Clean Energy Communities

Energy Study

Prepared for:
Village of Philmont

Village Hall

124 Main Street, Philmont, NY 12565

Audit No: CEC-400097-1-S - Village Hall

Submitted by:
L&S Energy Services
58 Clifton Country Road, Suite 203
Clifton Park, NY 12065

Date: 12/27/2022

For questions regarding this report, please contact cec@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

Kathy Hochul, Governor

New York State Energy Research and Development Authority

Consultant Disclaimer

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Executive Summary

This study was performed to understand how your facility is currently using energy and identify ways to reduce energy use and operating expenses.

No specific areas of concern were identified by the owner for evaluation.

The following energy efficiency measures (EEMs) and observations to reduce energy use were identified during the site visit:

- Interior Lighting Retrofit – replace all fluorescent and incandescent lamps with LED
- Improve Temperature Control – install new wi-fi thermostats and implement temperature setbacks
- Insulate Building Envelope – Install wall and roof insulation to current code levels
- Weatherstripping and Caulking – Replace weatherstripping and install door sweeps on old doors (that do not need replacement)
- Install Insulated Doors – Replace one door that has excessive wear and tear
- Install Double Glazing – Replace the single pane windows, and weatherstrip leaky double pane windows
- Insulate Heating and Hot Water Pipes – Exposed piping should be insulated for the heating plant and the domestic hot water system
- Install a More Efficient Boiler – Replace the existing boiler with a condensing unit
- Replace Air Conditioners – Install new high efficiency split system and window AC units per Energy Star compliance
- Turn Off Unused Refrigerators – Consolidate the refrigerators in the Firehouse (and other offices if possible)
- Install Ground Source Heat Pumps – Replace the fossil fuel system with a geothermal based electric heat pump system.
- Install a Heat Pump Water Heater – Replace the existing 40-gallon unit with a heat pump equivalent

These Energy Efficiency Measures are summarized in the Project Summary Table below and discussed in more detail in the Energy Efficiency Measures section of this report.

Present Energy Use and Cost

The energy use for your facility has been compiled to calculate the Energy Cost Index and the Energy Use Intensity.

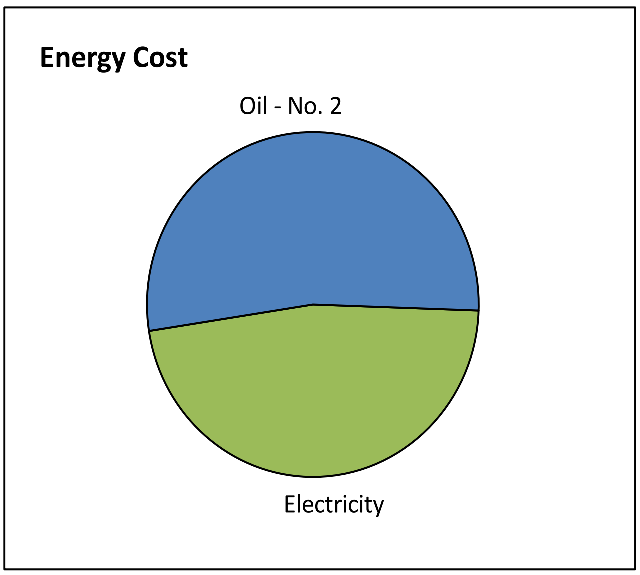
- The Energy Cost Index (ECI) is the total cost of energy divided by the conditioned floor area and is shown as dollars per square foot per year.
- The Energy Use Intensity (EUI) is the total heat content of energy divided by the conditioned floor area and is shown in units of one thousand Btus (kBtu) per square foot per year.

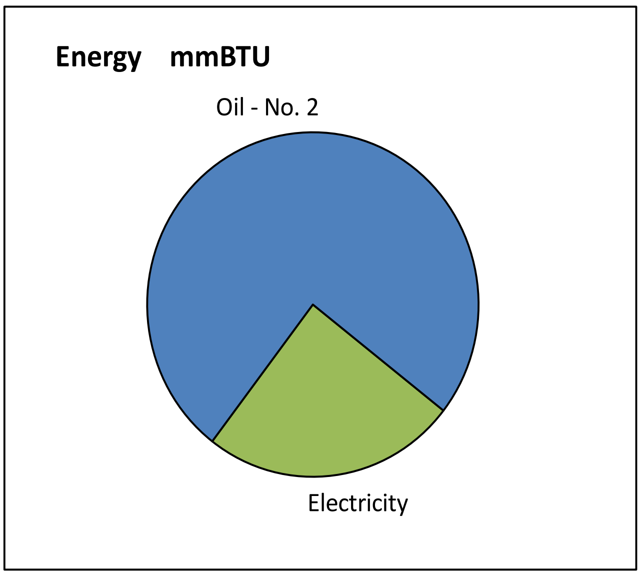
Energy Cost Index

Electricity	$ 5,597	$ 0.80	$/sq.ft./year
Oil - No. 2	$ 6,314	$ 0.91	$/sq.ft./year
Total Cost	$ 11,911	$ 1.71	$/sq.ft./year

Energy Use Intensity

Electricity	108	mmBtu	15.6	kBtu/sq.ft./year
Oil - No. 2	328	mmBtu	47.1	kBtu/sq.ft./year
Total Energy Use	436	mmBtu	62.7	kBtu/sq.ft./year





Energy Cost Index $ 1.71 /sf/yr.

Energy Use Intensity 62.7 kBTU/sf/yr.

Benchmarking Your Building

The EPA's ENERGY STAR Portfolio Manager website allows you to upload energy use information and compare your energy use to that of other buildings of similar use. Portfolio Manager generates a benchmark score that indicates your performance. A benchmark score of 50 indicates average performance while a score of 75 or higher would earn the Energy Star designation. You can use the website to track your energy use over time and document the success of your energy conservation efforts.

You can find the Portfolio Manager at:

https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

Project Summary Table

Energy Efficiency Measures				$ Savings & Cost		
EEM #	Measure Status	EEM Description	Reduction in Greenhouse Gas Emissions (Lbs. CO2e/Year)	Total Annual Savings	Install Costs	Simple Payback (years)
EEM-1	R	Interior Lighting Retrofit	1,424	$ 444	$ 5,954	13.4
EEM-2	R	Improve Temperature Control	8,305	$ 982	$ 1,000	1.0
EEM-3	RS	Insulate Building Envelope	19,751	$ 2,337	$ 202,559	86.7
EEM-4	R	Weather-Stripping And Caulking	997	$ 118	$ 340	2.9
EEM-5	RNE	Install Insulated Doors	382	$ 45	$ 1,500	33.2
EEM-6	R	Install Double Glazing	5,359	$ 634	$ 4,716	7.4
EEM-7	RS	Insulate Heating And Domestic Hot Water Pipes	417	$ 49	$ 1,130	22.9
EEM-8	NR	Install A More Efficient Boiler	7,393	$ 874	$ 14,000	16.0
EEM-9	NR	Replace Air Conditioners	471	$ 91	$ 6,667	73.6
EEM-10	R	Turn Off Unused Refrigerators	661	$ 80	$ 0	0.0
Total of Recommended Measures:			**17,127**	**$ 2,303**	**$ 13,510**	**5.9**

Measure Status Explanation:

- **(I) - Implemented:** Measure has been installed
- **(R) - Recommended:** Energy saved with a reasonable payback (within measure life)
- **(NR) - Not Recommended:** When payback exceeds measure life and equipment is not at end of life
- **(RME) - Recommended Mutually Exclusive:** Energy is saved and recommended over other options for a particular measure
- **(ME) - Mutually Exclusive:** Non-recommended option(s) to a Recommended Mutually Exclusive (RME) measure
- **(RNE) - Recommended Non-Energy:** Recommended based on other, non-energy factors such as comfort, water savings or equipment at end of life
- **(RS) - Recommended for Further Study:** For measures that require analysis beyond the scope of this program.
- **(BE) – Building Electrification:** Measures that should be considered based on greenhouse gas reductions, eliminating on-site use of fossil fuels, or other sustainability factors

Building Electrification Measures				$ Savings & Cost					
EEM #	Measure Status	Building Electrification Measure Descriptions	Reduction in Greenhouse Gas Emissions (Lbs. CO2e/Year)	Total Annual Savings	Install Costs	Simple Payback (years)	Estimated Incentives	Simple Payback after incentives
BE-1	RS	Install Clean Heating System - Ground Source Heat Pump	28,367	$ 2,944	$ 184,050	62.5	$ 20,399	55.6
BE-2	NR	Install A Heat Pump Water Heater	569	$ 73	$ 4,500	61.9	$ 134	60.1
		Total of Recommended Measures:	**0**	**$ 0**	**$ 0**	**0.0**	**$ 0**	

Simple Payback Period is the length of time it will take to recover the initial capital investment from the energy savings of the new equipment. The Simple Payback Period is calculated by dividing the initial installed cost by the annual energy cost savings. For example, an energy-saving measure that costs $5,000 and saves $2,500 per year has a Simple Payback Period of $5,000 divided by $2,500 or 2 years.

Note on Energy Project Implementation Costs

The "Project Costs" shown in this report for each Energy Efficiency Measure represent an initial estimate of the implementation cost. Unless otherwise noted in the Energy Efficiency Measure description, these costs reflect a preliminary estimate of material and labor. There may be other variables associated with your specific project that will impact the true project costs that the study may not capture. Other external factors that may impact true project costs and payback include material availability, vendor scheduling, access within the facility, general inflation, available measure incentives, and other unknown factors and conditions. For measures which significantly impact your building's usage, it is also important to determine any potential utility rate and/or tariff changes, those of which are beyond the scope of this report. We recommend that you seek several quotes from qualified vendors prior to implementation.

Greenhouse Gas Reductions for the Recommended Measures

Reducing your energy use will reduce the release of greenhouse gases associated with the use of fossil fuels and the production of electricity. If the measures recommended in this report are implemented, the following reductions of greenhouse gases can be expected:

Electricity	2,553	kWh =	2,962	pounds CO2 equivalent
Oil - No. 2	630	gal. =	14,166	pounds CO2 equivalent
			17,127	pounds CO2 equivalent
			19.0%	reduction

Emissions factors are used to translate the energy savings data from energy efficiency and renewable generation projects into annual GHG emissions reduction values. NYSERDA uses emission factors derived from U.S. Environmental Protection Agency (EPA) emission coefficients to calculate emissions from onsite fuel. The CO2e values represent aggregate CO2, CH4, and N2O emissions.

Assistance for Implementation of Recommendations

This study provides recommendation on specific actions to take to increase energy efficiency; the next step is implementing the recommendation(s). Complimentary assistance with implementing energy efficiency recommendations is available.

We can assist with identifying utility company incentives and various financing options available for energy efficiency improvements, such as GJGNY Loans or Commercial Property Assessed Clean Energy (CPACE) on bill Financing.

Please contact the Green Jobs Green New York Program coordinator for assistance:

Michelle Wooddell
1-888-338-0089
Info@NYEnergyStudy.com

COVID-19

NYSERDA encourages study participants to review COVID-related building operation guidelines published by New York State, ASHRAE and other trusted sources, as applicable. Links to these resources are included below along with a link to the FlexTech Program Indoor Air Quality (IAQ) effort, which is focused on the evaluation of filtration, ventilation, and building operation optimization measures as well as Ultraviolet Germicidal Irradiation (UVGI) in response to the COVID-19 crisis.

- New York State: https://forward.ny.gov/
- ASHRAE: https://www.ashrae.org/technical-resources/resources
- FlexTech Program IAQ Effort: https://www.nyserda.ny.gov/All-Programs/Programs/FlexTech Program/Indoor-Air-Quality

Energy Efficiency Measure Descriptions

EEM-1 Interior Lighting Retrofit

Electric Savings:	$ 540	1,928	kWh per year
		2.1	kW demand
Fuel Savings:	($ 96)	(5.0)	MMBtu fuel per year
			Oil - No. 2
Total Annual Savings:	**$ 444**		
Project Cost:	**$ 5,954**		
Simple Payback:	**13.4**	**years**	

Introduction:

Lighting usually represents a major portion of a facility's electricity use, and given the continuous hours of use, it contributes to the peak electric demand each month. Taking steps to improve the efficiency of your lighting will reduce both the total electric energy used and lower your peak electric demand. Lighting retrofit projects now consist of installing Light Emitting Diode, or LED, light sources in all fixtures. Some fixtures, such as indoor fluorescent fixtures, can be retrofitted to use T-8 replacement lamps, but most fixtures should simply be replaced with LED fixtures. Energy savings of 50% are common when replacing fluorescent and HID light sources with LED sources.

LED light sources for interior applications should list their color on the label; this is expressed in degrees Kelvin, or °K. Lights with higher values will be bluer in color and may not be appropriate for indoor use. Look for values between 3500 and 4000°K for "cool white" light. For spaces where a warmer color of light is desired, select lights with values between 2700 and 3000°K.

Recommendation:

Retrofit interior fluorescent fixtures and replace other fixtures as indicated in the lighting calculations and the Equipment Inventory, both of which may be found in the Appendix.

LED lamps and fixtures should be Energy Star labeled or listed with the Design Lights Consortium (DLC). Your utility incentive program may have other requirements that must be met in order to qualify for incentives.

EEM-2 Improve Temperature Control

Electric Savings:	$ 8		55	kWh per year
			0.0	kW demand
Fuel Savings:	$ 974		50.6	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 982**			
Project Cost:	**$ 1,000**			
Simple Payback:	**1.0**	**years**		

Introduction:

Proper temperature control is important in order to minimize energy costs. Maintaining space temperatures within a reasonable range during occupied periods and reliably reducing the amount of heating and cooling energy during unoccupied periods should be the goal for your temperature control system.

This building is unique in the fact that most of the space has low to no occupancy or variable occupancy. The heating plant thermostats are rotary dial with manual controls. Some of the low occupancy spaces had lower thermostat settings than that of the occupied spaces, such as the Hall (60 °F) and Court (63 °F) as compared to the Office (66 °F). On the other hand, the Firehouse was set higher (68 °F) than the Office despite have minimal foot traffic.

Recommendation:

Digital Wi-Fi thermostats should be installed so that the unoccupied spaces can be set to a low temperature during the heating season. A facility manager should be in charge of checking that the thermostats are properly programmed without manual overrides from staff, volunteers, and other community members who enter the building.

This calculation provides an example of the potential savings for basing the average building temperature setpoint at 66 °F in heating mode with a 4 °F average setback. This measure also estimates savings for the Firehouse Kitchen AC, which has local controls. Currently, the unit remain on throughout the summer. It is recommended to remind occupants to turn off the unit when they leave the space.

Setbacks can be even deeper than in this estimated calculation. However, there will be a sweet spot on how low the space temperatures can be achieved and how fast they can be brought back when needed. Because there is a lot of exposed piping and heat transfer from each story, the facility managers should conduct functional testing to determine these thresholds.

