Clean Energy Communities

Energy Study

Prepared for:

Village of Medina

600 Main St

Medina, NY 14103

Audit No: CEC300354

Submitted by:

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

Date: 12/9/2024

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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This report was prepared by:

C.J. Brown Energy, P.C.

4245 Union Rd, Buffalo, NY 14225

(716) 565-9190

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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 drafty windows throughout both buildings. The Firehouse in particular gets very cold in the winter, suspected due to poor insulation. Additionally, the kitchen window in the Firehouse lets in water, suggesting faulty seals, that has resulted in some water damage to the inside windowsill.

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

- Interior Lighting Retrofit - Replace all interior lamps with LEDs.
- Implement Deeper Setback - Program thermostats to a deeper setback temperature during unoccupied hours.
- Insulate Heating and Domestic Hot Water Pipes - Insulate piping in unconditioned spaces to help heating water and domestic hot water retain its heat until it is used.
- Building Airflow Reduction - Reduce air infiltration with airsealing around exterior doors and windows.
- Install Insulated Doors - Replace the poorly insulated glass doors on the catwalk with better insulated models to reduce heat loss.
- Exterior Lighting Retrofit - Replace all exterior lamps with LEDs.
- Insulate Building Envelope - Insulate the exterior wall of the Police Chief Office to reduce heat loss in the room.
- Install Double Glazing - Replace the Firehouse kitchen window with a better insulating and better fitting model to reduce heat loss and prevent further water damage.
- Install a Tankless Water Heater – Replace the Village Hall natural gas domestic hot water heating system with an electric tankless water heater.
- Switch Fuels for Heating Water - Replace the natural gas tankless water heater in the Firehouse with an electric model.

- Install Clean Heating System - Air Source Heat Pump - Replace the natural gas heating system with an air source heat pump to electrify a portion of the building's heating system.

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.

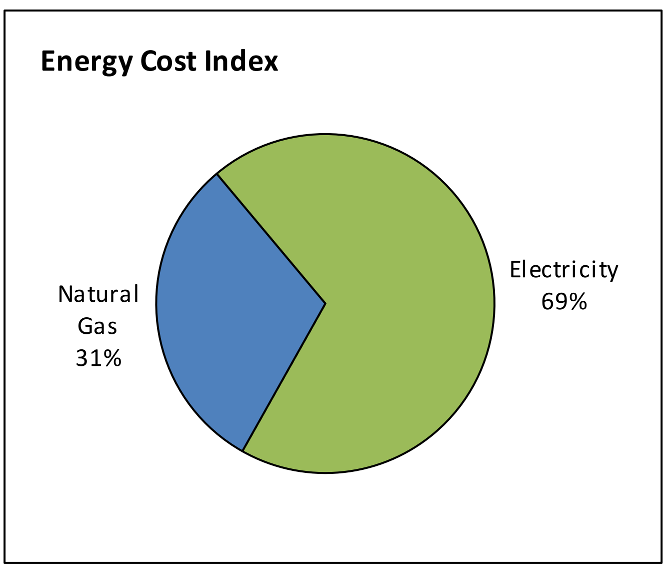
- The Energy Cost Index (ECI) is the total cost of energy divided by the conditioned floor area and is shown as dollars per square foot per year.
- The Energy Use Intensity (EUI) is the total heat content of energy divided by the conditioned floor area and is shown in units of one thousand Btus (kBtu)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

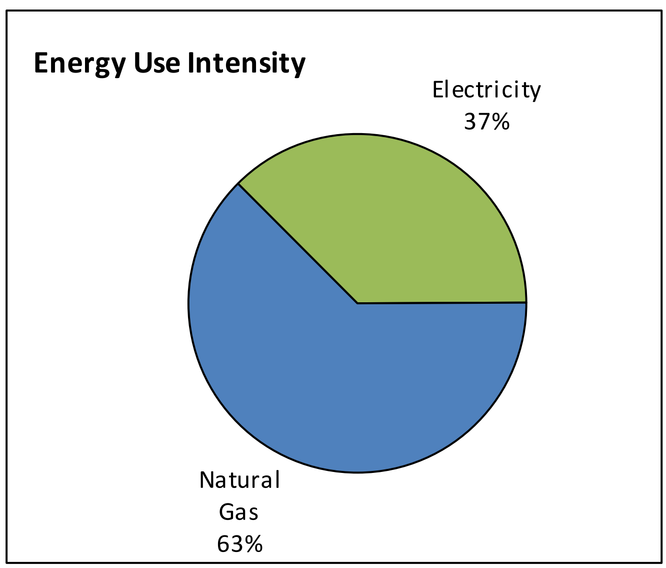
Energy Cost Index

Electricity	$ 11,154	$ 0.52	$/sq.ft./year
Natural Gas	$ 4,947	$ 0.23	$/sq.ft./year
Total Cost	$ 16,102	$ 0.75	$/sq.ft./year

Energy Use Intensity

Electricity	355	mmBtu	16.6	kBtu/sq.ft./year
Natural Gas	593	mmBtu	27.7	kBtu/sq.ft./year
Total Energy Use	947	mmBtu	44.2	kBtu/sq.ft./year





Energy Cost Index $ 0.75 /sf/yr. **Energy Use Intensity 44.2 kBTU/sf/yr.**

Benchmarking Your Building

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

You can find the Portfolio Manager at:

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

Project Summary Table

Energy Efficiency Measures				$ Savings & Cost		
EEM #	Measure Status	EEM Description	Reduction in Greenhouse Gas Emissions (Lbs. CO2e/Year)	Total Annual Savings	Install Costs	Simple Payback (years)
EEM-1	R	Interior Lighting Retrofit	11,758	$ 1,582	$ 3,406	2.2
EEM-2	R	Implement Deeper Setback	1,143	$ 75	$ 400	5.4
EEM-3	R	Insulate Heating And Domestic Hot Water Pipes	277	$ 18	$ 182	10.0
EEM-4	R	Building Airflow Reduction	2,924	$ 192	$ 2,196	11.4
EEM-5	R	Install Insulated Doors	1,011	$ 66	$ 790	12.0
EEM-6	R	Exterior Lighting Retrofit	356	$ 19	$ 300	15.5
EEM-7	R	Insulate Building Envelope	228	$ 15	$ 236	15.9
EEM-8	RNE	Install Double Glazing	300	$ 20	$ 998	50.7
EEM-9	NR	Install A Tankless Water Heater	466	$ 25	$ 3,176	124.8
EEM-10	NR	Switch Fuels For Heating Water	212	$ 9	$ 3,176	361.2
		All Energy Efficiency Measures:	**18,673**	**$ 2,021**	**$ 14,860**	**7.4**
		Total of Recommended Measures:	**17,995**	**$ 1,987**	**$ 8,508**	**4.3**

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	NR	Install Clean Heating System - Air Source Heat Pump	(1,572)	($ 568)	$ 13,192	n/a	$ 3,720	n/a
		All Measures:	**(1,572)**	**($ 568)**	**$ 13,192**	**n/a**	**$ 3,720**	**n/a**
		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	13,092	kWh =	15,187	pounds CO2 equivalent
Natural Gas	240	therm =	2,808	pounds CO2 equivalent
			17,995	pounds CO2 equivalent
			9.5%	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 comprised of two buildings: the Village Hall and the Firehouse serving the Village of Medina. The Village Hall holds the Police Department, Court, and Division of Code Enforcement on the 1st, 2nd, and 3rd floors, respectively. The 2nd floor also holds the Police Chief's office, the Police Gym, and the Village Clerk-Treasurer's office. The Firehouse holds the Fire Department: the garage on the ground floor, and offices, training rooms, break rooms, and storage on the second floor.

The site consists of two buildings totaling 21,411 square feet. The first building, the Village Hall, was originally constructed in 1908 and has 3 floors. The interior walls are finished plaster and drywall with unknown insulation, and the exterior walls have the well maintained original sandstone finish. The Firehouse, built in the 19050's, has similar interior walls, but with an exterior brick finish. Both buildings have a flat roof with a membrane exterior surface, fiberglass insulation and an interior finished ceiling of acoustic tile.

The Village Hall windows are mostly single hung, single pane windows with wooden frames. There are some decorative single pane fixed windows. The Firehouse windows are all fixed double pane. All exterior doors are steel, except for the front entrance double doors, which are wood. Many of the exterior doors have damaged weatherstripping.

Major energy end uses include the heating, cooling, and interior lighting systems. The first floor of the Village Hall and the entire Firehouse is occupied 24/7 by some emergency response staff. As a result, the HVAC system maintains occupied conditions in these areas 24/7. On the second and third floors of the Village Hall, day-to-day staff is present during regular working hours. In these areas, the HVAC maintains occupied conditions for 8 hours on weekdays, totaling 40 hours a week.

Winter space temperatures are on average maintained at 66°F and are setback to 65°F during unoccupied periods in applicable areas. In the summer, temperatures are maintained on average at 71°F during occupied hours and 75°F during unoccupied periods. All areas utilize programmable thermostats except for the Fire Truck Bay, which is on a nonprogrammable heat-only thermostat.

Lighting Systems

The interior lighting systems of these buildings mostly rely on incandescent lamps. The exterior lighting systems, while mostly LED, have a couple faulty photocell sensors.

Heating Ventilating and Air Conditioning Systems

The Village Hall uses three furnaces and a boiler to meet heating needs, while the Firehouse uses a single furnace and a unit heater in the garage. All heating systems are natural gas fired. There are three air conditioning units serving cooling to the majority of both buildings.

Water Heating System

The Village hall uses a storage type natural gas fired domestic hot water heating system, and the Firehouse uses a tankless natural gas fired system.

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:	$ 1,778		12,703	kWh per year
			5.5	kW demand
Fuel Savings:	($ 196)		(25.4)	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 1,582**			
Project Cost:	**$ 3,406**			
Simple Payback:	**2.2**	**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.

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 Implement Deeper Setback

Electric Savings:	$ 2		36	kWh per year
			0.0	kW demand
Fuel Savings:	$ 72		9.4	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 75**			
Project Cost:	**$ 400**			
Simple Payback:	**5.4**	**years**		

Introduction:

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

Facilities that are occupied only on weekdays can maintain a lower space temperature setpoint on weekends. Programmable thermostats are available that permit full 7 day schedules to be defined. 5-2 or 5-1-1 thermostats use the same schedule for all weekdays and provide one or two schedules for weekend days.

Recommendation:

Reprogram the thermostats to setback temperature of 60 degrees for heating and 80 degrees for cooling during unoccupied periods in spaces that aren't used 24/7. This should include the 2nd and 3rd floors of the Village Hall.

