.1 W/ft)
Circulator Flow Rate	9.9 gpm
Standard Deviation of Power	0.22%
Maximum Variation in Power	0.47%

LINE SOURCE DATA ANALYSIS

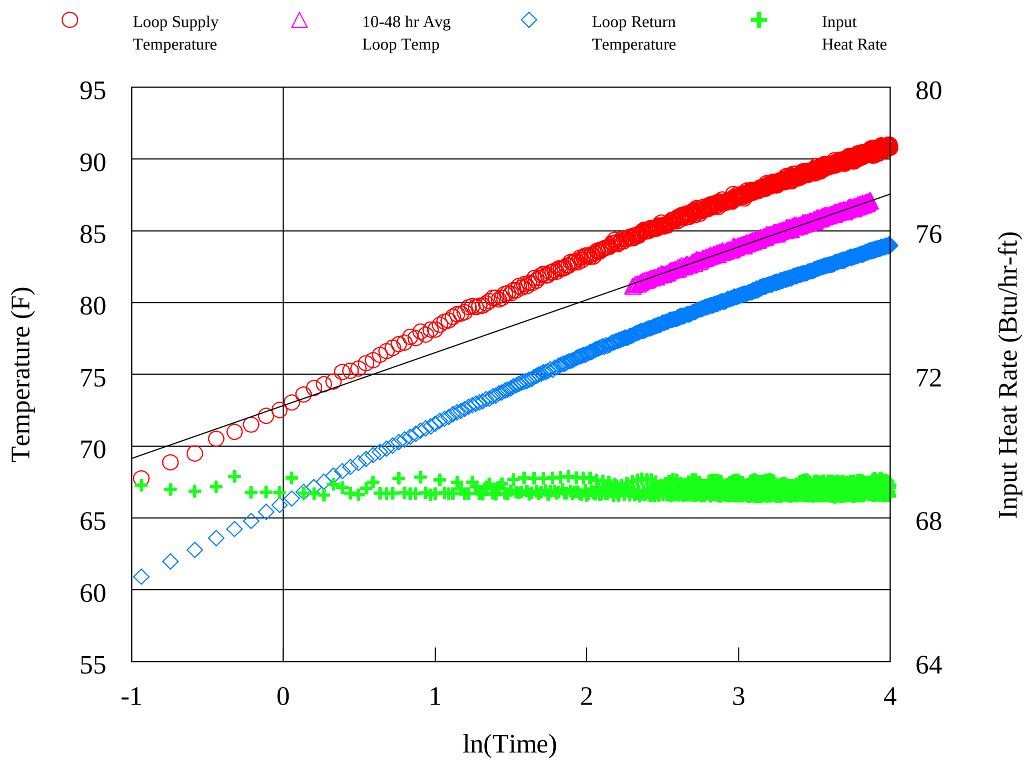

FIG. 2: TEMPERATURE & HEAT RATE VS NATURAL LOG OF TIME

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 48.0 hours. The slope of the curve fit was found to be 3.69. The resulting thermal conductivity was found to be **1.49 Btu/hr-ft-°F**.

THERMAL DIFFUSIVITY

The reported drilling log for this test borehole indicated that the formation consisted of sand and shale. A heat capacity value for shale was calculated from specific heat and density values listed by Kavanaugh and Rafferty[1]. A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 30.8 Btu/ft^3-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **1.16 ft^2/day**.

[1]Stephen P. Kavanaugh and Kevin Rafferty, Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems (Atlanta: ASHRAE, 2014), 75.

