



Clean Energy Communities Energy Study

Prepared for:

Town of Copake
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Copake NY 12516

Audit No: CEC401-M-01

Submitted by:

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Date: 8/15/2025

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.

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State of New York

Kathy Hochul, Governor

New York State Energy Research and Development Authority



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Executive Summary

In consideration of NYSERDA's objectives, the primary focus of this Energy Study is the evaluation of energy efficient electric building technologies. Limited opportunities that reduce fossil fuel use may be considered, however, the evaluation of new systems and equipment that utilize fossil fuels is excluded from the analysis contained herein and as such will not be recommended as energy efficiency improvements. The replacement of systems and equipment that utilize fossil fuels are not eligible for Clean Energy Communities Funding.

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

Specific areas of concern that were identified by the owner for evaluation include high energy bills, occupants complaining of drafts and insufficient heating in certain spots.

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

- Replace interior lighting with LED lamps and bulbs
- Replace existing entry and garage doors with new insulated doors
- Replace existing windows with new double pane windows
- Install air source heat pumps
- Install geothermal heat pumps

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.

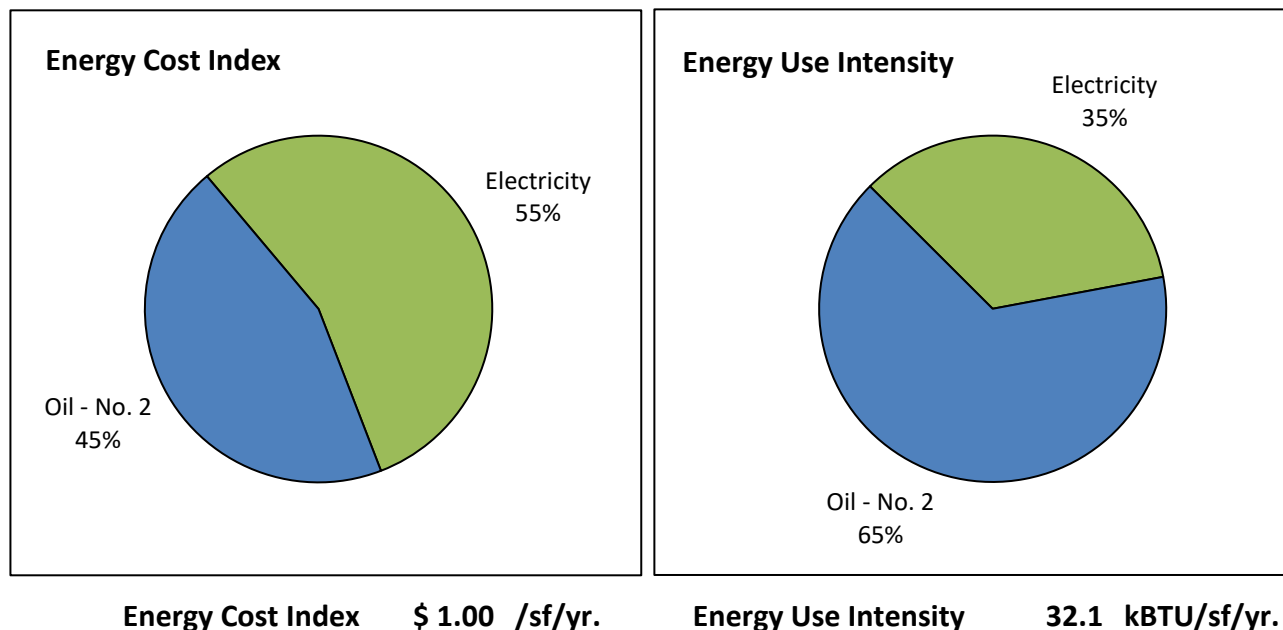
- The Energy Cost Index (ECI) is the total cost of energy divided by the conditioned floor area and is shown as dollars per square foot per year.
- The Energy Use Intensity (EUI) is the total heat content of energy divided by the conditioned floor area and is shown in units of one thousand Btus (kBtu)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

Energy Cost Index

Electricity	\$ 6,219	\$ 0.55	\$/sq.ft./year
Oil - No. 2	\$ 5,035	\$ 0.45	\$/sq.ft./year
Total Cost	\$ 11,254	\$ 1.00	\$/sq.ft./year

Energy Use Intensity

Electricity	125	mmBtu	11.1	kBtu/sq.ft./year
Oil - No. 2	237	mmBtu	21.0	kBtu/sq.ft./year
Total Energy Use	362	mmBtu	32.1	kBtu/sq.ft./year



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	16,187	\$ 2,914	\$ 4,605	1.6
EEM-2	R	Install Insulated Doors	14,836	\$ 1,934	\$ 26,465	13.7
EEM-3	RNE	Install Double Glazing	982	\$ 129	\$ 9,206	71.1
All Energy Efficiency Measures:			32,006	\$ 4,977	\$ 40,276	8.1
Total of Recommended Measures:			32,006	\$ 4,977	\$ 40,276	8.1

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.

(RBE) – Recommended Beneficial Electrification: Measures that should be considered based on greenhouse gas reductions, eliminating on-site use of fossil fuels, and/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	RBE	Install Clean Heating System - Air Source Heat Pump	20,363	\$ 2,245	\$ 89,627	39.9	\$ 13,284	34.0
BE-2	RBE	Install Clean Heating System - Ground Source Heat Pump	6,755	\$ 806	\$ 62,486	77.6	\$ 4,152	72.4
All Measures:			27,118	\$ 3,051	\$ 152,113	49.9	\$ 17,435	44.1
Total of Recommended Measures:			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	29,136	kWh =	33,798	pounds CO2 equivalent
Oil - No. 2	(80)	gal. =	(1,792)	pounds CO2 equivalent
			32,006	pounds CO2 equivalent
			39.5%	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.

Existing Conditions

The site is a town highway garage.

The building consists of 11,250 square feet on 1 floor; it was built in approximately 1987. The exterior walls have a block structure with an exterior finish of block and fiberglass insulation. The hip roof has a metal exterior surface, fiberglass insulation and no interior finished ceiling.

The windows are double glazed single hung aluminum sash. The exterior doors are steel with partial single glazing, with damaged weather stripping.

Major energy end uses include interior lighting and heating and cooling.

The facility is occupied 5 days per week for a total of 50 hours per week. The HVAC system maintains occupied conditions for 42.5 hours per week.

Winter space temperatures are normally maintained at 64.8 and are setback to 60°F during unoccupied periods. Temperature control is provided by programmable thermostats. In the summer, temperatures are maintained at 76 and are setup to 80°F during unoccupied periods.

Lighting Systems

The building has a mix of fluorescent T12 and T8 tubes, incandescent bulbs and high-pressure sodium high bay bulbs.

Heating Ventilating and Air Conditioning Systems

The building uses an oil-fired boiler and fan-powered terminal units equipped with hot water coils to heat the space. During the cooling season, they use portable air conditioners with flexible ducts in the office and break room.

Water Heating System

There is one electric storage type 40 gal. domestic water heater.

Other Energy-using Systems

Other systems using energy include the garage door openers, exhaust fan motors and kitchen appliances.

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

Energy Efficiency Measure Descriptions

EEM-1 Interior Lighting Retrofit

Electric Savings:	\$ 5,201	29,048 kWh per year
		11.6 kW demand
Fuel Savings:	(\$ 2,287)	(107.5) MMBtu fuel per year
		Oil - No. 2
Total Annual Savings:	\$ 2,914	
Project Cost:	\$ 4,605	
Simple Payback:	1.6 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 more blue 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. The garage has a mix of fluorescent T12 and T8 tubes, incandescent bulbs and high pressure sodium high bay bulbs. We recommend replacing these with LED tubes and bulbs with equivalent lumens and color temperatures as indicated in the appendix. This will ensure that the Town Garage employees do not experience lack of adequate lighting in work zones.

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 Install Insulated Doors

Electric Savings:	\$ 10	89 kWh per year
		0.0 kW demand
Fuel Savings:	\$ 1,924	90.4 MMBtu fuel per year
		Oil - No. 2
Total Annual Savings:	\$ 1,934	
Project Cost:	\$ 26,465	
Simple Payback:	13.7 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 new doors should be tight fitting and completely weather-stripped and caulked. The door itself should be filled with a urethane or polystyrene foam. Any glazed area should be double glazed with safety glass, and should comprise no more than 25% of the total door area.

The building has 6 garage doors measuring 16 ft X 14 ft and 3 single exterior doors measuring 3 ft X 7 ft.