EEM-3 Insulate Heating And Domestic Hot Water Pipes

Electric Savings:	($ 0)		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 18		2.4	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 18**			
Project Cost:	**$ 182**			
Simple Payback:	**10.0**	**years**		

Introduction:

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

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

Recommendation:

Insulate all exposed heating pipes that are located in unconditioned space. Insulate the first eight feet of domestic hot water piping after the water heater. Insulation thickness should be per the New York State Energy Conservation Construction Code, and should be pre-formed fiberglass pipe insulation with protective jacketing.

Install 1 in. insulation on (8 ft.) of 0.75 in. Dull Copper DHW pipe on the water heater in the Village Hall, 1 in. insulation on (8 ft.) of 0.75 in. Dull Copper DHW pipe on the water heater in the Firehouse, and 1 in. insulation on (10 ft.) of 0.75 in. Dull Copper Hot Water pipe on the boiler in the Village Hall.

EEM-4 Building Airflow Reduction

Electric Savings:	$ 0		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 192		24.9	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 192**			
Project Cost:	**$ 2,196**			
Simple Payback:	**11.4**	**years**		

Introduction:

Reducing air infiltration is vital to creating a more energy efficient building. The purpose of air sealing is to create an effective air tight seal on the building envelope. This will reduce the amount of air flow and heat loss from conditioned to un-conditioned space. Factors that cause high air flow rates include the size and number of openings that connect the conditioned and unconditioned spaces and pressure differences between the interior and exterior of the building. The differences in pressures are typically caused by stack effect, wind, and temperature differences between the inside and outside of the building. An air sealing contractor will use special diagnostic tools to pinpoint and seal hidden air leaks, typically hidden under the attic insulation.

Sealing the largest openings at the highest and lowest levels first is the most effective way to reduce unwanted air flow. These types of openings may include attic access doors, large mechanical chases that house ductwork and vent flues, and wall bypasses. Wall bypasses are holes created by irregular framing and can be found in interior and exterior wall systems. Smaller openings from wire holes, plumbing lines, and gaps around windows, doors and chimney flues are equally as important. Materials that should be considered for different applications are caulks, expanding foam, non-expanding foam, weather-stripping, and rigid insulation board.

Recommendation:

All exterior man doors should have damaged weatherstripping replaced. All garage doors also have damaged weatherstripping and thresholds. Replace the weather stripping around the sides and bottom of each garage door. Also install threshold seal strips along the garage floor ground where the bottom of the door closes. The new strips should be aligned to ensure a tight seal.

Additionally, most of the windows in both buildings have gaps in caulk seams. Remove and replace cracked caulkwork around all windows.

EEM-5 Install Insulated Doors

Electric Savings:	$ 2		38	kWh per year
			0.0	kW demand
Fuel Savings:	$ 64		8.3	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 66**			
Project Cost:	**$ 790**			
Simple Payback:	**12.0**	**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:

Replace the two glass doors on the catwalk connecting the Firehouse and the Village Hall. The new door should be tight fitting and completely caulked around the wall seams. Weatherstripping should be installed around all edges. The bottom of each door should have sturdy door sweeps installed. The door itself should be filled with a urethane or polystyrene foam. The listed R-value should be no lower than 5. Any glazed area should be double glazed with safety glass, and should comprise no more than 25% of the total door area.

EEM-6 Exterior Lighting Retrofit

Electric Savings:	$ 19	307	kWh per year
		0.0	kW demand
Fuel Savings:	$ 0	0.0	MMBtu fuel per year
Total Annual Savings:	**$ 19**		
Project Cost:	**$ 300**		
Simple Payback:	**15.5 years**		

Introduction:

High Intensity Discharge (HID) fixtures are often used outdoors for parking areas, grounds illumination and outdoor security lighting. HID fixtures may use mercury vapor, high pressure sodium or metal halide lamps that resemble incandescent lamps in outward appearance but require a ballast to operate. Of these, high pressure sodium and metal halide are the most common. All HID lamp types are point light sources, so HID fixtures usually have a reflector to redirect light into the desired distribution pattern. HID fixtures do not provide very uniform lighting in exterior applications.

Light Emitting Diode (LED) fixtures use an array of LEDs, which are solid state devices that produce light. The array is designed to distribute light into the desired distribution pattern, utilizing the directional nature of LEDs to achieve very uniform light levels without "hot spots" that are common with HID fixtures. This enables LED fixtures to provide the required illumination levels with lower overall energy use than traditional HID fixtures. LED exterior fixtures have replaced HID fixtures in the marketplace because they are more efficient, more compact, and they last longer.

Recommendation:

The two exterior lighting fixtures were observed as powered during the day, suggesting faulty photocell sensors. Replace selected exterior fixtures as indicated in the lighting calculations and the Equipment Inventory, both of which may be found in the Appendix.

LED 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-7 Insulate Building Envelope

Electric Savings:	$ 1		9	kWh per year
			0.0	kW demand
Fuel Savings:	$ 14		1.9	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 15**			
Project Cost:	**$ 236**			
Simple Payback:	**15.9**	**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.

Insulation can be installed in enclosed spaces, such as wall cavities, cathedral ceiling cavities, and floored attic cavities. It can also be installed in unfloored attics, which can accommodate greater thickness resulting in higher R-value. When insulation is combined with air sealing, convective air currents that circulate air within cavities and through insulation are reduced, which increases the effective R-value of the insulation.

Recommendation:

The fire chief office gets frigid during the winter, likely due to the poorly insulated wall area where a window used to be. The R-value of this wall is likley much lower than the rest of the building. This calculation assumes R-value 10 for the wall- just below the standard 13, as it was noted during the site visit interview that there can be frost build up in the room. An insulation study may be useful to determine the true state of insulation throughout the Firehouse offices.

Add insulation equal to or greater than R-10 to 200 square feet of the fire chief office wall.

EEM-8 Install Double Glazing

Electric Savings:	$ 0		0	kWh per year
			0.0	kW demand
Fuel Savings:	$ 20		2.6	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 20**			
Project Cost:	**$ 998**			
Simple Payback:	**50.7**	**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:

The kitchen window in the Firehouse is poorly inulated and contributes to significant heat loss in the building. Additionally, the window lets in water which has overtime caused water damage to the surrounding wall and windowsill. Install a new double glazed window with low-e coatings. Be sure that window is 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 window should bear the Energy Star label.

Despite its long payback period, this measure is still recommended for implementation. The building owner reported that this area of the Firehouse is particularly cold due to the window, and does not retain heat. Additionally, the water damage allowed by the window will grow over time, and result in more devastating damage.

EEM-9 Install A Tankless Water Heater

Electric Savings:	($ 11)		(77)	kWh per year
			(0.0)	kW demand
Fuel Savings:	$ 36		4.7	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 25**			
Project Cost:	**$ 3,176**			
Simple Payback:	**124.8**	**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. Water heaters with gas, oil or propane burners also lose heat through the flue when the burner is not firing.

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:

Replace the present storage type water heater serving the Village Hall with an electric tankless water heater.

This measure is not recommended as the payback period extends beyond its effective useful life.

EEM-10 Switch Fuels For Heating Water

Electric Savings:	($ 11)		(77)	kWh per year
			(0.0)	kW demand
Fuel Savings:	$ 20		2.6	MMBtu fuel per year Natural Gas
Total Annual Savings:	**$ 9**			
Project Cost:	**$ 3,176**			
Simple Payback:	**361.2**	**years**		

Introduction:

The cost of heating water may be reduced by switching to a fuel that offers a lower cost and/or higher efficiency equipment. A fuel switch is also one way to increase system capacity if the current system cannot meet your demand for hot water. High efficiency condensing water heaters using natural gas or propane are available in tankless and storage-type configurations. Electric heat pump water heaters are another high efficiency option. Small electric waters located at the point of use may also be more energy efficient than distant oversized storage type systems.

The new systems will usually require the installation of power and natural gas or propane piping. Fossil fuel systems must be vented to the outdoors and condensing systems must be piped to a suitable drain to remove condensate. Fossil fuel fired systems must be located in a space with access to the outdoors. All state and local regulations must be adhered to for the safe and proper installation of these units.

Recommendation:

Replace the present natural gas tankless water heater serving the Firehouse with an electric tankless water heater.

This measure is not recommended as its payback period extends beyond its effective useful life.

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:	($ 1,246)	(10,261)	kWh per year
		(1.7)	kW demand
Fuel Savings:	$ 679	88.1	MMBtu fuel per year Natural Gas
Total Annual Savings:	**($ 568)**		
Project Cost:	**$ 13,192**		
Simple Payback:	**n/a years,**	**n/a**	**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:

Replace your natural gas heating system with a central ducted air source heat pump system serving the Firehouse garage. The system type is: Central Ducted ASHP with Integrated/ Modulating controls sized to 16% of the building heating load. The 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 2.59 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 is not recommended as the payback period extends beyond its effective useful life.

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
Furnace	1	York	120	96%				Firehouse	2016
Unit Heater	1	Trane	200	80%				Fire Truck Bay	1995
Furnace	1	ICP	120	98%				Police Chief	2011
Furnace	1	Luxaire	80	95%				Court Room	2017
Furnace	1	ICP	100	80%				Police Dept.	2002
Air Conditioner	3	Luxaire			3	tons	11.0	Both Buildings	
Boiler	1	Weil McLain	200	84%				Village Hall	2016

Domestic Hot Water									
Unit Type	Qty	Make/Model	Capacity	Units	Fuel Type	Storage Capacity (gal.)	Eff.	Serves/Location	Year
Tankless	1	Navien	200	kbtuh	Natural Gas	0	96%	Firehouse	2021
Storage	1	Reliance	35.0	kbtuh	Natural Gas	40	80%	Town Hall	2008