The new thermostats should be installed in the Firehouse, Firehouse kitchen, Office, Hall, and Court. Be sure to remove the older thermostats (currently there is a defunct rotary thermostat right next to the operating thermostat in many of the zones).

EEM-3 Insulate Building Envelope

Electric Savings:	$ 68		484	kWh per year
			0.0	kW demand
Fuel Savings:	$ 2,269		117.8	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 2,337**			
Project Cost:	**$ 202,559**			
Simple Payback:	**86.7**	**years**		

Introduction:

Heat moves from areas of high temperature to areas of low temperature. As the temperature difference between a heated and an unheated space becomes greater, so does the rate of heat transfer. Insulation reduces the rate of heat transfer by filling the space with material that is less conductive than what is currently there. The effectiveness of insulation is measured by R-value, which is the resistance to heat transfer. As the R-value increases, the rate at which heat is transferred decreases.

Recommendation:

This building has masonry walls and a flat roof. The walls have no insulation, and the roof was likely last replaced around 30 years ago, which would indicate that it may be at the end of its useful life.

Insulating this building will require significant work. If the walls were to be insulated from the interior, the walls will need to be brought in with wood framing, electrical work, insulation, drywall and paint. This could be an issue since some of the offices already appear to be small and cluttered with equipment and files.

Exterior insulation, however, will not disrupt operations. Installing an exterior insulating system will transform the look of the building from concrete to a synthetic stucco type of material. Depending on the materials, the system may require a specialty license. Thus, the materials and labor associated could be more expensive.

Further study should be evaluated to improve the wall and roof insulation to current code levels. When undergoing a project of this magnitude, there should also be input from design engineers who can integrate solar and geothermal heating/cooling systems into the design. This would take advantage of simultaneous work, and lower potential overall costs.

The calculation estimates are based on improving the wall insulation from R-5 to R-19, and the roof insulation from R-19 to R-39.

EEM-4 Weather-Stripping And Caulking

Electric Savings:	$ 0		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 118		6.1	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 118**			
Project Cost:	**$ 340**			
Simple Payback:	**2.9**	**years**		

Introduction:

Sealing the cracks between windows and wall openings will reduce the amount of unwanted outside air infiltration into conditioned spaces. The elimination of infiltration or drafts makes occupants feel more comfortable and reduces heating and cooling costs. Caulking and weather-stripping are cost effective ways to reduce infiltration and to tighten the building envelope.

Recommendation:

This measure is specifically for replacing weatherstripping and door sweeps on the front entrance doors (Office/Court), and the Village Hall side door to eliminate infiltration. Subsequent measures will detail potential savings for replacing doors and windows while simultaneously addressing any infiltrative savings.

In addition to the three doors, two window AC units remain in place throughout the year. Infiltration can occur around the units, but also through the unit. The units can also be damaged by snow and also have mold grow, which can lead to poor indoor air quality. It is recommended that these units are removed in the winter.

EEM-5 Install Insulated Doors

Electric Savings:	$ 0		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 45		2.3	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 45**			
Project Cost:	**$ 1,500**			
Simple Payback:	**33.2**	**years**		

Introduction:

Single pane wooden frame or metal frame doors can be very inefficient. Heat loss due to conduction through single pane glass can be very high. Also heat loss due to air infiltration past loose fitting or worn-out frames can increase the cost of energy to heat this air. Drafts can also occur causing discomfort to occupants. The installation of insulated replacement doors will reduce these heating loads.

Energy efficient doors are built with thermal breaks and insulated cores to reduce conduction heat losses. Weather stripping along the perimeter of the door minimizes the infiltration of unconditioned air.

Recommendation:

The rear door to the heated vestibule leading to the firehouse and the stairs has significant wear and tear. It does not close on its own. A new high efficiency polyurethane insulated steal door, or equivalent is recommended for replacement.

The estimated cost relative to the payback does not make sense to replace solely for energy efficiency reasons. However, because the door is damaged and does not close, it should be replaced for non-energy reasons.

EEM-6 Install Double Glazing

Electric Savings:	($ 0)		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 634		32.9	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 634**			
Project Cost:	**$ 4,716**			
Simple Payback:	**7.4**	**years**		

Introduction:

Single pane wooden or metal frame windows can be very inefficient. Heat loss due to conduction through single pane windows can be very high. New windows utilize two panes of glass instead of one. Glass performance is measured in two ways Solar Heat Gain Co-efficient (SHGC) or Visible Transmittance (VT). SHGC is the amount of solar gain transmitted through a window into the building. VT refers to the amount of visible light that moves through the glass from exterior to interior. These two factors can be altered for a higher performing window by adding Low-E coatings and spacers with gas. The overall thermal performance of windows is generally assigned a u-value. This measurement considers all parts of a window. These parts include the frame, sash, and glass. The installation of windows with double glazing will reduce infiltration and conduction losses.

Recommendation:

Install new double-glazed windows with low-e coatings. Be sure that windows are fully caulked on the exterior and interior where they meet the existing building structure. The EPA and DOE have developed stringent standards for windows. Windows that meet these standards can earn the Energy Star Label. Replacement windows should bear the Energy Star label.

This measure provides an estimate of savings for 11 new windows in the firehouse that are single pane and do not fit frames, as well as new weatherstripping for the double pane windows in the Village Office that staff state leak.

Further study is recommended for diagnosing the issue with the leaking windows in the Office. If the frames need replacement, then the cost would increase perhaps causing the potential payback time to be longer.

EEM-7 Insulate Heating And Domestic Hot Water Pipes

Electric Savings:	$ 2		15	kWh per year
			0.0	kW demand
Fuel Savings:	$ 47		2.5	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 49**			
Project Cost:	**$ 1,130**			
Simple Payback:	**22.9**	**years**		

Introduction:

Heat is distributed through the building by pipes containing hot water or steam. Heating distribution system pipes lose heat to the surrounding space. If the heat is lost to an area that does not require heating, the drop in system efficiency can be significant. Un-insulated pipes in conditioned space may also overheat the space, wasting energy and causing comfort problems. All heating distribution system pipes located in unconditioned space should be insulated.

Domestic hot water (DHW) is water that is heated for hand washing, showering, dish washing, laundry, etc. Domestic hot water pipes lose heat to the surrounding space. This loss is significant in facilities with recirculating hot water systems, or in facilities that use hot water for a large portion of the day. In a recirculating system, all domestic hot water pipes should be insulated. In a non-recirculating system, domestic hot water pipes within eight feet of the water heater should be insulated.

Recommendation:

The hot water heating piping in the boiler room is totally uninsulated. There is an estimated 30' of 2" copper pipe for this space. There are also uninsulated pipe runs from the boiler room across the firehouse with an estimated 100' of 2" copper that has been painted.

The domestic hot water maker is also in the boiler room. It has insulation for the first 8' feet or so, but there is another 15' of exposed pipe. Since the boiler room has large fixed louvres, the heat can be lost before it gets to the conditioned space.

Further study is recommended for inquiring with a contractor who can more effectively measure the length of pipes, their circumference, and the quantity of elbows and tees that can be insulated along with the cost to implement.

EEM-8 Install A More Efficient Boiler

Electric Savings:	($ 0)		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 874		45.4	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 874**			
Project Cost:	**$ 14,000**			
Simple Payback:	**16.0**	**years**		

Introduction:

Boiler efficiency is determined by the efficiency of the boiler burner and heat exchanger, jacket heat losses, flue losses, and boiler sizing relative to the heating load. Boilers with atmospheric burners experience greater flue losses than power burners during off cycles when the burner is not firing. Boilers that are oversized spend more time in standby mode, increasing the impact of high off-cycle flue losses. These types of boilers perform at overall efficiencies significantly lower than their nominal thermal efficiency (Et), which is measured at a steady state of boiler operation. Boilers under 300,000 BTU input are rated using the annual fuel utilization efficiency, or AFUE. A boiler's AFUE rating assumes that it is properly sized for the building it serves. Boilers that are over-sized and poorly-controlled will perform less efficiently than the published AFUE.

Non-condensing boilers are limited to thermal efficiencies up to ~85% Et if equipped with power burners and low-mass heat exchangers; 80% Et boilers are more common. Condensing boilers are designed to cool flue gases to the point where water vapor produced in the combustion process condenses. The thermal efficiency of a condensing boiler depends on the entering water temperature, with lower temperatures yielding higher efficiency. Condensing boilers can achieve thermal efficiencies between 88% and 98%.

Recommendation:

The new boiler should be a condensing design with a modulating burner and outdoor reset control. Perform complete load calculations for the building and size the new equipment according to the load calculations, and not according to the size of the equipment scheduled for removal. Revise the near-boiler piping to ensure the boiler entering water temperature is as low as possible to maximize efficiency.

This calculation uses a rated combustion efficiency for the existing unit at 88% going to 96% for a condensing unit.

If a new boiler has an oil-fired burner, the payback is estimated at 16 years. If the Village were to install a propane fired unit, the boiler may require about 1/3 more gallons due to the difference in heat content between oil and propane. Therefore, if the price of propane is not 1/3 less than fuel oil, then the payback on that boiler would be longer. Overall, this measure is not recommended at this time.

EEM-9 Replace Air Conditioners

Electric Savings:	$ 91		406	kWh per year
			0.6	kW demand
Fuel Savings:	$ 0		0.0	MMBtu fuel per year
Total Annual Savings:	**$ 91**			
Project Cost:	**$ 6,667**			
Simple Payback:	**73.6**	**years**		

Introduction:

Air conditioning units that are over 15 years old may use reciprocating compressors and obsolete refrigerants. Current models use reliable scroll compressors and modern refrigerants to meet today's more stringent efficiency requirements. Replacement models are rated with an Energy Efficiency Ratio, commonly called EER. The higher the EER, the more efficient the unit. SEER is the Seasonal Energy Efficiency Ratio, which indicates the average EER over the course of a cooling season. The SEER will be higher than the EER for a given piece of equipment, so be sure to compare products using the same measurements.

Recommendation:

This calculation provides an example of installing new split system and wall AC units for the Village Office, Court, and Firehouse. The existing units have variable sizes and efficiencies, as can be observed in Appendix A and the calculations. The new equipment comparison is based on the Energy Star highest efficiency listings.

This measure is based on an in-kind replacement. The estimated implementation costs far exceed the minor incremental efficiency savings, and this measure is not recommended based on a long payback.

Since the Police Offices already use Air Source Heat Pumps, these were discounted from the analysis. Likewise, a building wide Air Source replacement was not calculated because of the complexity and limited cooling hours in some of the spaces.

EEM-10 Turn Off Unused Refrigerators

Electric Savings:	$ 80	569	kWh per year
		0.0	kW demand
Fuel Savings:	$ 0	0.0	MMBtu fuel per year
Total Annual Savings:	**$ 80**		
Project Cost:	**$ 0**		
Simple Payback:	**0.0 years**		

Introduction:

Energy Star qualified refrigerators are 10 percent more efficient than models that simply meet the federal minimum standard for energy efficiency. Refrigerators manufactured prior to 1993 can be expected to use twice as much energy as current Energy Star labeled refrigerators.

The Energy Star website has a list of all refrigerator models that meet current Energy Star requirements at http://www.energystar.gov/certified-products/detail/refrigerators.

Visit the Energy Star website to find a list of all refrigerator models that meet current Energy Star requirements.

Recommendation:

This measure has been added to the list, because during the walk through it was identified that some of the refrigerators were sparsely used. Specifically, the 12-year-old unit with a top freezer in the Firehouse was nearly empty. Nearby a newer unit looks as is if it used more often. if the items were consolidated into the newer unit, this older unit can be disconnected. The firehouse can simply turn it on when needed for a big event.

If it is decided that the unit cannot be disconnected, then consider purchasing a new Energy Star unit. Savings will be somewhat limited, however.

For this measure, the savings are based on turning off the old unit, which has a 6.5 Amp rating at 120 Volts, and an estimated run time of 2 hours daily.

Building Electrification Measures

The following measures evaluate the impact of replacing your existing fossil-fuel heating systems with clean heating and cooling systems powered by electricity. For space heating, air source heat pumps and ground source heat pumps are available in various system types to provide both heating and cooling to your building.

Fossil fuel-fired water heaters may also be replaced with heat pump water heaters to further reduce your use of fossil fuels.

When combined with renewable electricity, heat pump systems can eliminate the use of fossil fuels in your building.

See Appendix E - BENEFITS OF CLEAN HEATING AND COOLING (CHC) TECHNOLOGIES for more information on these system types.

BE-1 Install Clean Heating System - Ground Source Heat Pump

Electric Savings:	($ 3,400)		(21,799)	kWh per year
			1.6	kW demand
Fuel Savings:	$ 6,344		329.4	MMBtu fuel per year Oil - No. 2
Total Annual Savings:	**$ 2,944**			
Project Cost:	**$ 184,050**			
Simple Payback:	**62.5**	**years,**	**55.6**	**years after incentives**

Introduction:

Smaller buildings can take advantage of water-to-air ground source heat pump technology by replacing furnaces and other ducted systems with heat pumps having either open or closed loop ground heat exchangers. Closed loop ground heat exchangers that are properly sized provide water between 32° and 77° for heat pumps to draw heat from or reject heat to. Open loop systems see water temperatures of ~50° throughout the year. This allows heat pumps to operate at higher efficiency than air-source heat pumps that must draw from more extreme outdoor air temperatures.

The heat pumps in this type of system each have a loop pump. The building may have multiple heat pumps, but every heat pump must have a dedicated ground source heat exchanger. The heat pumps should have two-stage or variable capacity compressors for the highest efficiency. The loop pump may be constant speed, but two-speed or variable speed pumps offer higher efficiency and are preferred.

Recommendation:

Consider replacing your present heating system with a clean heating and cooling system using ground source heat pumps.

Install a closed loop heat pump system with variable-speed compressors and variable pumping. The heat pumps are assumed to be rated at 17 EER full load cooling, 22 EER part load. The heat pumps are assumed to be rated at 3.6 COP full load heating, 4.1 COP part load.

This measure is recommended for further study, because if the previous measures are adopted this system can be reduced in size and cost. Coupled with incentives and other grant money, this measure could have a decent payback.

Consult with a qualified geothermal design firm to ensure that the loop is designed correctly as the building loads have lower AC consumption (if any) to recharge the loop. It may be necessary to investigate a hybrid air source solution to have an effective payback in conjunction with the ground loop system.

BE-2 Install A Heat Pump Water Heater

Electric Savings:	$ 73		490	kWh per year
			0.0	kW demand
Fuel Savings:	$ 0		0.0	MMBtu fuel per year
Total Annual Savings:	**$ 73**			
Project Cost:	**$ 4,500**			
Simple Payback:	**61.9**	**years,**	**60.1**	**years after incentives**

Introduction:

Instead of using a fuel or electricity to heat water directly, a heat pump water heater uses a mechanical refrigeration system to heat water using the surrounding room air. Heat pump water heaters are two to three times more efficient than standard electric water heaters.

Because they transfer heat from room air to the water tank, heat pump water heaters have a cooling effect on the space temperature. This is helpful in the summer cooling system, but adds to the heating system load in winter.