We recommend installing new garage doors with polyurethane insulation. Polyurethane insulation is a liquid foam injected between two steel skins that expands to fill the space completely. It hardens, resulting in a rigid, durable garage door that is going to resist dents and dings better than an uninsulated door. These doors have an approximate R-value of 18. Garage doors with polyurethane insulation will provide improved levels of sound isolation and climate control.

For the 3 exterior doors, we recommend installing new foam filled doors with an R-value of 4 and new weatherstripping.

EEM-3 Install Double Glazing

Electric Savings:	\$ 1	0 kWh per year 0.0 kW demand
Fuel Savings:	\$ 128	6.0 MMBtu fuel per year Oil - No. 2
Total Annual Savings:	\$ 129	
Project Cost:	\$ 9,206	
Simple Payback:	71.1 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 Coefficient (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.

The building has 14 windows of varying sizes in the offices, lunchroom and garage areas. They are original to the building, wood framed sliding windows with double pane glazing and an approximate U-value of 0.59.

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 proposed windows are vinyl sliding double pane style, with new weatherstripping and a U-value of 0.39. The new windows will reduce the heat lost from the building to the outdoors in the heating season and reduce drafts. While this measure has high equipment and installation costs and a very high payback, we recommend that the management team install the proposed windows as they will improve occupant comfort.

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 - Air Source Heat Pump

Electric Savings:	(\$ 3,059)	(17,461) kWh per year
		1.2 kW demand
Fuel Savings:	\$ 5,305	249.3 MMBtu fuel per year
		Oil - No. 2
Total Annual Savings:	\$ 2,245	
Project Cost:	\$ 89,627	
Simple Payback:	39.9 years,	34.0 years after incentives

Introduction:

Air source heat pumps (ASHP) provide both heating and cooling using electricity to exchange energy with the outdoor air. Existing buildings may be retrofitted with various heat pump technologies to reduce or eliminate their dependence on fossil fuels for space heating. System options range from centrally-ducted cold climate air source heat pumps and mini-split heat pumps to large variable refrigerant flow systems having multiple indoor units supported by each outdoor unit.

At very cold outdoor air conditions, air source heat pumps may require supplemental heat to meet your building's heating load. Supplemental heat may be in the form of electric resistance heat or your existing fossil-fueled heating system, if it remains in service. The extent to which an ASHP system reduces your fossil fuel use will depend on the exact design and control of your new system.

Recommendation:

Consider replacing your oil - no. 2 heating system with a multi zone ductless air source heat pump system serving the entire building. The system type is: Multi-Zone Ductless Multi-split with Integrated/ Modulating controls sized to 100% of the building heating load.

The proposed heat pumps are assumed to be rated at 13.05 EER full load cooling, 15 SEER. The heat pumps are assumed to be rated at 10 HSPF for heating, which may be adjusted to 4.12 COP. Be sure to specify heat pumps that meet NEEP requirements (Northeast Energy Efficiency Partnerships). See https://ashp.neep.org/#!/product_list/ for current models that meet these requirements. This measure decreases the building's fossil fuel consumption and as such, it would reduce the building's greenhouse gas emissions. It should be considered for building electrification purposes.

BE-2 Install Clean Heating System - Ground Source Heat Pump

Electric Savings:	(\$ 805)	(4,811) kWh per year
		0.6 kW demand
Fuel Savings:	\$ 1,611	75.7 MMBtu fuel per year
		Oil - No. 2
Total Annual Savings:	\$ 806	
Project Cost:	\$ 62,486	
Simple Payback:	77.6 years,	72.4 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:

This measure evaluates replacing your present heating system with a clean heating and cooling system using ground source heat pumps. This measure decreases the building's fossil fuel consumption and as such, it would reduce the building's greenhouse gas emissions. It should be considered for building electrification purposes.

Consider installing an open loop heat pump system with two-stage compressors and staged 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. Be sure to specify heat pumps that meet NEEP requirements (Northeast Energy Efficiency Partnerships). See https://ashp.neep.org/#!/product_list/ for current models that meet these requirements.

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
non condensing boiler	1	Peerless EC/ECT-06-W/S	321	80%	0	tons	0.0	Whole building	
dronic unit heater	6	Rinnai							

Domestic Hot Water									
Unit Type	Qty	Make/Model	Capacity	Units	Fuel Type	Storage Capacity (gal.)	Eff.	Serves/Location	Year
Storage	1	American Water Heating Company E62-40R-045DV	3	kW	Electricity	40	100%	Bathrooms	2005

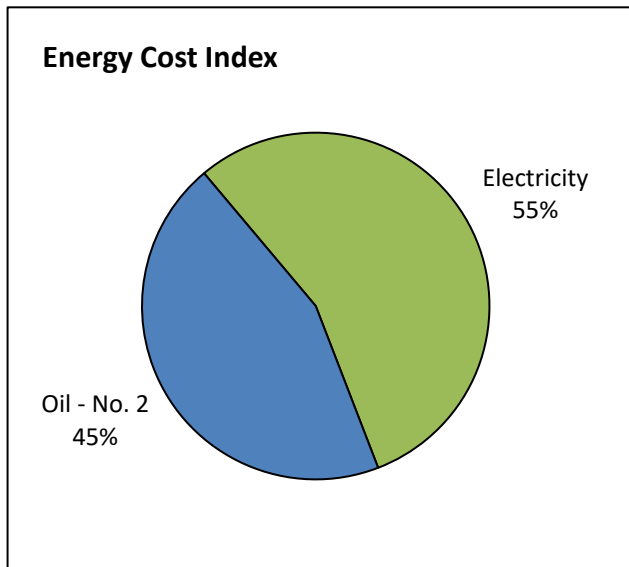
Interior Lighting Fixtures										
Existing Fixtures					Recommended	Recommended Interior Lighting Efficiency Improvements				
Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
Office	5	4' 40w T12 Std. Mag. bal.	4	188	No Change	LED Relamp	5	4' LED T8 1850 lu. 12W	4	48
Break Room	4	4' 40w T12 Std. Mag. bal.	4	188	No Change	LED Relamp	4	4' LED T8 1850 lu. 12W	4	48
Entrance Room	1	U 40w T12 Std. Mag. bal.	2	96	No Change	LED Relamp	1	U-tube LED, 15W	2	30
Bathroom	1	U 40w T12 Std. Mag. bal.	2	96	No Change	LED Relamp	1	U-tube LED, 15W	2	30
Furnace Room	1	60 watt Incandescent	1	60	No Change	LED Relamp	1	A19 LED, 9W	1	9
Tool Bench	4	4' 32w T8 EE Mag. bal.	1	35	No Change	LED Relamp	4	4' LED T8 2200 lu. 17W	1	17
Saw bench	1	8' 95w T12 HO Std. Mag. bal.	2	227	No Change	LED Relamp	1	8' LED fixture, 8645 lu., 65W	2	130
Grinder bench	1	8' 95w T12 HO Std. Mag. bal.	2	227	No Change	LED Relamp	1	8' LED fixture, 8645 lu., 65W	2	130
Over used oil barrel	1	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	1	4' LED T8 2200 lu. 17W	2	34
Over oil drums	2	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	2	4' LED T8 2200 lu. 17W	2	34
Welding room sink	1	U 40w T12 Std. Mag. bal.	2	96	No Change	LED Relamp	1	U-tube LED, 15W	2	30
Paint dept	6	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	6	4' LED T8 2200 lu. 17W	2	34
Paint cabinet	1	4' 40w T12 Std. Mag. bal.	2	94	No Change	LED Relamp	1	4' LED T8 2200 lu. 17W	2	34
Chain bench	2	100w HPS	1	138	No Change	LED Relamp	2	LED HID lamp, 63W 4000K	1	63
Front outside light	1	150w HPS	1	188	No Change	LED Relamp	1	LED HID lamp, 63W 4000K	1	63
Lift door outside light	1	70w HPS	1	95	No Change	LED Relamp	1	LED HID lamp, 54W 4000K	1	54
East outside light	1	70w HPS	1	95	No Change	LED Relamp	1	LED HID lamp, 54W 4000K	1	54
Flag light	1	150w HPS	1	188	No Change	LED Relamp	1	LED HID lamp, 63W 4000K	1	63
Fuel tank light	1	150w HPS	1	188	No Change	LED Relamp	1	LED HID lamp, 63W 4000K	1	63
Truck room	12	400w HPS	1	465	No Change	LED Relamp	12	LED HID lamp, 63W 4000K	1	63
Lift room	6	400w HPS	1	465	No Change	LED Relamp	6	LED HID lamp, 63W 4000K	1	63
Welding room	4	400w HPS	1	465	No Change	LED Relamp	4	LED HID lamp, 63W 4000K	1	63