Interior Lighting Fixtures										
Existing Fixtures						Recommended	Recommended Interior Lighting Efficiency Improvements			
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
1	Fire Offices	2	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	2	4' LED T8 2000 lu. 14W	2	28
2	Fire Hall Hallways	8	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	8	4' LED T8 2000 lu. 14W	2	28
3	Fire Mop Closet	1	2' 17w T8 Elec. bal.	3	47	No Change	LED Relamp	1	2' LED tube 1150 lu. 7W	3	21
4	Fire Store Closet	1	4' 32w T8 EE Mag. bal.	3	110	No Change	LED Relamp	1	4' LED T8 2000 lu. 14W	3	42
5	Fire Training Room	8	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	8	4' LED T8 2000 lu. 14W	2	28
6	Fire Kitchen (Pucks)	4	11w CFL Spiral Elec. bal.	1	11	No Change	LED Relamp	4	4' LED T8 2000 lu. 14W	1	14
7	Fire Kitchen	2	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	2	A19 LED, 9W	2	18
8	Fire Kitchen (Above Sink)	1	4' 30w T8 Elec. bal.	1	28	No Change	LED Relamp	1	4' LED T8 2000 lu. 14W	1	14
9	Fire Break Room	5	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	5	4' LED T8 2000 lu. 14W	2	28
10	Fire Back Stairwell	1	4' 40w T12 EE Mag. bal.	2	86	No Change	LED Relamp	1	8' LED T12/8 IS, 33W	2	66
11	Court Room	12	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	12	4' LED T8 2000 lu. 14W	2	28
12	Gym	15	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	15	4' LED T8 2000 lu. 14W	2	28
13	Code Enforcement Lobby	6	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	6	4' LED T8 2000 lu. 14W	2	28
14	Code Enforcement Office	25	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	25	4' LED T8 2000 lu. 14W	2	28
15	Police Offices	15	2' 17w T8 Elec. bal.	3	47	No Change	LED Relamp	15	2' LED tube 1150 lu. 7W	3	21
16	Police Offices	15	4' 32w T8 EE Mag. bal.	2	71	No Change	LED Relamp	15	4' LED T8 2000 lu. 14W	2	28

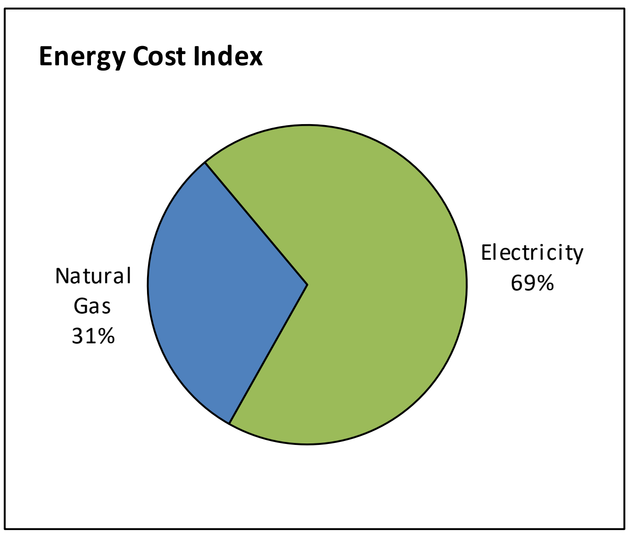
Exterior Lighting Fixtures											
Existing Fixtures						Recommended	Lighting Efficiency Improvements				
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
1	South Face	1	LED wallpack, 50W	1	80	Photocell	No change	1	LED wallpack, 50W	1	80
2	West Face	1	LED wallpack, 50W	1	80	Photocell	No change	1	LED wallpack, 50W	1	80

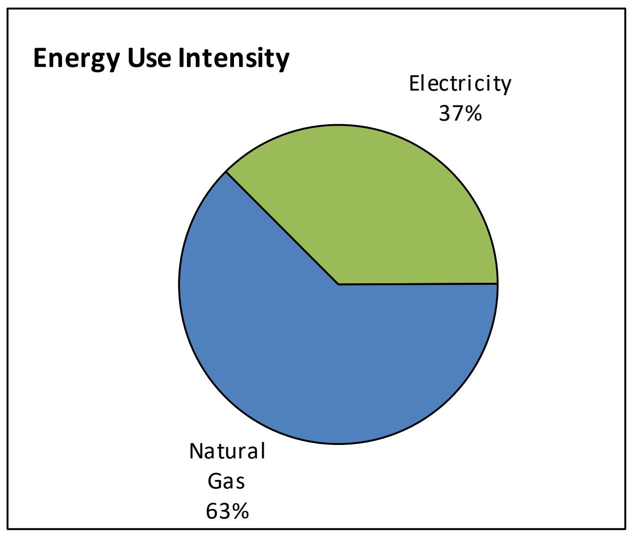
Appendix B

Energy Use and Cost Summary

Energy		Units Used		BTU/unit	mmBTU	% of total	kBtu/sq.ft./year
	Electricity	103,906	kwh	3,412	355	37%	16.6
	Natural Gas	5,926	therm	100,000	593	63%	27.7
	Total				947		44.2

Cost	Energy Cost	Unit Costs		% of total	$/sq.ft./year
Electricity	$ 11,154	$ 0.063	kwh	69%	$ 0.52
Natural Gas	$ 4,947	$ 0.770	therm	31%	$ 0.23
Total	$ 16,102				$ 0.75





Energy Cost Index $ 0.75 /sf/yr. **Energy Use Intensity 44.2 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 Medina

Gross Area:	21,411	s.f.
	16,558	Btu/s.f./Yr
	$ 0.52	/s.f.
	1.4	watts/s.f.

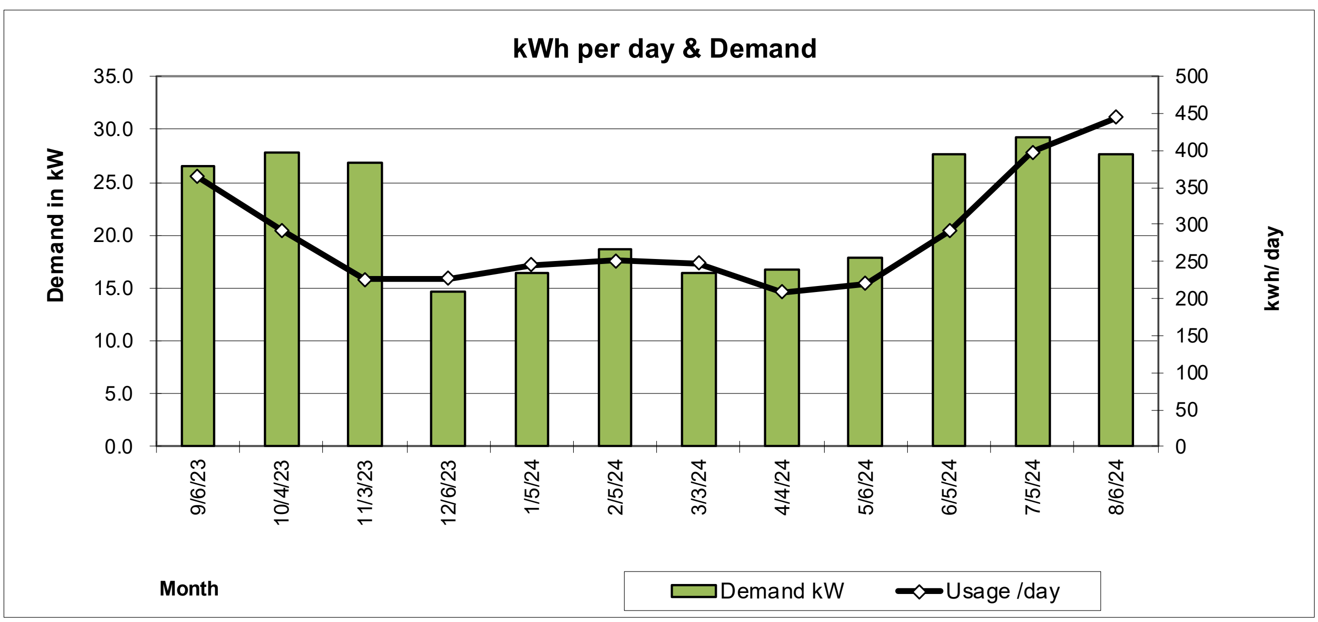
Utility:	National Grid	
Account #	ends w/ 0105	
Rate:	SC SC2D	
Meter Charge:	$ 53.57	/ month
Demand Charge:	$ 14.82	/ kW
Supplier:	National Grid	

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
9/6/23	30	10,954	26.5	$ 483	$ 693	$ 1,176	$ 393	$ 0.067	0.57	365
10/4/23	28	8,192	27.8	$ 514	$ 432	$ 946	$ 412	$ 0.059	0.44	293
11/3/23	30	6,776	26.9	$ 499	$ 351	$ 850	$ 399	$ 0.059	0.35	226
12/6/23	33	7,503	14.7	$ 314	$ 396	$ 709	$ 218	$ 0.058	0.64	227
1/5/24	30	7,360	16.5	$ 328	$ 328	$ 656	$ 244	$ 0.049	0.62	245
2/5/24	31	7,803	18.6	$ 377	$ 639	$ 1,016	$ 276	$ 0.088	0.56	252
3/3/24	27	6,701	16.4	$ 342	$ 426	$ 768	$ 243	$ 0.070	0.63	248
4/4/24	32	6,670	16.7	$ 357	$ 265	$ 622	$ 247	$ 0.048	0.52	208
5/6/24	32	7,041	17.8	$ 357	$ 273	$ 630	$ 264	$ 0.044	0.52	220
6/5/24	30	8,748	27.6	$ 471	$ 422	$ 893	$ 409	$ 0.049	0.44	292
7/5/24	30	11,932	29.2	$ 498	$ 796	$ 1,294	$ 433	$ 0.068	0.57	398
8/6/24	32	14,226	27.7	$ 509	$ 1,084	$ 1,594	$ 410	$ 0.079	0.67	445
	365	**103,906**	**266.4**	**$ 5,048**	**$ 6,106**	**$ 11,154**	**$ 3,948**	**$ 0.063**	**0.54**	**285**

Annual Energy:	**103,906**	**kWh / year**	**$ 11,154**	**/year**
Peak Demand:	**29**	**kW Peak**		
Average Demand:	**22**	**kW**		

Unit Costs

Demand	**$ 14.82**	**$/kW**
Energy	**$ 0.063**	**$/kWh Incremental**
Blended	**$ 0.107**	**$/kWh Blended**



