Clean Energy Communities

Energy Study

Prepared for:
Village of Philmont - Community Center

14 Lake View Drive

Philmont, NY 12565

Audit No: CEC-400097-2-S

Submitted by:
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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:

- Weatherstripping and door sweeps – Install new for two doors
- Insulate building envelope – Insulate exterior building walls, and seal attic space
- Install double glazed windows – replace plexiglass windows and ensure that there are no leaks
- Install a tankless water heater – replace 40-gallon unit with a point of use unit
- Install New Heat Pump – Use heat pump for HVAC and let furnace become backup

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.

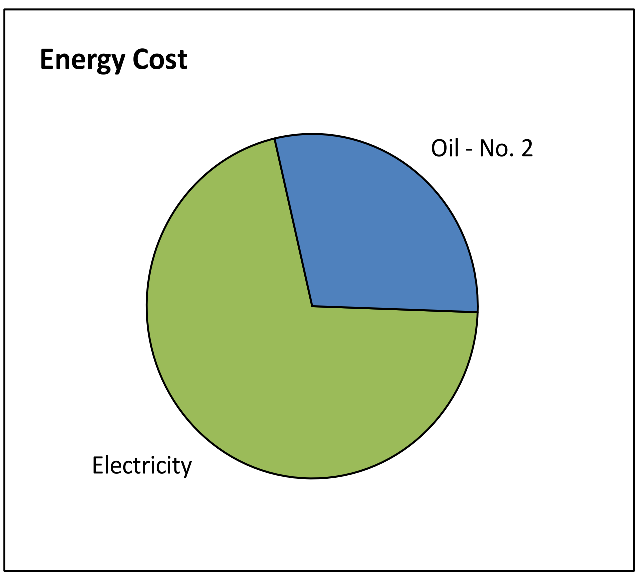
- The Energy Cost Index (ECI) is the total cost of energy divided by the conditioned floor area and is shown as dollars per square foot per year.
- The Energy Use Intensity (EUI) is the total heat content of energy divided by the conditioned floor area and is shown in units of one thousand Btus (kBtu)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

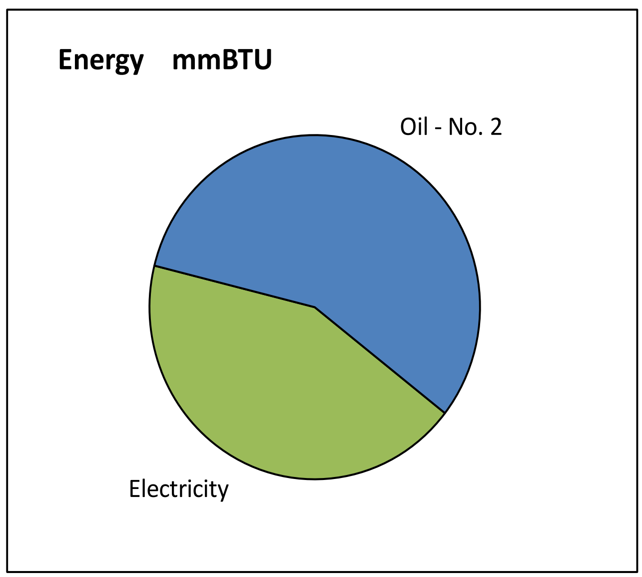
Energy Cost Index

Electricity	$ 1,208	$ 2.52	$/sq.ft./year
Oil - No. 2	$ 498	$ 1.04	$/sq.ft./year
Total Cost	$ 1,706	$ 3.55	$/sq.ft./year

Energy Use Intensity

Electricity	21	mmBtu	44.0	kBtu/sq.ft./year
Oil - No. 2	28	mmBtu	57.5	kBtu/sq.ft./year
Total Energy Use	49	mmBtu	101.5	kBtu/sq.ft./year





Energy Cost Index $ 3.55 /sf/yr. **Energy Use Intensity 101.5 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	Weather-Stripping And Caulking	401	$ 50	$ 120	2.4
EEM-2	NR	Insulate Building Envelope	5,621	$ 700	$ 34,140	48.8
EEM-3	R	Install Double Glazing	793	$ 99	$ 1,280	13.0
EEM-4	R	Install A Tankless Water Heater	268	$ 36	$ 500	13.8
Total of Recommended Measures:			**1,462**	**$ 185**	**$ 1,900**	**10.3**

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	R	Install A New Air Source Heat Pump	2,152	$ 399	$ 5,500	13.8	$ 1,657	9.6
Total of Recommended Measures:			**2,152**	**$ 399**	**$ 5,500**	**13.8**	**$ 1,657**	**9.6**

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	799	kWh =	1,462	pounds CO2 equivalent
Oil - No. 2	24	gal. =	535	pounds CO2 equivalent
			1,462	pounds CO2 equivalent
			12.5%	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 Weather-Stripping And Caulking

Electric Savings:	$ 30		191	kWh per year
			0.0	kW demand
Fuel Savings:	$ 20		1.1	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 50**			
Project Cost:	**$ 120**			
Simple Payback:	**2.4**	**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.

The eaves overhanging the sidewalls had icicle buildup. This is likely indicative of poor sealing between the heated space and the perimeter of the attic cavity. It is recommended for further study to have a contractor identify if there are indeed leaks that can be eliminated with spray foam. Ice damming can be dangerous for people walking around the building and the roof itself.

Recommendation:

This calculation only estimates potential savings for the front and rear doors that need new weatherstripping and door sweeps. Infiltrative savings for windows is in a subsequent measure.

EEM-2 Insulate Building Envelope

Electric Savings:	$ 426		2,712	kWh per year
			0.0	kW demand
Fuel Savings:	$ 274		15.2	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 700**			
Project Cost:	**$ 34,140**			
Simple Payback:	**48.8**	**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 measure provides an example of the potential savings for insulating the roof and walls. There is no clear way to get into the roof cavity, so the calculation estimates increasing the existing assumed R value of 14 to an R value of 39.

For the walls, it may be easier to insulate the exterior walls than the interior walls, which could require electrical work and rehanging cabinets. It would also reduce the overall interior space. Installing an exterior insulation finishing system (EIFS) can avoid that, but it will cost more. The siding will need be removed. Then adhesive and mechanical fasteners will be used to attach the insulation boards to the concrete block. Synthetic stucco-like materials with a mesh will then be used as a base and finishing coat to complete the job. EIFS should also provide a moisture and vapor barrier to further protect the building.

This measure is not recommended due to the high payback. If the building were to be used similar to an office building with full occupancy, the overall utility consumption would increase, which would make the economic payback better for this type of measure. However, since the building is small and is mostly heated to a minimum, adding expensive wall insulation does not make sense.

EEM-3 Install Double Glazing

Electric Savings:	$ 59		378	kWh per year
			0.0	kW demand
Fuel Savings:	$ 39		2.2	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 99**			
Project Cost:	**$ 1,280**			
Simple Payback:	**13.0**	**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.

The calculations are based on replacing four of the nine windows. These windows have single pane plexiglass (the other five have double pane glass). When receiving contractor quotes assess whether the other five windows should also be replaced if they have reached the end of their useful lives (or if they need to be replaced to match).