Appendix B

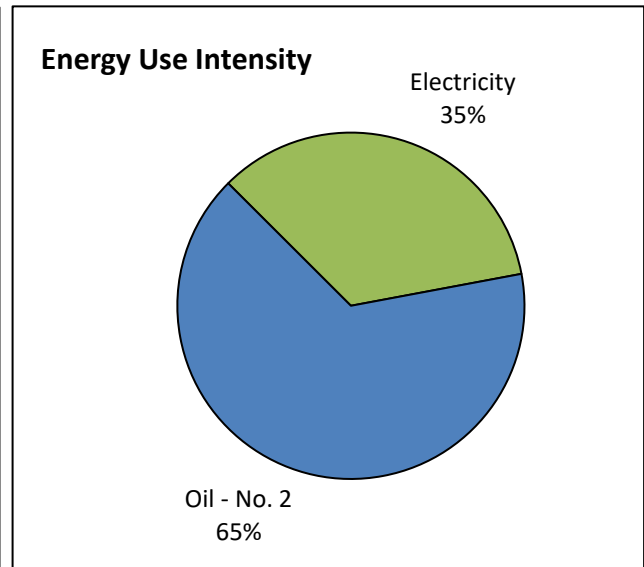
Energy Use and Cost Summary

Energy	Units Used		BTU/unit	mmBTU	% of total	kBtu/sq.ft./year
Electricity	36,604	kwh	3,412	125	35%	11.1
Oil - No. 2	1,715	gal.	138,000	237	65%	21.0
Total				362		32.1

Cost	Energy Cost	Unit Costs		% of total	\$/sq.ft./year
Electricity	\$ 6,219	\$ 0.108	kwh	55%	\$ 0.55
Oil - No. 2	\$ 5,035	\$ 2.936	gal.	45%	\$ 0.45
Total	\$ 11,254				\$ 1.00



Energy Cost Index \$ 1.00 /sf/yr.



Energy Use Intensity 32.1 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

Town of Copake

Gross Area: 11,250 s.f.
11,101 Btu/s.f./Yr
\$ 0.55 /s.f.
1.6 watts/s.f.

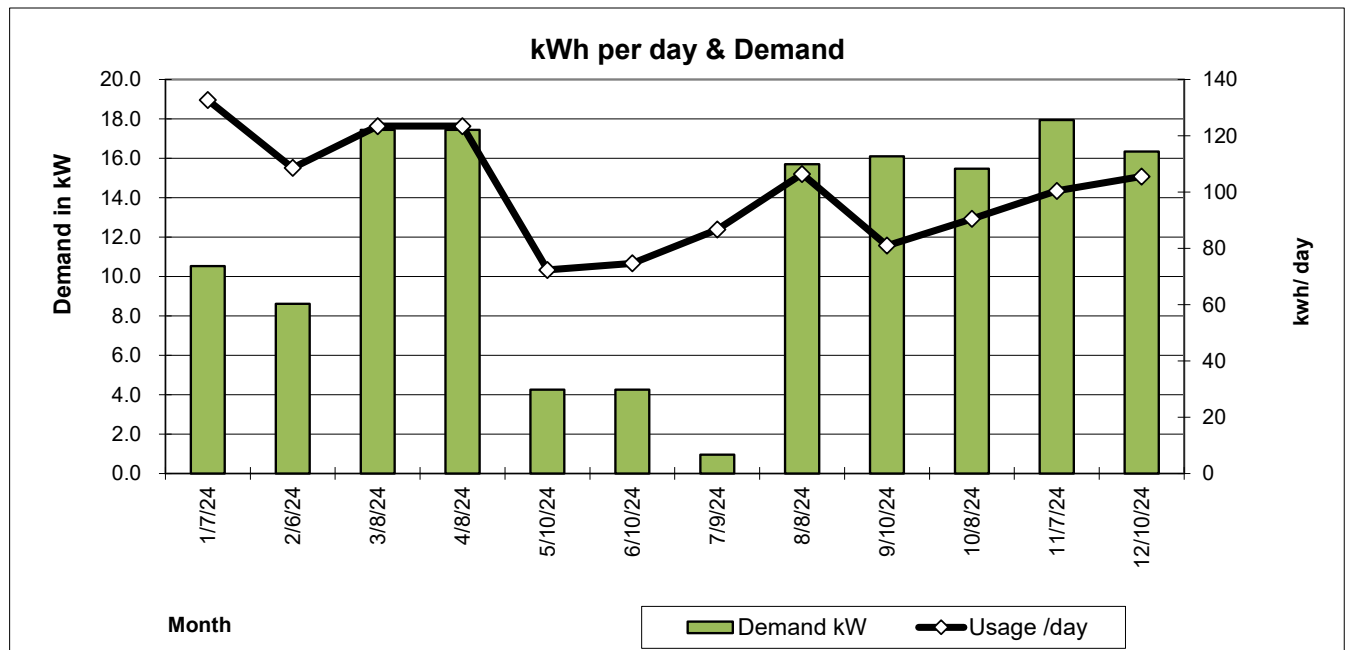
Utility: NYSEG
Account # ends w/ -294

Rate: SC
Meter Charge: \$ 9.50 / month
Demand Charge: \$ 14.80 / kW
Supplier:

Month Ending	Days	Usage		Electricity Charges		Total Electricity Cost	Demand Cost	Energy \$/kWh	Load Factor	Usage /day
		Energy kWh	Demand kW	Utility Cost	Supply Costs					
1/7/24	30	3,980	10.5	\$ 349	\$ 308	\$ 657	\$ 156	\$ 0.124	0.53	133
2/6/24	30	3,256	8.6	\$ 286	\$ 252	\$ 538	\$ 127	\$ 0.123	0.53	109
3/8/24	31	3,826	17.4	\$ 531	\$ 218	\$ 748	\$ 258	\$ 0.126	0.29	123
4/8/24	31	3,826	17.4	\$ 531	\$ 218	\$ 748	\$ 258	\$ 0.126	0.29	123
5/10/24	32	2,314	4.3	\$ 191	\$ 132	\$ 323	\$ 63	\$ 0.108	0.71	72
6/10/24	31	2,314	4.3	\$ 191	\$ 132	\$ 323	\$ 63	\$ 0.108	0.73	75
7/9/24	29	2,513	1.0	\$ 63	\$ 170	\$ 233	\$ 14	\$ 0.083	3.80	87
8/8/24	30	3,193	15.7	\$ 322	\$ 250	\$ 572	\$ 232	\$ 0.103	0.28	106
9/10/24	33	2,671	16.1	\$ 325	\$ 174	\$ 499	\$ 238	\$ 0.094	0.21	81
10/8/24	28	2,533	15.5	\$ 312	\$ 169	\$ 481	\$ 229	\$ 0.096	0.24	90
11/7/24	30	3,012	17.9	\$ 352	\$ 191	\$ 544	\$ 266	\$ 0.089	0.23	100
12/10/24	30	3,165	16.3	\$ 327	\$ 226	\$ 553	\$ 242	\$ 0.095	0.27	106
365		36,604	145.0	\$ 3,779	\$ 2,440	\$ 6,219	\$ 2,146	\$ 0.108	0.35	100

Annual Energy: 36,604 kWh / year \$ 6,219 /year
Peak Demand: 18 kW Peak
Average Demand: 12 kW