Recommendation:

Replace the 40 gallon electric water heater with a heat pump water heater.

The new water heater should have a unified energy factor of at least 4.

This measure is currently not recommended due to low usage, causing a high payback.

Alternatively, further study should be conducted for replacing the unit with a smaller, on-demand or tankless unit. For example, the other point of use unit serving the laundry has a 1.3 kW coil. Since demand is around $11/kW, the potential savings for replacing a 4.5 kW coil with a 1.3 kW is potentially $400 in demand chargers alone (3.2 kW * $11/kW * 12 Month). This would have a decent payback for the new unit provided that the existing unit contributes to demand at 4.5 kW each month.

Existing Conditions

The site is a mixed-use building for the Village Office, Hall, Clerk, Court, Police, and Firehouse. Constructed in 1964 on two stories, this facility spans approximately 6,960 ft^2. The building is made of concrete block walls on slab, with the south side of the first floor built into the ground, allowing for the second-floor entrances to be at ground level even with Main Street. These main entrances lead to the Village Office and Court. The doors and windows have metal framing, and double pane glass. The windows are either fixed or sliding. The operable windows leak, while the doors have worn weatherstripping and door sweeps. Village staff working in this area state that it can be uncomfortable. The main entrance wall has brick siding, whereas the rest of the building concrete walls are painted white. The first and second floors have wood decking, and while the roof was unable to be accessed at the time of the inspection (due to a snowstorm the night prior), according to satellite imagery found online, the roof has what appears to be black rolled membrane with significant patching. According to Village staff, the roof has not been replaced in approximately 30 years. Likely there is insulation between the deck and the dropped ceiling consistent with building practices in the early 1990s.

The first floor is used entirely for the fire department, and has four 9' tall by 12' wide overhead doors to fit two firetrucks and two emergency services vehicles. These door seal well. The side windows, however, are almost exclusive single pane plastic and glass that leak considerably. The rear of the building is the main access point for the firehouse. It consists of a heated vestibule that leads to the firehouse and the stairwell to the Village Hall. The entrance to the building is a steel frame door with a double pane half window that does not close well, and has no weatherstripping nor a door sweep. The entrances the Firehouse and the stairwell appear to seal better. The Firehouse door is a solid steel door. The entrance to the stairwell is a metal frame full length double pane glass door, similar to the Main Street entrances on the second floor. Lastly, there is one side glass door entering the Village Hall that is the same as the other three. This door also needs new weatherstripping and a door sweep. The windows on the second-floor rear and sides of the building all appear to seal better than the Main Street entrance. This is because they have either vinyl or aluminum siding. They are a mixture of sliding double pane glass windows. The facility windows were manufactured in 2002 & 2003 based on the date stamp in the gasket. During the walkthrough it was observed that the window air conditioners in the Firehouse kitchen and the Court's office are left in the windows all year round, which will cause infiltration during the winter.

This building has different operations and hours of occupancy for each service type. The Village Office is occupied the most often, but almost all the staff are part-time Village employees (or volunteers, like with the Firehouse). The Village Office is occupied from 7:30-2:30 Monday through Thursday, and Friday until noon. The Court office hours are Thursday and Friday from noon to 5pm, and Court proceedings as needed are the third and fourth Thursdays of the month at 6pm. The firehouse is used when an emergency occurs, of which the predominant calling point is for emergency medical services. According to Village Staff there will be around 260-270 calls this calendar year. The Police officers have several offices on the second floor next to the Village Hall, and they come in only to collect their equipment at the beginning of their shift, and to fill out reports at the end of their shift. The Village Hall is used for meetings and can also be rented.

Lighting Systems

Lighting consists predominantly of fluorescent fixtures. The second-floor offices all have 4' T8 tubes in recessed troffers with lenses. The Firehouse has a mixture of 8' T8 and T12 pendant fixtures. The Firehouse kitchen and bathrooms were recently renovated to have 2'x2' LED fixtures. Any other lights in the facility are a combination of incandescent and LED lamps. All fixtures are on switches. The light switch below the Firehouse Kitchen window AC unit trips the breaker associated with the lights when turned on. It is unknown what it is connected to, but could pose a safety risk if not removed.

Exterior lighting consists of LED flood lights over the parking lot and LED lamps over the entrances. These are all on photocells.

Heating Ventilating and Air Conditioning Systems

Heating is provided by an oil fired Buderus Logano hot water boiler, model G215/6. Age could not be discerned from the serial number, but it looks to be in good condition. Its maximum input is 2.1 gallons per hour, which is around 291 Mbh input. With a gross output of 256 Mbh, the rated efficiency is around 88%. There are four zones with Taco 1/8 hp circulation pumps. The four zones are controlled by rotary dial thermostats located in the Firehouse, Village Office, Court, and Village Hall. The Firehouse heating setpoint was 68 °F, and is likely to remain at that temperature all heating season. The Village Hall was set to 60 °F, but is likely adjusted during meetings. The Court was set at 63 °F, and is likely similarly adjusted during office hours. The Village Office is the most occupied space and it is set to maintain 66 °F.

The 1.5"-2" pipes are not insulated in the boiler room, nor throughout the Firehouse ceiling as the pipes distribute to the second-floor perimeter baseboards and radiators. The Firehouse has three ceiling mounted unit heaters with 1/15 hp motors. The Firehouse kitchen has a wall ventilator and a perimeter baseboard in the bathroom.

Air conditioning is provided by two split system heat pumps, one split system AC unit, and two window AC units. The heat pumps serving the Village Hall and Police Station offices are multi-split Carrier units with an outdoor model of 38MGRQ30D—3. They have a total capacity of 2.5 Tons, a 12.5 EER and a 23.8 SEER. Heating is rated for an outdoor air temperature between 5 and 47 °F. Capacity fluctuates from 29,230 Btu/h to 28,000 Btu/h as the temperature increases. Conversely, as the temperature decreases, the rated coefficient of performance (COP) decreases from 3.8 to 2.0. The specification sheet claims to have Energy Star rating.

The Village Hall likely has a 1-ton interior unit, while the Police offices likely have ½ ton units. The Police offices have computer and radio equipment that need tighter temperature controls, and it is likely that the perimeter radiators are disconnected. Therefore, the heat pumps provide both the cooling and heating to each office maintaining a temperature of

72 °F. It is unlikely that the Village Hall needs supplemental heat from the heat pumps in the winter.

The Village Office has a ComfortStar split system AC unit. The nameplate ratings suggest it is a 2-ton system (23,000 Btu/h) with a SEER of 16.4, and is used as needed. The Firehouse kitchen window AC unit is an Arctic King, model WWK+05CR5. It has a 5,000 Btu/h capacity and an EER of 11.2, with a CEER of 11. Per the staff, this unit operates throughout the summer and is not turned off when unoccupied. The Court window AC model could not be observed, but it is likely a 1-ton unit with an estimated efficiency of 9 EER. It is likely only used as needed.

The bathrooms have ceiling fan ventilators. All other occupant ventilation is provided by the fenestration. There is a ducted exhaust system for each of the four emergency vehicles. Hoses are connected to the vehicle exhaust that collects centrally and rejected out the side wall and up above the roof. A small motor, estimated at ½ hp (snow covered nameplate) is turned on as needed.

Water Heating System

There are several water heating systems for this facility. The Firehouse Kitchen sink, bathroom faucets and showers as well as the second-floor restrooms are served by an American Water Heater Company, model E62-40R-045DV, 40-gallon, electric hot water maker with a 4.5 kW coil. The measured temperature was 115 °F. It has a 92% energy factor, and is located in the boiler room.

The firefighter outerwear has a dedicated laundry system. The hot water maker for the slop sink and the washing machine is a small Stiebel Eltron, 4-gallon, 1.3 kW unit. It's measured temperature was 108 °F.

The Village Hall kitchen is no longer used. There is an undercounter American Water Heater Company Proline, model E61-20U-0158V, 19-gallon, 1.5 kW hot water maker.

Other Energy-using Systems

This building has a lot of equipment due to the nature of its services. In addition to the typical office equipment such as computers, screens, printers, and telephony each space some unique equipment to itself. They are listed below.

- Firehouse kitchen – Used mainly when there is a large fire requiring long hours
  - Refrigerators - one newer medium sized with a glass door, and two older units. One is nearly empty, yet on, while the other is locked.
  - Coffee maker
  - Microwave
  - Icemaker
  - Oven Range
- Firehouse
  - Ingersoll Rand air compressor likely to pressurize the water in the trucks.
  - Eagle Aire systems compressor to regenerate the oxygen tanks

    - Kenmore Elite washer and Ready Rack firehouse express dryer
- Village Hall Kitchen – not used, except refrigerator
    - Frigidaire refrigerator
    - Microwave
    - Commercial stove and ranges (with side wall exhaust)
- Police Office
    - Radio equipment
    - Mini-fridge
- Village Office
    - Mini-fridge
    - Coffee maker

Note that the process equipment, such as the compressors were not investigated for this study. These energy consuming devices are needed by the Firehouse to provide the emergency services. Further investigations into reducing the energy intensity of the Police Station and Firehouse equipment could have a big impact on the building.

See Appendix D for further details regarding the energy calculations performed for this study.

Appendix A

Equipment Inventory

Heating and Air Conditioning Equipment									
Unit Type	**Qty**	**Make/Model**	**Heating kBtuh**	**Heating Eff.**	**Cooling Capacity**	**Units**	**EER**	**Serves/Location**	**Year**
Hot water boiler	1	Buderus Logano G215/6	256	88%				Building Radiators/Heaters	
Multi-Split System HP	2	Carrier 38MGRQ30D—3	29	380%	2 1/2	tons	12.5	Village Hall/Police Offices	2021
Split System AC	1	ComfortStar			2	tons	~11	Village Office	
Window AC	1	Unknown			1	tons	9.0	Court	
Window AC	1	Arctic King WWK+05CR5			3/7	tons	11.2	Firehouse Kitchen	2015

Domestic Hot Water									
Unit Type	**Qty**	**Make/Model**	**Capacity**	**Units**	**Fuel Type**	**Storage Capacity (gal.)**	**Eff.**	**Serves/Location**	**Year**
Storage	1	American E62-40R	4.5	kW	electricity	40	92%	Firehouse & Bathrooms	2011
Tankless	1	Stiebel Eltron SHC 4	1.3	kW	electricity	4	100%	Firehouse Laundry	
Tankless	1	American E61-20U	1.5	kW	electricity	19	100%	Village Hall Kitchen	

Motors									
Unit Type	**Qty**	**Make/Model**	**HP**	**Loading**	**Type**	**Hours/year**	**Eff.**	**Serves/Location**	**Year**
Boiler Circulators	4	Taco	1/8					Boiler Room	
Unit Heater Fans	3	Multiple	1/15						

Interior Lighting Fixtures											
Existing Fixtures						Recommended	Recommended Interior Lighting Efficiency Improvements				
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
1	Boiler Room	1	CFL13w	1	13	No Change	No change	1	CFL13w	1	13
2	Firehouse Kitchen	3	2x2 LED Panels	1	45	No Change	No change	3	2x2 LED Panels	1	45
3	Firehouse Kitchen	1	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	1	2x2 LED Panels	1	45
4	Firehouse BR's	3	2x2 LED Panels	1	45	No Change	No change	3	2x2 LED Panels	1	45
5	Firehouse	6	8' 110w T12 HO Std. Mag	2	257	No Change	LED Relamp	6	8' LED T12/8 IS, 33W	2	66
6	Firehouse	1	8' 59w T8 Elec. bal.	2	109	No Change	LED Relamp	1	8' LED T12/8 IS, 33W	2	66
7	Firehouse	1	2' 17w T8 Elec. bal.	1	20	No Change	LED Relamp	1	2' LED tube 1150 lu. 7W	1	7
8	Rear Door	1	LED 9w	1	9	No Change	No change	1	LED 9w	1	9
9	Rear Stair (1 Out)	1	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	1	4' LED fixture 4500 lu. 42w	1	42
10	Village Hall (3 Out)	13	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	13	4' LED fixture 4500 lu. 42w	1	42
11	Village Hall Door	1	60 watt Incandescent	2	120	No Change	LED Relamp	1	60 watt Incandescent	2	120
12	Village Hall Kitche	3	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	3	4' LED fixture 4500 lu. 42w	1	42
13	Police Office	3	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	3	4' LED fixture 4500 lu. 42w	1	42
14	Police Office (est.)	3	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	3	4' LED fixture 4500 lu. 42w	1	42
15	Hallway to Court	4	4' 32w T8 Elec. bal.	1	31	No Change	New LED Fixture	4	4' LED fixture 4500 lu. 42w	1	42
16	Hall Bathrooms	2	60 watt Incandescent	2	120	No Change	LED Relamp	2	60 watt Incandescent	2	120
17	Village Court	6	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	6	4' LED fixture 4500 lu. 42w	1	42
18	Village Office (3 O	12	4' 32w T8 Elec. bal.	2	59	No Change	New LED Fixture	12	4' LED fixture 4500 lu. 42w	1	42
19	Village Office Clos	1	LED 9w	1	9	No Change	No change	1	LED 9w	1	9

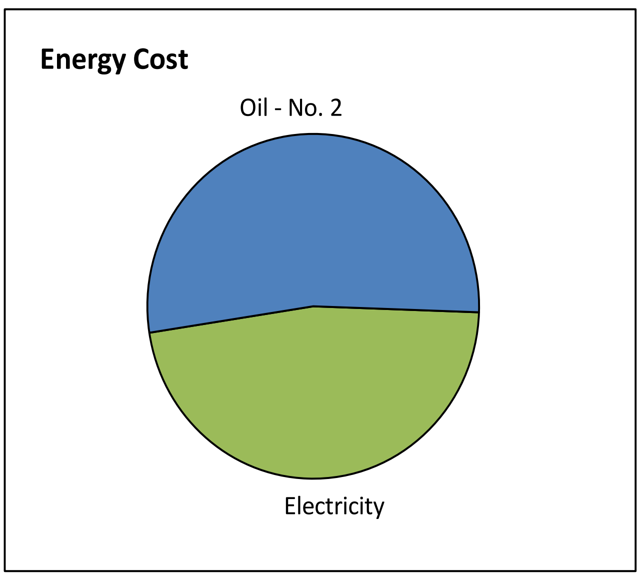
Exterior Lighting Fixtures											
Existing Fixtures						Recommended	Lighting Efficiency Improvements				
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
1	Exterior	3	LED Flood	1	27	No Change	LED Area Light	3	LED Flood	1	27
2	Exterior	3	LED Wallpack	1	9	No Change	LED Relamp	3	LED Wallpack	1	9

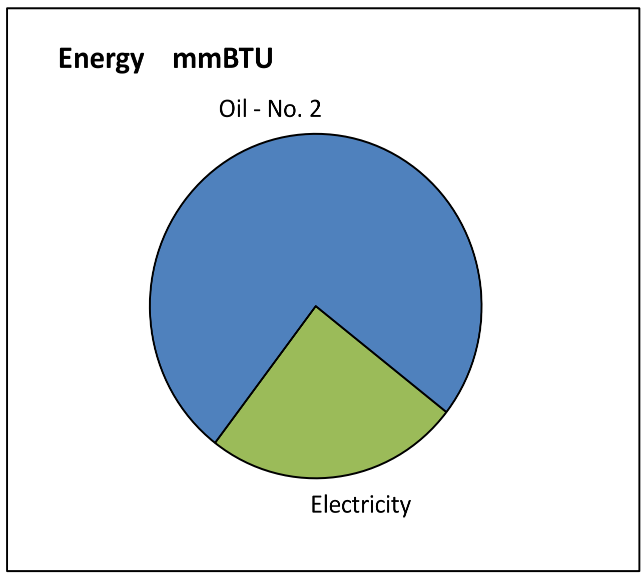
Appendix B

Energy Use and Cost Summary

Energy		Units Used		BTU/unit	mmBTU	% of total	kBtu/sq.ft./year
	Electricity	31,746	kwh	3,412	108	25%	15.6
	Oil - No. 2	2,376	gal.	138,000	328	75%	47.1
	Total				436		62.7

Cost	Energy Cost	Unit Costs		% of total	$/sq.ft./year
Electricity	$ 5,597	$ 0.140	kwh	47%	$ 0.80
Oil - No. 2	$ 6,314	$ 2.658	gal.	53%	$ 0.91
Total	$ 11,911				$ 1.71





Energy Cost Index $ 1.71 /sf/yr. **Energy Use Intensity 62.7 kBTU/sf/yr.**

Utility Bill Data

The following pages present the energy use and cost data for your facility and establish the value of each type of energy. Electricity is measured and billed in units of kilowatt-hours (kWh) that represent the total amount of electricity used in the billing period. Electricity may also be billed based on the highest rate of use, or peak demand, that occurred during the billing period. Electric demand is billed in units of kilowatts (kW).