EEM-4 Install A Tankless Water Heater

Electric Savings:	$ 36	231	kWh per year
		0.0	kW demand
Fuel Savings:	$ 0	0.0	MMBtu fuel per year
Total Annual Savings:	**$ 36**		
Project Cost:	**$ 500**		
Simple Payback:	**13.8**	**years**	

Introduction:

Storage type water heaters maintain a tank of hot water continuously, so that hot water is available when it is needed. These storage tanks continuously lose heat through the outer surfaces of the tank, even though they are insulated.

Tankless water heaters produce hot water only when there is a demand for it. They sense the flow of water and quickly heat the water as long as there is flow, or demand, for hot water. Tankless water heaters are available with electricity, natural gas or propane as energy sources. They are best located close to the point where hot water is used.

Recommendation:

The existing storage type water heater is located in the utility closet area that is not conditioned. The usage of the hot water is limited, and the tank is giving up heat to the space. Replacement is recommended when the existing unit reaches the end of its useful life.

Consult a plumber to see if it is possible to install a small 1-1.5 kW, point of use water heater underneath the cabinet in the kitchen or in the bathroom that can be tied into the existing pipework for the faucets.

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 A New Air Source Heat Pump

Electric Savings:	($ 99)		(2,020)	kWh per year
			0.0	kW demand
Fuel Savings:	$ 498		27.6	MMBtu fuel per year
				Oil - No. 2
Total Annual Savings:	**$ 399**			
Project Cost:	**$ 5,500**			
Simple Payback:	**13.8**	**years,**	**9.6**	**years after incentives**

Introduction:

This measure provides an analysis for installing a new high efficiency cold climate air source heat pump to heat the space rather than the existing furnace and heat pump. The oil furnace thermostat is engaged to meet occupied temperatures, and then is brought back down to 55 degrees, effectively turning the unit off. The heat pump temperature setpoint is maintained at 60 degrees, which is the minimum temperature that staff feel comfortable with to prevent pipes from freezing. Therefore, the heat pump is used most of the time since the building is largely unoccupied.

The primary calculation uses the building load calculation isolating for oil consumption at the furnace efficiency of 83% compared to a new heat pump, while the auxiliary calculation estimates savings for using the new heat pump as the primary heating and cooling compared to the existing heat pump. The existing unit has a rated efficiency of 17 SEER and 9.5 HSPF, while the new unit is estimated to have a 20 SEER and a 13 HSPF.

Recommendation:

Install a high efficiency cold climate air source ductless mini-split heat pump on the sidewall or the front of the building so that it is spaced out with the other unit. Do not remove the oil furnace, which can be used for emergency backup. Use the new heat pump as the primary heating source, with the older unit also as backup.

The estimated installation cost of $5,500 yields an estimated payback of around 14 years, which should pay back in its lifetime. Obtain quotes and reevaluate the payback prior to installation.

Existing Conditions

The site is a community center that can be rented for meetings and is occupied several times a month in each of the four seasons. The original building was constructed in 1979 as a locker room and hot dog stand for summer reservoir swimmers. It was a small, single story hipped roof building. At some point, the sidewall was removed and another hipped roof building was added, effectively doubling the building area. It now stands at around 1,080 ft^2. The building is on slab with concrete walls. The wood roof is double hipped, with asphalt shingles. There is minimal insulation in the attic space, but likely none, or minimal within the interior walls.

The exterior walls have vinyl siding, and the windows reside along the addition front and side. The original design of the windows consists of double hung, double pane glass, however, several of the windows had been broken over the years and replaced with plexiglass panes. The seals on the locks are stripped and there are considerable leaks. There are two steal doors (front and rear), that have worn weatherstripping and door sweeps that have need to be replaced.

Lighting Systems

All of the lighting in the facility has been upgraded with LEDs. There are recessed lamps internally controlled via switches, and wall packs externally controlled via photocells.

Heating Ventilating and Air Conditioning Systems

Heating is provided by two systems: one oil fired furnace and one heat pump. The heat pump is the only source of cooling. The furnace is an Olsen, model HMC-80C, with an output capacity of 74.9 Mbh. The firing rate is 0.65 gallons per hour, which yields a rated efficiency of around 83%. Heat is sent to the space through ceiling ductwork. It is unknown if the ducts are insulated in the attic space. A PurePro digital thermostat that has no programming is set to maintain 55 °F as a base temperature. When occupied, the groups may adjust the temperature as needed for comfort and then return the temperature back when they leave. The heat pump, however, is set to maintain 60 °F in the winter and its setpoint is not adjusted. This is to prevent pipes from freezing. Both systems are used for redundancy.

The heat pump is a split system, ductless unit located in the rear of the facility. It is a Fujitsu, model AOU30RLX, with a 30 Mbh cooling capacity and a 10 EER/17.5 SEER. The heating capacity is rated at 32 Mbh that can operate from 0-75 °F according to the specification sheet. It does not explain how the 9.5 HSPF rating is affected by the outside air temperature. It is not an Energy Star rated unit.

An enclosed utility closet outside of the main building space has an electric wall mount heater that is likely not ever used.

Water Heating System

Hot water is provided by a Craftsman, 40-gallon, 4.5 kW in the utility closet. The hot water was measured at 99 °F. It is used sparingly for bathroom and kitchen faucets.

Other Energy-using Systems

There is a refrigerator, stove, microwave, and coffee maker in the kitchen that have been remodeled recently.

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
Oil Furnace	1	Olsen HMC-80C	75	83%				All	2009
Mini Split Heat Pump	1	Fujitsu AOU30RLX	32	278%	30	kbtuh	10.0	All	

Domestic Hot Water									
Unit Type	Qty	Make/Model	Capacity	Units	Fuel Type	Storage Capacity (gal.)	Eff.	Serves/Location	Year
Storage	1	Craftsman	4.5	kW	electricity	40		Faucets	

Interior Lighting Fixtures					
Existing Fixtures					
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt
1	Interior	24	LED 9 W Lamp	1	9

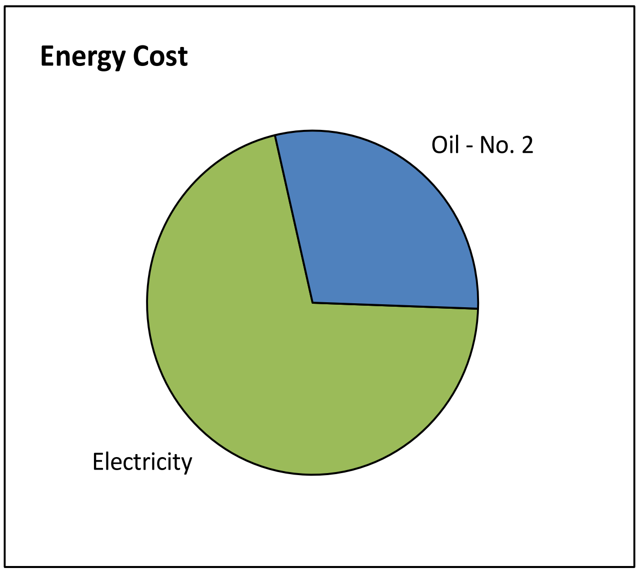
Exterior Lighting Fixtures					
Existing Fixtures					
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt
1	Exterior	1	LED 13 W Wallpack	1	13