CERTIFICATE OF CALIBRATION

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a regular schedule. The components are calibrated by the manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

FTC Unit 207

DA Unit 60

PRIMARY EQUIPMENT		
COMPONENT	CALIBRATION DATE	CALIBRATION DUE DATE
Datalogger	7/14/2017	7/14/2020
Current Transducer	7/14/2017	7/14/2020
Voltage Transducer	7/14/2017	7/14/2020

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via a water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

DATE	8/13/2019			
THERMOCOUPLE 1 (°F)	32.3 32.3 32.3			
THERMOCOUPLE 2 (°F)	32.2 32.2 32.2			
THERMOCOUPLE 3 (°F)	32.2 32.1 32.2			
THERMOCOUPLE 4 (°F)	32.2 32.1 32.2			
DIGITAL THERMOMETER (°F)	32.3 32.3 32.3			

PE4 Action: Renewable Energy Feasibility Studies

3 Points 4 Points 5 Points

A. Why is this action important?

Prior to implementing any renewable energy technologies, local governments must understand which technologies are most feasible or applicable to their local constraints. A feasibility study evaluates the geographical, technological, financial, and regulatory considerations around implementing renewable energy for government operations.

B. How to implement this action

Local governments should determine the types of technologies they would like to include in the the study, and then develop a scope of work for the study. Renewable energy technologies may include wind, solar, biomass, geothermal, and related storage technolgies, such as battery storage.

Depending on the scope and budget for the study, some local governments may prefer to issue a request for proposals to hire an external consultant with expertise in analyzing and installing renewable energy systems. The consultant should be familiar with various renewable energy technologies, the cost to implement those technologies, and all relevant federal, state, and local regulations.

Local governments should also explore the possibility of working with a local university to analyze renewable energy options. Some graduate level courses include projects with external "clients" to allow professors and students to work on real-world situations. These types of reports can be a useful way to gather some initial information on the feasibility of various technologies; they are not, however, a substitute for a more comprehensive feasibility study performed by an engineer or renewable energy expert. In addition, local governments should consider consulting with utilities, state or federal agencies, and green power marketers and brokers.

In examining the options, local governments should review any data collected on energy use in government operations to determine where renewable energy investments will have the greatest impact and how much power is needed. Such data may have been collected under actions *PE2 Action: Government Operations GHG Inventory*, *PE3 Action: Government Building Energy Audits*, and *PE3 Action: Energy Benchmarking for Government Buildings*.

Local governments can earn points for this Climate Smart Communities (CSC) action by submitting a completed feasibility study that analyzes the potential for at least one, if not more, renewable energy technologies. The study must have been completed within five years of the application date. The study should consider geographical and local considerations, policy considerations, financing options, costs, and risks.

C. Time frame, project costs, and resource needs

The time frame to complete a renewable energy feasibility study depends on the scope of the analysis. Local governments can estimate approximately 3 to 6 months to complete the study. The project may require a project manager or liaison from the local government and, for most applicants, the expertise of an outside consultant. Local governments could also consider working with a local university with relevant expertise to complete an initial analysis.

D. Which local governments implement this action? Which departments within the local government are most likely to have responsibility for this?

This action is applicable to any type of local government. Departments such as the sustainability office, planning, purchasing, economic development, or facilities may be involved in implementing this action.

E. How to obtain points for this action

Points for this action are tiered based on the number of renewable energy technologies analyzed in the feasibility study.

	POSSIBLE POINTS
Conduct a feasibility study for 1 renewable energy technology	3
Conduct a feasibility study for 2 renewable energy technologies	4
Conduct a feasibility study for 3 or more renewable energy technologies	5

F. What to submit

Submit a copy of a feasibility study report that analyzes the feasibility of at least one renewable energy technology to supply energy for the local government's facilities and operations. The study should consider geographical and local considerations, policy considerations, financing options, costs, and risks. The study must have been completed within five years of the application date

All CSC action documentation is available for public viewing after an action is approved. Action submittals should not include any information or documents that are not intended to be viewed by the public.

G. Links to additional resources or best practices

- US EPA On-Site Renewable Energy Generation: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs
- US EPA RE-Powering America's Land
- Columbia University CHP in NYC: A Viability Assessment
- NYSERDA Renewable Energy

H. Recertification requirements

The recertification requirements are the same as the initial certification requirements.