Other fuels may be billed in volume units (gallons, hundred cubic feet or ccf, etc.) or based on their heat content (therms, equal to 100,000 British Thermal Units). All energy types may be converted into a common unit, such as BTUs, to facilitate analysis and comparison with other facilities. One million BTUs is abbreviated as mmBtu in this report.

ELECTRICITY CONSUMPTION AND COST ANALYSIS

CEC-400097-1-S - Village of Philmont

Gross Area:	6,960	s.f.
	15,563	Btu/s.f./Yr
	$ 0.80	/s.f.
	2.0	watts/s.f.

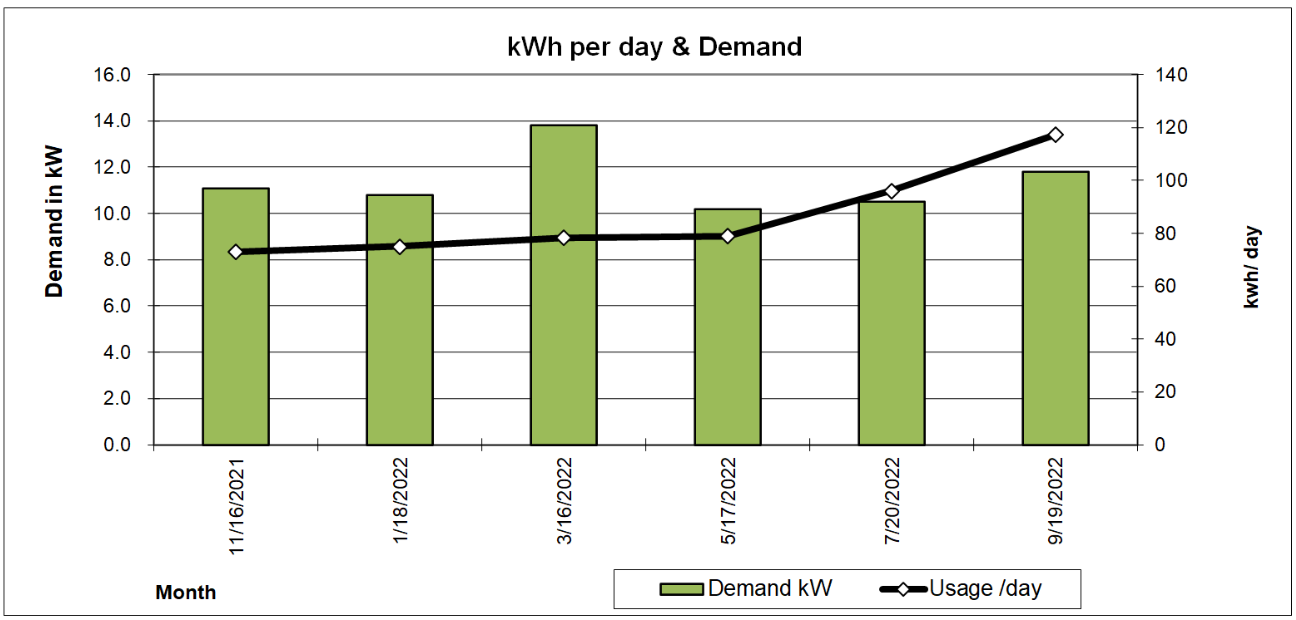
Utility:	NYSEG	
Account #	ends w/ -900	
Rate:	SC 12002 Supply Services	
Meter Charge:	$ 33.00	/ month
Demand Charge:	$ 10.96	/ kW
Supplier:		

Month Ending	Days	Usage Energy kWh	Usage Demand kW	Electricity Charges Utility Cost	Electricity Charges Supply Costs	Total Electricity Cost	Demand Cost	Energy $/kWh	Load Factor	Usage /day
11/16/2021	60	4,381	11.1			$ 703	$ 122	$ 0.118	0.27	73
1/18/2022	63	4,723	10.8			$ 754	$ 118	$ 0.121	0.29	75
3/16/2022	57	4,461	13.8			$ 950	$ 151	$ 0.164	0.24	78
5/17/2022	62	4,887	10.2			$ 809	$ 112	$ 0.129	0.32	79
7/20/2022	64	6,147	10.5			$ 1,032	$ 115	$ 0.138	0.38	96
9/19/2022	61	7,147	11.8			$ 1,349	$ 129	$ 0.161	0.41	117
	367	**31,746**	**68.2**	**$ 0**	**$ 0**	**$ 5,597**	**$ 747**	**$ 0.140**	**0.65**	**87**

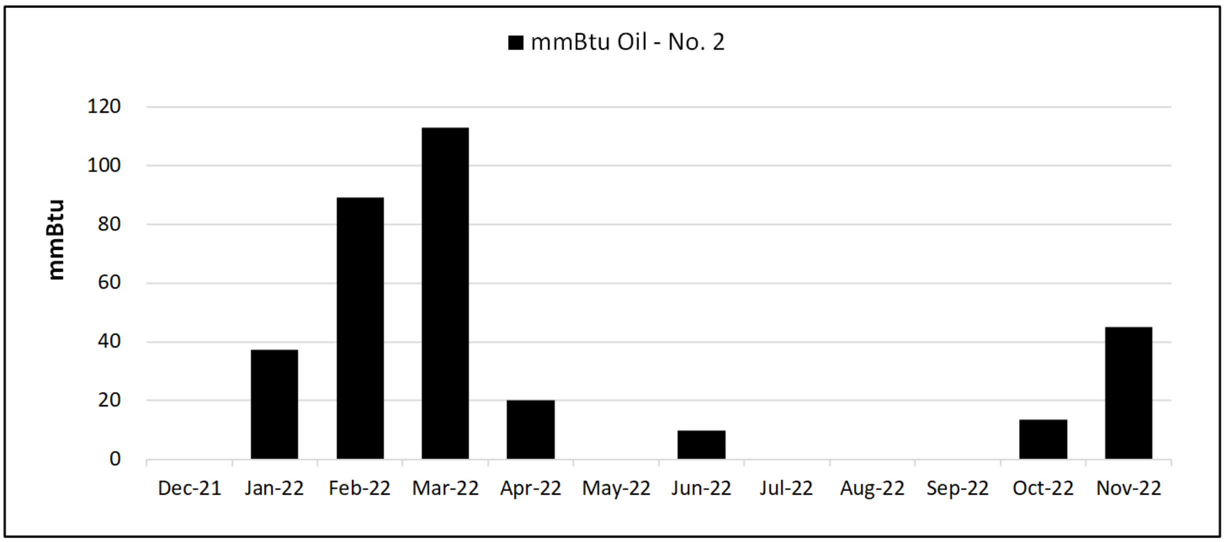
Annual Energy:	**31,746**	**kWh / year**	**$ 5,597**	**/year**
Peak Demand:	**14**	**kW Peak**		
Average Demand:	**11**	**kW**		

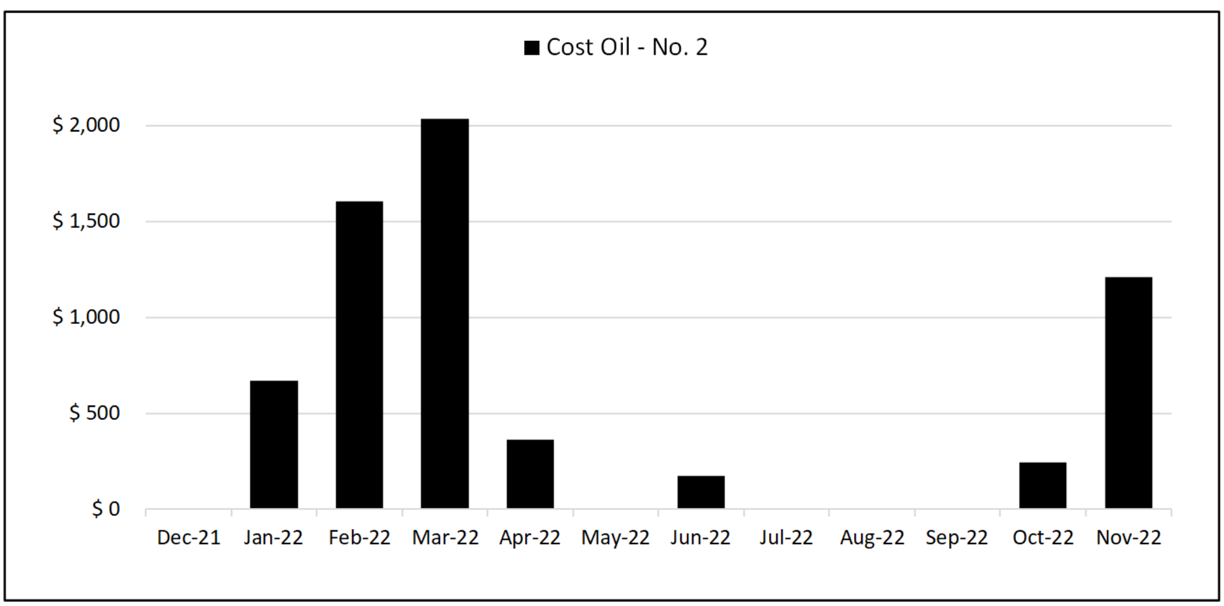
Unit Costs

Demand	**$ 10.96**	**$/kW**
Energy	**$ 0.140**	**$/kWh Incremental**
Blended	**$ 0.176**	**$/kWh Blended**



Month	mmBtu Oil - No. 2	Cost Oil - No. 2
Dec-21	0	$ 0
Jan-22	37	$ 672
Feb-22	89	$ 1,606
Mar-22	113	$ 2,038
Apr-22	20	$ 363
May-22	0	$ 0
Jun-22	10	$ 177
Jul-22	0	$ 0
Aug-22	0	$ 0
Sep-22	0	$ 0
Oct-22	14	$ 246
Nov-22	45	$ 1,211
Total	328	$ 6,314
$/mmBtu	$ 19.26	
BTU/unit	138,000	1 mmBtu = 1,000,000 Btus
kBtu/SF/Yr.	47.1	1 kBtu = 1,000 Btus





Appendix C

EEM Calculations

Interactions

The Energy Efficiency Measure calculations in this section are stand-alone measures that are not interacted with the other calculations. Each measure shows the energy savings that may be expected if it is the only measure to be implemented. If multiple measures will be implemented, energy savings will likely be lower than the calculations represent.

As an example, replacing an 80% efficient boiler with a 92% efficient boiler will reduce the amount of fuel required to heat the building. If the walls and roof are insulated such that the required heating energy is reduced by 30%, the new boiler will serve a smaller heating load, and the energy savings gained from the boiler replacement will be reduced by 30%.

CALCULATIONS FOR INTERIOR LIGHTING RETROFIT

EEM-1 **CEC-400097-1-S - Village of Philmont**

Type:	Units:	Unit cost:	BTU/unit	
Multiple	mmBtu	$ 19.653	1,000,000	
Electricity	kwh	$ 0.140	3,412	
Demand	kW	$ 10.96	12	Months of demand savings/year
50%	of building is air conditioned			

HVAC Adjustment Factors		
Cooling	Demand	Fuel
HVACc	HVACd	HVACg
13.00%	20.00%	-2.60%

Existing Interior Lighting Systems / **Recommended Lighting Controls** / **Recommended Interior Lighting Efficiency Improvements**

Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	% Reduction	Present Hrs./yr.	Proposed Hrs./yr.	# Controls required	Measure Type	Qty	Proposed Lighting Type
Boiler Room	1	CFL13w	1	13	No Change	0%	50	50	0	No change	1	CFL13w
Firehouse Kitchen	3	2x2 LED Panels	1	45	No Change	0%	500	500	0	No change	3	2x2 LED Panels
Firehouse Kitchen	1	4' 32w T8 Elec. bal.	2	59	No Change	0%	500	500	0	New LED Fixture	1	2x2 LED Panels
Firehouse BR's	3	2x2 LED Panels	1	45	No Change	0%	50	50	0	No change	3	2x2 LED Panels
Firehouse	6	8' 110w T12 HO Std. Mag	2	257	No Change	0%	1,000	1,000	0	LED Relamp	6	8' LED T12/8 IS, 33W
Firehouse	1	8' 59w T8 Elec. bal.	2	109	No Change	0%	1,000	1,000	0	LED Relamp	1	8' LED T12/8 IS, 33W
Firehouse	1	2' 17w T8 Elec. bal.	1	20	No Change	0%	1,000	1,000	0	LED Relamp	1	2' LED tube 1150 lu. 7W
Rear Door	1	LED 9w	1	9	No Change	0%	2,500	2,500	0	No change	1	LED 9w
Rear Stair (1 Out)	1	4' 32w T8 Elec. bal.	2	59	No Change	0%	8,760	8,760	0	New LED Fixture	1	4' LED fixture 4500 lu. 42
Village Hall (3 Out)	13	4' 32w T8 Elec. bal.	2	59	No Change	0%	250	250	0	New LED Fixture	13	4' LED fixture 4500 lu. 42
Village Hall Door	1	60 watt Incandescent	2	120	No Change	0%	200	200	0	LED Relamp	1	60 watt Incandescent
Village Hall Kitchen	3	4' 32w T8 Elec. bal.	2	59	No Change	0%	5	5	0	New LED Fixture	3	4' LED fixture 4500 lu. 42
Police Office	3	4' 32w T8 Elec. bal.	2	59	No Change	0%	500	500	0	New LED Fixture	3	4' LED fixture 4500 lu. 42
Police Office (est.)	3	4' 32w T8 Elec. bal.	2	59	No Change	0%	500	500	0	New LED Fixture	3	4' LED fixture 4500 lu. 42
Hallway to Court	4	4' 32w T8 Elec. bal.	1	31	No Change	0%	250	250	0	New LED Fixture	4	4' LED fixture 4500 lu. 42
Hall Bathrooms	2	60 watt Incandescent	2	120	No Change	0%	200	200	0	LED Relamp	2	60 watt Incandescent
Village Court	6	4' 32w T8 Elec. bal.	2	59	No Change	0%	500	500	0	New LED Fixture	6	4' LED fixture 4500 lu. 42
Village Office (3 Out)	12	4' 32w T8 Elec. bal.	2	59	No Change	0%	1,625	1,625	0	New LED Fixture	12	4' LED fixture 4500 lu. 42
Village Office Closet	1	LED 9w	1	9	No Change	0%	50	50	0	No change	1	LED 9w
	66		4.9	kW existing					0		66	