NATURAL GAS CONSUMPTION AND COST ANALYSIS

Village of Medina

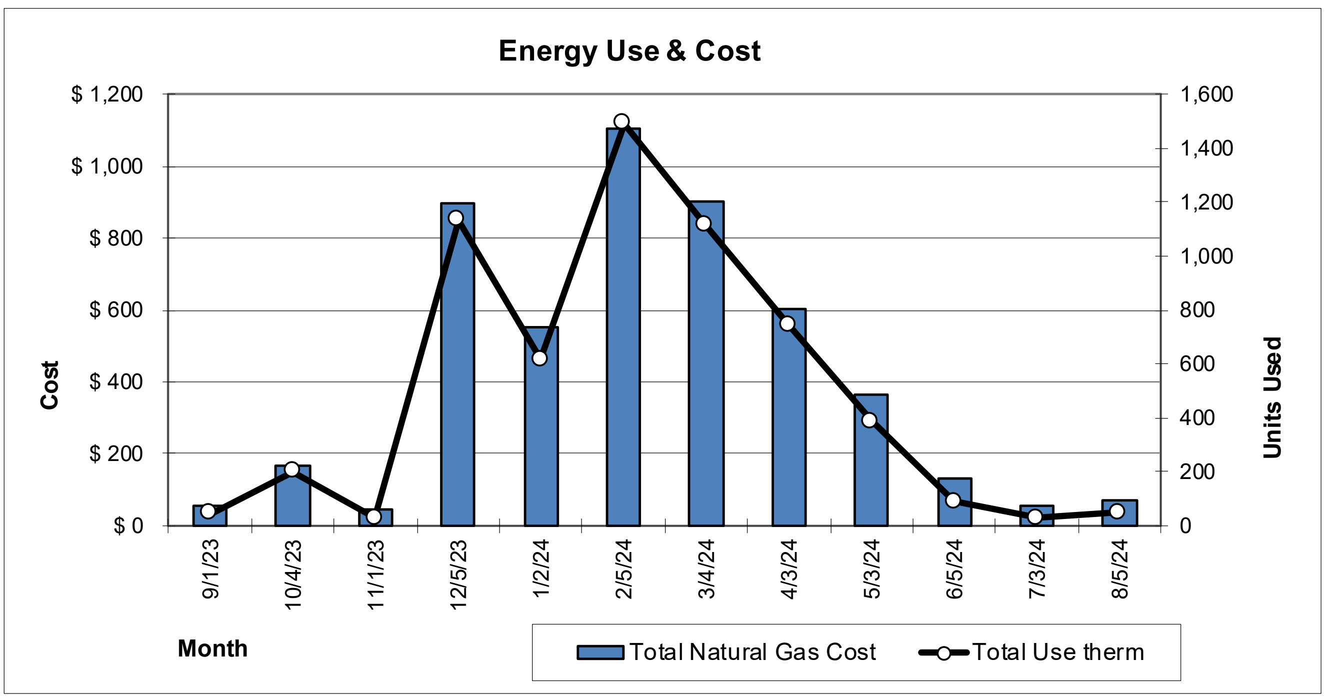
Utility: **NYSEG**
Account # : ends w/ -599,
Rate: SC SC02
Billing unit: therm
BTU/Unit: **100,000**
Meter Charge: **$ 32.00** / month
Supplier: **NYSEG**

21,411 s.f.
27,676 Btu/s.f./Yr
$ 0.23 /s.f.

Natural Gas
Use & Cost Summary:

Month Ending	# Days	Utility Charges therm	Utility Charges Cost	Supplier Charges therm	Supplier Charges Cost	**Total Use therm**	**Total Natural Gas Cost**	Average $/therm
9/1/23	30	44	$ 44	44	$ 12	44	$ 56	$ 0.54
10/4/23	33	202	$ 113	202	$ 54	202	$ 167	$ 0.67
11/1/23	28	27	$ 36	27	$ 8	27	$ 44	$ 0.45
12/5/23	34	1,135	$ 432	1,135	$ 465	1,135	$ 897	$ 0.76
1/2/24	28	617	$ 318	617	$ 236	617	$ 553	$ 0.85
2/5/24	34	1,492	$ 563	1,492	$ 541	1,492	$ 1,103	$ 0.72
3/4/24	28	1,114	$ 514	1,114	$ 387	1,114	$ 901	$ 0.78
4/3/24	30	744	$ 354	744	$ 250	744	$ 604	$ 0.77
5/3/24	30	388	$ 248	388	$ 118	388	$ 366	$ 0.86
6/5/24	33	88	$ 104	88	$ 27	88	$ 131	$ 1.13
7/3/24	28	28	$ 45	28	$ 10	28	$ 54	$ 0.80
8/5/24	33	50	$ 55	50	$ 17	50	$ 72	$ 0.81
	369	**5,926**	**$ 2,824**	**5,926**	**$ 2,123**	**5,926**	**$ 4,947**	$ 0.77

Annual Natural Gas Cost	**$ 4,947**	**/year**	
Annual Natural Gas Consumption	**5,926**	**therm**	
Average Unit Cost per therm:	**$ 0.770**	**$ 7.70**	**/ mmBtu**



Appendix C

EEM Calculations

Interactions

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

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

CALCULATIONS FOR INTERIOR LIGHTING RETROFIT

EEM-1 **Village of Medina**

Type:	Units:	Unit cost:	BTU/unit	
Natural Gas	therm	$ 0.770	100,000	
Electricity	kwh	$ 0.063	3,412	
Demand	kW	$ 14.82	12	Months of demand savings/year

80% of building is air conditioned

HVAC Adjustment Factors		
Cooling	Demand	Fuel
HVACc	HVACd	HVACg
9.00%	20.00%	-2.00%

	Existing Interior Lighting Systems					**Recommended Lighting Controls**					**Recommended Interior Lighting Efficiency Improvements**									
Line #	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)
1	Fire Offices	2	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	2	4' LED T8 2000 lu. 14W	2		28	$ 53	$ 29	215	1.8
2	Fire Hall Hallways	8	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	8	4' LED T8 2000 lu. 14W	2		28	$ 211	$ 115	860	1.8
3	Fire Mop Closet	1	2' 17w T8 Elec. bal.	3	47	No Change	0%	2,500	2,500	0	LED Relamp	1	2' LED tube 1150 lu. 7W	3		21	$ 43	$ 9	65	5.0
4	Fire Store Closet	1	4' 32w T8 EE Mag. bal.	3	110	No Change	0%	2,500	2,500	0	LED Relamp	1	4' LED T8 2000 lu. 14W	3		42	$ 40	$ 23	170	1.7
5	Fire Training Room	8	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	8	4' LED T8 2000 lu. 14W	2		28	$ 211	$ 115	860	1.8
6	Fire Kitchen (Pucks)	4	11w CFL Spiral Elec. bal	1	11	No Change	0%	2,500	2,500	0	LED Relamp	4	4' LED T8 2000 lu. 14W	1		14	$ 53	($ 4)	(30)	(13.1)
7	Fire Kitchen	2	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	2	A19 LED, 9W	2		18	$ 14	$ 36	265	0.4
8	Fire Kitchen (Above Sink)	1	4' 30w T8 Elec. bal.	1	28	No Change	0%	2,500	2,500	0	LED Relamp	1	4' LED T8 2000 lu. 14W	1		14	$ 13	$ 5	35	2.8
9	Fire Break Room	5	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	5	4' LED T8 2000 lu. 14W	2		28	$ 132	$ 72	538	1.8
10	Fire Back Stairwell	1	4' 40w T12 EE Mag. bal.	2	86	No Change	0%	2,500	2,500	0	LED Relamp	1	8' LED T12/8 IS, 33W	2		66	$ 60	$ 7	50	8.9
11	Court Room	12	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	12	4' LED T8 2000 lu. 14W	2		28	$ 317	$ 173	1,290	1.8
12	Gym	15	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	15	4' LED T8 2000 lu. 14W	2		28	$ 396	$ 216	1,613	1.8
13	Code Enforcement Lobby	6	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	6	4' LED T8 2000 lu. 14W	2		28	$ 158	$ 87	645	1.8
14	Code Enforcement Offices	25	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	25	4' LED T8 2000 lu. 14W	2		28	$ 660	$ 360	2,688	1.8
15	Police Offices	15	2' 17w T8 Elec. bal.	3	47	No Change	0%	2,500	2,500	0	LED Relamp	15	2' LED tube 1150 lu. 7W	3		21	$ 648	$ 131	975	5.0
16	Police Offices	15	4' 32w T8 EE Mag. bal.	2	71	No Change	0%	2,500	2,500	0	LED Relamp	15	4' LED T8 2000 lu. 14W	2		28	$ 396	$ 216	1,613	1.8
		121			8.0	kW existing				0		121		3.2	kW proposed					

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
C	EEM-1C	LED Relamp	121		11,850	4.7	$ 3,406	$ 1,589	2.1	Screw-in or Socket based LED lamps
			121	0	11,850	4.7	$ 3,406	$ 1,589		

Gross Energy Savings	11,850 kwh				
Net Energy Savings	**12,703 kwh**	**5.5**	**-254 therm**	**$ 1,582**	**net**

PAYBACK PERIOD:

Estimated Cost Interior Lighting:	$ 3,406	= 2.2 year payback
Annual Energy Savings (kWh + kW):	$ 1,582	

CALCULATIONS TO IMPLEMENT DEEPER SETBACK

EEM-2 Village of Medina

INPUT DATA: 45% of Building to be Setback

		Current	Proposed	
Heating T Setpoint:	Occupied	66	66	deg. F.
	Unoccupied	65	60	deg. F.
Cooling T Setpoint:	Occupied	71	71	deg. F.
	Unoccupied	75	80	deg. F.
HVAC Schedule	Occupied	126.0	126.0	Hours per week
	Unoccupied	42.0	42.0	Hours per week
Q internal gains:	Occupied	26,146	26,146	Btuh
	Unoccupied	10,072	10,072	Btuh
Q internal gains:	Schedule	50	50	Hours per week
BLC:	Occupied	2,035	2,035	Btuh/deg. F.
(excludes DOAS)	Unoccupied	1,214	1,214	Btuh/deg. F.