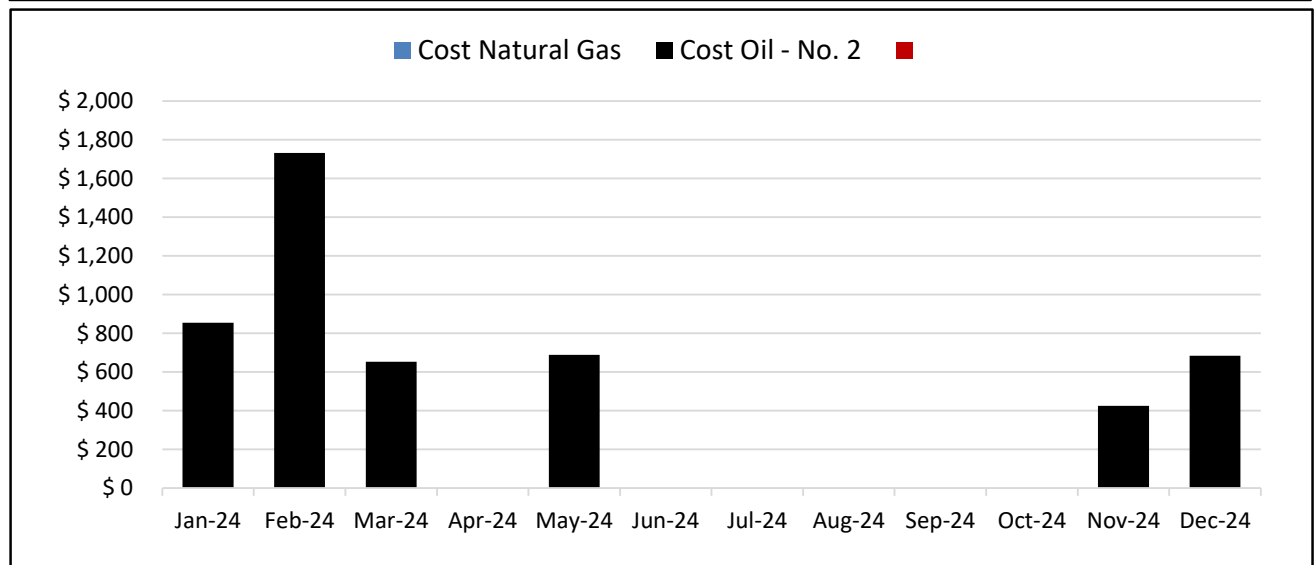
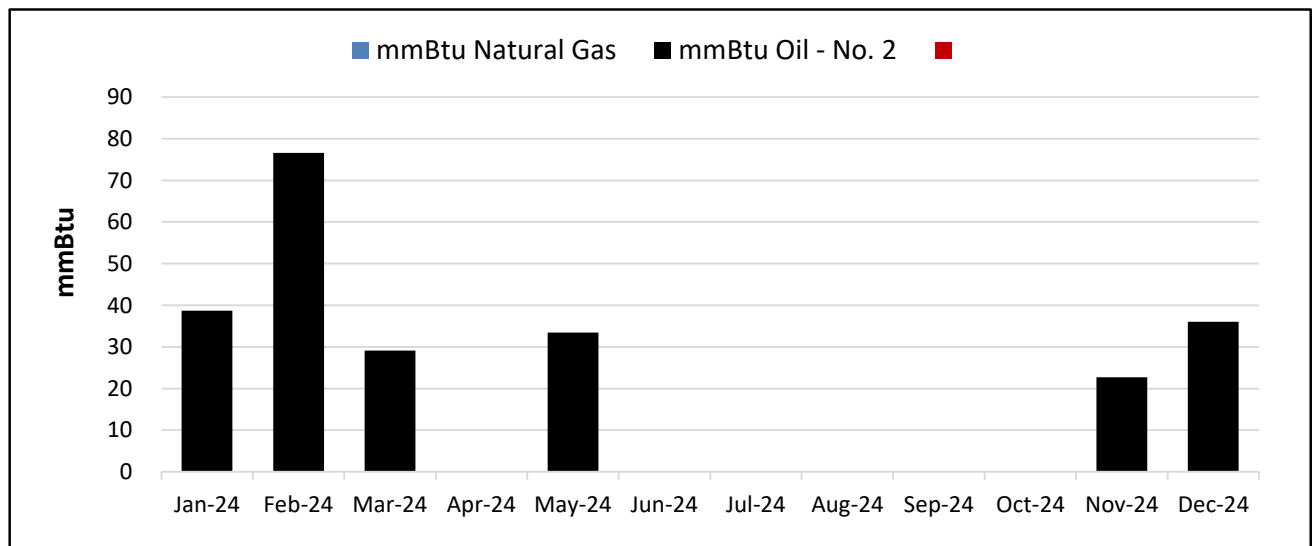
Unit Costs
Demand \$ 14.80 \$/kW
Energy \$ 0.108 \$/kWh Incremental
Blended \$ 0.170 \$/kWh Blended



ALL FUELS CONSUMPTION AND COST ANALYSIS

Town of Copake

Month	mmBtu Natural Gas	mmBtu Oil - No. 2		All Fuel mmBtu	Cost Natural Gas	Cost Oil - No. 2		All Fuel Cost
Jan-24	0	39	0	39	\$ 0	\$ 854	\$ 0	\$ 854
Feb-24	0	77	0	77	\$ 0	\$ 1,732	\$ 0	\$ 1,732
Mar-24	0	29	0	29	\$ 0	\$ 652	\$ 0	\$ 652
Apr-24	0	0	0	0	\$ 0	\$ 0	\$ 0	\$ 0
May-24	0	33	0	33	\$ 0	\$ 688	\$ 0	\$ 688
Jun-24	0	0	0	0	\$ 0	\$ 0	\$ 0	\$ 0
Jul-24	0	0	0	0	\$ 0	\$ 0	\$ 0	\$ 0
Aug-24	0	0	0	0	\$ 0	\$ 0	\$ 0	\$ 0
Sep-24	0	0	0	0	\$ 0	\$ 0	\$ 0	\$ 0
Oct-24	0	0	0	0	\$ 0	\$ 0	\$ 0	\$ 0
Nov-24	0	23	0	23	\$ 0	\$ 425	\$ 0	\$ 425
Dec-24	0	36	0	36	\$ 0	\$ 683	\$ 0	\$ 683
Total	0	237	0	237	\$ 0	\$ 5,035	\$ 0	\$ 5,035
\$/mmBtu		\$ 21.28		\$ 21.28				
BTU/unit	1,000,000	138,000	92,000			1 mmBtu =	1,000,000 Btus	
kBtu/SF/Yr.	0.0	21.0	0.0	21.0		1 kBtu =	1,000 Btus	



Appendix C

EEM Calculations

CALCULATIONS FOR INTERIOR LIGHTING RETROFIT

EEM-1

Town of Copake

Type: Oil - No. 2
Units: gal.
Unit cost: \$ 2.936
Electricity: kwh \$ 0.108
Demand: kW \$ 14.80
BTU/unit: 138,000
3,412
12 Months of demand savings/year
100% of building is air conditioned

HVAC Adjustment Factors		
Cooling	Demand	Fuel
HVACc	HVACd	HVACg
0.00%	0.00%	-3.70%