Energy & Demand Calculations (Demand / Total Use / Energy Savings)

Area	Lamps /fixt	Reflect or ?	Watts /Fixt	Project Cost	Annual Savings	kWh/yr. Savings	Payback (Years)	Present kW	Proposed kW	kW Saved	Present kwh/year	Proposed kwh/year	Controls kwh/year	Efficiency kwh/year
Boiler Room	1		13	$ 0	$ 0	0		0.0	0.0	0.0	1	1	0	0
Firehouse Kitchen	1		45	$ 0	$ 0	0		0.1	0.1	0.0	68	68	0	0
Firehouse Kitchen	1		45	$ 120	$ 3	7	42.5	0.1	0.0	0.0	30	23	0	7
Firehouse BR's	1		45	$ 0	$ 0	0		0.1	0.1	0.0	7	7	0	0
Firehouse	2		66	$ 360	$ 311	1,146	1.2	1.5	0.4	1.1	1,542	396	0	1,146
Firehouse	2		66	$ 60	$ 12	43	5.1	0.1	0.1	0.0	109	66	0	43
Firehouse	1		7	$ 14	$ 4	13	4.1	0.0	0.0	0.0	20	7	0	13
Rear Door	1		9	$ 0	$ 0	0		0.0	0.0	0.0	23	23	0	0
Rear Stair (1 Out)	1		42	$ 120	$ 23	149	5.2	0.1	0.0	0.0	517	368	0	149
Village Hall (3 Out)	1		42	$ 1,560	$ 37	55	42.4	0.8	0.5	0.2	192	137	0	55
Village Hall Door	2		120	$ 0	$ 0	0		0.1	0.1	0.0	24	24	0	0
Village Hall Kitchen	1		42	$ 360	$ 7	0	53.4	0.2	0.1	0.1	1	1	0	0
Police Office	1		42	$ 360	$ 10	26	35.0	0.2	0.1	0.1	89	63	0	26
Police Office (est.)	1		42	$ 360	$ 10	26	35.0	0.2	0.1	0.1	89	63	0	26
Hallway to Court	1		42	$ 480	($ 7)	(11)	(65.5)	0.1	0.2	(0.0)	31	42	0	(11)
Hall Bathrooms	2		120	$ 0	$ 0	0		0.2	0.2	0.0	48	48	0	0
Village Court	1		42	$ 720	$ 21	51	35.0	0.4	0.3	0.1	177	126	0	51
Village Office (3 Out)	1		42	$ 1,440	$ 73	332	19.7	0.7	0.5	0.2	1,151	819	0	332
Village Office Closet	1		9	$ 0	$ 0	0		0.0	0.0	0.0	0	0	0	0
	3.1	kW proposed						4.9	3.1	1.9	4,115	2,279	0	1,836
													1,836	kwh

Note: bal. = ballast, EE = energy efficient, STD = standard efficiency, mag. = magnetic, Elec. = electronic, CFL = compact fluorescent lamp

SUMMARY OF SAVINGS BY MEASURE TYPE:

	Measure Type	Fixture Qty.	Energy Savings Controls kwh/year	Energy Savings Efficiency kwh/year	Demand kW Savings	Project Cost	Electric Savings	Payback (Years)	Measure Description
EEM-1C	LED Relamp	11		1,202	1.2	$ 434	$ 326	1.3	Screw-in or Socket based LED lamps
EEM-1G	New LED Fixture	46		634	0.7	$ 5,520	$ 176	31.3	New LED fixture for surface mounting
		66	0	1,836	1.9	$ 5,954	$ 503		

Gross Energy Savings 1,836 kwh

Net Energy Savings **1,955** **kwh** **2.1** **-5 mmBtu** **$ 444** **net**

PAYBACK PERIOD:

Estimated Cost Interior Lighting: $ 5,954 = 13.4 year payback

Annual Energy Savings (kWh + kW): $ 444

CALCULATIONS TO IMPROVE TEMPERATURE CONTROL

EEM-2 CEC-400097-1-S - Village of Philmont

INPUT DATA: 100% of Building to be Setback

		Current	Proposed	
Heating T Setpoint:	Occupied	66	66	deg. F.
	Unoccupied	66	62	deg. F.
Cooling T Setpoint:	Occupied	72	72	deg. F.
	Unoccupied	72	80	deg. F.
HVAC Schedule	Occupied	32.5	32.5	Hours per week
	Unoccupied	135.5	135.5	Hours per week
Q internal gains:	Occupied	14,368	14,368	Btuh
	Unoccupied	5,644	5,644	Btuh
Q internal gains:	Schedule	33	33	Hours per week
BLC:	Occupied	1,771	1,771	Btuh/deg. F.
(excludes DOAS)	Unoccupied	2,213	2,213	Btuh/deg. F.

Fuel Data	Heating	Cooling		
Type:	Oil - No. 2	Electricity	Economizer?	
Units:	gal.	kwh	No	
Unit cost:	$ 2.658	$ 0.140		
BTU/unit	138,000	3,412		
Efficiency/ COP:	88.0%	3.52	Avg. COP. EER:	12.0
		5.0%	cooling setback	

CALCULATIONS:

Current — Newburgh, 33 hrs./week

Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use gal.	Cooling Energy kwh
(2.5)	4	23	106,919	145,965	31	0
2.5	11	52	98,066	134,899	67	0
7.5	17	40	89,213	123,832	53	0
12.5	31	119	80,360	112,766	131	0
17.5	44	229	71,507	101,700	218	0
22.5	45	274	62,654	90,633	228	0
27.5	48	317	53,801	79,567	229	0
32.5	123	651	44,948	68,501	413	0
37.5	142	679	36,095	57,434	363	0
42.5	176	616	27,241	46,368	275	0
47.5	181	639	18,388	35,302	213	0
52.5	122	600	9,535	24,235	129	0
57.5	129	635	682	13,169	70	0
62.5	121	651	0	2,103	11	0
67.5	146	546	(6,400)	0	0	4
72.5	105	351	(15,253)	(6,751)	0	17
77.5	126	281	(24,106)	(17,817)	0	34
82.5	86	190	(32,959)	(28,883)	0	35
87.5	44	100	(41,813)	(39,950)	0	24
92.5	22	42	(50,666)	(51,016)	0	14
97.5	0	2	(59,519)	(62,082)	0	1
102.5	0	0	(68,372)	(73,149)	0	0
107.5	0	0	(77,225)	(84,215)	0	0
112.5	0	0	(86,078)	(95,281)	0	0
	8,760	hours			2,431	127

Proposed — Newburgh, 33 hrs./week

Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use gal.	Cooling Energy kwh
(2.5)	4	23	106,919	137,112	29	0
2.5	11	52	98,066	126,046	63	0
7.5	17	40	89,213	114,979	50	0
12.5	31	119	80,360	103,913	122	0
17.5	44	229	71,507	92,847	201	0
22.5	45	274	62,654	81,780	208	0
27.5	48	317	53,801	70,714	206	0
32.5	123	651	44,948	59,648	365	0
37.5	142	679	36,095	48,581	314	0
42.5	176	616	27,241	37,515	230	0
47.5	181	639	18,388	26,448	167	0
52.5	122	600	9,535	15,382	86	0
57.5	129	635	682	4,316	23	0
62.5	121	651	0	0	0	0
67.5	146	546	(6,400)	0	0	4
72.5	105	351	(15,253)	0	0	7
77.5	126	281	(24,106)	(111)	0	13
82.5	86	190	(32,959)	(11,177)	0	21
87.5	44	100	(41,813)	(22,243)	0	17
92.5	22	42	(50,666)	(33,310)	0	10
97.5	0	2	(59,519)	(44,376)	0	0
102.5	0	0	(68,372)	(55,443)	0	0
107.5	0	0	(77,225)	(66,509)	0	0
112.5	0	0	(86,078)	(77,575)	0	0
	8,760	hours			2,064	72

	Present	Proposed	Savings	
Heating	2,431	2,064	367	gal.
Cooling	127	72	55	kwh
Annual Energy $			$ 982	

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material $/unit	Labor $/unit	Quantity	Total
Wifi thermostat	$ 150	$ 50	5	$ 1,000
				$ 0
				$ 1,000

Implementation Cost:	$ 1,000	= 1 year payback
Annual Energy Savings:	$982	

CALCULATIONS TO INSULATE BUILDING ENVELOPE

EEM-3 **CEC-400097-1-S - Village of Philmont**

INPUT DATA:

	Roof	Walls			
Surface to be insulated:	Roof	Walls			
Area:	3,480	3,759	sq ft		
Present R value:	19.0	5.0			
Revised R value	39.0	19.0			
Present U factor::	0.053	0.200	Btuh/sq ft-deg F		
Revised U factor:	0.026	0.053	Btuh/sq ft-deg F		
Present U x Area	183	752		935	UA Total present
Proposed U x Area	89	198		287	UA Total proposed

CALCULATIONS:	Occupied	Unoccupied	**Fuel Data**	Heating	Cooling
Heating Setpoint:	66	66	Type:	Oil - No. 2	Electricity
Cooling Setpoint:	72	72	Units:	gal.	kwh
Q internal gains (Btuh):	14,368	5,644	Unit cost:	$ 2.658	$ 0.140
BLC (Btuh/degree F):	1,771	2,213	BTU/unit	138,000	3,412
T Balance (°F.):	57.9	63.4	Efficiency/ COP:	88.0%	351.7%
T Balance = T Setpoint - (Q internal gains / BLC)			EER:		12.0

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat Loss	Change in Unoccupied Heat Loss	Heating Savings gal.	Cooling Savings kwh
(2.5)	4	23	44,380	44,380	10	0
2.5	11	52	41,141	41,141	21	0
7.5	17	40	37,901	37,901	18	0
12.5	31	119	34,662	34,662	43	0
17.5	44	229	31,422	31,422	71	0
22.5	45	274	28,183	28,183	74	0
27.5	48	317	24,943	24,943	75	0
32.5	123	651	21,704	21,704	138	0
37.5	142	679	18,465	18,465	125	0
42.5	176	616	15,225	15,225	99	0
47.5	181	639	11,986	11,986	81	0
52.5	122	600	8,746	8,746	52	0
57.5	129	635	5,507	5,507	35	0
62.5	121	651	0	2,268	12	0
67.5	146	546	0	0	0	0
72.5	105	351	(324)	(324)	0	12
77.5	126	281	(3,563)	(3,563)	0	121
82.5	86	190	(6,803)	(6,803)	0	156
87.5	44	100	(10,042)	(10,042)	0	121
92.5	22	42	(13,282)	(13,282)	0	71
97.5	0	2	(16,521)	(16,521)	0	3
102.5	0	0	(19,760)	(19,760)	0	0
107.5	0	0	(23,000)	(23,000)	0	0
112.5	0	0	(26,239)	(26,239)	0	0
	8,760	hours		Energy Savings:	854	484
					$ 2,269	$ 68

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
Roof	$ 15.00	3,480	$ 52,200
Walls	$ 40.00	3,759	$ 150,359
	$ 0.00	7,239	$ 0

Implementation Cost:	$ 202,559	= 86.7 year payback
Annual Energy Savings:	$ 2,337	

CALCULATIONS FOR WEATHER-STRIPPING AND CAULKING

EEM-4 **CEC-400097-1-S - Village of Philmont**

INPUT DATA:

Bldg. Volume	69,600	cubic feet		Present infiltration		
		ACH	Period	Cu. ft./hr.	CFM	btuh/deg.
Baseline infiltration rate		0.50	Occupied	34,800	580	626
from heat loss study		0.50	Unoccupied	34,800	580	626
Proposed Reductions	Crack Length	Leakage Rate - cfh		Leakage - net cfh		
Cubic feet per hour	lineal feet	Present	New	Present	Proposed	Savings
Roof - Wall Joint				0	0	0
Window Jamb to Wall				0	0	0
Operable Window WS	8	60	5	240	20	220
Door Sweeps & WS	60	60	5	1,800	150	1,650
Fireplace				0	0	0
				2,040	170	1,870
Proposed Reductions	Air changes/Hour			Proposed infiltration		
Air changes/hour	% reduction	Proposed	Period	Cu. ft./hr.	CFM	btuh/deg.
	5%	0.47	Occupied	32,930	549	593
	5%	0.47	Unoccupied	32,930	549	593
Total Infiltration & Reduction	**Occupied**	**34,800**	**32,930**	**1,870**	cfh savings	
Cu.Ft./hour	**Unoccupied**	**34,800**	**32,930**	**1,870**	cfh savings	

CALCULATIONS:

Leakage = 1/2 x Crack Length x Leakage Rate ***-or-*** ACH x Building Volume
Energy Savings = (Present Leakage - New Leakage) x Accum Hours x Temp Difference x CF2
Energy Cost Savings = (Energy Savings / CF1) x (Unit cost / Efficiency)

	Occupied	Unoccupied	
T Setpoint:	66	66	°F
Q internal gains:	14,368	5,644	Btuh
BLC:	1,771	2,213	Btuh/°F
T Balance:	57.9	63.4	°F. T Balance = T Setpoint - (Q internal gains / BLC)
Bin Data for Newburgh, 33 hrs./week			
Accumulated Hours	1,073	5,525	below balance temp.
Avg. OAT	39.9	42.1	°F below balance temp.
(T Set- Avg OAT)	26.1	23.9	°F difference

Type:	Oil - No. 2	
Units:	gal.	
Unit cost:	$ 2.658	/gal.
CF1	138,000	Btu/gal.
Efficiency:	88.0%	
CF2	0.018	Btu/hr-°F-cfh