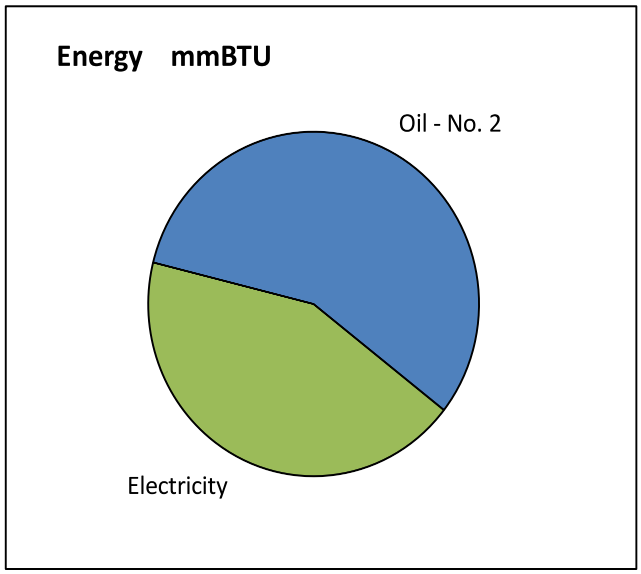
Appendix B

Energy Use and Cost Summary

Energy		Units Used		BTU/unit	mmBTU	% of total	kBtu/sq.ft./year
	Electricity	6,188	kwh	3,412	21	43%	44.0
	Oil - No. 2	200	gal.	138,000	28	57%	57.5
	Total				49		101.5

Cost		Energy Cost	Unit Costs		% of total	$/sq.ft./year
	Electricity	$ 1,208	$ 0.157	kwh	71%	$ 2.52
	Oil - No. 2	$ 498	$ 2.490	gal.	29%	$ 1.04
	Total	$ 1,706				$ 3.55





Energy Cost Index $ 3.55 /sf/yr. **Energy Use Intensity 101.5 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

Village of Philmont Community Center

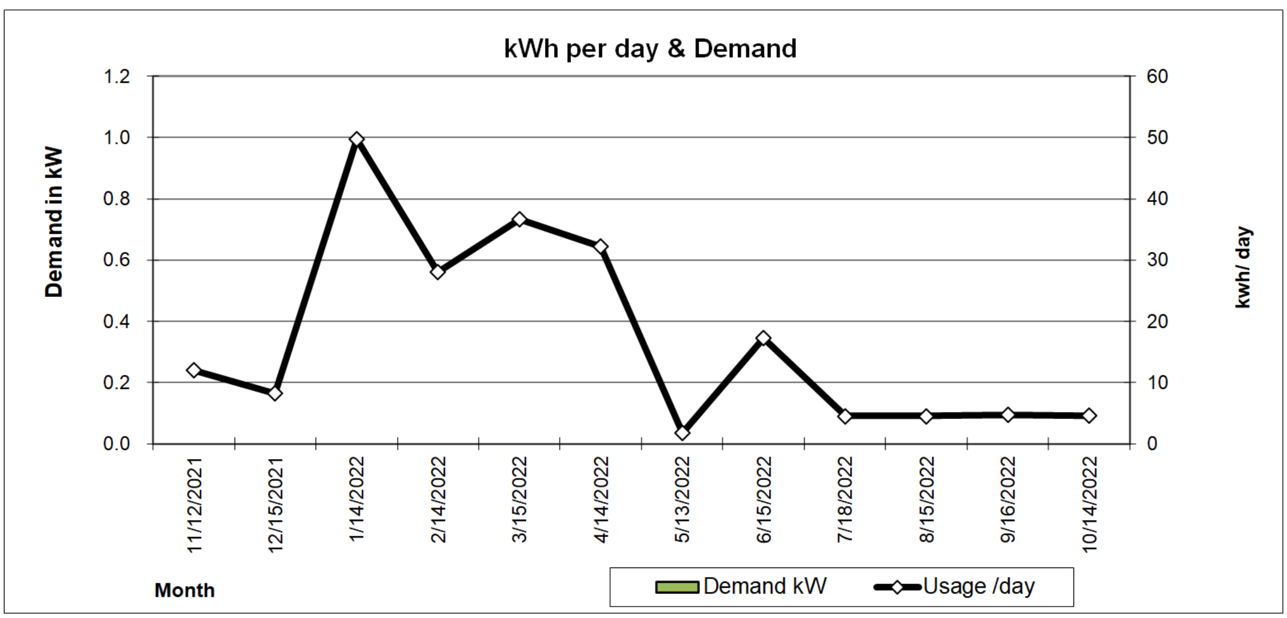
Utility: NYSEG
Account # ends w/ -218
Rate: SC 12006 NYSEG Supply Charge
Meter Charge: $ 19.80 / month
Demand Charge: $ 0.00 / kW
Supplier:

Gross Area: 480 s.f.
43,986 Btu/s.f./Yr
$ 2.52 /s.f.

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
11/12/2021	30	358				$ 69	$ 0	$ 0.137	N/A	12
12/15/2021	33	271				$ 58	$ 0	$ 0.141	N/A	8
1/14/2022	30	1,491				$ 252	$ 0	$ 0.156	N/A	50
2/14/2022	31	867				$ 153	$ 0	$ 0.154	N/A	28
3/15/2022	29	1,063				$ 192	$ 0	$ 0.162	N/A	37
4/14/2022	30	965				$ 192	$ 0	$ 0.178	N/A	32
5/13/2022	29	51				$ 28	$ 0	$ 0.163	N/A	2
6/15/2022	33	568				$ 93	$ 0	$ 0.129	N/A	17
7/18/2022	33	149				$ 43	$ 0	$ 0.153	N/A	5
8/15/2022	28	126				$ 42	$ 0	$ 0.179	N/A	5
9/16/2022	32	150				$ 44	$ 0	$ 0.163	N/A	5
10/14/2022	28	129				$ 41	$ 0	$ 0.165	N/A	5
	366	**6,188**	**0.0**	**$ 0**	**$ 0**	**$ 1,208**	**$ 0**	**$ 0.157**	**N/A**	**17**

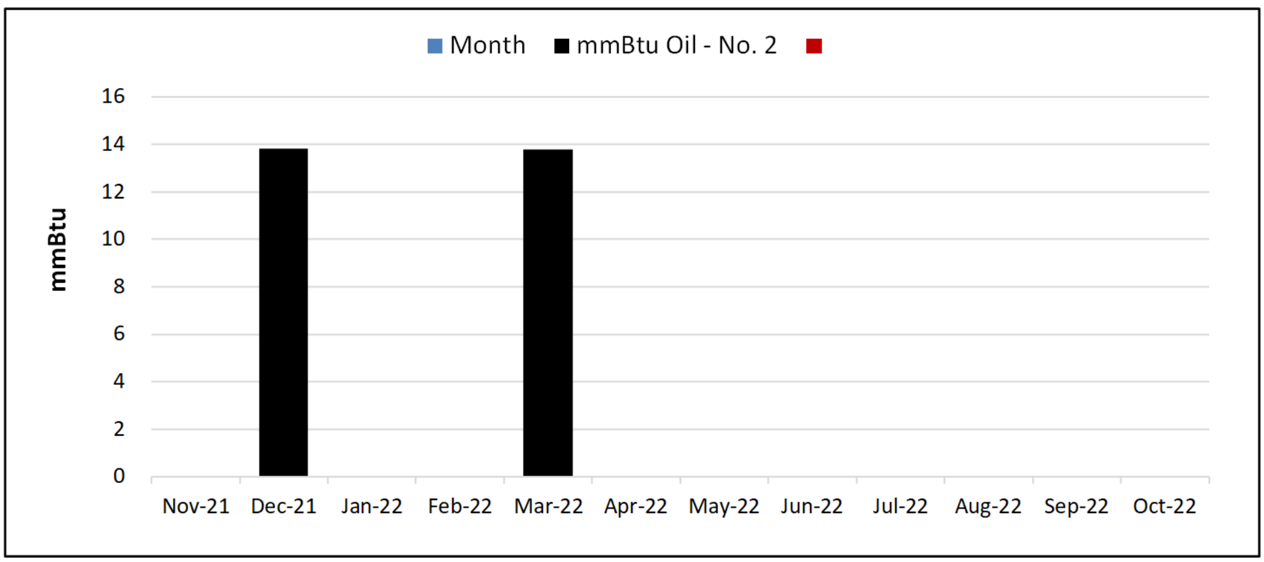
Annual Energy: **6,188 kWh / year** **$ 1,208 /year**
Peak Demand: **0 kW Peak**
Average Demand: **kW**