Existing Interior Lighting Systems					Recommended Lighting Controls					Recommended Interior Lighting Efficiency Improvements										Energy & Demand Calculations							
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	Lamps /fixt	Reflect or ?	Watts /fixt	Project Cost	Annual Savings	kWh/yr. Savings	Payback (Years)	Demand			Total Use		Energy Savings		
																				Present kW	Proposed kW	kW Saved	Present kWh/year	Proposed kWh/year	Controls kWh/year	Efficiency kWh/year	
Office	5	4' 40w T12 Std. Mag. bal.	4	188	No Change	0%	2,500	2,500	0	LED Relamp	5	4' LED T8 1850 lu. 12W	4		48	\$ 210	\$ 313	1,750	0.7	0.9	0.2	0.7	2,350	600	0	1,750	
Break Room	4	4' 40w T12 Std. Mag. bal.	4	188	No Change	0%	2,500	2,500	0	LED Relamp	4	4' LED T8 1850 lu. 12W	4		48	\$ 168	\$ 251	1,400	0.7	0.8	0.2	0.6	1,880	480	0	1,400	
Entrance Room	1	U 40w T12 Std. Mag. bal.	2	96	No Change	0%	2,500	2,500	0	LED Relamp	1	U-tube LED, 15W	2		30	\$ 35	\$ 30	165	1.2	0.1	0.0	0.1	240	75	0	165	
Bathroom	1	U 40w T12 Std. Mag. bal.	2	96	No Change	0%	2,500	2,500	0	LED Relamp	1	U-tube LED, 15W	2		30	\$ 35	\$ 30	165	1.2	0.1	0.0	0.1	240	75	0	165	
Furnace Room	1	60 watt Incandescent	1	60	No Change	0%	2,500	2,500	0	LED Relamp	1	A19 LED, 9W	1		9	\$ 4	\$ 23	128	0.2	0.1	0.0	0.1	150	23	0	128	
Tool Bench	4	4' 32w T8 EE Mag. bal.	1	35	No Change	0%	2,500	2,500	0	LED Relamp	4	4' LED T8 2200 lu. 17W	1		17	\$ 29	\$ 32	180	0.9	0.1	0.1	0.1	350	170	0	180	
Saw bench	1	8' 95w T12 HO Std. Mag. ba	2	227	No Change	0%	2,500	2,500	0	LED Relamp	1	8' LED fixture, 8645 lu., 65W	2		130	\$ 124	\$ 43	243	2.8	0.2	0.1	0.1	568	325	0	243	
Grinder bench	1	8' 95w T12 HO Std. Mag. ba	2	227	No Change	0%	2,500	2,500	0	LED Relamp	1	8' LED fixture, 8645 lu., 65W	2		130	\$ 124	\$ 43	243	2.8	0.2	0.1	0.1	568	325	0	243	
Over used oil barrel	1	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	1	4' LED T8 2200 lu. 17W	2		34	\$ 14	\$ 17	93	0.9	0.1	0.0	0.0	178	85	0	93	
Over oil drums	2	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	2	4' LED T8 2200 lu. 17W	2		34	\$ 29	\$ 33	185	0.9	0.1	0.1	0.1	355	170	0	185	
Welding room sink	1	U 40w T12 Std. Mag. bal.	2	96	No Change	0%	2,500	2,500	0	LED Relamp	1	U-tube LED, 15W	2		30	\$ 35	\$ 30	165	1.2	0.1	0.0	0.1	240	75	0	165	
Paint dept	6	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	6	4' LED T8 2200 lu. 17W	2		34	\$ 86	\$ 99	555	0.9	0.4	0.2	0.2	1,065	510	0	555	
Paint cabinet	1	4' 40w T12 Std. Mag. bal.	2	94	No Change	0%	2,500	2,500	0	LED Relamp	1	4' LED T8 2200 lu. 17W	2		34	\$ 14	\$ 27	150	0.5	0.1	0.0	0.1	235	85	0	150	
Chain bench	2	100w HPS	1	138	No Change	0%	2,500	2,500	0	LED Relamp	2	LED HID lamp, 63W 4000K	1		63	\$ 258	\$ 67	375	3.8	0.3	0.1	0.2	690	315	0	375	
Front outside light	1	150w HPS	1	188	No Change	0%	2,500	2,500	0	LED Relamp	1	LED HID lamp, 63W 4000K	1		63	\$ 129	\$ 56	313	2.3	0.2	0.1	0.1	470	158	0	313	
Lift door outside light	1	70w HPS	1	95	No Change	0%	2,500	2,500	0	LED Relamp	1	LED HID lamp, 54W 4000K	1		54	\$ 110	\$ 18	103	6.0	0.1	0.1	0.0	238	135	0	103	
East outside light	1	70w HPS	1	95	No Change	0%	2,500	2,500	0	LED Relamp	1	LED HID lamp, 54W 4000K	1		54	\$ 110	\$ 18	103	6.0	0.1	0.1	0.0	238	135	0	103	
Flag light	1	150w HPS	1	188	No Change	0%	2,500	2,500	0	LED Relamp	1	LED HID lamp, 63W 4000K	1		63	\$ 129	\$ 56	313	2.3	0.2	0.1	0.1	470	158	0	313	
Fuel tank light	1	150w HPS	1	188	No Change	0%	2,500	2,500	0	LED Relamp	1	LED HID lamp, 63W 4000K	1		63	\$ 129	\$ 56	313	2.3	0.2	0.1	0.1	470	158	0	313	
Truck room	12	400w HPS	1	465	No Change	0%	2,500	2,500	0	LED Relamp	12	LED HID lamp, 63W 4000K	1		63	\$ 1,546	\$ 2,159	12,060	0.7	5.6	0.8	4.8	13,950	1,890	0	12,060	
Lift room	6	400w HPS	1	465	No Change	0%	2,500	2,500	0	LED Relamp	6	LED HID lamp, 63W 4000K	1		63	\$ 773	\$ 1,080	6,030	0.7	2.8	0.4	2.4	6,975	945	0	6,030	
Welding room	4	400w HPS	1	465	No Change	0%	2,500	2,500	0	LED Relamp	4	LED HID lamp, 63W 4000K	1		63	\$ 515	\$ 720	4,020	0.7	1.9	0.3	1.6	4,650	630	0	4,020	
58		14.6 kW existing		0		58		3.0 kW proposed		14.6		3.0		11.6		36,568		7,520		0		29,048 kwh		29,048 kwh			

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

SUMMARY OF SAVINGS BY MEASURE TYPE:		Fixture	Energy Savings		Demand				
	Measure Type	Qty.	Controls kwh/year	Efficiency kwh/year	kW Savings	Project Cost	Electric Savings	Payback (Years)	Measure Description
EEM-1C	LED Relamp	58		29,048	11.6	\$ 4,605	\$ 5,201	0.9	Screw-In or Socket based LED lamps
		58	0	29,048	11.6	\$ 4,605	\$ 5,201		

Gross Energy Savings 29,048 kwh
Net Energy Savings 29,048 kwh 11.6 -779 gal. \$ 2,914 net

PAYBACK PERIOD:

Estimated Cost Interior Lighting: \$ 4,605 = 1.6 year payback
Annual Energy Savings (kWh + kW): \$ 2,914

CALCULATIONS TO INSTALL INSULATED DOORS

EEM-2 Town of Copake

INPUT DATA:

Type & Qty.	Doors 1	6	Type & Qty.	Doors 2	3
	Present	Proposed		Present	Proposed
Area:	1,344	sq ft total	Area:	63	sq ft total
Perimeter:	360	360	Perimeter:	60	60 linear feet
Infilt. rate:	60	30	Infiltration rate:	60	30 cu.ft./hr.
R value:	2.5	18.0	R value:	1.7	4.0
U factor:	0.400	0.056	U factor:	0.588	0.250
U x Area	538	75	U x Area	37	16

	Present	Proposed	Change
Total UA	575	90	484 Btuh/deg F
Infiltration Load	227	113	113 Btuh/deg F
	801	204	598 Btuh/deg F

CALCULATIONS:

	Occupied	Unoccupied	Fuel Data	Heating	Cooling
Heating Setpoint:	65	60	Type:	Oil - No. 2	Electricity
Cooling Setpoint:	76	80	Units:	gal.	kwh
Q internal gains (Btuh):	30,554	7,219	Unit cost:	\$ 2.936	\$ 0.108
BLC (Btuh/degree F):	2,220	2,220	BTU/unit	138,000	3,412
Heating T Balance (°F.):	51.0	56.7	Efficiency/ COP:	79.4%	4.76
Cooling T Balance (°F.):	72.1	76.1	EER:		16.2
T Balance = T Setpoint - (Q internal gains / BLC)			Portion of bldg. cooled:		100.0%

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat Loss	Change in Unoccupied Heat Loss	Heating Savings gal.	Cooling Savings kwh
(12.5)	2	8	46,198	43,329	4	0
(7.5)	2	19	43,210	40,341	8	0
(2.5)	6	26	40,221	37,353	11	0
2.5	10	85	37,233	34,364	30	0
7.5	22	73	34,245	31,376	28	0
12.5	26	99	31,257	28,388	33	0
17.5	49	162	28,268	25,400	50	0
22.5	67	271	25,280	22,412	71	0
27.5	72	342	22,292	19,423	75	0
32.5	112	434	19,304	16,435	85	0
37.5	112	647	16,316	13,447	96	0
42.5	184	575	13,327	10,459	77	0
47.5	205	580	10,339	7,471	59	0
52.5	131	547	0	4,482	22	0
57.5	217	698	0	0	0	0
62.5	208	691	0	0	0	0
67.5	208	562	0	0	0	0
72.5	156	394	2,092	0	3	0
77.5	136	220	(896)	1,494	3	8
82.5	117	183	(3,885)	(1,494)	0	45
87.5	44	50	(6,873)	(4,482)	0	32
92.5	2	6	(9,861)	(7,471)	0	4
97.5	0	0	(12,849)	(10,459)	0	0
102.5	0	0	(15,838)	(13,447)	0	0

8,760 hours

Energy Savings:

655
\$ 1,924

89
\$ 10

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor (\$ / each)	Quantity	Total
Doors 1	\$ 345	64	\$ 22,080
Doors 2	\$ 345	3	\$ 1,035
Demolition	\$ 50	67	\$ 3,350

Implementation Cost: \$ 26,465 = 13.7 year payback
Annual Energy Savings: \$ 1,934

CALCULATIONS TO INSTALL DOUBLE GLAZING **EEM-3 Town of Copake**

Type: Oil - No. 2
Units: gal.
Unit cost: \$ 2.936 /gal.
Heat Content of Fuel: 138,000 Btu/gal.
Combustion Efficiency: 79%

DATA:

	Occupied	Unoccupied	
T Setpoint:	65	60	degrees F
Q internal gains:	30,554	7,219	Btuh
BLC:	2,220	2,220	Btuh/degree F
T Balance:	51.0	56.7	degrees F
T Balance = T Setpoint - (Q internal gains / BLC)			

Glazing Information

	Glazing 1	Glazing 2
Present Conditions	Double glazed windows	Double glazed windows
Present Area:	181 sq ft	24 sq ft
U factor:	0.59 Btuh/sq ft-deg F	0.59 Btuh/sq ft-deg F
Crack Length:	0 feet	0 feet
Present Infiltration:	40 cfh	40 cfh
Proposed Condition:	Double glazed sliding windows	Double glazed sliding windows
Proposed Area:	181 sq ft	24 sq ft
New U factor:	0.39 Btuh/sq ft-deg F	0.39 Btuh/sq ft-deg F
New Crack Length:	0 feet	0 feet
Proposed Infiltration:	40 cfh	40 cfh