	Energy Use - Btu/year			Fuel Use	
	Occupied	Unoccupied	Total	gal. / yr	
Baseline infiltration rate	17,514,500	82,714,600	100,229,100	825	
Proposed infiltration rate	16,573,300	78,269,800	94,843,100	781	
			Total Savings	44	$ 118

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Matl. & Labor ($ / lin ft)	Quantity (lin ft)	Total	
Weather-stripping	$ 5.00	68	$ 340	
Caulking		0	$ 0	
Air Sealing			$ 0	
	Implementation Cost:		$ 340	= 2.9 year payback
	Annual Energy Savings:		$ 118	

CALCULATIONS TO INSTALL INSULATED DOORS
EEM-5 CEC-400097-1-S - Village of Philmont

INPUT DATA:

Type & Qty.	Rear Door	1
	Present	Proposed
Area:	21	sq ft total
Perimeter:	20	20
Infilt. rate:	60	5
R value:	2.0	2.8
U factor:	0.500	0.357
U x Area	11	8

	Present	Proposed	Change	
Total UA	11	8	3	Btuh/deg F
Infiltration Load	11	1	10	Btuh/deg F
	21	8	13	Btuh/deg F

CALCULATIONS:

	Occupied	Unoccupied	Fuel Data	Heating
Heating Setpoint:	66	66	Type:	Oil - No. 2
Cooling Setpoint:	72	72	Units:	gal.
Q internal gains (Btuh):	14,368	5,644	Unit cost:	$ 2.658
BLC (Btuh/degree F):	1,771	2,213	BTU/unit	138,000
T Balance (°F.):	57.9	63.4	Efficiency/ COP:	88.0%
T Balance = T Setpoint - (Q internal gains / BLC)			EER:	

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat Loss	Change in Unoccupied Heat Loss	Heating Savings gal.
(2.5)	4	23	884	884	0
2.5	11	52	819	819	0
7.5	17	40	755	755	0
12.5	31	119	690	690	1
17.5	44	229	626	626	1
22.5	45	274	561	561	1
27.5	48	317	497	497	1
32.5	123	651	432	432	3
37.5	142	679	368	368	2
42.5	176	616	303	303	2
47.5	181	639	239	239	2
52.5	122	600	174	174	1
57.5	129	635	110	110	1
62.5	121	651	0	45	0
67.5	146	546	0	0	0
72.5	105	351	(6)	(6)	0
77.5	126	281	(71)	(71)	0
82.5	86	190	(135)	(135)	0
87.5	44	100	(200)	(200)	0
92.5	22	42	(264)	(264)	0
97.5	0	2	(329)	(329)	0
102.5	0	0	(393)	(393)	0
107.5	0	0	(458)	(458)	0
112.5	0	0	(522)	(522)	0
	8,760	hours		Energy Savings:	17
					$ 45

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / each)	Quantity	Total
Rear Door	$ 1,500	1	$ 1,500
			$ 0
			$ 0

Implementation Cost:	$ 1,500	= 33.2 year payback
Annual Energy Savings:	$ 45	

CALCULATIONS TO INSTALL DOUBLE GLAZING

EEM-6 **CEC-400097-1-S - Village of Philmont**

Type:	Oil - No. 2
Units:	**gal.**
Unit cost:	**$ 2.658** /gal.
Heat Content of Fuel	**138,000** Btu/gal.
Combustion Efficiency:	88%

DATA:

	Occupied	Unoccupied	
T Setpoint:	**66**	**66**	degrees F
Q internal gains:	**14,368**	**5,644**	Btuh
BLC:	**1,771**	**2,213**	Btuh/degree F
T Balance:	57.9	63.4	degrees F

T Balance = T Setpoint - (Q internal gains / BLC)

Glazing Information

Present Conditions	Single pane windows in the firehouse with leaks		double glazed windows in the Village Office with leaks	
Present Area:	**100**	sq ft	**30**	sq ft
U factor:	**1.16**	Btuh/sq ft-deg F	**1.16**	Btuh/sq ft-deg F
Crack Length:	136	feet	46	feet
Present Infiltration:	60	cfh	60	cfh
Proposed Conditions	Double pane sealed windows		new weatherstripping	
Proposed Area:	**100**	sq ft	**30**	sq ft
New U factor:	0.25	Btuh/sq ft-deg F	1.16	Btuh/sq ft-deg F
New Crack Length:	136	feet	46	feet
Proposed Infiltration:	5	cfh	5	cfh

Bin Data for Newburgh, 33 hrs./week

	T Setpoint	T Balance	Accum Hours	Average O.A. Temp below T Balance	Temp Difference (T Set- Avg OAT)
Occupied	66	57.9	**1,073**	**39.9**	26.1
Unoccupied	66	63.4	**5,525**	**42.1**	23.9

CALCULATIONS:

Conduction Savings = (AreaPr x Upr) - (AreaRev x Urev + AreaInfill x Uinfill) x Accum Hours x Temp Differenc

Infiltration Savings = 1/2 x 0.018 x {(LengthPr x Ipr) - (Length Rev x Irev)} x Accum Hours x Temp Difference

Energy Cost Savings = (Energy Savings / Conversion Factor) x (Unit cost / Efficiency)

Winter	Conduction Savings (Btu/year)	Infiltration Savings (Btu/year)	Total Savings (Btu/year)	Total Annual Fuel Savings (gal./year)	Energy Cost Savings ($/year)
Occupied	2,544,000	2,514,000	5,058,000	42	$ 111
Unoccupied	12,016,000	11,874,000	23,890,000	197	$ 523
Annual Savings:	14,560,000	14,388,000	28,948,000	238	$ 634

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor	Quantity	Total	
Double Pane Windows ($/sf)	$ 45	100	$ 4,486	
Weatherstripping ($/LF)	$ 5	46	$ 230	
	Implementation Cost:		$ 4,716	= 7.4 year payback
	Annual Energy Savings:		$ 634	

CALCULATIONS TO INSULATE HEATING AND DOMESTIC HOT WATER PIPES

EEM-7 CEC-400097-1-S - Village of Philmont

Input Data

Fuel Information	Type:	Units:	Unit cost:	BTU/unit	Efficiency
Heating System	Oil - No. 2	gal.	$ 2.658	138,000	88%
DHW System	Electricity	kwh	$ 0.140	3,412	100%

	Type #1	Type #2			
Fluid	Hot Water	DHW			
Pipe Material	Bright Copper	Dull Copper			
O.D., inches (d)	2.00	0.75			
Total Length, ft	130	20			
Fluid Temperature Inside Pipe, °F (Ts)	110	115			
Ambient Temperature, °F (Ta)	65	65			
Annual Operating Hours	782	200			
New Insulation Thickness, inches	1.5	1.0			
Thermal Conductivity - "k" (Btu-in/hr-sq ft-°F)	0.250	0.260			
Heat Loss - Bare Pipe					
C factor	1.016	1.016			
emissivity based on pipe material	0.08	0.44			
Outside Radius Pipe, inches (Ri)	1.00	0.38			
h convection, Btu/hr - s.f. pipe surface area -°F	1.08	1.35			
h radiation, Btu/hr - s.f. pipe surface area - °F	0.09	0.50			
h total	1.17	1.85			
Pipe area, sq ft/lin ft of pipe	0.523	0.196			
Q bare, Btu/hr-lin ft	**28**	**18**			
Heat Loss - Insulated Pipe					
Outside Radius Insulation, inches (Rs)	2.50	1.38			
Q i, Btu/hr-sq ft of outer area of insulation	4.9	7.3			
Insulation Area - sq ft/lin ft of pipe	1.3	0.7			
Q insul, Btu/hr-lin ft	**6.4**	**5.2**			
Avoided Energy Loss					
Existing Loss - mmBtu/year	2.8	0.1			
Proposed Loss - mmBtu/year	0.7	0.0			
Avoided Loss - mmBtu/year	2.2	0.1			

Total Avoided Fuel Consumption

			Type #1	Type #2
18	15	Units Saved	18	15
Oil - No. 2	Electricity	Fuel Type	Oil - No. 2	Electricity
$ 49		$/year	**$ 47**	**$ 2**

Formulae:

Based on ASHRAE 1993 Fundamentals Handbook pages 20.9 and 22.17

h convection = C x {(1 / d) ^ 0.2} x { (1 / ((Ts + Ta)/2)) ^ 0.181 } x { (Ts - Ta) ^ 0.266 }

h radiation = { emissivity x 0.1713 x 10 ^ -8 x [(Ta + 460) ^ 4 - (Ts +460) ^ 4]} / (Ta - Ts)

Q bare = h total x Pipe Area x (Ts - Ta)

Q i = (Ts - Ta) / { [Rs x (ln (Rs / Ri)] / k }

Q insul = Q i x Insul Area

Total Avoided Consumption = (Q bare - Q insul) x Total length of pipe x Annual Operating Hours

Payback Period:

Implementation Cost:	$ 1,130	= 22.9 years payback
Annual Energy Savings:	$ 49	

CALCULATIONS TO INSTALL A MORE EFFICIENT BOILER

EEM-8 CEC-400097-1-S - Village of Philmont

INPUT DATA:

Present Annual Heating Fuel Consumption:	2,376	gal.s	
% of Building Served by Boiler	100%		
Boiler Fuel Use	2,376	gal.s	

Fuel Data	Present		Proposed	
Type:	Oil - No. 2		Oil - No. 2	
Units:	gal.		gal.	
Unit cost:	$ 2.658	/gal.	$ 2.658	/gal.
BTU/Unit	138,000	Btu/gal.	138,000	Btu/gal.

Boiler Type	Present		Proposed	
Boiler Firing Rate	256	kBtuh Input	256	kBtuh Input
Combustion Efficiency	88.0%		96.0%	annual avg.
Jacket Losses	1.5%	of capacity	1.0%	of capacity
Boiler Capacity	**221**	kBtuh Output	**243**	kBtuh Output
Off-cycle Flue Losses	2.0%	of capacity	0.5%	of capacity
Boiler is hot when OAT<	65	°F.	65	°F.
Hours/ Yr. Unit is Hot	5,288	hrs.	5,288	hrs.
Off-Cycle Hours/Year	4,007	hrs.	4,205	hrs.
Standby Losses	18	MMBtu	13	MMBtu
Off-Cycle Flue Losses	18	MMBtu	5	MMBtu
Useful Heat Output	253	MMBtu	253	MMBtu

CALCULATIONS:

Off-Cycle Flue Losses = Boiler kBtuh Output x 1000 x % Off-Cycle Flue Losses x Hrs Off-Cycle per Year / 1,000,000

Jacket Losses = Boiler kBtuh Output x 1000 x % Jacket Losses x Hrs Hot per Year / 1,000,000

Useful Heat Output = Htg Fuel Use x BTU per Unit x Present Efficiency / 1,000,000 - Off Cycle Losses - Jacket Loss

Proposed Annual Fuel Consumption =

(Proposed Standby Losses + Useful Heat Output) / Proposed Efficiency x 1,000,000 / BTU per Unit

	Annual Fuel Consumption		Annual Cost
Present:	2,376	gal.	$ 6,315
Proposed:	2,047	gal.	$ 5,441
Annual Savings:	329	gal.	$ 874

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Quantity	Material	Labor	Total
New Boiler	1	$ 9,000	$ 5,000	$ 14,000
	0	$ 0	$ 0	$ 0
Totals:				$ 14,000

Implementation Cost	$ 14,000	= 16 year payback
Annual Energy Savings	$ 874	

CALCULATIONS TO REPLACE AIR CONDITIONERS

EEM-9 **CEC-400097-1-S - Village of Philmont**

INPUT DATA

kWh:	$ 0.140	per kWh
Demand:	$ 10.96	per kW
months /yr. demand:	5	
Coincidence Factor CF:	0.80	

Location or Area Served	Village Office	Court	Firehouse		
Unit Tag	Split System	Wall	Wall		
tons/unit	1.9	1.0	0.4		
# of Units	1	1	1		
Unit Type (AC or HP)	AC	AC	AC		
EFLH cool	574	574	574		
EFLH heat					
Present Efficiency EER *	11.0	9.0	11.0		
Present Efficiency SEER *	16.4	11.0	11.2		
Present Heating COP					
Air Side Economizer?					
Proposed Efficiency EER **	14.0	11.6	11.6		
Proposed Efficiency SEER **	20.0	15.7	15.7		
Proposed Heating COP	n/a	n/a	n/a		
Air Side Economizer?					
Economizer savings kwh/ton	-	-	-		

CALCULATIONS:						Sum
Present kwh/year Cooling	805	626	256			1,687
Present kwh/year Heating	-	-	-			-
Proposed kwh/year Cooling	660	439	183			1,282
Proposed kwh/year Heating	-	-	-			-
Efficiency ΔkWh =	145	187	73			406
Economizer ΔkWh =	-	-	-			0
Demand Savings						
Present kW (peak)	1.7	1.1	0.4			3.1
Proposed kW (peak)	1.3	0.8	0.3			2.5
ΔkW =	0.4	0.2	0.0			0.6

FORMULAE:

New York Standard Approach for Estimating Energy Savings-Residential, Multi-Family and Commercial/Industrial Measures:

ΔkWh eff cooling = units x tons/unit x (12/SEERbase-12/SEERee) x EFLHcooling

ΔkWh eff heating = units x kBtuh/unit /3.412 x (1/COPbase-1/COPee) x EFLHheating

ΔkWh econ = units x tons/unit x kwh economizer savings per ton (from Tech Manual Appendix J)

ΔkW = units x tons/unit x (12/EERbase-12/EERee) x CF

EFLHcool = Annual kWhcooling/kWpeak cooling without economizer (from Appendix G)

** Present EER and SEER are based on 2000*

*** Proposed EER and SEER are based on NYSECCC (IECC-2015)*

Existing Energy Consumption	1,687	kwh/yr	3.1	kW peak
Proposed Energy Consumption	1,282	kwh/yr	2.5	kW peak
Annual Energy Savings	406	kwh/yr	0.6	kW peak

IMPLEMENTATION COST AND PAYBACK PERIOD:

Replacement cost is estimated at $ 2,000 per installed ton of capacity

Implementation Cost	$6,667	= 73.6 years payback
Annual Energy Savings	$91	

CALCULATIONS TO TURN OFF UNUSED REFRIGERATORS

EEM-10 CEC-400097-1-S - Village of Philmont

	Electricity
Unit cost:	$ 0.140 /kwh

INPUT DATA:

			kwh per year each			Annual kWh
Qty	cu.ft.	Type	Present	Proposed	Savings	Savings
1	19	Refrigerator w/ top freezer	569	0	569	569
				0	0	0
				0	0	0
				0	0	0
						569

CALCULATIONS:

	Annual		Annual	
	Energy use		Energy cost	
Present:	569	kwh	$ 80	
Proposed:	0	kwh	$ 0	
Annual Savings:	569	kwh	$ 80	per year

IMPLEMENTATION COST:

Cu.Ft.	Description		Qty	Material	Labor	Total
19	Refrigerator w/ top freezer		1	$ 0	$ 0	$ 0
0		0	0	$ 0	$ 0	$ 0
0		0	0	$ 0	$ 0	$ 0
0		0	0	$ 0	$ 0	$ 0
	Totals:		1			$ 0

PAYBACK:

Implementation Cost	$ 0	= 0 year payback
Annual Energy Savings	$ 80	

CALCULATIONS TO INSTALL CLEAN HEATING SYSTEM - GROUND SOURCE HEAT PUMP							
BE-1	**CEC-400097-1-S - Village of Philmont**						
			Fuel Information				
Building Information	Assembly			Heating	Cooling		
Location	Poughkeepsie	Climate Zone 5	Type:	Multiple	Electricity		
Portion of Building HP will serve:	100%		Units:	mmBtu	kwh		
Building Heating Load (BHL)	151,609	BTU/h	Unit cost:	$ 19.653	$ 0.140	/kwh	
Building Cooling Load (BCL)	76,420	BTU/h	BTU/unit	1,000,000	3,412	/kwh	
BEFLHheating	1,947	Hours	Heating Eff.	88%	$ 10.96	/kW	
BEFLHcooling	248	Hours	CO2	0.00	1.16	lbs/unit	
Existing System							
Is baseline heating system electric?	N						
Is baseline heating system fossil fuel?	Y						
Present Heating System	Boiler, Steam, Oil Fired < 300 kBTU/h						
Present Cooling System	Split System – Air Conditioner (<65 kBTU/h)						
% of Portion to be served by GSHP that is presently cooled		100%					
Proposed System							
GSHP Loop Type	Closed Loop	GLHP					
GSHP Compressor Type	Variable-Speed	0.40	Capacity Ratio				
Estimated Pump Power	60 watts per ton						
Pumping Control Strategy	Variable						
Heating Capacity	160,000	BTU	rating condition				
Energy Efficiency Ratio Full Load	17.0	EER GLHP,full	77	° EWT			
Energy Efficiency Ratio Part Load	22.0	EER GLHP,part	68	° EWT			
Heating COP Full Load	3.6	COP GLHP,full	32	° EWT			
Heating COP Part Load	4.1	COP GLHP,part	41	° EWT			
Adjusted Efficiency Values	Baseline	Energy Efficient					
EERseason,baseline	13.0	18.51	EERseason,ee				
EERpeak,baseline	11.2	17.0	EER GSHP, full,ee				
COPseason,baseline	1.00	3.60	COPseason,ee				
FElecHeat	0.00						
EFFbaseline	0.88	0.69	CF				
FFuelHeat	1.00						
					Savings	Savings	
	Baseline	Energy Efficient	Savings	Units	$	CO2 Lbs/yr.	
Cooling Electric Use (kWh/yr.)	1,457	1,023	434	kWh			
Heating Electric Use (kWh/yr.)	0	24,004	(24,004)	kWh			
Total Electric Use (kWh/yr.)	**1,457**	**25,028**	**(23,570)**	**kWh**	**($ 3,300)**	**(27,342)**	
Peak Demand (kW)	4.7	3.1	1.6	kW	($ 348)		
Fossil Fuel Energy Use (MMBTU)	335	0	335	MMBtu			
Fossil Fuel Energy Use : mmBtu	**335**	**0**	**335**	**mmBtu**	**$ 6,592**	**0**	
Annual Energy Costs	**$ 6,989**	**$ 4,045**	**$ 2,944**		$ 2,944	(27,342)	
Estimated Project Cost	**$ 14,568**	**per ton =**	**$ 184,050**	**63**	**year payback**		

CALCULATIONS TO INSTALL A HEAT PUMP WATER HEATER

BE-2 **CEC-400097-1-S - Village of Philmont**

INPUT DATA:					
		Present Fuel		Proposed Fuel	
	Fuel:	**Electricity**		Electricity	
	Units:	kwh		kwh	
	Fuel Cost:	$ 0.14	per kwh	$ 0.14	per kwh
	BTU / unit:	3,412	Btu per kwh	3,412	Btu per kwh
Annual DHW Consumption:		Present		Proposed	
	Hot Water Usage:	**0.5**	Gallons/person	0.5	Gallons/person
	Number of persons:	**3**	(estimate)	3	(estimate)
	Days of Usage:	**365**	per year	365	per year
	Average inlet water Temp:	56	degrees F	56	degrees F
	Average hot water temp:	115	degrees F	115	degrees F
Storage Tank Losses:		Present Tank		Proposed Tank	
	Tank U factor:	0.15	Btu/SF/Hour	0.15	Btu/SF/Hour
	Height of Tank:	47.0	inches	47.0	inches
	Diameter of Tank:	18.0	inches	18.0	inches
		40	gallons/tank	40	gallons/tank
	# of Tanks	1	Qty.	1	Qty.
	Hours Tank is Hot:	8,760	Hours	8,760	
	Water Temperature:	125	Deg. F.	125	
	Ambient Temperature:	65	Deg. F.	65	
Recirculation Losses:		0.0%	of boiler capacity =	0	BTUh
		8,760	hours/year	8,760	hours/year =
Boiler Jacket & Flue Losses:					
	Burner Input	15	BTUH	15	BTUH
	Efficiency:	**92.0%**		400.0%	
	Boiler Output Capacity	14	BTU output	61	BTU output
	Jacket & Flue Losses:	0.0%	of boiler capacity	0.0%	of boiler capacity
	Boiler is Hot:	8,760	hours/year	8,760	hours/year =
CALCULATIONS:					
		Present		Proposed	
	Consumption Energy:	269,577	BTU output rqd/yr	269,577	BTU output rqd/yr
	Tank Energy Losses:	1,729,995	BTU/year	1,729,995	BTU/year
	Recirculation Losses:	0	BTU/year	0	BTU/year
	Boiler Jacket Losses:	0	BTU/year	0	BTU/year
	Output BTU/Year	1,999,572		1,999,572	
	Annual Fuel Consumption	637	kwh	147	kwh
	Demand	0	billed kW /yr.	0	kW
	Annual Fuel Cost	$ 93		$ 21	
	Annual Savings:	**490**	**kwh**	**$ 73**	**per year**
		0			
		0	billed kW /yr.		

IMPLEMENTATION COST & PAYBACK PERIOD:

Item		Quantity	Matl. & Labor Cost	Total	
		1	$ 4,500	$ 4,500	
		Implementation Cost:		**$ 4,500**	**= 61.9 year payb**
		Annual Energy Savings:		**$ 73**	

Appendix D

Assumptions/Data Used to Develop Energy and Dollar Savings Figures

Building and Occupancy Information

		Avg. # of occupants	Heating Setpoint	Cooling Setpoint	% of base electricity use resulting in internal heat gains	
Floor Area: 6,960 square feet	days /occupied	3	66	72	days	100%
	nights/unoccupied	0	66	72	nights	100%
	# of computers	5				

Interior lighting, people and occupied levels of internal loads occur for 32.5 hours per week

Electricity use at night is usually 20% of the usual electricity use during day periods

(This results in an average daytime kW that is 73% of the peak metered kW)

Heating System Information

		% of bldg. served	COP heat	EER	Heat kBTUH	Heating Fuel	Efficiency	
Primary system:	Non-Condensing Boiler	97%	0.88	12.00	256	Oil - No. 2	88.0%	Et
Secondary:	Air Source Heat Pump	3%	3.80	12.50	29	Electricity	380.0%	Et

50% of building is air conditioned. Does the cooling system have economizer? No

Describe the **direct outside air** or **central make-up air** system: Fuel ______ Eff. ______ EER for DOAS

______ cfm outside air, running hours / week ______ heat recovery efficiency

Domestic Hot Water

	Fuel	Efficiency						
DHW system energy type	Electricity	92%	Is there a pump to circulate DHW?		Yes			
Hot Water usage is	0.5	gallons per	person	/ day for	3	persons on	365	days/year

Weather & Schedule Information:

Select nearest weather station for bin data:	NEWBURGH		for TRM:	Poughkeepsie
Base temperature for heating degree days:	65 °F. yields	6,359 HDD base65	for TRM:	Assembly
Base temperature for cooling degree days:	70 °F. yields	478 CDD base70	for TRM:	AC with Gas Heat

Present Schedule for Occupied/Day HVAC setpoints

Day of week		Start	End	Hours
Sun	1	12:00 AM	12:00 AM	-
Mon	2	7:30 AM	2:30 PM	7.0
Tue	3	7:30 AM	2:30 PM	7.0
Wed	4	7:30 AM	2:30 PM	7.0
Thu	5	7:30 AM	2:30 PM	7.0
Fri	6	7:30 AM	12:00 PM	4.5
Sat	7	12:00 AM	12:00 AM	-
Newburgh, 33 hrs./week				32.5
				135.5

Proposed Schedule for Occupied/Day HVAC setpoints

Day of week	Start	End	Hours
1	12:00 AM	12:00 AM	-
2	7:30 AM	2:30 PM	7.0
3	7:30 AM	2:30 PM	7.0
4	7:30 AM	2:30 PM	7.0
5	7:30 AM	2:30 PM	7.0
6	7:30 AM	12:00 PM	4.5
7	12:00 AM	12:00 AM	-
Newburgh, 33 hrs./week			32.5

Bin Data for Newburgh, 33 hrs./week

Mid Point	Enthalpy all hours	Present Occupied Hours	Present Unoccupied Hours	Occ enthalpy	Unocc enthalpy
-2.5	0.1	4	23	0.2	0.0
2.5	1.5	11	52	1.4	1.5
7.5	2.6	17	40	2.6	2.7
12.5	4.0	31	119	3.7	4.0
17.5	5.5	44	229	5.4	5.5
22.5	7.2	45	274	7.1	7.3
27.5	8.8	48	317	8.8	8.8
32.5	10.9	123	651	10.6	10.9
37.5	12.6	142	679	12.5	12.7
42.5	14.9	176	616	14.5	15.0
47.5	17.1	181	639	16.5	17.3
52.5	19.5	122	600	18.8	19.6
57.5	21.6	129	635	21.0	21.7
62.5	24.7	121	651	23.3	25.0
67.5	28.0	146	546	26.2	28.4
72.5	30.1	105	351	28.1	30.7
77.5	30.8	126	281	29.8	31.3
82.5	33.4	86	190	32.9	33.6
87.5	35.4	44	100	36.1	35.1
92.5	39.4	22	42	39.8	39.2
97.5	39.9	0	2		39.9
102.5	0.0	0	0		
107.5	0.0	0	0		
112.5	0.0	0	0		
		1,723	7,037		

ESTIMATE OF BUILDING LOAD COEFFICIENT & TRUE-UP TO BILLED ENERGY USE

CEC-400097-1-S - Village of Philmont

Village Hall

124 Main Street, Philmont, NY 12565

Building Information

Width (typical)	39	feet	Building Floor Area	6,960	sq. ft.
Equivalent Length	90	feet	Roof Area	3,480	sq. ft.
Number of Floors	2.0	floors	Gross Wall Area	5,147	sq. ft.
Avg. Floor to Floor Height	10	feet per floor	Building Volume	69,600	cubic feet
Roof or Ceiling rise is	0	feet in 12' run			

Estimate of Conductive Heat Loss

Surface			Area	R-value	U Factor	U x A Btuh/deg. F.	% of BLC w/o ventilation
Roof	n/a		3,480	19.0	0.053	183	8%
Walls	73.0%	of GWA	3,759	5.0	0.200	752	34%
Glazing 1	15.0%	of GWA	772	2.0	0.500	386	17%
Glazing 2	1.9%	of GWA	100	0.86	1.163	116	5%
Doors 1	4	9x12 doors	432	4.0	0.250	108	5%
Doors 2	4	3x7 doors	84	2.0	0.500	42	2%
	Total Exterior Surface Area		8,627	sq.ft.		1,587	72%

		ACH	equiv. cfm	Btuh/deg. F.	BLC (without ventilation)	
Est. Infiltration Rate	Occupied	0.50	580	626	1,771	Btuh/deg. F. Occupied
Est. Infiltration Rate	Unoccupied	0.50	580	626	2,213	Btuh/deg. F. Unoccupied

		cfm	Fraction	Btuh/deg. F.	**Total BLC with Ventilation**	
Est. Ventilation Rate	Occupied	0	100%	0	**1,771**	**Btuh/deg. F. Occupied**
Est. Ventilation Rate	Unoccupied		100%	0	**2,213**	**Btuh/deg. F. Unoccupied**

Heat Gain Estimation

Estimated Solar Gain 20% of building heat loss during occupied periods will be met by solar gains

		kW	# People	Total BTUH	Hours/wk.
Loads & People	Occupied	**4.0**	**3**	14,368	32.5
	Unoccupied	**1.7**	**0**	5,644	135.5

Heat Loss Study - continued

CEC-400097-1-S - Village of Philmont
Village Hall
124 Main Street, Philmont, NY 12565

Fuel Data	Heating	Cooling	
Type:	Oil - No. 2	Electricity	Economizer?
Units:	gal.	kwh	No
Unit cost:	$ 2.658	$ 0.140	
BTU/unit	138,000	3,412	
Nom. Eff, COP	0.88	3.517	COP
Avg. Eff, COP	0.92	4.56	Avg. COP
		12.0	EER
		50%	of bldg. cooled

		Current	
Heating T Setpoint:	Occupied	66	deg. F.
	Unoccupied	66	deg. F.
Cooling T Setpoint:	Occupied	72	deg. F.
	Unoccupied	72	deg. F.
HVAC Schedule	Occupied	33	Hrs. per week
	Unoccupied	136	Hrs. per week
Q internal gains:	Occupied	14,368	Btuh
	Unoccupied	5,644	Btuh
Q internal gains:	Schedule	33	Hrs. per week
BLC:	Occupied	1,771	Btuh/deg. F.
	Unoccupied	2,213	Btuh/deg. F.