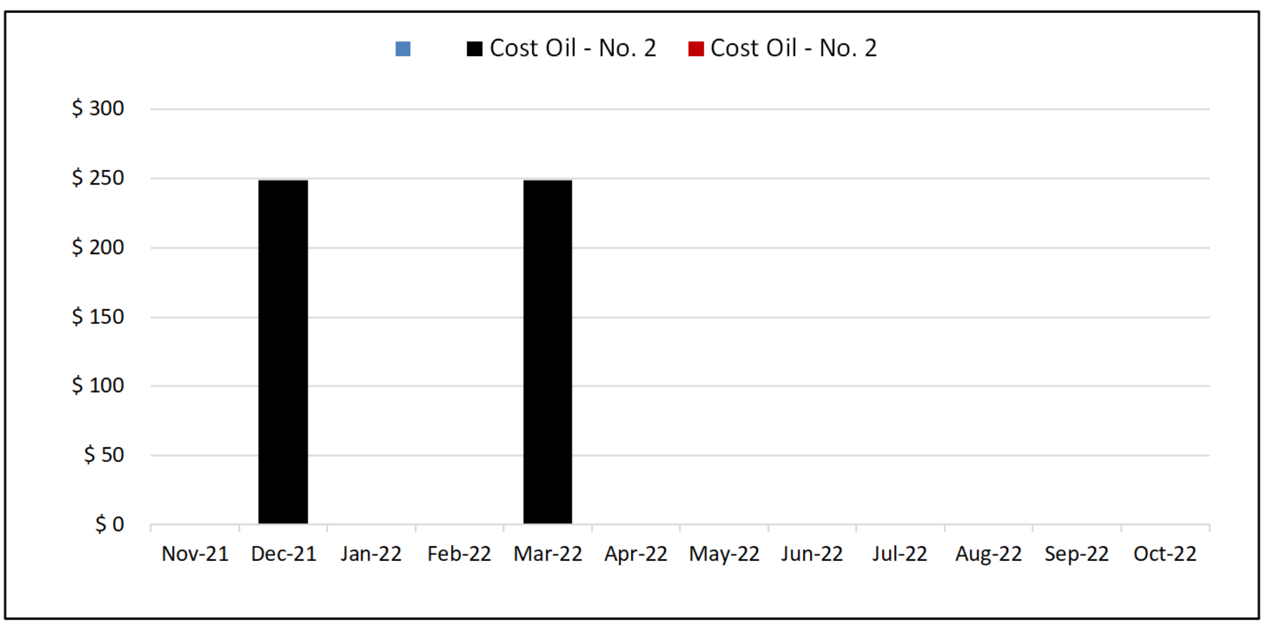
Unit Costs
Demand $ 0.00 $/kW
Energy $ 0.157 $/kWh Incremental
Blended $ 0.195 $/kWh Blended



ALL FUELS CONSUMPTION AND COST ANALYSIS **Village of Philmont Community Center**

Month		mmBtu Oil - No. 2				Cost Oil - No. 2		
Nov-21		0	0			$ 0		
Dec-21		14	0			$ 249		
Jan-22		0	0			$ 0		
Feb-22		0	0			$ 0		
Mar-22		14	0			$ 249		
Apr-22		0	0			$ 0		
May-22		0	0			$ 0		
Jun-22		0	0			$ 0		
Jul-22		0	0			$ 0		
Aug-22		0	0			$ 0		
Sep-22		0	0			$ 0		
Oct-22		0	0			$ 0		
Total		28	0			$ 498		
$/mmBtu		$ 18.04						
BTU/unit		138,000				1 mmBtu =	1,000,000 Btus	
kBtu/SF/Yr.		57.5				1 kBtu =	1,000 Btus	





Appendix C

EEM Calculations

The default fuel type is 'Multiple'; this indicates that more than one energy type is used to meet the thermal loads in this facility. If electricity is one of the fuels used for space heating, the mmBtu savings shown in the energy calculations below includes electricity, and the kWh savings represents only a portion of the net electricity savings. The energy unit savings shown in the Savings Summary and the EEM Descriptions are correct and represent the total electricity and non-electricity savings; these values may be different from those shown in the calculations in Appendix C.

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 WEATHER-STRIPPING AND CAULKING

EEM-1 **Village of Philmont Community Center**

INPUT DATA:

Bldg. Volume	8,640	cubic feet		Present infiltration		
		ACH	Period	Cu. ft./hr.	CFM	btuh/deg.
Baseline infiltration rate		0.50	Occupied	4,320	72	78
from heat loss study		0.50	Unoccupied	4,320	72	78
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				0	0	0
Door Sweeps & WS	40	60	5	1,200	100	1,100
Fireplace				0	0	0
				1,200	100	1,100
Proposed Reductions	Air changes/Hour			Proposed infiltration		
Air changes/hour	% reduction	Proposed	Period	Cu. ft./hr.	CFM	btuh/deg.
	25%	0.37	Occupied	3,220	54	58
	25%	0.37	Unoccupied	3,220	54	58
Total Infiltration & Reduction	**Occupied**	**4,320**	**3,220**	**1,100**	cfh savings	
Cu.Ft./hour	**Unoccupied**	**4,320**	**3,220**	**1,100**	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:	70	60	°F
Q internal gains:	3,041	128	Btuh
BLC:	455	506	Btuh/°F
T Balance:	63.3	59.7	°F. T Balance = T Setpoint - (Q internal gains / BLC)
Bin Data for Newburgh, 5 hrs./week			
Accumulated Hours	172	5,788	below balance temp.
Avg. OAT	43.4	39.4	°F below balance temp.
(T Set- Avg OAT)	26.6	20.6	°F difference

Type:	Multiple	
Units:	mmBtu	
Unit cost:	$ 28.439	/mmBtu
CF1	1,000,000	Btu/mmBtu
Efficiency:	139.6%	
CF2	0.018	Btu/hr-°F-cfh

	Energy Use - Btu/year			Fuel Use	
	Occupied	Unoccupied	Total	mmBtu / yr	
Baseline infiltration rate	356,100	9,265,500	9,621,600	7	
Proposed infiltration rate	265,500	6,906,200	7,171,700	5	
			Total Savings	2	$ 50