Bin Data for Poughkeepsie, 43 hrs./week

	T Setpoint	T Balance	Accum Hours	Average O.A. Temp below T Balance	Temp Difference (T Set- Avg OAT)
Occupied	65	51.0	869	34.8	30.0
Unoccupied	60	56.7	3,868	36.0	24.0

CALCULATIONS:

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

	Conduction Savings (Btu/year)	Infiltration Savings (Btu/year)	Total Savings (Btu/year)	Total Annual Fuel Savings (gal./year)	Energy Cost Savings (\$/year)
Winter					
Occupied	1,059,000	0	1,059,000	10	\$ 28
Unoccupied	3,771,000	0	3,771,000	34	\$ 101
Annual Savings:	4,830,000	0	4,830,000	44	\$ 129

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor \$ / sq. ft.	Quantity	Total
Office windows	\$ 45	181	\$ 8,126
Break room windows	\$ 45	24	\$ 1,080
Implementation Cost:			\$ 9,206
Annual Energy Savings:			\$ 129 = 71.1 year payback

CALCULATIONS TO INSTALL CLEAN HEATING SYSTEM - AIR SOURCE HEAT PUMP

BE-1

Town of Copake

Building Information		Fuel Information			
Location	Auto Repair Poughkeepsie	Climate Zone 5	Type:	Heating Oil - No. 2	Cooling Electricity
Portion of Building HP will serve:	100%		Units:	gal.	kwh
Building Heating Load (BHL)	171,574 BTU/h		Unit cost:	\$ 2.936	\$ 0.108 /kwh
Building Cooling Load (BCL)	70,722 BTU/h		BTU/unit	138,000	3,412 /kwh
BEFLHheating	1,192 Hours		Heating Eff.	81%	\$ 14.80 /kW
BEFLHcooling	468 Hours		CO2	22.48	1.16 lbs/unit

Existing System

Is baseline heating system electric?	N
Is baseline heating system fossil fuel?	Y
If yes, will it remain in place in the efficient case?	N

Present Heating System	Boiler, Hot Water, Oil Fired ≥ 300 kBTU/h and $\leq 2,500$ kBTU/h
Present Cooling System	Air-cooled AC w/ other heat (≥ 240 and < 760 kBTU/h)
% of Portion to be served by ASHP that is presently cooled	100%

Proposed System

Does proposed ASHP require supplemental resistance heat?		Y
ASHP Type	Multi Zone Ductless	
ASHP Application	Whole	(the ASHP will meet all of the heating load)
Control Type	Integrated/Modulating	
Heating Capacity	180,000	BTU/h at 5°F
Energy Efficiency Ratio	13.1	EER _{ee}
Seasonal Energy Efficiency Ratio	15.0	SEER
Heating Season Performance Factor	10.0	HSPF
		1.0 HP Sizing Ratio

Resulting system to be modeled

Scenario 3c

Multi-Zone Ductless Multi-split with Integrated/ Modulating controls sized to 100%

Adjusted Efficiency Values

Adjusted Efficiency Values		Baseline	Energy Efficient				
	SEERbaseline	11.4	15.1	EERseason,ee	15.270 c	cooling offset	
	EERbaseline	9.8	13.1	EERee	-0.009 d	cooling slope	
	COPseason,baseline	1.00	4.12	COPseason,ee	-2.395 a	heating offset	
	FElecHeat	0.00	1.00	FElecHeat,new	1.645 b	heating slope	
	EFFbaseline	0.82	1.00	Fload,cooling			
	FFuelHeat	1.00	0.92	Fload,heating			
			1.00	Fload,heating,FuelHeat		0.69 CF	
			0.92	Fload,heating,ElecHeat			
					Savings	Savings	
		Baseline	Energy Efficient	Savings	Units	\$	CO2 Lbs/yr.
Cooling Electric Use (kWh/yr.)		2,904	2,187	717	kWh		
Heating Electric Use (kWh/yr.)		0	18,177	(18,177)	kWh		
Total Electric Use (kWh/yr.)		2,904	20,365	(17,461)	kWh	(\$ 1,886)	(20,254)
Peak Demand (kW)		5.0	3.7	1.2	kW	(\$ 1,174)	
Fossil Fuel Energy Use (MMBTU)		249	0	249	MMBTu		
Fossil Fuel Energy Use : gal.		1,807	0	1,807	gal.	\$ 5,305	40,618
Annual Energy Costs		\$ 5,894	\$ 3,649	\$ 2,245		\$ 2,245	20,363
Estimated Project Cost		\$ 6,269	per ton =	\$ 89,627		40 year payback	

CALCULATIONS TO INSTALL CLEAN HEATING SYSTEM - GROUND SOURCE HEAT PUMP

BE-2

Town of Copake

Fuel Information

Building Information

Location	Auto Repair Poughkeepsie	Climate Zone 5	Type:	Heating Multiple	Cooling Electricity
Portion of Building HP will serve:	30%		Units:	mmBtu	kwh
Building Heating Load (BHL)	51,472 BTU/h		Unit cost:	\$ 21.275	\$ 0.108 /kwh
Building Cooling Load (BCL)	21,217 BTU/h		BTU/unit	1,000,000	3,412 /kwh
BEFLHheating	1,192 Hours		Heating Eff.	81%	\$ 14.80 /kW
BEFLHcooling	468 Hours		CO2	162.90	1.16 lbs/unit

Existing System

Is baseline heating system electric?	N
Is baseline heating system fossil fuel?	Y
Present Heating System	Warm Air Furnace, Oil Fired ≥ 225 kBTU/h
Present Cooling System	Air-cooled AC w/ other heat (≥ 240 and < 760 kBTU/h)
% of Portion to be served by GSHP that is presently cooled	100%

Proposed System

GSHP Loop Type	Open Loop	GWHP
GSHP Compressor Type	Two-Stage	0.75 Capacity Ratio
Estimated Pump Power	60 watts per ton	
Pumping Control Strategy	Staged	
Heating Capacity	60,000 BTU	rating condition
Energy Efficiency Ratio Full Load	17.0	EER GWHP,full 59 ° EWT
Energy Efficiency Ratio Part Load	22.0	EER GWHP,par 59 ° EWT
Heating COP Full Load	3.6	COP GWHP,ful 50 ° EWT
Heating COP Part Load	4.1	COP GWHP,pa 50 ° EWT

Adjusted Efficiency Values

	Baseline	Energy Efficient	
EERseason,baseline	11.4	19.16	EERseason,ee
EERpeak,baseline	9.8	17.0	EER GSHP, full,ee
COPseason,baseline	1.00	3.48	COPseason,ee
FElecHeat	0.00		
EFFbaseline	0.81	0.69 CF	
FFuelHeat	1.00		

	Baseline	Energy Efficient	Savings	Units	Savings \$	Savings CO2 Lbs/yr.
Cooling Electric Use (kWh/yr.)	871	518	353	kWh		
Heating Electric Use (kWh/yr.)	0	5,164	(5,164)	kWh		
Total Electric Use (kWh/yr.)	871	5,682	(4,811)	kWh	(\$ 520)	(5,581)
Peak Demand (kW)	1.5	0.9	0.6	kW	(\$ 286)	
Fossil Fuel Energy Use (MMBTU)	76	0	76	MMBTU		
Fossil Fuel Energy Use : mmBtu	76	0	76	mmBtu	\$ 1,611	12,336
Annual Energy Costs	\$ 1,870	\$ 1,065	\$ 806		\$ 806	6,755
Estimated Project Cost	\$ 14,568	per ton =	\$ 62,486		78 year payback	

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%.