	Heating	Cooling	
Fuel Data			
Type:	Natural Gas	Electricity	Economizer?
Units:	therm	kwh	No
Unit cost:	$ 0.770	$ 0.063	
BTU/unit	100,000	3,412	
Efficiency/ COP:	84.2%	4.56	Avg. COP. EER: 15.5
		80.0%	of bldg. is cooled

CALCULATIONS:

Current — Rochester, 126 hrs./week

Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use therm	Cooling Energy kwh
(7.5)	3	0	133,465	77,755	5	0
(2.5)	3	7	123,291	71,684	10	0
2.5	21	13	113,117	65,613	38	0
7.5	76	32	102,943	59,542	116	0
12.5	150	73	92,769	53,471	212	0
17.5	293	89	82,595	47,401	338	0
22.5	306	115	72,421	41,330	320	0
27.5	315	141	62,247	35,259	292	0
32.5	481	176	52,074	29,188	359	0
37.5	721	250	41,900	23,117	428	0
42.5	500	177	31,726	17,047	224	0
47.5	372	177	21,552	10,976	118	0
52.5	320	115	11,378	4,905	50	0
57.5	491	244	1,204	0	7	0
62.5	655	295	0	0	0	0
67.5	621	199	(9,815)	(915)	0	323
72.5	411	64	(19,989)	(6,986)	0	446
77.5	480	19	(30,163)	(13,057)	0	758
82.5	285	4	(40,337)	(19,127)	0	596
87.5	57	0	(50,511)	(25,198)	0	148
92.5	9	0	(60,685)	(31,269)	0	28
97.5	0	0	(70,859)	(37,340)	0	0
102.5	0	0	(81,033)	(43,411)	0	0
107.5	0	0	(91,207)	(49,481)	0	0
	8,760	hours			2,517	2,299

Proposed	Rochester, 126 hrs./week					
Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use therm	Cooling Energy kwh
(7.5)	3	0	133,465	71,884	5	0
(2.5)	3	7	123,291	65,813	10	0
2.5	21	13	113,117	59,742	37	0
7.5	76	32	102,943	53,671	113	0
12.5	150	73	92,769	47,601	207	0
17.5	293	89	82,595	41,530	332	0
22.5	306	115	72,421	35,459	312	0
27.5	315	141	62,247	29,388	282	0
32.5	481	176	52,074	23,317	346	0
37.5	721	250	41,900	17,247	410	0
42.5	500	177	31,726	11,176	212	0
47.5	372	177	21,552	5,105	106	0
52.5	320	115	11,378	0	43	0
57.5	491	244	1,204	0	7	0
62.5	655	295	0	0	0	0
67.5	621	199	(9,815)	0	0	314
72.5	411	64	(19,989)	(966)	0	426
77.5	480	19	(30,163)	(7,037)	0	752
82.5	285	4	(40,337)	(13,107)	0	594
87.5	57	0	(50,511)	(19,178)	0	148
92.5	9	0	(60,685)	(25,249)	0	28
97.5	0	0	(70,859)	(31,320)	0	0
102.5	0	0	(81,033)	(37,391)	0	0
107.5	0	0	(91,207)	(43,461)	0	0
	8,760	hours			2,423	2,263

	Present	Proposed	Savings	
Heating	2,517	2,423	94	therm
Cooling	2,299	2,263	36	kwh
Annual Energy $			$ 75	

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material $/unit	Labor $/unit	Quantity	Total
Thermostat Reprogramming	$ 0	$ 200	2	$ 400
				$ 400

Implementation Cost:	$ 400	= 5.4 year payback
Annual Energy Savings:	$75	

CALCULATIONS TO INSULATE HEATING AND DOMESTIC HOT WATER PIPES

EEM-3 Village of Medina

Input Data

Fuel Information	Type:	Units:	Unit cost:	BTU/unit	Efficiency
Heating System	Natural Gas	therm	$ 0.770	100,000	86%
DHW System	Natural Gas	therm	$ 0.770	100,000	86%

		Type #1	Type #2	Type #3
Fluid		DHW	DHW	Hot Water
Pipe Material		Dull Copper	Dull Copper	Dull Copper
O.D., inches (d)		0.75	0.75	0.75
Total Length, ft		8	8	10
Fluid Temperature Inside Pipe, °F (Ts)		110	110	160
Ambient Temperature, °F (Ta)		65	65	65
Annual Operating Hours		8,760	8,760	1,413
New Insulation Thickness, inches		1.0	1.0	1.0
Thermal Conductivity - "k" (Btu-in/hr-sq ft-°F)		0.250	0.250	0.250
Heat Loss - Bare Pipe				
C factor		1.016	1.016	1.016
emissivity based on pipe material		0.44	0.44	0.44
Outside Radius Pipe, inches (Ri)		0.38	0.38	0.38
h convection, Btu/hr - s.f. pipe surface area -°F		1.32	1.32	1.54
h radiation, Btu/hr - s.f. pipe surface area - °F		0.50	0.50	0.57
h total		1.81	1.81	2.11
Pipe area, sq ft/lin ft of pipe		0.196	0.196	0.196
Q bare, Btu/hr-lin ft		**16**	**16**	**39**
Heat Loss - Insulated Pipe				
Outside Radius Insulation, inches (Rs)		1.38	1.38	1.38
Q i, Btu/hr-sq ft of outer area of insulation		6.3	6.3	13.3
Insulation Area - sq ft/lin ft of pipe		0.7	0.7	0.7
Q insul, Btu/hr-lin ft		**4.5**	**4.5**	**9.6**
Avoided Energy Loss				
Existing Loss - mmBtu/year		1.1	1.1	0.6
Proposed Loss - mmBtu/year		0.3	0.3	0.1
Avoided Loss - mmBtu/year		0.8	0.8	0.4
Annual Fuel Consumption	existing	13	13	6
	proposed	4	4	2
24	Units Saved	9	9	5
Natural Gas	Fuel Type	Natural Gas	Natural Gas	Natural Gas
$ 18	$/year	**$ 7**	**$ 7**	**$ 4**

Formulae:

Based on ASHRAE 1993 Fundamentals Handbook pages 20.9 and 22.17

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

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

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

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

Q insul = Q i x Insul Area

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

Payback Period:

Implementation Cost:	$ 182	= 10 years payback
Annual Energy Savings:	$ 18	

CALCULATIONS FOR BUILDING AIRFLOW REDUCTION

EEM-4 Village of Medina Village Hall

INPUT DATA:

				0	0	0
Proposed Reductions	Air changes/Hour			Proposed infiltration		
Air changes/hour	% reduction	Proposed	Period	Cu. ft./hr.	CFM	btuh/deg.
Weatherstripping	10%	0.27	Occupied	67,127	1,119	1,208
Weatherstripping	10%	0.27	Unoccupied	67,127	1,119	1,208
Total Infiltration & Reduction	**Occupied**	**74,586**	**67,127**	**7,459**	cfh savings	
Cu.Ft./hour	**Unoccupied**	**74,586**	**67,127**	**7,459**	cfh savings	

CALCULATIONS:

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

	Occupied	Unoccupied	
T Setpoint:	66	65	°F
Q internal gains:	58,495	22,534	Btuh
BLC:	4,552	2,716	Btuh/°F
T Balance:	53.3	56.5	°F. T Balance = T Setpoint - (Q internal gains / BLC)
Bin Data for Rochester, 126 hrs./week			
Accumulated Hours	3,561	1,365	below balance temp.
Avg. OAT	34.1	33.9	°F below balance temp.
(T Set- Avg OAT)	32.0	31.0	°F difference

Type:	Natural Gas	
Units:	therm	
Unit cost:	$ 0.770	/therm
CF1	100,000	Btu/therm
Efficiency:	84.2%	
CF2	0.018	Btu/hr-°F-cfh

	Energy Use - Btu/year			Fuel Use	
	Occupied	Unoccupied	Total	therm / yr	
Baseline infiltration rate	153,211,900	56,719,200	209,931,100	2,495	
Proposed infiltration rate	137,890,700	51,047,300	188,938,000	2,245	
			Total Savings	249	$ 192

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Matl. & Labor ($ / lin ft)	Quantity (lin ft)	Total	
Door Weatherstripping	$ 3.00	74	$ 222	
Garage Door Thresholds	$ 5.00	50	$ 250	
Window Caulking	$ 2.00	862	$ 1,724	
	Implementation Cost:		$ 2,196	= 11.4 year payback
	Annual Energy Savings:		$ 192	

CALCULATIONS TO INSTALL INSULATED DOORS
EEM-5 Village of Medina

INPUT DATA:

Type & Qty.	Man	2
	Present	Proposed
Area:	42	sq ft total
Perimeter:	40	40
Infilt. rate:	60	30
R value:	1.0	5.0
U factor:	1.000	0.200
U x Area	42	8

	Present	Proposed	Change	
Total UA	42	8	34	Btuh/deg F
Infiltration Load	22	11	11	Btuh/deg F
	64	19	44	Btuh/deg F

CALCULATIONS:

	Occupied	Unoccupied	Fuel Data	Heating	Cooling
Heating Setpoint:	66	65	Type:	Natural Gas	Electricity
Cooling Setpoint:	71	75	Units:	therm	kwh
Q internal gains (Btuh):	58,495	22,534	Unit cost:	$ 0.770	$ 0.063
BLC (Btuh/degree F):	4,552	2,716	BTU/unit	100,000	3,412
T Balance (°F.):	53.3	56.5	Efficiency/ COP:	84.2%	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 therm	Cooling Savings kwh
(7.5)	3	0	3,271	3,212	0	0
(2.5)	3	7	3,049	2,990	0	0
2.5	21	13	2,827	2,768	1	0
7.5	76	32	2,605	2,546	3	0
12.5	150	73	2,383	2,324	6	0
17.5	293	89	2,161	2,102	10	0
22.5	306	115	1,939	1,880	10	0
27.5	315	141	1,717	1,658	9	0
32.5	481	176	1,495	1,436	12	0
37.5	721	250	1,273	1,214	15	0
42.5	500	177	1,051	992	8	0
47.5	372	177	829	770	5	0
52.5	320	115	607	548	3	0
57.5	491	244	0	0	0	0
62.5	655	295	0	0	0	0
67.5	621	199	0	0	0	0
72.5	411	64	(77)	0	0	3
77.5	480	19	(299)	(109)	0	15
82.5	285	4	(521)	(331)	0	15
87.5	57	0	(743)	(553)	0	4
92.5	9	0	(965)	(775)	0	1
97.5	0	0	(1,187)	(997)	0	0
102.5	0	0	(1,409)	(1,219)	0	0
107.5	0	0	(1,631)	(1,441)	0	0
	8,760 hours			Energy Savings:	83	38
					$ 64	$ 2

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / each)	Quantity	Total
Man	$ 345	2	$ 690
Demolition	$ 50	2	$ 100

Implementation Cost:	$ 790	= 12 year payback
Annual Energy Savings:	$ 66	

CALCULATIONS FOR EXTERIOR LIGHTING RETROFIT

EEM-6 Village of Medina

	Electricity	
Unit cost:	$ 0.063	/kwh
kW demand	$ 14.82	
Months of demand savings:	0	months/year

Existing Exterior Lighting Systems						Recommended Lighting Controls					Recommended Exterior Lighting Efficiency Improvements										
Line #	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)
1	South Face	1	LED wallpack, 50W	1	80	Photocell	50%	3,833	1,916	1	No change	1	LED wallpack, 50W	1		80	$ 150	$ 10	153	15.5
2	West Face	1	LED wallpack, 50W	1	80	Photocell	50%	3,833	1,916	1	No change	1	LED wallpack, 50W	1		80	$ 150	$ 10	153	15.5
		2			0.2	kW				2		2				0.2	kW			

SUMMARY OF SAVINGS BY MEASURE TYPE:

Measure Type	Fixture Qty.	Energy Savings Controls kwh/year	Energy Savings Efficiency kwh/year	kW Reduction	Project Cost	Annual Savings	Payback (Years)	Measure Description
Photocell	2	307			$ 300	$ 19	15.5	
	0	307	0	0.0	$ 300	$ 19	15.5	
		307 kwh						

PAYBACK PERIOD:

Estimated Cost Exterior Lighting:	$ 300	= 15.5 year payback
Annual Energy Savings (kWh + kW):	$ 19	

CALCULATIONS TO INSULATE BUILDING ENVELOPE
EEM-7 Village of Medina

INPUT DATA:

Surface to be insulated:	Fire Chief Wall			
Area:	200	sq ft		
Present R value:	10.0			
Revised R value	20.0			
Present U factor::	0.100	Btuh/sq ft-deg F		
Revised U factor:	0.050	Btuh/sq ft-deg F		
Present U x Area	20		20	UA Total present
Proposed U x Area	10		10	UA Total proposed

CALCULATIONS:	Occupied	Unoccupied	**Fuel Data**	Heating	Cooling
Heating Setpoint:	66	65	Type:	Natural Gas	Electricity
Cooling Setpoint:	71	75	Units:	therm	kwh
Q internal gains (Btuh):	58,495	22,534	Unit cost:	$ 0.770	$ 0.063
BLC (Btuh/degree F):	4,552	2,716	BTU/unit	100,000	3,412
T Balance (°F.):	53.3	56.5	Efficiency/ COP:	84.2%	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 therm	Cooling Savings kwh
(7.5)	3	0	737	723	0	0
(2.5)	3	7	687	673	0	0
2.5	21	13	637	623	0	0
7.5	76	32	587	573	1	0
12.5	150	73	537	523	1	0
17.5	293	89	487	473	2	0
22.5	306	115	437	423	2	0
27.5	315	141	387	373	2	0
32.5	481	176	337	323	3	0
37.5	721	250	287	273	3	0
42.5	500	177	237	223	2	0
47.5	372	177	187	173	1	0
52.5	320	115	137	123	1	0
57.5	491	244	0	0	0	0
62.5	655	295	0	0	0	0
67.5	621	199	0	0	0	0
72.5	411	64	(17)	0	0	1
77.5	480	19	(67)	(25)	0	3
82.5	285	4	(117)	(75)	0	3
87.5	57	0	(167)	(125)	0	1
92.5	9	0	(217)	(175)	0	0
97.5	0	0	(267)	(225)	0	0
102.5	0	0	(317)	(275)	0	0
107.5	0	0	(367)	(325)	0	0
	8,760 hours			Energy Savings:	19	9
					$ 14	$ 1

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
Fire Chief Wall	$ 1.18	200	$ 236

Implementation Cost:	$ 236	= 15.9 year payback
Annual Energy Savings:	$ 15	

CALCULATIONS TO INSTALL DOUBLE GLAZING

EEM-8 Village of Medina

Type:	Natural Gas	
Units:	**therm**	
Unit cost:	**$ 0.770**	/therm
Heat Content of Fuel	**100,000**	Btu/therm
Combustion Efficiency:	84%	

DATA:

	Occupied	Unoccupied	
T Setpoint:	**66**	**65**	degrees F
Q internal gains:	**58,495**	**22,534**	Btuh
BLC:	**4,552**	**2,716**	Btuh/degree F
T Balance:	53.3	56.5	degrees F

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

Glazing Information

	Firehouse Kitchen Window	
Present Conditions	Fixed Double Glazes	
Present Area:	**36**	sq ft
U factor:	**0.50**	Btuh/sq ft-deg F
Crack Length:	26	feet
Present Infiltration:	30	cfh
Proposed Condition	Double glazed casement windows	
Proposed Area:	**36**	sq ft
New U factor:	0.28	Btuh/sq ft-deg F
New Crack Length:	26	feet
Proposed Infiltration:	5	cfh

Bin Data for Rochester, 126 hrs./week

	T Setpoint	T Balance	Accum Hours	Average O.A. Temp below T Balance	Temp Difference (T Set- Avg OAT)
Occupied	66	53.3	**3,561**	**34.1**	32.0
Unoccupied	65	56.5	**1,365**	**33.9**	31.0

CALCULATIONS:

Conduction Savings = (AreaPr x Upr) - (AreaRev x Urev + AreaInfill x Uinfill) x Accum Hours x Temp Differ
Infiltration Savings = 1/2 x 0.018 x {(LengthPr x Ipr) - (Length Rev x Irev)} x Accum Hours x Temp Differen
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 (therm/year)	Energy Cost Savings ($/year)
Occupied	904,000	668,000	1,572,000	19	$ 14
Unoccupied	335,000	247,000	582,000	7	$ 5
Annual Savings:	1,239,000	915,000	2,154,000	26	$ 20

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor $ / sq. ft.	Quantity	Total	
Vinyl Single Hung Windows	$ 26	36	$ 938	
Removals	$ 30	2	$ 60	
	Implementation Cost:		$ 998	= 50.7 year payback
	Annual Energy Savings:		$ 20	

CALCULATIONS TO INSTALL A TANKLESS WATER HEATER

EEM-9 Village of Medina

INPUT DATA:

	Present Fuel		Proposed Fuel	
Fuel:	**Natural Gas**		Electricity	
Units:	therm		kwh	
Fuel Cost:	$ 0.77	per therm	$ 0.06	per kwh
BTU / unit:	100,000	Btu per therm	3,412	Btu per kwh
kW Demand cost:	$ 0.00	per kW	$ 14.82	per kW
Average kW demand:	**0.0**	kW	**0.0**	kW
Demand Diversity:	**33%**		**90%**	
Net kW Demand Savings:	-	kW per month	0.0	kW per month
Months of demand:	**12**	per year	**12**	per year

Annual DHW Consumption:	Present		Proposed	
Hot Water Usage:	**0.5**	Gallons/person	0.5	Gallons/person
Number of persons:	**9**	(estimate)	9	(estimate)
Days of Usage:	**250**	per year	250	per year
Hours of Usage per Day:	8	hours	8	hours
Average inlet water Temp	55	degrees F	55	degrees F
Average hot water temp:	125	degrees F	125	degrees F

Storage Tank Losses:	Present Tank		Proposed Tank	
Tank U factor:	0.15	Btu/SF/Hour	0.15	Btu/SF/Hour
Height of Tank:	47.0	inches		inches
Diameter of Tank:	18.0	inches		inches
	40	gallons/tank		gallons/tank
# of Tanks	1	Qty.	1	Qty.
Hours Tank is Hot:	8,760	Hours	8,760	
Water Temperature:	125	Deg. F.	125	
Ambient Temperature:	65	Deg. F.	65	

Recirculation Losses:					
	0.0%	of boiler capacity =	0	BTUh	
	0	hours/year	8,760	hours/year =	100%

Boiler Jacket & Flue Losses:					
Burner Input	40,000	BTUH	40,000	BTUH	
COP:	**0.80**		2.50	COP	
Boiler Output Capacity	32,000	BTU output	100,000	BTU output	
Jacket & Flue Losses:	0.5%	of boiler capacity	0.0%	of boiler capacity	
Boiler is Hot:	8,760	hours/year	8,760	hours/year =	100%

CALCULATIONS:

	Present		Proposed	
Consumption Energy:	657,658	BTU output rqd/yr	657,658	BTU output rqd/yr
Tank Energy Losses:	1,729,995	BTU/year	0	BTU/year
Recirculation Losses:	0	BTU/year	0	BTU/year
Boiler Jacket Losses:	1,401,600	BTU/year	0	BTU/year
Output BTU/Year	3,789,253		657,658	
Annual Fuel Consumption	47	therm	77	kwh
Demand	0	billed kW /yr.	0	kW
Annual Fuel Cost	$ 36		$ 11	
Annual Savings:	**47**	**therm**	**$ 25**	**per year**
	(77)	**kwh**		
	(0)	billed kW /yr.		

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Quantity	Matl. & Labor Cost	Total	
Tankless Water Heater	1	$ 3,176	$ 3,176	
	Implementation Cost:		**$ 3,176**	**= 124.8 year payback**
	Annual Energy Savings:		**$ 25**	

CALCULATIONS TO SWITCH FUELS FOR HEATING WATER
EEM-10 Village of Medina

INPUT DATA:

	Present Fuel		Proposed Fuel	
Fuel:	**Natural Gas**		Electricity	
Units:	therm		kwh	
Fuel Cost:	$ 0.77	per therm	$ 0.06	per kwh
BTU / unit:	100,000	Btu per therm	3,412	Btu per kwh
kW Demand cost:	$ 0.00	per kW	$ 14.82	per kW
Average kW demand:	**0.0**	kW	**0.0**	kW
Demand Diversity:	**33%**		**90%**	
Net kW Demand Savings:	-	kW per month	0.0	kW per month
Months of demand:	**12**	per year	**12**	per year

Annual DHW Consumption:	Present		Proposed	
Hot Water Usage:	**0.5**	Gallons/person	0.5	Gallons/person
Number of persons:	**9**	(estimate)	9	(estimate)
Days of Usage:	**250**	per year	250	per year
Hours of Usage per Day:	8	hours	8	hours
Average inlet water Temp:	55	degrees F	55	degrees F
Average hot water temp:	125	degrees F	125	degrees F

Storage Tank Losses:	Present Tank		Proposed Tank	
Tank U factor:	0.15	Btu/SF/Hour	0.15	Btu/SF/Hour
Height of Tank:		inches		inches
Diameter of Tank:		inches		inches
		gallons/tank		gallons/tank
# of Tanks	1	Qty.	1	Qty.
Hours Tank is Hot:	8,760	Hours	8,760	
Water Temperature:	125	Deg. F.	125	
Ambient Temperature:	65	Deg. F.	65	

Recirculation Losses:					
	0.0%	of boiler capacity =	0	BTUh	
	0	hours/year	8,760	hours/year =	100%

Boiler Jacket & Flue Losses:					
Burner Input	40,000	BTUH	40,000	BTUH	
COP:	**0.80**		2.50	COP	
Boiler Output Capacity	32,000	BTU output	100,000	BTU output	
Jacket & Flue Losses:	0.5%	of boiler capacity	0.0%	of boiler capacity	
Boiler is Hot:	8,760	hours/year	8,760	hours/year =	100%

CALCULATIONS:

	Present		Proposed	
Consumption Energy:	657,658	BTU output rqd/yr	657,658	BTU output rqd/yr
Tank Energy Losses:	0	BTU/year	0	BTU/year
Recirculation Losses:	0	BTU/year	0	BTU/year
Boiler Jacket Losses:	1,401,600	BTU/year	0	BTU/year
Output BTU/Year	2,059,258		657,658	
Annual Fuel Consumption	26	therm	77	kwh
Demand	0	billed kW /yr.	0	kW
Annual Fuel Cost	$ 20		$ 11	
Annual Savings:	**26**	**therm**	**$ 9**	**per year**
	(77)	**kwh**		
	(0)	billed kW /yr.		