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Matl. & Labor ($ / lin ft)	Quantity (lin ft)	Total	
Weather-stripping	$ 3.00	40	$ 120	
Caulking		0	$ 0	
Air Sealing			$ 0	
	Implementation Cost:		$ 120	= 2.4 year payback
	Annual Energy Savings:		$ 50	

CALCULATIONS TO INSULATE BUILDING ENVELOPE
EEM-2 Village of Philmont Community Center

INPUT DATA:

	Roof	Walls			
Surface to be insulated:	Roof	Walls			
Area:	1,080	958	sq ft		
Present R value:	14.0	3.5			
Revised R value	39.0	19.0			
Present U factor::	0.071	0.286	Btuh/sq ft-deg F		
Revised U factor:	0.026	0.053	Btuh/sq ft-deg F		
Present U x Area	77	274		351	UA Total present
Proposed U x Area	28	50		78	UA Total proposed

CALCULATIONS:	Occupied	Unoccupied	**Fuel Data**	Heating	Cooling
Heating Setpoint:	70	60	Type:	Multiple	Electricity
Cooling Setpoint:	74	80	Units:	mmBtu	kwh
Q internal gains (Btuh):	3,041	128	Unit cost:	$ 28.439	$ 0.157
BLC (Btuh/degree F):	455	506	BTU/unit	1,000,000	3,412
T Balance (°F.):	63.3	59.7	Efficiency/ COP:	139.6%	293.1%
T Balance = T Setpoint - (Q internal gains / BLC)			EER:		10.0

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat Loss	Change in Unoccupied Heat Loss	Heating Savings mmBtu	Cooling Savings kwh
(2.5)	0	27	19,774	17,046	0	0
2.5	1	62	18,410	15,683	1	0
7.5	2	55	17,046	14,319	1	0
12.5	3	147	15,683	12,955	1	0
17.5	5	268	14,319	11,592	2	0
22.5	5	314	12,955	10,228	2	0
27.5	8	357	11,592	8,864	2	0
32.5	13	761	10,228	7,500	4	0
37.5	28	793	8,864	6,137	4	0
42.5	26	766	7,500	4,773	3	0
47.5	19	801	6,137	3,409	2	0
52.5	25	697	4,773	2,046	1	0
57.5	24	740	3,409	682	0	0
62.5	13	759	2,046	0	0	0
67.5	20	672	0	0	0	0
72.5	15	441	0	0	0	0
77.5	18	389	(955)	0	0	2
82.5	19	257	(2,318)	(682)	0	22
87.5	11	133	(3,682)	(2,046)	0	31
92.5	6	58	(5,046)	(3,409)	0	23
97.5	0	2	(6,409)	(4,773)	0	1
102.5	0	0	(7,773)	(6,137)	0	0
107.5	0	0	(9,137)	(7,500)	0	0
112.5	0	0	(10,501)	(8,864)	0	0
	8,760 hours			Energy Savings:	24	79
					$ 688	$ 12

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
Roof	$ 5.00	1,080	$ 5,400
Walls	$ 30.00	958	$ 28,740
	$ 0.00	2,038	$ 0

Implementation Cost:	$ 34,140	= 48.8 year payback
Annual Energy Savings:	$ 700	

CALCULATIONS TO INSTALL DOUBLE GLAZING

EEM-3 Village of Philmont Community Center

Type:	Multiple
Units:	mmBtu
Unit cost:	$ 28.439 /mmBtu
Heat Content of Fuel	1,000,000 Btu/mmBtu
Combustion Efficiency:	140%

DATA:

	Occupied	Unoccupied	
T Setpoint:	**70**	**60**	degrees F
Q internal gains:	**3,041**	**128**	Btuh
BLC:	**455**	**506**	Btuh/degree F
T Balance:	63.3	59.7	degrees F

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

Glazing Information

	Glazing 1		
Present Conditions	Single Pane Windows		
Present Area:	**32**	sq ft	
U factor:	**1.00**	Btuh/sq ft-deg F	
Crack Length:	48	feet	
Present Infiltration:	40	cfh	
Proposed Conditions	Double Pane Low E Windows		
Proposed Area:	**32**	sq ft	
New U factor:	0.25	Btuh/sq ft-deg F	
New Crack Length:	48	feet	
Proposed Infiltration:	5	cfh	

Bin Data for Newburgh, 5 hrs./week

	T Setpoint	T Balance	Accum Hours	Average O.A. Temp below T Balance	Temp Difference (T Set- Avg OAT)
Occupied	70	63.3	**172**	**43.4**	26.6
Unoccupied	60	59.7	**5,788**	**39.4**	20.6

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 (mmBtu/year)	Energy Cost Savings ($/year)
Occupied	110,000	69,000	179,000	0	$ 4
Unoccupied	2,860,000	1,802,000	4,662,000	3	$ 95
Annual Savings:	2,970,000	1,871,000	4,841,000	3	$ 99

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor $ / sq. ft.	Quantity	Total	
	$ 40	32	$ 1,280	
		0	$ 0	
	Implementation Cost:		$ 1,280	= 13 year payback
	Annual Energy Savings:		$ 99	

CALCULATIONS TO INSTALL A TANKLESS WATER HEATER

EEM-4 **Village of Philmont Community Center**

INPUT DATA:

		Present Fuel		Proposed Fuel	
	Fuel:	**Electricity**		Electricity	
	Units:	kwh		kwh	
	Fuel Cost:	$ 0.16	per kwh	$ 0.16	per kwh
	BTU / unit:	3,412	Btu per kwh	3,412	Btu per kwh
	kW Demand cost:	$ 0.00	per kW	$ 0.00	per kW
Annual DHW Consumption:		Present		Proposed	
	Hot Water Usage:	**0.3**	Gallons/person	0.3	Gallons/person
	Number of persons:	**5**	(estimate)	5	(estimate)
	Days of Usage:	**200**	per year	200	per year
	Hours of Usage per Day:	8	hours	8	hours
	Average inlet water Temp:	56	degrees F	56	degrees F
	Average hot water temp:	99	degrees F	99	degrees F
Storage Tank Losses:		Present Tank		Proposed Tank	
	Tank U factor:	0.15	Btu/SF/Hour	0.08	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:	99	Deg. F.	99	
	Ambient Temperature:	50	Deg. F.	60	
Recirculation Losses:		0.0%	of boiler capacity =	0	BTUh
		8,760	hours/year	8,760	hours/year =
Boiler Jacket & Flue Losses:					
	Burner Input	15,359	BTUH	5,120	BTUH
	Efficiency:	**100.0%**		100.0%	
	Boiler Output Capacity	15,359	BTU output	5,120	BTU output
	Jacket & Flue Losses:		of boiler capacity		of boiler capacity
	Boiler is Hot:	8,760	hours/year	8,760	hours/year =

CALCULATIONS:

		Present		Proposed	
	Consumption Energy:	89,774	BTU output rqd/yr	89,774	BTU output rqd/yr
	Tank Energy Losses:	1,412,829	BTU/year	625,970	BTU/year
	Recirculation Losses:	0	BTU/year	0	BTU/year
	Boiler Jacket Losses:	0	BTU/year	0	BTU/year
	Output BTU/Year	1,502,604		715,744	
	Annual Fuel Consumption	440	kwh	210	kwh
	Demand	0	billed kW /yr.	0	kW
	Annual Fuel Cost	$ 69		$ 33	
	Annual Savings:	**231**	**kwh**	**$ 36**	**per year**
		0			
		0	billed kW /yr.		