DOAS Energy Use		
	0	cfm
	0%	heat recov. Eff.
Heating	0	
	0	
	0%	eff.
	0.00	COP cool
	0	hrs/week

Current — Newburgh, 33 hrs./week

Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use gal.	Cooling Energy kwh	DOAS Hours	DOAS Heating kBtu/yr.
(2.5)	4	23	106,919	145,965	31	0	0	0
2.5	11	52	98,066	134,899	67	0	0	0
7.5	17	40	89,213	123,832	53	0	0	0
12.5	31	119	80,360	112,766	131	0	0	0
17.5	44	229	71,507	101,700	218	0	0	0
22.5	45	274	62,654	90,633	228	0	0	0
27.5	48	317	53,801	79,567	229	0	0	0
32.5	123	651	44,948	68,501	413	0	0	0
37.5	142	679	36,095	57,434	363	0	0	0
42.5	176	616	27,241	46,368	275	0	0	0
47.5	181	639	18,388	35,302	213	0	0	0
52.5	122	600	9,535	24,235	129	0	0	0
57.5	129	635	682	13,169	70	0	0	0
62.5	121	651	0	2,103	11	0	0	0
67.5	146	546	(6,400)	0	0	24	0	0
72.5	105	351	(19,604)	(11,101)	0	167	0	0
77.5	126	281	(27,155)	(20,865)	0	281	0	0
82.5	86	190	(39,655)	(35,579)	0	333	0	0
87.5	44	100	(50,582)	(48,719)	0	253	0	0
92.5	22	42	(66,818)	(67,169)	0	167	0	0
97.5	0	2	(73,856)	(76,420)	0	7	0	0
102.5	0	0	(68,372)	(73,149)	0	0	0	0
107.5	0	0	(77,225)	(84,215)	0	0	0	0
112.5	0	0	(86,078)	(95,281)	0	0	0	0
	8,760	hours			2,431	1,231	DOAS fuel use	0
							DOAS cool use	0

Cross Check Against Historic Consumption

	Historic		Calculated	Difference	
Present Annual Heating Fuel Use is	334	mmBTU	335	100%	of present fuel use

Appendix E

Clean Heating and Cooling Technology Overview

BENEFITS OF CLEAN HEATING AND COOLING (CHC) TECHNOLOGIES

Commercial building owners are becoming increasing aware of how their choice of HVAC system impacts bottom line operating costs and the environment. Most conventional heating systems either burn fuel or convert electricity into heat. CHC technologies, such as heat pumps, are different because they don't generate heat. Instead, they move existing heat energy from outside into your facility, which makes them more efficient since they deliver more heat energy than the electrical energy they consume.

There are many compelling reasons to install a CHC System in commercial buildings.

CHC systems:

- Can cost less to run than a traditional fossil fuel heating system.
- Integrate well with renewable and resilient building designs
- Offer the highest efficiency and most cost-effective space conditioning for HVAC
- Offer reduced maintenance costs because the exterior equipment is buried underground
- Offers flexible design and installation with many configurations available.
- Provides superior thermal comfort for all seasons.

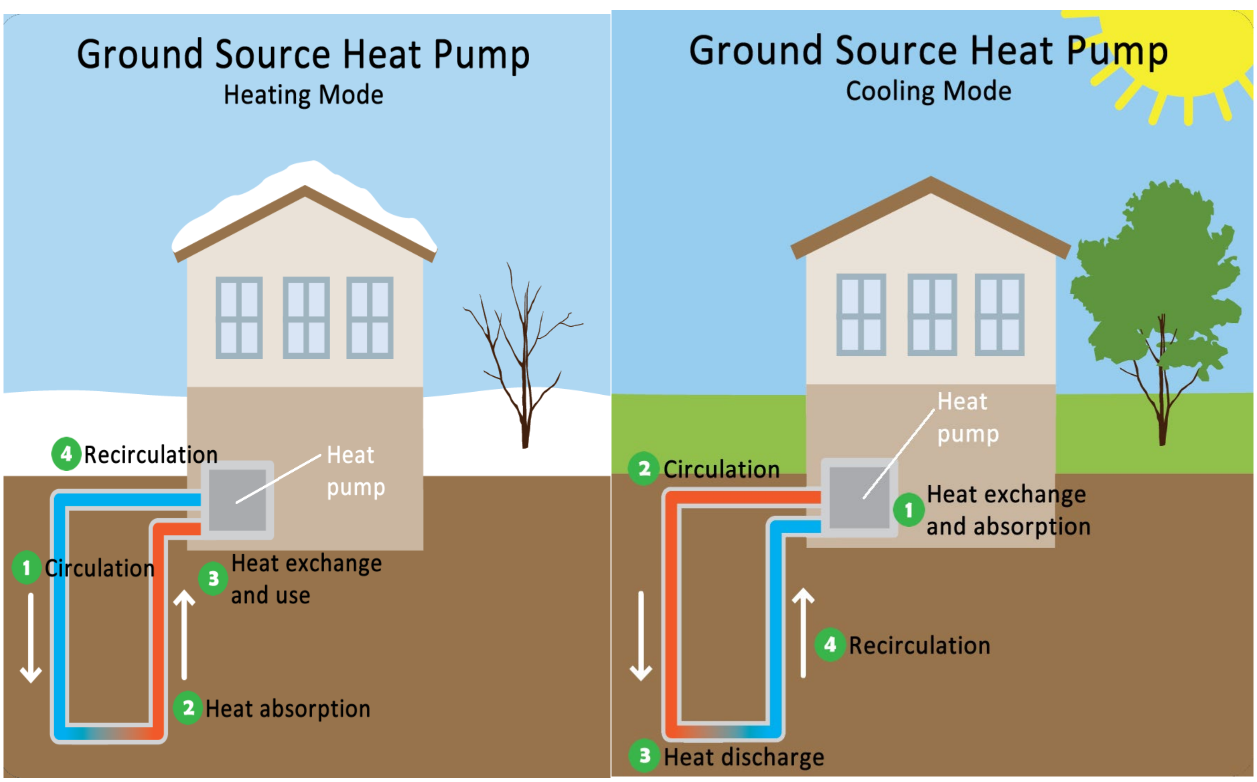
TYPES OF CLEAN HEATING AND COOLING (CHC) TECHNOLOGIES

What is a Ground Source Heat Pump (GSHP)?

GSHP's are self-contained electrically powered systems that provide heating and cooling more efficiently than other types of conventional HVAC systems. This increase in efficiency is obtained due to the GSHP systems coupling with the earth's relatively stable ground temperature. For example, while the temperature of the of the outside air may vary drastically from summer to winter, the ground temperature remains relatively stable, making it an ideal heat "source" for heating and heat "sink" for cooling.

The GSHP system utilizes an electric vapor compression refrigeration cycle to exchange energy between the building load and a ground coupled loop. When in heating mode, energy is transferred from the low temperature ground loop source to the higher temperature heat sink (the load).

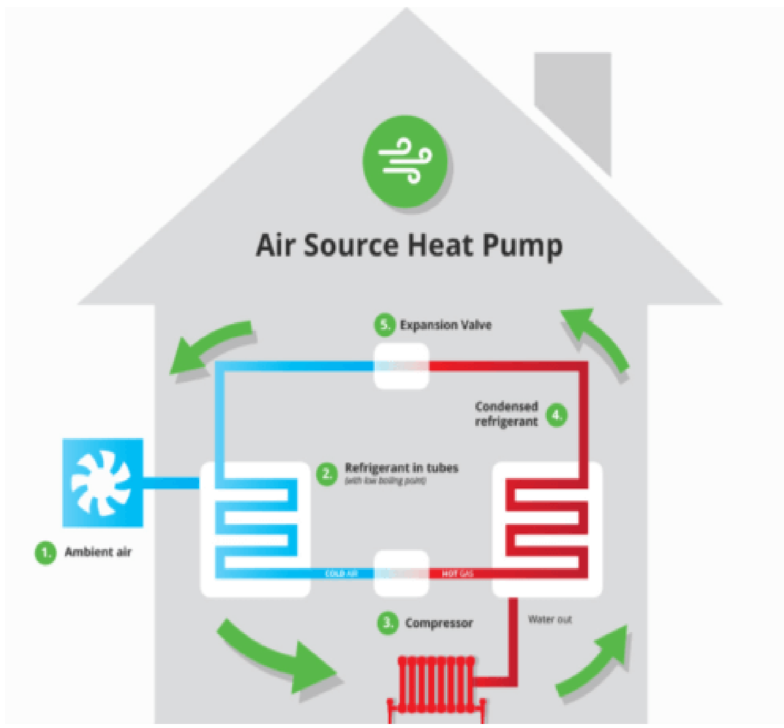
The system reverses during cooling, where the energy is absorbed by the ground loop.



Source: https://www.epa.gov/rhc/geothermal-heating-and-cooling-technologies

What is an Air Source Heat Pump (ASHP)?

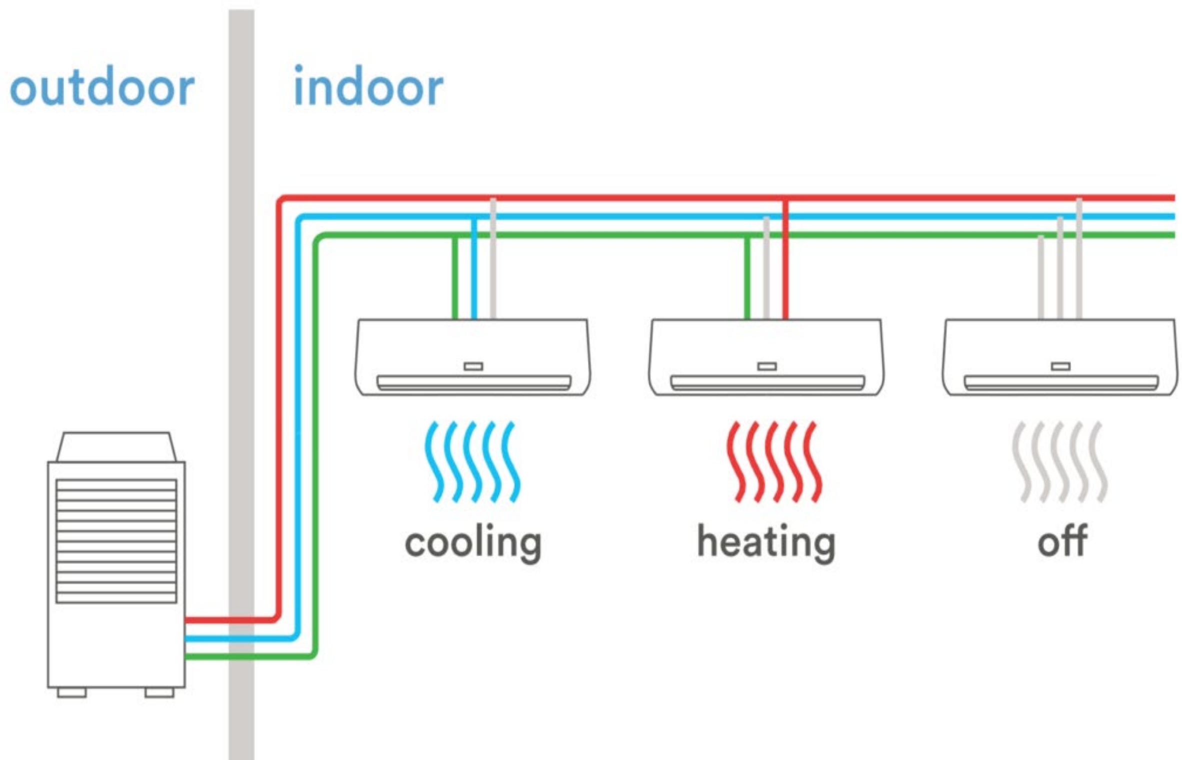
An air source heat pump works much like a refrigerator operating in reverse. Outside air is blown over a network of tubes filled with a refrigerant. This warms up the refrigerant, and it turns from a liquid into a gas. This gas passes through a compressor, which increases the pressure. Compression also adds more heat – similar to how the air hose warms up when you top up the air pressure in your tires. The compressed, hot gases pass into a heat exchanger, surrounded by cool air or water. The refrigerant transfers its heat to this cool air or water, making it warm. And this is circulated around your facility to provide heating and hot water. Meanwhile, the refrigerant condenses back into a cool liquid and starts the cycle all over again.



Source: https://www.ways2gogreenblog.com/2017/10/18/a-brief-introduction-to-air-source-heat-pumps/

What is a Variable Refrigerant Flow (VRF)?

VRF systems use heat pumps or heat recovery systems to provide heating and cooling for all indoor and outdoor units without the use of air ducts. With a VRF system, your building will have multiple indoor units utilized by a single outdoor condensing unit, either with a heat pump or heat recovery system. A VRF HVAC system can heat and cool different zones or rooms within a building at the same time. If the appropriate VRF system is selected, building occupants have the ability to customize the temperature settings to their personal preferences. VRF equipment can be used in conjunction with a wide range of heating and cooling products. This means that a VRF system can be scaled to meet the climate control needs.



Source: https://be-exchange.org/tech_primer/tech-primer-variable-refrigerant-flow-vrf-systems/

Appendix F

Energy Savings Summaries

Energy Efficiency Measures			GHG	Electric Savings			Fuel Savings			$ Savings & Cost		
EEM #	Measure Status	EEM Description	CO2e Lbs./Year	kWh	kW	Electric Cost Savings	Fuel Type	Fuel MMBtu Savings	Fuel Cost Savings	Total Annual Savings	Install Costs	Simple Payback (years)
EEM-1	R	Interior Lighting Retrofit	1,424	1,928	2.1	$ 540	Oil - No. 2	(5)	($ 96)	$ 444	$ 5,954	13.4
EEM-2	R	Improve Temperature Control	8,305	55	0.0	$ 8	Oil - No. 2	51	$ 974	$ 982	$ 1,000	1.0
EEM-3	RS	Insulate Building Envelope	19,751	484	0.0	$ 68	Oil - No. 2	118	$ 2,269	$ 2,337	$ 202,559	86.7
EEM-4	R	Weather-Stripping And Caulking	997	0	0.0	$ 0	Oil - No. 2	6	$ 118	$ 118	$ 340	2.9
EEM-5	RNE	Install Insulated Doors	382	0	0.0	$ 0	Oil - No. 2	2	$ 45	$ 45	$ 1,500	33.2
EEM-6	R	Install Double Glazing	5,359	0	0.0	($ 0)	Oil - No. 2	33	$ 634	$ 634	$ 4,716	7.4
EEM-7	RS	Insulate Heating And Domestic Hot Water Pipes	417	15	0.0	$ 2	Oil - No. 2	2	$ 47	$ 49	$ 1,130	22.9
EEM-8	NR	Install A More Efficient Boiler	7,393	0	0.0	($ 0)	Oil - No. 2	45	$ 874	$ 874	$ 14,000	16.0
EEM-9	NR	Replace Air Conditioners	471	406	0.6	$ 91		0	$ 0	$ 91	$ 6,667	73.6
EEM-10	R	Turn Off Unused Refrigerators	661	569	0.0	$ 80		0	$ 0	$ 80	$ 0	0.0
		Total of Recommended Measures:	**17,127**	**2,553**	**2.1**	**$ 628**		**87**	**$ 1,675**	**$ 2,303**	**$ 13,510**	**5.9**

Building Electrification Measures				Savings & Cost								
EEM #	Measure Status	Building Electrification Measure Descriptions	GHG	kWh	kW	Electric Cost Savings	Fuel Type	Fuel MMBtu Savings	Fuel Cost Savings	Total Annual Savings	Install Costs	Simple Payback (years)
BE-1	RS	Install Clean Heating System - Ground Source Heat Pump	28,367	(21,799)	1.6	($ 3,400)	Oil - No. 2	329	$ 6,344	$ 2,944	$ 184,050	62.5
BE-2	NR	Install A Heat Pump Water Heater	569	490	0.0	$ 73		0	$ 0	$ 73	$ 4,500	61.9
		Total of Recommended Measures:	**0**	**0**	**0.0**	**$ 0**	**$ 0**	**0**	**$ 0**	**$ 0**	**$ 0**	