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Quantity	Matl. & Labor Cost	Total	
Tankless Water Heater	1	$ 3,176	$ 3,176	
	Implementation Cost:		**$ 3,176**	**= 361.2 year payback**
	Annual Energy Savings:		**$ 9**	

CALCULATIONS TO INSTALL CLEAN HEATING SYSTEM - AIR SOURCE HEAT PUMP

BE-1 Village of Medina

Building Information				Fuel Information	Heating	Cooling	
	Small Office						
Location	Buffalo		Climate Zone 5	Type:	Natural Gas	Electricity	
Portion of Building HP will serve:	16%			Units:	therm	kwh	
Building Heating Load (BHL)		53,665	BTU/h	Unit cost:	$ 0.770	$ 0.063	/kwh
Building Cooling Load (BCL)		33,005	BTU/h	BTU/unit	100,000	3,412	/kwh
BEFLHheating		1,413	Hours	Heating Eff.	86%	$ 14.82	/kW
BEFLHcooling		713	Hours	CO2	11.72	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	Warm Air Furnace, Gas Fired < 225 kBTU/h
Present Cooling System	Air-cooled AC w/ other heat (≥ 65 and < 135 kBTU/h)
% of Portion to be served by ASHP that is presently cooled	0%

Proposed System

Does proposed ASHP require supplemental resistance heat?		Y		
ASHP Type	Central Ducted			
ASHP Application	Whole	(the ASHP will meet all of the heating load)		
Control Type	Integrated/Modulating			
Heating Capacity	60,000	BTU/h at 5°F	1.0	HP Sizing Ratio
Energy Efficiency Ratio	13.1	EERee		
Seasonal Energy Efficiency Ratio	15.0	SEER		
Heating Season Performance Factor	10.0	HSPF		

Resulting system to be modeled **Scenario 1d**

Central Ducted ASHP with Integrated/ Modulating controls sized to 100%

Adjusted Efficiency Values	Baseline	Energy Efficient				
SEERbaseline	12.7	13.9	EERseason,ee	-1.670	c	cooling offset
EERbaseline	11.0	13.1	EERee	1.041	d	cooling slope
COPseason,baseline	1.00	2.59	COPseason,ee	0.081	a	heating offset
FElecHeat	0.00	1.00	FElecHeat,new	0.876	b	heating slope
EFFbaseline	0.86	1.00	Fload,cooling			
FFuelHeat	1.00	1.00	Fload,heating			
		1.00	Fload,heating,FuelHeat	0.69	CF	
		1.00	Fload,heating,ElecHeat			

	Baseline	Energy Efficient	Savings	Units	Savings $	Savings CO2 Lbs/yr.
Cooling Electric Use (kWh/yr.)	0	1,687	(1,687)	kWh		
Heating Electric Use (kWh/yr.)	0	8,574	(8,574)	kWh		
Total Electric Use (kWh/yr.)	**0**	**10,261**	**(10,261)**	**kWh**	**($ 646)**	**(11,903)**
Peak Demand (kW)	0.0	1.7	(1.7)	kW	($ 600)	
Fossil Fuel Energy Use (MMBTU)	88	0	88	MMBtu		
Fossil Fuel Energy Use : therm	**881**	**0**	**881**	**therm**	**$ 679**	**10,331**
Annual Energy Costs	**$ 679**	**$ 1,246**	**($ 568)**		($ 568)	(1,572)
Estimated Project Cost	**$ 2,950**	**per ton =**	**$ 13,192**		**-23 year payback**	

Appendix D

Assumptions/Data Used to Develop Energy and Dollar Savings Figures

Building and Occupancy Information

Floor Area: 21,411 square feet

	Avg. # of occupants	Heating Setpoint	Cooling Setpoint	% of base electricity use resulting in internal heat gains	
days /occupied	9	66	71	days	100%
nights/unoccupied	0	65	75	nights	100%
# of computers	9				

Interior lighting, people and occupied levels of internal loads occur for 50 hours per week
Electricity use at night is usually 40% 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:	Forced Air	60%	0.80	10.00	548	Natural Gas	84%	Et
Secondary:	Condensing Boiler	40%	0.95	10.00	167	Natural Gas	92.0%	Et

80% of building is air conditioned. Does the cooling system have economizer? No

Describe the **direct outside air** or **central make-up air** system: Fuel: Natural Gas; 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	Natural Gas	80%

Is there a pump to circulate DHW? No

Hot Water usage is 0.5 gallons per person / day for 9 persons on 250 days/year

Weather & Schedule Information:

			for TRM:
Select nearest weather station for bin data:	ROCHESTER		Buffalo
Base temperature for heating degree days:	65 °F. yields	6,664 HDD base65	Small Office
Base temperature for cooling degree days:	70 °F. yields	381 CDD base70	AC with Gas Heat

Present Schedule for Occupied/Day HVAC setpoints

Day of week		Start	End	Hours
Sun	1	4:00 AM	10:00 PM	18.0
Mon	2	4:00 AM	10:00 PM	18.0
Tue	3	4:00 AM	10:00 PM	18.0
Wed	4	4:00 AM	10:00 PM	18.0
Thu	5	4:00 AM	10:00 PM	18.0
Fri	6	4:00 AM	10:00 PM	18.0
Sat	7	4:00 AM	10:00 PM	18.0
Rochester, 126 hrs./week				126.0
				42.0

Proposed Schedule for Occupied/Day HVAC setpoints

Day of week	Start	End	Hours
1	4:00 AM	10:00 PM	18.0
2	4:00 AM	10:00 PM	18.0
3	4:00 AM	10:00 PM	18.0
4	4:00 AM	10:00 PM	18.0
5	4:00 AM	10:00 PM	18.0
6	4:00 AM	10:00 PM	18.0
7	4:00 AM	10:00 PM	18.0
Rochester, 126 hrs./week			126.0

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

Village of Medina
600 Main St
Medina, NY 14103

Building Information

Width (typical)	97	feet	Building Floor Area	21,411	sq. ft.
Equivalent Length	171	feet	Roof Area	8,313	sq. ft.
Number of Floors	1.3	floors	Gross Wall Area	15,736	sq. ft.
Avg. Floor to Floor Height	12	feet per floor	Building Volume	248,619	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		8,313	31.1	0.032	268	10%
Walls	91.4%	of GWA	14,382	23.7	0.042	607	22%
Town Hall	2.7%	of GWA	430	2.0	0.500	215	8%
Fire Hall	1.6%	of GWA	256	2.0	0.500	128	5%
Garage	5	10x10 doors	500	5.0	0.200	100	4%
Man	8	3x7 doors	168	3.0	0.333	56	2%
	Total Exterior Surface Area		24,049	sq.ft.		1,374	51%

		ACH	equiv. cfm	Btuh/deg. F.	BLC (without ventilation)	
Est. Infiltration Rate	Occupied	0.30	1,243	1,343	2,716	Btuh/deg. F. Occupied
Est. Infiltration Rate	Unoccupied	0.30	1,243	1,343	2,716	Btuh/deg. F. Unoccupied

		cfm	Fraction	Btuh/deg. F.	**Total BLC with Ventilation**	
Est. Ventilation Rate	Occupied	1,700	100%	1,836	**4,552**	**Btuh/deg. F. Occupied**
Est. Ventilation Rate	Unoccupied		100%	0	**2,716**	**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	**16.5**	**9**	58,495	50.0
	Unoccupied	**6.6**	**0**	22,534	118.0

Heat Loss Study - continued

Village of Medina
600 Main St
Medina, NY 14103

Fuel Data	Heating	Cooling	Economizer?
Type:	Natural Gas	Electricity	
Units:	therm	kwh	No
Unit cost:	$ 0.770	$ 0.063	
BTU/unit	100,000	3,412	
Nom. Eff, COP	0.860	2.931	COP
Avg. Eff, COP	0.842	4.56	Avg. COP
		15.5	Avg. EER
		80%	of bldg. cooled

		Current	
Heating T Setpoint:	Occupied	66	deg. F.
	Unoccupied	65	deg. F.
Cooling T Setpoint:	Occupied	71	deg. F.
	Unoccupied	75	deg. F.
HVAC Schedule	Occupied	126	Hrs. per week
	Unoccupied	42	Hrs. per week
Q internal gains:	Occupied	58,495	Btuh
	Unoccupied	22,534	Btuh
Q internal gains:	Schedule	50	Hrs. per week
BLC:	Occupied	4,552	Btuh/deg. F.
	Unoccupied	2,716	Btuh/deg. F.

DOAS Energy Use	
0	cfm
0%	heat recov. Eff.
Heating	Natural Gas
100,000	Btu/therm
80%	eff.
2.78	COP cool
0	hrs/week

Current — Rochester, 126 hrs./week

Bin Mid Pt.	Occupied Hours	Unoccupied Hours	Occ Net Heat Loss BTUH	Unocc Net Heat Loss BTUH	Heating Fuel Use therm	Cooling Energy kwh	DOAS Hours	DOAS Heating kBtu/yr.
(7.5)	3	0	298,602	173,961	11	0	0	0
(2.5)	3	7	275,840	160,379	23	0	0	0
2.5	21	13	253,078	146,796	86	0	0	0
7.5	76	32	230,316	133,214	259	0	0	0
12.5	150	73	207,553	119,632	474	0	0	0
17.5	293	89	184,791	106,050	756	0	0	0
22.5	306	115	162,029	92,467	716	0	0	0
27.5	315	141	139,267	78,885	653	0	0	0
32.5	481	176	116,504	65,303	803	0	0	0
37.5	721	250	93,742	51,721	957	0	0	0
42.5	500	177	70,980	38,138	502	0	0	0
47.5	372	177	48,218	24,556	265	0	0	0
52.5	320	115	25,455	10,974	112	0	0	0
57.5	491	244	2,693	0	16	0	0	0
62.5	655	295	0	0	0	0	0	0
67.5	621	199	(50,088)	(19,675)	0	1,578	0	0
72.5	411	64	(86,227)	(38,907)	0	1,840	0	0
77.5	480	19	(112,161)	(53,829)	0	2,875	0	0
82.5	285	4	(150,360)	(73,932)	0	2,451	0	0
87.5	57	0	(192,274)	(95,603)	0	677	0	0
92.5	9	0	(206,279)	(105,487)	0	125	0	0
97.5	0	0	(158,533)	(83,540)	0	0	0	0
102.5	0	0	(181,296)	(97,123)	0	0	0	0
107.5	0	0	(204,058)	(110,705)	0	0	0	0
	8,760	hours			5,630	9,546	DOAS fuel use	0
							DOAS cool use	0

Cross Check Against Historic Consumption

	Historic		Calculated	Difference	
Present Annual Heating Fuel Use is	560	mmBTU	563	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 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.