Appendix D

Assumptions/Data Used to Develop Energy and Dollar Savings Figures

Building and Occupancy Information

Floor Area:	11,250 square feet	Avg. # of occupants	Heating Setpoint	Cooling Setpoint	% of base electricity use resulting in internal heat gains	
		days /occupied	7	65	76	days 100%
		nights/unoccupied	0	60	80	nights 100%
		# of computer	7			
Interior lighting, people and occupied levels of internal loads occur for			50	hours per week		
Electricity use at night is usually			25%	of the usual electricity use during day periods		
(This results in an average daytime kW that is			90%	of the peak metered kW)		

Heating System Information

	% of bldg. served	COP heat	EER	Heat kBTUH	Heating Fuel	Efficiency	
Primary system: Non-Condensing Boiler	100%	0.81	10.00	800	Oil - No. 2	80.0%	Et
Secondary: Forced Air	0%	0.80	10.00				Et
100% of building is air conditioned		Does the cooling system have economizer?		No			
		Fuel					
Describe the <u>direct outside air</u> or <u>central make-up air</u> system:		80% Eff.		9.50 EER for DOAS			
		0 cfm outside air, running					
		0 hours / week		0% heat recovery efficiency			

Domestic Hot Water

	Fuel	Efficiency					
DHW system energy type	Electricity	80%	Is there a pump to circulate DHW?		No		
Hot Water usage is	0.5	gallons per	person	/ day for	7	persons on	250 days/year

Weather & Schedule Information:

Select nearest weather station for bin data:	POUGHKEEPSIE		for TRM:	Poughkeepsie
Base temperature for heating degree days:	65 °F. yields	6,193 HDD base65	for TRM:	Auto Repair
Base temperature for cooling degree days:	70 °F. yields	392 CDD base70	for TRM:	Gas Heat Only

Present Schedule for Occupied/Day HVAC setpoints

Day of week		Start	End	Hours
Sun	1	6:00 AM	6:00 AM	-
Mon	2	7:00 AM	3:30 PM	8.5
Tue	3	7:00 AM	3:30 PM	8.5
Wed	4	7:00 AM	3:30 PM	8.5
Thu	5	7:00 AM	3:30 PM	8.5
Fri	6	7:00 AM	3:30 PM	8.5
Sat	7	6:00 AM	6:00 AM	-
Poughkeepsie, 43 hrs./week				42.5
				125.5

Proposed Schedule for Occupied/Day HVAC setpoints

Day of week		Start	End	Hours
1		6:00 AM	6:00 AM	-
2		7:00 AM	3:30 PM	8.5
3		7:00 AM	3:30 PM	8.5
4		7:00 AM	3:30 PM	8.5
5		7:00 AM	3:30 PM	8.5
6		7:00 AM	3:30 PM	8.5
7		6:00 AM	6:00 AM	-
Poughkeepsie, 43 hrs./week				42.5

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

Town of Copake
47 School Rd
Copake NY 12516

Building Information

Width (typical)	120 feet	Building Floor Area	11,400 sq. ft.
Equivalent Length	95 feet	Roof Area	11,751 sq. ft.
Number of Floors	1.0 floors	Gross Wall Area	5,547 sq. ft.
Avg. Floor to Floor Height	13 feet per floor	Building Volume	147,060 cubic feet
Roof or Ceiling rise is	3 feet in 12' run		

Estimate of Conductive Heat Loss

<u>Surface</u>		<u>Area</u>	<u>R-value</u>	<u>U Factor</u>	<u>U x A</u> <u>Btuh/deg. F.</u>	<u>% of BLC</u> <u>w/o ventilation</u>
Roof	n/a	11,751	21.1	0.047	558	25%
Walls	70.9% of GWA	3,935	22.8	0.044	173	8%
Glazing 1	3.3% of GWA	181	1.7	0.588	106	5%
Glazing 2	0.4% of GWA	24	1.7	0.588	14	1%
Doors 1	64 3x7 doors	1,344	2.5	0.400	538	24%
Doors 2	3 3x7 doors	63	1.7	0.588	37	2%
Total Exterior Surface Area		17,298 sq.ft.			1,425	64%

		ACH	equiv. cfm	Btuh/deg. F.	BLC (without ventilation)
Est. Infiltration Rate	Occupied	0.30	735	794	2,220 Btuh/deg. F. Occupied
Est. Infiltration Rate	Unoccupied	0.30	735	794	2,220 Btuh/deg. F. Unoccupied
		cfm	Fraction	Btuh/deg. F.	Total BLC with Ventilation
Est. Ventilation Rate	Occupied	0	100%	0	2,220 Btuh/deg. F. Occupied
Est. Ventilation Rate	Unoccupied		100%	0	2,220 Btuh/deg. F. Unoccupied

Heat Gain Estimation

Estimated Solar Gain 0% of building heat loss during occupied periods will be met by solar gains

		kW	# People	Total BTUH	Hours/wk.
Loads & People	Occupied	8.5	7	30,554	50.0
	Unoccupied	2.1	0	7,219	118.0

Heat Loss Study - continued

Town of Copake
47 School Rd
Copake NY 12516

Fuel Data
Heating Type: Oil - No. 2
Cooling Electricity: kwh
Economizer? No

		Current						
Heating T Setpoint:	Occupied	65	deg. F.	BTU/unit	138,000	3,412		
	Unoccupied	60	deg. F.	Nom. Eff, COP	0.810	2.931	COP	
Cooling T Setpoint:	Occupied	76	deg. F.	Avg. Eff, COP	0.794	4.76	Avg. COP	
	Unoccupied	80	deg. F.			16.2	Avg. EER	
HVAC Schedule	Occupied	43	Hrs. per week					100% of bldg. cooled
	Unoccupied	126	Hrs. per week					DOAS Energy Use
Q internal gains:	Occupied	30,554	Btuh					0 cfm
	Unoccupied	7,219	Btuh					0% heat recov. Eff.
Q internal gains:	Schedule	50	Hrs. per week					Heating 0
BLC:	Occupied	2,220	Btuh/deg. F.					0
	Unoccupied	2,220	Btuh/deg. F.					80% eff.
								2.78 COP cool
								0 hrs/week

Current Poughkeepsie, 43 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.
(12.5)	2	8	141,020	152,307	14	0	0	0
(7.5)	2	19	129,922	141,209	27	0	0	0
(2.5)	6	26	118,824	130,111	37	0	0	0
2.5	10	85	107,726	119,013	102	0	0	0
7.5	22	73	96,628	107,915	91	0	0	0
12.5	26	99	85,530	96,817	108	0	0	0
17.5	49	162	74,432	85,719	160	0	0	0
22.5	67	271	63,334	74,621	223	0	0	0
27.5	72	342	52,236	63,523	233	0	0	0
32.5	112	434	41,138	52,426	250	0	0	0
37.5	112	647	30,040	41,328	275	0	0	0
42.5	184	575	18,942	30,230	190	0	0	0
47.5	205	580	7,844	19,132	116	0	0	0
52.5	131	547	0	8,034	40	0	0	0
57.5	217	698	0	0	0	0	0	0
62.5	208	691	(590)	0	0	6	0	0
67.5	208	562	(11,688)	0	0	126	0	0
72.5	156	394	(26,510)	(6,901)	0	382	0	0
77.5	136	220	(37,293)	(9,650)	0	434	0	0
82.5	117	183	(53,864)	(26,221)	0	725	0	0
87.5	44	50	(67,935)	(40,292)	0	355	0	0
92.5	2	6	(70,722)	(43,079)	0	31	0	0
97.5	0	0	(78,276)	(47,456)	0	0	0	0
102.5	0	0	(89,374)	(58,554)	0	0	0	0
8,760 hours					1,866	2,059	DOAS fuel use	0
							DOAS cool use	0

Cross Check Against Historic Consumption

	Historic	Calculated	Difference
Present Annual Heating Fuel Use is	237 mmBTU	257	109% 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 increasingly 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.