IMPLEMENTATION COST & PAYBACK PERIOD:

Item		Quantity	Matl. & Labor Cost	Total	
		1	$ 500	$ 500	
		Implementation Cost:		**$ 500**	**= 13.8 year payb**
		Annual Energy Savings:		**$ 36**	

CALCULATIONS TO INSTALL A NEW AIR SOURCE HEAT PUMP

BE-1 Village of Philmont Community Center

INPUT DATA

HVAC system to replace:	Primary	Present Fuels	Type:	Units:	Unit cost:	BTU/unit	COP	Rated at	EER
Forced Air		Heating 1	Oil - No. 2	gal.	$ 2.490	138,000	0.830	Et	
non-heat pump		Heating 2	(none)		$ 0.000	0			
37%									
Proposed HVAC system:		Proposed Fuel	Type:	Units:	Unit cost:	BTU/unit	COP	Rated at	EER
Ductless Heat Pump		Heating 1	Electricity	kwh	$ 0.157	3,412	4.000	47° OAT	
heat pump		Heating 2	ambient air		$ 0.000	0			
Below (2.5)	°F. OA Temp								
All heat is provided by	Ductless Heat Pump	Heating 2 Low			$ 0.000	0		47° OAT	

HVAC Loads (excluding any DOAS system)			HVAC system to replace: Forced Air						Proposed HVAC system: Ductless Heat Pump					
Bin Mid Pt.	Bin Hours	BLC Btu/h	Heating 1 Et or COP Oil - No. 2			Heating 1 Oil - No. 2 gal.			Heating 1 Et or COP Electricity			Heating 1 Electricity kwh		
(2.5)	27	11,215	0.83			3			2.21			40		
2.5	63	10,338	0.83			6			2.34			82		
7.5	57	9,461	0.83			5			2.48			64		
12.5	150	8,584	0.83			11			2.64			143		
17.5	273	7,707	0.83			18			2.81			219		
22.5	319	6,830	0.83			19			3.00			213		
27.5	365	5,953	0.83			19			3.20			199		
32.5	774	5,076	0.83			34			3.42			337		
37.5	821	4,199	0.83			30			3.65			277		
42.5	792	3,322	0.83			23			3.90			198		
47.5	820	2,445	0.83			18			4.16			141		
52.5	722	1,568	0.83			10			4.44			75		
57.5	764	691	0.83			5			4.73			33		
					Present Energy units:	200					Proposed Energy units:	2,020		
					Energy types	Oil - No. 2					Energy types	Electricity		
					Units	gal.					Units	kwh		
					BTU/unit	138,000					BTU/unit	3,412		
					mmBtu	28					mmBtu	7		
					mmBtu		28	mmBtu			mmBtu		7	mmBtu
					Unit Cost	$ 2.490					Unit Cost	$ 0.157		
					Annual Cost	$ 498					Annual Cost	$ 317		
					Pumps & Fans:						Pumps & Fans:			
					Total Annual Costs	Present	$ 498	ann. Cost			Total Annual Costs	Proposed	$ 317	ann. Cost

Auxiliary calculation estimating heating and cooling savings from using new Heat Pump as Primary compared to existing

Existing Consumption	789	kWh/year	AC derived from utility bills
	4,787	kWh/year	Heating derived from utility bills
	32,400	Capacity Cooling	Btu/h Existing - estimated same for new
	32,000	Capacity Heating	Btu/h Existing - estimated same for new
	17.5	SEER	Btu/W-h
	9.5	HSPF	Btu/W-h
	1.9	Ave kWh Cooling	Capacity / SEER / 1000
	3.4	Ave kWh Heating	Capacity / HSPF / 1000
	426	ELFH Cooling	kWh/year / Ave kWh
	1,421	ELFH Heating	kWh/year / Ave kWh
	20	New SEER	
	13	New HSPF	
	1.6	Ave kWh Cooling	Capacity / SEER / 1000
	2.5	Ave kWh Heating	Capacity / HSPF / 1000
	690	New kWh/year	Ave kWh * ELFH
	3,498	New kWh/year	Ave kWh * ELFH
	99	Estimated Savings	kWh/year
	1,289	Estimated Savings	kWh/year
	1,387	Total	kWh/year
	$218	Cost	$/year

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / unit)	Quantity	Total
Ductless Heat Pump	$ 4,500	1	$ 4,500
	$ 0	0	$ 0
		Implementation Cost:	$ 4,500

Implementation Costs:	$ 5,500	= 13.8 years payback
Annual Energy Savings:	$ 399	

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:	1,080 square feet					
	days /occupied	10	70	74	days	100%
	nights/unoccupied	0	60	80	nights	100%
	# of computers					

Interior lighting, people and occupied levels of internal loads occur for 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 N/A of the peak metered kW)

Heating System Information

		% of bldg. served	COP heat	EER	Heat kBTUH	Heating Fuel	Efficiency	
Primary system:	Forced Air	63%	0.83	10.00	75	Oil - No. 2	83.0%	Et
Secondary:	Air Source Heat Pump	37%	2.78	10.00	32	Electricity	278.0%	Et

100% of building is air conditioned. Does the cooling system have economizer? Yes

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		Is there a pump to circulate DHW?	Yes				
Hot Water usage is	0.25	gallons per	person	/ day for	5	persons on	200	days/year

Weather & Schedule Information:

Select nearest weather station for bin data:	NEWBURGH		for TRM:	Albany
Base temperature for heating degree days:	65 °F. yields	6,359 HDD base65	for TRM:	Small Office
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	4:00 PM	5:00 PM	1.0
Tue	3	4:00 PM	5:00 PM	1.0
Wed	4	4:00 PM	5:00 PM	1.0
Thu	5	4:00 PM	5:00 PM	1.0
Fri	6	4:00 PM	5:00 PM	1.0
Sat	7	12:00 AM	12:00 AM	-
Newburgh, 5 hrs./week				5.0
				163.0

Proposed Schedule for Occupied/Day HVAC setpoints

Day of week	Start	End	Hours
1	12:00 AM	12:00 AM	-
2	4:00 PM	5:00 PM	1.0
3	4:00 PM	5:00 PM	1.0
4	4:00 PM	5:00 PM	1.0
5	4:00 PM	5:00 PM	1.0
6	4:00 PM	5:00 PM	1.0
7	12:00 AM	12:00 AM	-
Newburgh, 5 hrs./week			5.0

Bin Data for Newburgh, 5 hrs./week

Mid Point	Enthalpy all hours	Present Occupied Hours	Present Unoccupied Hours	Occ enthalpy	Unocc enthalpy
-2.5	0.1	0	27		0.1
2.5	1.5	1	62	1.7	1.4
7.5	2.6	2	55	2.4	2.7
12.5	4.0	3	147	4.0	4.0
17.5	5.5	5	268	5.1	5.5
22.5	7.2	5	314	6.8	7.2
27.5	8.8	8	357	8.6	8.8
32.5	10.9	13	761	10.9	10.8
37.5	12.6	28	793	12.0	12.6
42.5	14.9	26	766	14.6	14.9
47.5	17.1	19	801	16.9	17.1
52.5	19.5	25	697	18.5	19.5
57.5	21.6	24	740	20.6	21.6
62.5	24.7	13	759	22.2	24.8
67.5	28.0	20	672	25.7	28.0
72.5	30.1	15	441	28.3	30.2
77.5	30.8	18	389	29.4	30.9
82.5	33.4	19	257	31.1	33.6
87.5	35.4	11	133	34.1	35.5
92.5	39.4	6	58	39.2	39.5
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		
		261	8,499		