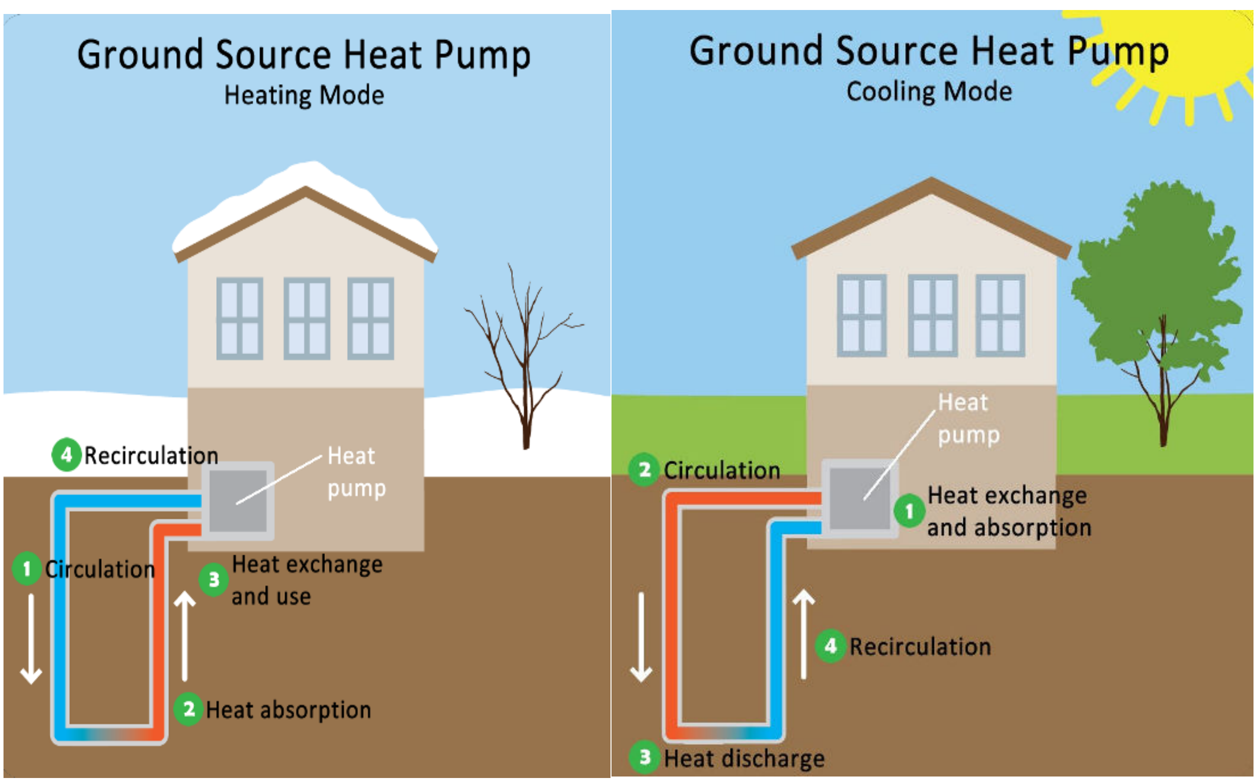
TYPES OF CLEAN HEATING AND COOLING (CHC) TECHNOLOGIES

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).

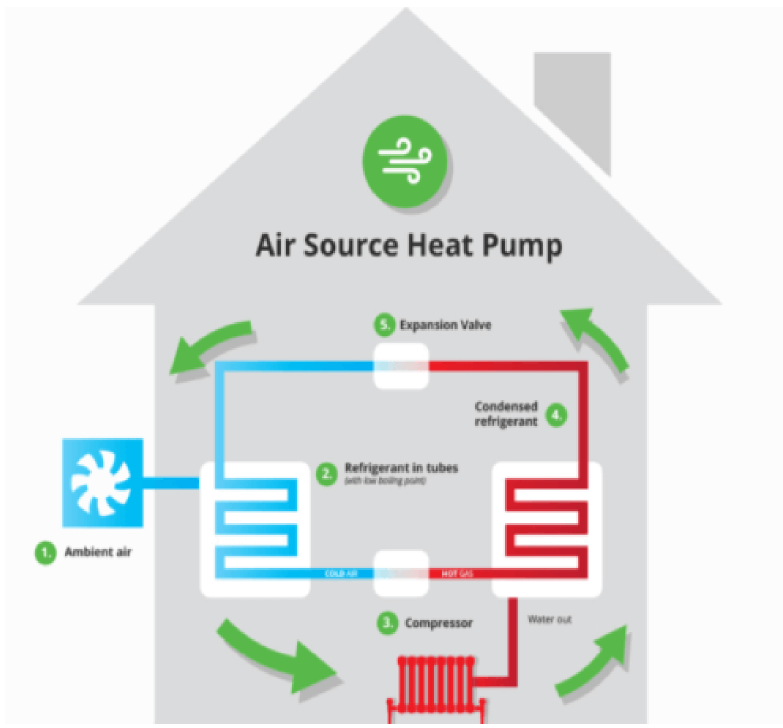
The system reverses during cooling, where the energy is absorbed by the ground loop.



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

What is an Air Source Heat Pump (ASHP)?

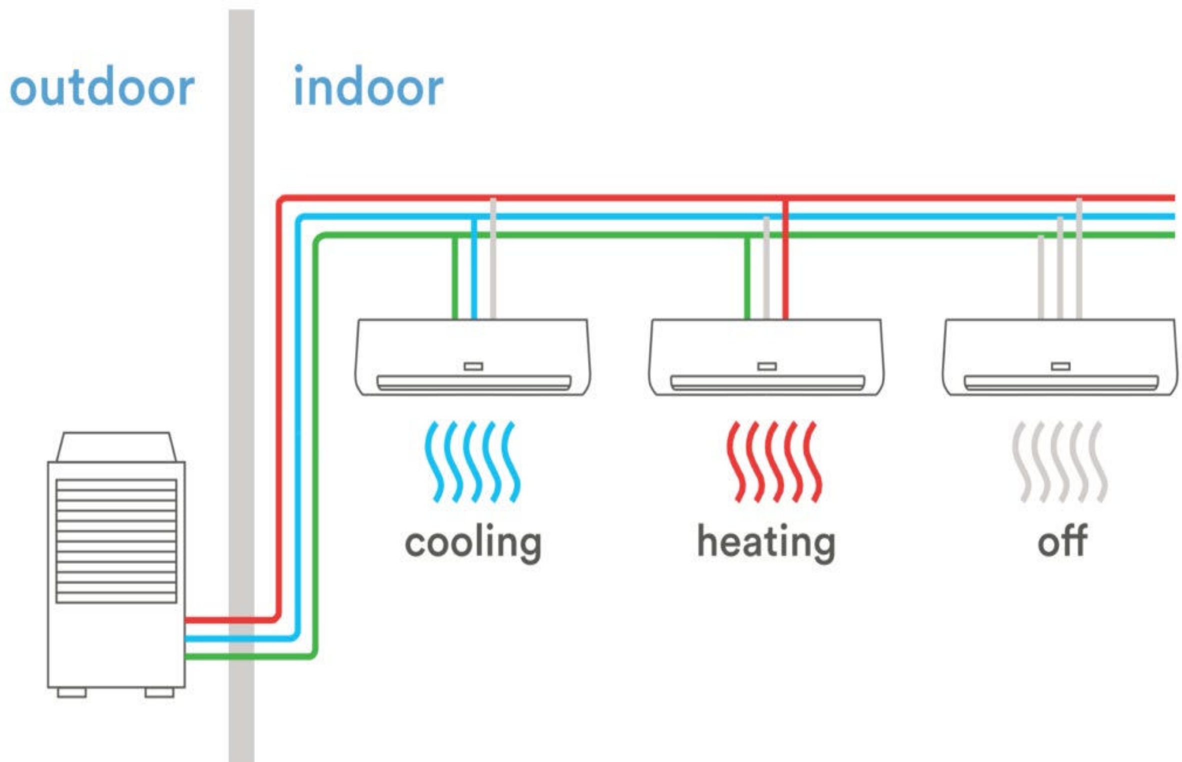
An air source heat pump works much like a refrigerator operating in reverse. Outside air is blown over a network of tubes filled with a refrigerant. This warms up the refrigerant, and it turns from a liquid into a gas. This gas passes through a compressor, which increases the pressure. Compression also 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	11,758	12,703	5.5	$ 1,778	Natural Gas	(25.4)	($ 196)	$ 1,582	$ 3,406	2.2
EEM-2	R	Controls	Implement Deeper Setback	1,143	36	0.0	$ 2	Natural Gas	9.4	$ 72	$ 75	$ 400	5.4
EEM-3	R	HVAC	Insulate Heating And Domestic Hot Water Pipes	277	0	0.0	($ 0)	Natural Gas	2.4	$ 18	$ 18	$ 182	10.0
EEM-4	R	Envelope	Building Airflow Reduction	2,924	0	0.0	$ 0	Natural Gas	24.9	$ 192	$ 192	$ 2,196	11.4
EEM-5	R	Envelope	Install Insulated Doors	1,011	38	0.0	$ 2	Natural Gas	8.3	$ 64	$ 66	$ 790	12.0
EEM-6	R	Lighting	Exterior Lighting Retrofit	356	307	0.0	$ 19		0.0	$ 0	$ 19	$ 300	15.5
EEM-7	R	Envelope	Insulate Building Envelope	228	9	0.0	$ 1	Natural Gas	1.9	$ 14	$ 15	$ 236	15.9
EEM-8	RNE	Envelope	Install Double Glazing	300	0	0.0	$ 0	Natural Gas	2.6	$ 20	$ 20	$ 998	50.7
EEM-9	NR	DHW	Install A Tankless Water Heater	466	(77)	(0.0)	($ 11)	Natural Gas	4.7	$ 36	$ 25	$ 3,176	124.8
EEM-10	NR	DHW	Switch Fuels For Heating Water	212	(77)	(0.0)	($ 11)	Natural Gas	2.6	$ 20	$ 9	$ 3,176	361.2
Total of Recommended Measures:				**17,995**	**13,092**	**5.5**	**$ 1,803**		**24.0**	**$ 184**	**$ 1,987**	**$ 8,508**	**4.3**

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	NR	ASHP	Install Clean Heating System - Air Source Heat Pump	(1,572)	(10,261)	(1.7)	($ 1,246)	Natural Gas	88.1	$ 679	($ 568)	$ 13,192	n/a
Total of Recommended Measures:				**0**	**0**	**0.0**	**$ 0**		**0.0**	**$ 0**	**$ 0**	**$ 0**	