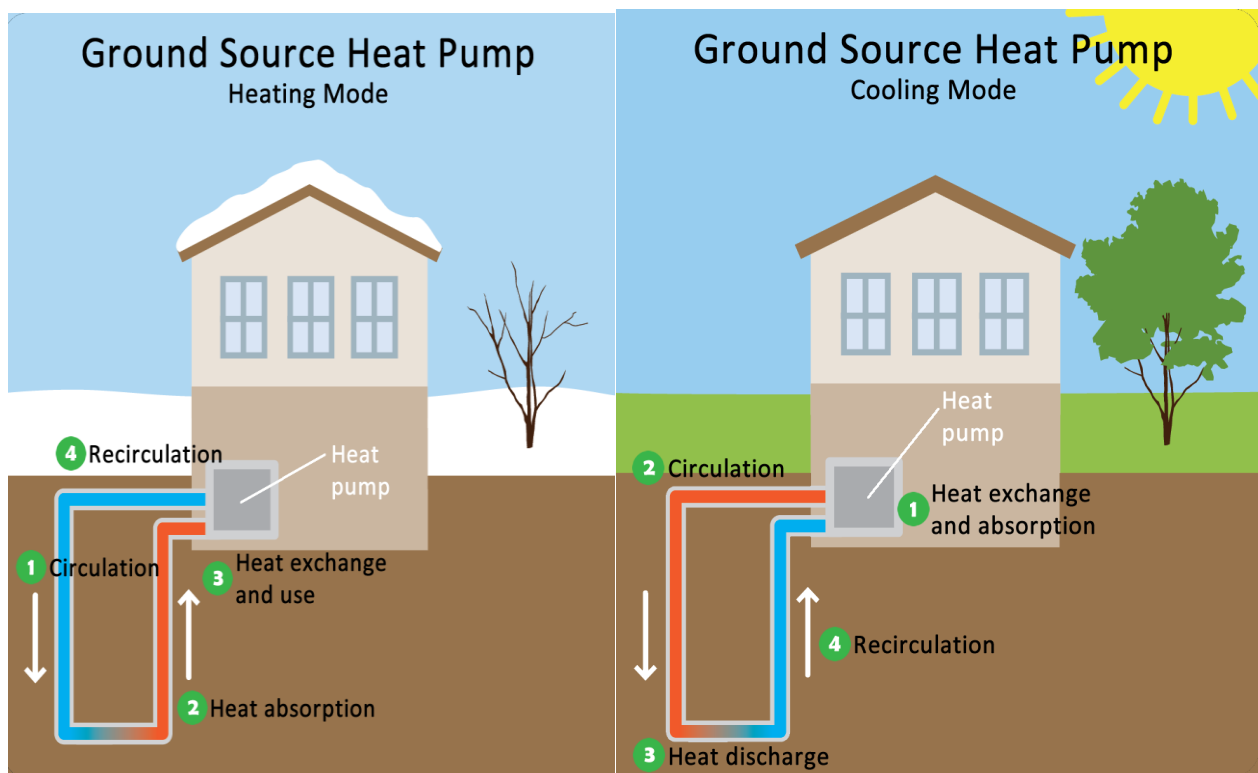
TYPES OF CLEAN HEATING AND COOLING (CHC) TECHNOLOGIES

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 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).

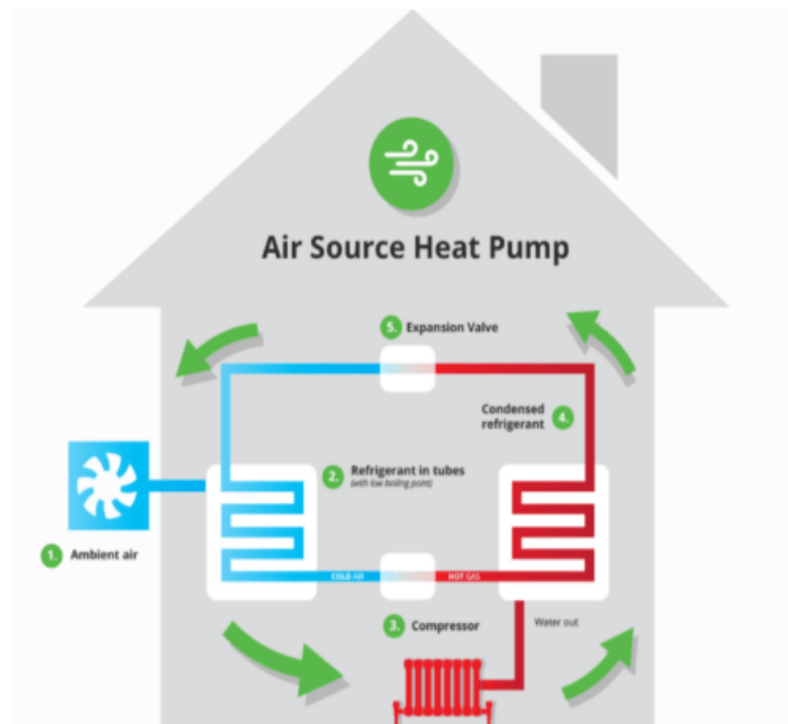
The system reverses during cooling, where the energy is absorbed by the ground loop.



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

What is an Air Source Heat Pump (ASHP)?

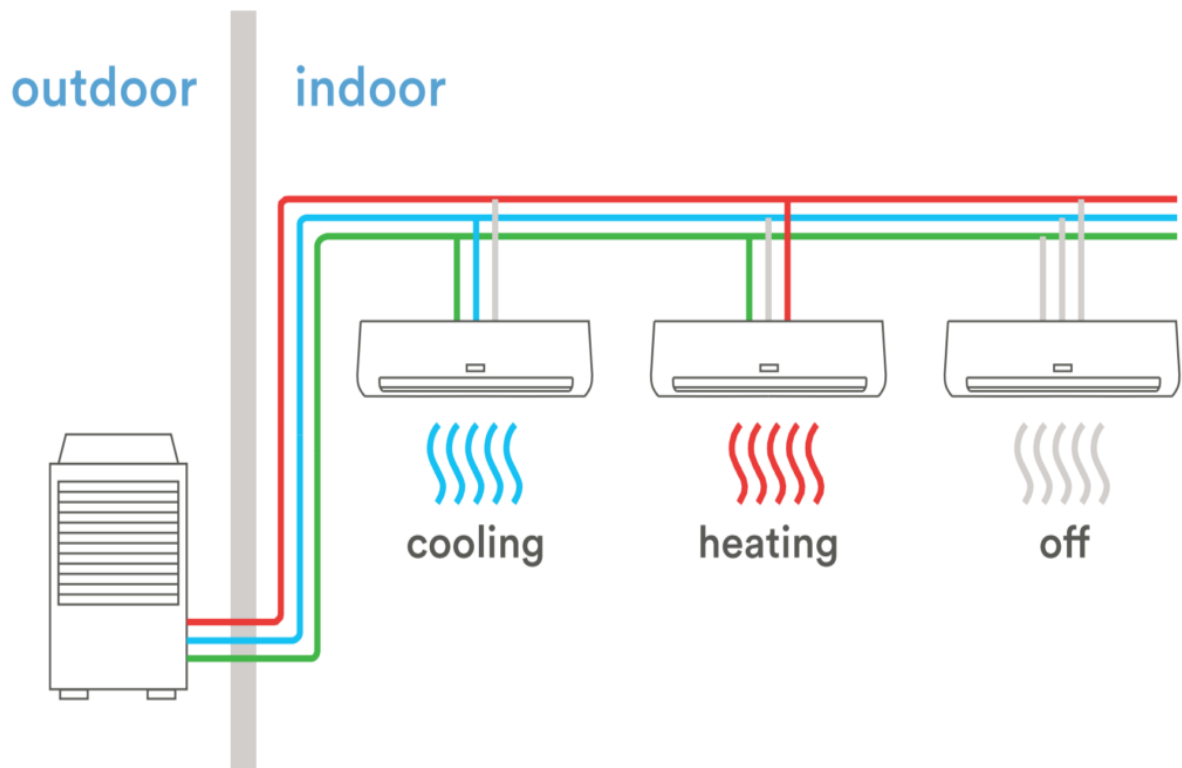
An air source heat pump works much like a refrigerator operating in reverse. Outside air is blown over a network of tubes filled with a refrigerant. This warms up the refrigerant, and it turns from a liquid into a gas. This gas passes through a compressor, which increases the pressure. Compression also 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 Category	EEM Description	CO2e Lbs./Yr.	kWh	kW	Electric Cost Savings	Fuel Type	Fuel MMBtu Savings	Fuel Cost Savings	Total Annual Savings	Install Costs	Simple Payback (years)
EEM-1	R	Lighting	Interior Lighting Retrofit	16,187	29,048	11.6	\$ 5,201	Oil - No. 2	(107.5)	(\$ 2,287)	\$ 2,914	\$ 4,605	1.6
EEM-2	R	Envelope	Install Insulated Doors	14,836	89	0.0	\$ 10	Oil - No. 2	90.4	\$ 1,924	\$ 1,934	\$ 26,465	13.7
EEM-3	RNE	Envelope	Install Double Glazing	982	0	0.0	\$ 1	Oil - No. 2	6.0	\$ 128	\$ 129	\$ 9,206	71.1
Total of Recommended Measures:				32,006	29,136	11.6	\$ 5,211		(11.0)	(\$ 234)	\$ 4,977	\$ 40,276	8.1

Building Electrification Measures					Savings & Cost								
EEM #	Measure Status	EEM Category	Building Electrification Measure Descriptions	CO2e Lbs./Yr.	kWh	kW	Electric Cost Savings	Fuel Type	Fuel MMBtu Savings	Fuel Cost Savings	Total Annual Savings	Install Costs	Simple Payback (years)
BE-1	RBE	VRF	Install Clean Heating System - Air Source Heat Pump	20,363	(17,461)	1.2	(\$ 3,059)	Oil - No. 2	249.3	\$ 5,305	\$ 2,245	\$ 89,627	39.9
BE-2	RBE	GSHP	Install Clean Heating System - Ground Source Heat Pump	6,755	(4,811)	0.6	(\$ 805)	Oil - No. 2	75.7	\$ 1,611	\$ 806	\$ 62,486	77.6
Total of Recommended Measures:					0	0	0.0	\$ 0	0.0	\$ 0	\$ 0	\$ 0	\$ 0