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

Village of Philmont Community Center
14 Lake View Drive
Philmont, NY 12565

Building Information

Width (typical)	27	feet		Building Floor Area	1,080	sq. ft.
Equivalent Length	40	feet		Roof Area	1,138	sq. ft.
Number of Floors	1.0	floors		Gross Wall Area	1,072	sq. ft.
Avg. Floor to Floor Height	8	feet per floor		Building Volume	8,640	cubic feet
Roof or Ceiling rise is	4	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		1,138	14.0	0.071	81	16%
Walls	89.4%	of GWA	958	3.5	0.286	274	54%
Glazing 1	3.0%	of GWA	32	1.0	1.000	32	6%
Glazing 2	3.7%	of GWA	40	2.0	0.500	20	4%
Doors 1	2	3x7 doors	42	2.0	0.500	21	4%
Doors 2	0	3x7 doors	0	1.0	1.000	0	0%
	Total Exterior Surface Area		2,210	sq.ft.		428	85%

		ACH	equiv. cfm	Btuh/deg. F.	BLC (without ventilation)	
Est. Infiltration Rate	Occupied	0.50	72	78	455	Btuh/deg. F. Occupied
Est. Infiltration Rate	Unoccupied	0.50	72	78	506	Btuh/deg. F. Unoccupied

		cfm	Fraction	Btuh/deg. F.	**Total BLC with Ventilation**	
Est. Ventilation Rate	Occupied	0	100%	0	**455**	**Btuh/deg. F. Occupied**
Est. Ventilation Rate	Unoccupied		100%	0	**506**	**Btuh/deg. F. Unoccupied**

Heat Gain Estimation

Estimated Solar Gain 10% of building heat loss during occupied periods will be met by solar gains

		kW	# People	Total BTUH	Hours/wk.
Loads & People	Occupied	0.2	10	3,041	5.0
	Unoccupied	0.0	0	128	163.0

Heat Loss Study - continued

Village of Philmont Community Center
14 Lake View Drive
Philmont, NY 12565

		Current	
Heating T Setpoint:	Occupied	70	deg. F.
	Unoccupied	60	deg. F.
Cooling T Setpoint:	Occupied	74	deg. F.
	Unoccupied	80	deg. F.
HVAC Schedule	Occupied	5	Hrs. per week
	Unoccupied	163	Hrs. per week
Q internal gains:	Occupied	3,041	Btuh
	Unoccupied	128	Btuh
Q internal gains:	Schedule	5	Hrs. per week
BLC:	Occupied	455	Btuh/deg. F.
	Unoccupied	506	Btuh/deg. F.

Fuel Data	Heating	Cooling	
Type:	Multiple	Electricity	Economizer?
Units:	mmBtu	kwh	Yes
Unit cost:	$ 28.439	$ 0.157	
BTU/unit	1,000,000	3,412	
Nom. Eff, COP	1.55	2.931	COP
Avg. Eff, COP	1.40	3.92	Avg. COP
		10.0	EER
		100%	of bldg. cooled

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

Current — Newburgh, 5 hrs./week

Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use mmBtu	Cooling Energy kwh	DOAS Hours	DOAS Heating kBtu/yr.
(2.5)	0	27	29,961	31,484	1	0	0	0
2.5	1	62	27,685	28,955	1	0	0	0
7.5	2	55	25,409	26,426	1	0	0	0
12.5	3	147	23,133	23,897	3	0	0	0
17.5	5	268	20,857	21,368	4	0	0	0
22.5	5	314	18,581	18,839	4	0	0	0
27.5	8	357	16,305	16,310	4	0	0	0
32.5	13	761	14,029	13,781	8	0	0	0
37.5	28	793	11,753	11,252	7	0	0	0
42.5	26	766	9,477	8,723	5	0	0	0
47.5	19	801	7,201	6,194	4	0	0	0
52.5	25	697	4,925	3,665	2	0	0	0
57.5	24	740	2,649	1,136	1	0	0	0
62.5	13	759	373	0	0	0	0	0
67.5	20	672	(83)	0	0	0	0	0
72.5	15	441	(2,642)	(750)	0	4	0	0
77.5	18	389	(4,756)	(588)	0	31	0	0
82.5	19	257	(7,485)	(2,434)	0	77	0	0
87.5	11	133	(10,019)	(5,220)	0	80	0	0
92.5	6	58	(13,211)	(8,666)	0	58	0	0
97.5	0	2	(15,262)	(10,969)	0	2	0	0
102.5	0	0	(16,015)	(11,509)	0	0	0	0
107.5	0	0	(18,291)	(14,038)	0	0	0	0
112.5	0	0	(20,567)	(16,566)	0	0	0	0
	8,760	hours			44	253	DOAS fuel use	0
							DOAS cool use	0

Cross Check Against Historic Consumption

	Historic		Calculated	Difference	
Present Annual Heating Fuel Use is	44	mmBTU	44	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.

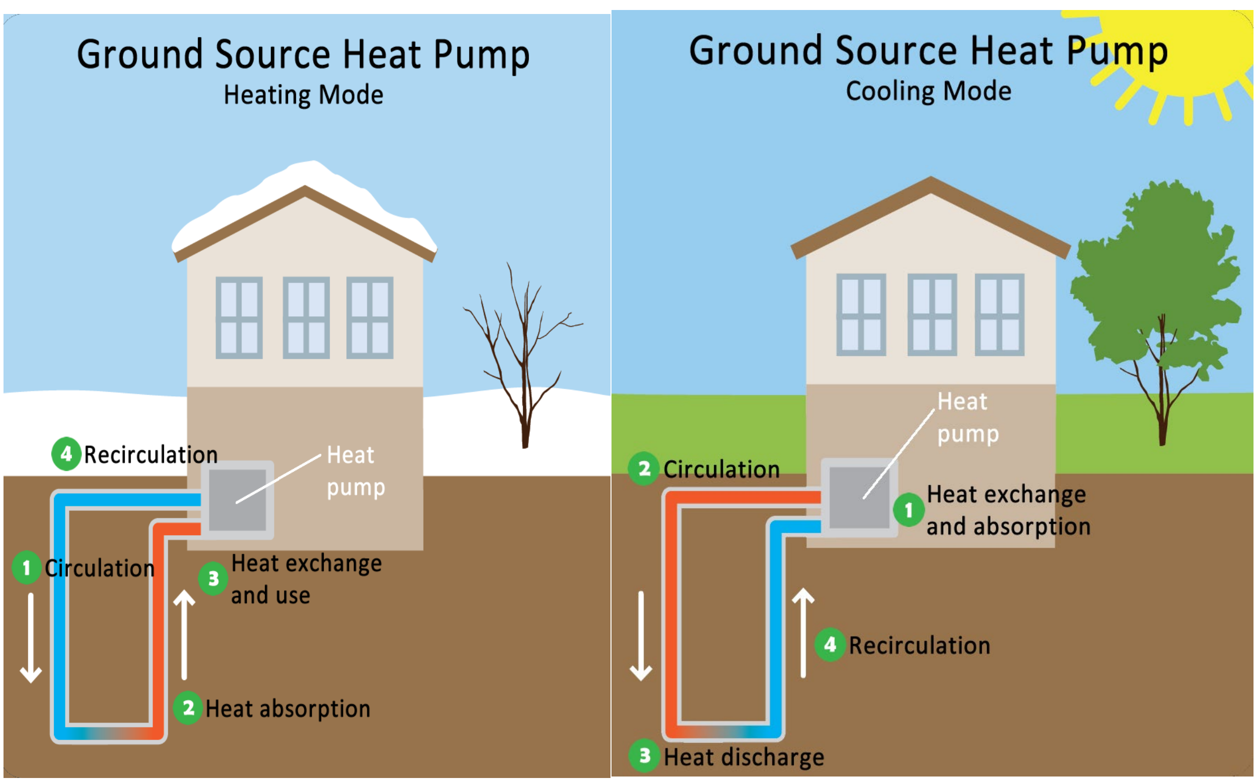
TYPES OF CLEAN HEATING AND COOLING (CHC) TECHNOLOGIES

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).

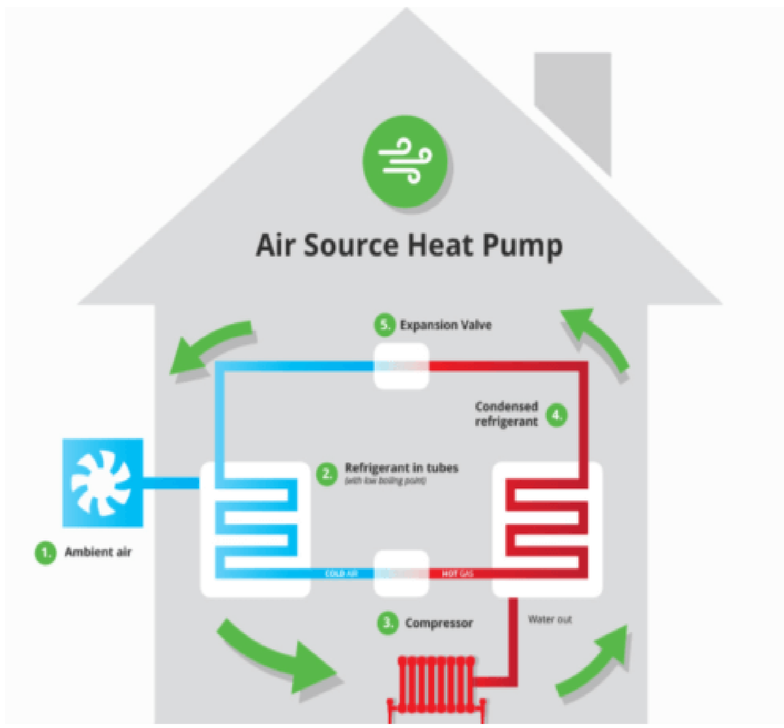
The system reverses during cooling, where the energy is absorbed by the ground loop.



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

What is an Air Source Heat Pump (ASHP)?

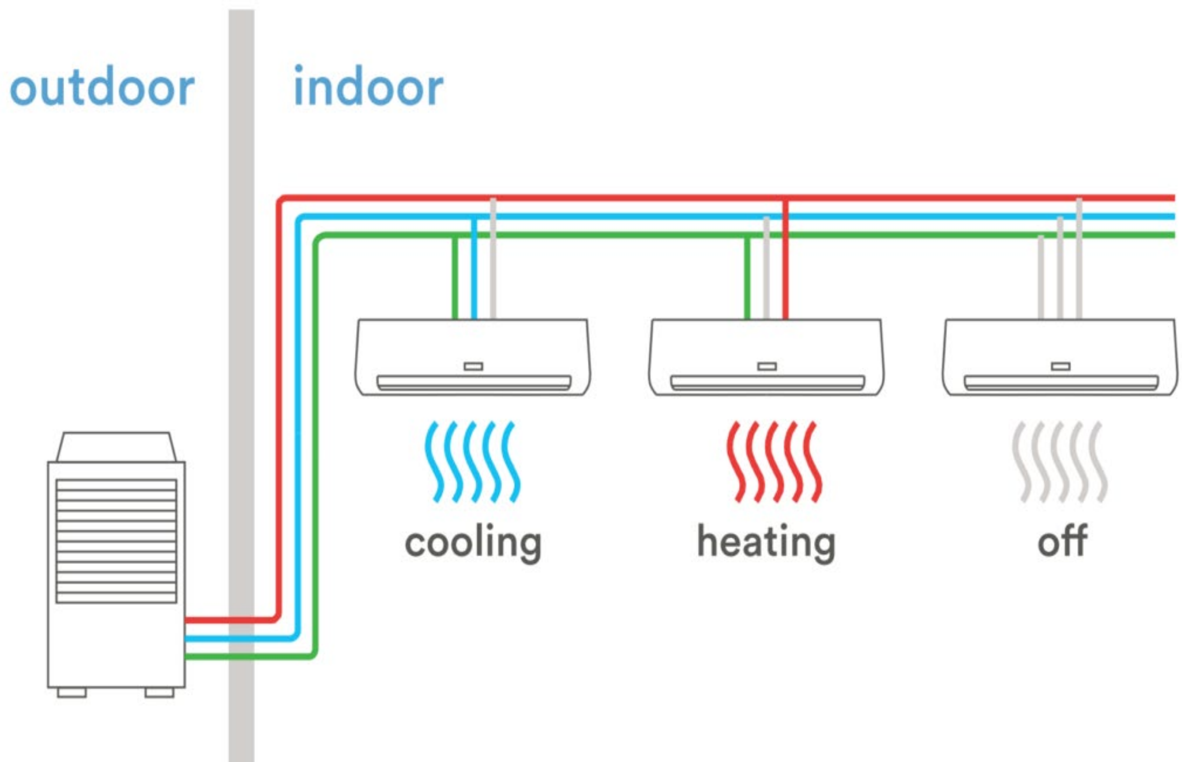
An air source heat pump works much like a refrigerator operating in reverse. Outside air is blown over a network of tubes filled with a refrigerant. This warms up the refrigerant, and it turns from a liquid into a gas. This gas passes through a compressor, which increases the pressure. Compression also 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	Weather-Stripping And Caulking	401	191	0.0	$ 30	Oil - No. 2	1	$ 20	$ 50	$ 120	2.4
EEM-2	NR	Insulate Building Envelope	5,621	2,712	0.0	$ 426	Oil - No. 2	15	$ 274	$ 700	$ 34,140	48.8
EEM-3	R	Install Double Glazing	793	378	0.0	$ 59	Oil - No. 2	2	$ 39	$ 99	$ 1,280	13.0
EEM-4	R	Install A Tankless Water Heater	268	231	0.0	$ 36		0	$ 0	$ 36	$ 500	13.8
		Total of Recommended Measures:	**1,462**	**799**	**0.0**	**$ 126**		**3**	**$ 59**	**$ 185**	**$ 1,900**	**10.3**

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	R	Install A New Air Source Heat Pump	2,152	(2,020)	0.0	($ 99)	Oil - No. 2	28	$ 498	$ 399	$ 5,500	13.8
		Total of Recommended Measures:	**2,152**	**(2,020)**	**0.0**	**($ 99)**	**$ 0**	**28**	**$ 498**	**$ 399**	**$ 5,500**	