Green Jobs Green New York

Energy Study

Prepared for:
Keene Valley Congregational Church - Manse
1791 NY-73
Keene, NY 12943

Audit No: G-190-S-S-L

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

Date: 12/21/2020

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

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

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State of New York

Andrew Cuomo, Governor

New York State Energy Research and Development Authority

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This report was prepared by:

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Executive Summary

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

Specific areas of concern that were identified by the owner for evaluation include roof and wall insulation.

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

- Upgrade to LED lamps. In-house labor will be used for the upgrade.
- Blown in wall insulation is recommended based on a payback of less than 18 years.
- Additional attic insulation is not recommended due to the long payback.
- Install a Wi-Fi thermostat to control the space temperature.
- Insulate the heating pipes located in the boiler room with fiberglass insulation.

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.

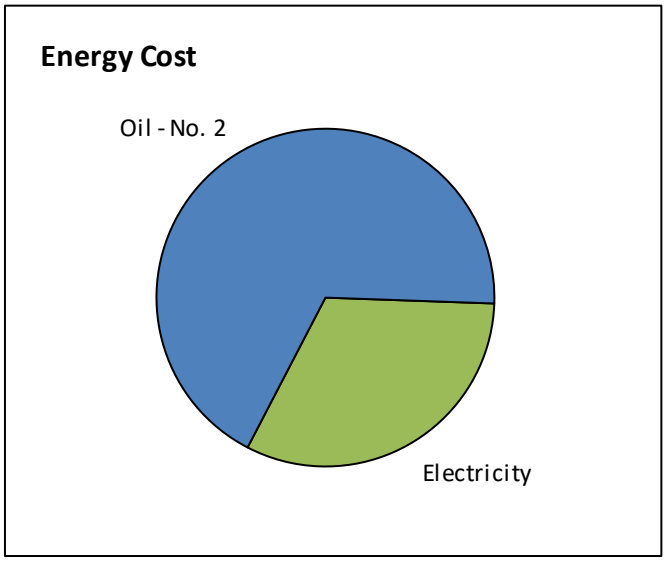
- The Energy Cost Index (ECI) is the total cost of energy divided by the conditioned floor area and is shown as dollars per square foot per year.
- The Energy Use Intensity (EUI) is the total heat content of energy divided by the conditioned floor area and is shown in units of one thousand Btus (kBtu)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

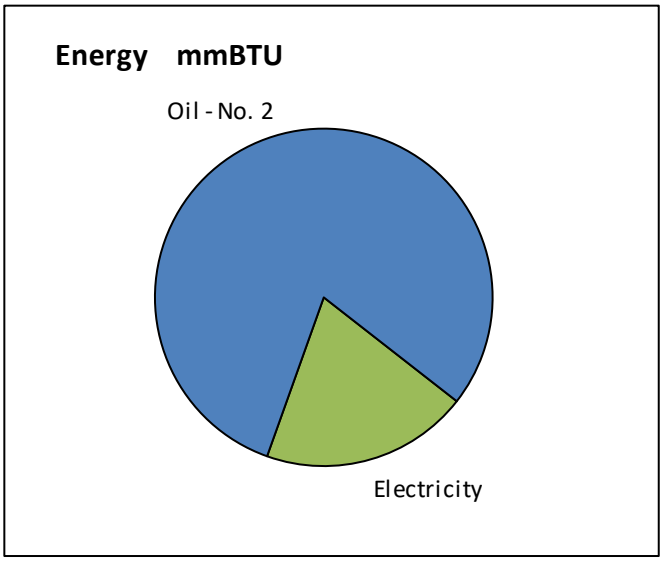
Energy Cost Index

Electricity	$ 883	$ 0.39	$/sq.ft./year
Oil - No. 2	$ 1,870	$ 0.83	$/sq.ft./year
Total Cost	$ 2,752	$ 1.23	$/sq.ft./year

Energy Use Intensity

Electricity	23	mmBtu	10.4	kBtu/sq.ft./year
Oil - No. 2	94	mmBtu	41.8	kBtu/sq.ft./year
Total Energy Use	117	mmBtu	52.2	kBtu/sq.ft./year





Energy Cost Index $ 1.23 /sf/yr. **Energy Use Intensity 52.2 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				Electric Savings			Fuel Savings					
EEM #	Measure Status	EEM Category	EEM Description	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	260	0.2	$ 34	Oil - No. 2	(0)	($ 10)	$ 24	$ 59	2.5
EEM-2	NR	Envelope	Insulate Building Envelope	0	0.0	$ 0	Oil - No. 2	8	$ 150	$ 150	$ 3,086	20.6
EEM-3	R	Envelope	Insulate Building Envelope	0	0.0	$ 0	Oil - No. 2	50	$ 987	$ 987	$ 7,410	7.5
EEM-4	R	HVAC	Insulate Heating Pipes	0	0.0	$ 0	Oil - No. 2	2	$ 38	$ 38	$ 248	6.5
EEM-5	R	Controls	Install Wi-Fi Thermostat	0	0.0	$ 0	Oil - No. 2	8	$ 150	$ 150	$ 200	1.3
			Total of Recommended Measures:	260	0.2	$ 34		59	$ 1,166	$ 1,199	$ 7,917	6.6

Measure Status: Implemented (I): Measure has been installed; Recommended (R): Energy saved with a reasonable payback (within measure life)
Not Recommended (NR): When payback exceeds measure life and equipment is not at end of life
Recommended Mutually Exclusive (RME): Energy is saved and recommended over other options for a particular measure
Mutually Exclusive (ME): Non-recommended option(s) to a Recommended Mutually Exclusive (RME) measure;
Recommended Non-Energy (RNE): Recommended but no electricity or fuel savings (ex. comfort only, water savings only) or recommended when the equipment is at the end of useful life and where the simple payback is reasonable
Recommended for Further Study (RS): For measures that require analysis beyond the scope of this program.

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.

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	260	kWh =	301	pounds CO2 equivalent
Oil - No. 2	424	gal. =	9,533	pounds CO2 equivalent
			9,835	pounds CO2 equivalent
			42.4%	reduction

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

Assistance for Implementation of Recommendations

This study provides recommendations on specific actions to take to increase energy efficiency; the next step is implementing the recommendation(s). Complimentary assistance with implementing energy efficiency recommendations is available through NYSERDA's Regional Community Energy Advisors (CEAs).

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

Your Community Energy Advisor is:

Cornell Cooperative Extension Tompkins County
Guillermo Metz
gm52@cornell.edu
(607) 272-2292 ext. 185

Energy Efficiency Measure Descriptions

EEM-1 Interior Lighting Retrofit

Electric Savings:	$ 34	260	kWh per year
		0.2	kW demand
Fuel Savings:	($ 10)	(0.5)	MMBtu fuel per year
			Oil - No. 2
Total Annual Savings:	**$ 24**		
Project Cost:	**$ 59**		
Simple Payback:	**2.5**	**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 with LED lamps as indicated in the lighting calculations and the Equipment Inventory, both of which may be found in the Appendix.

LED lamps 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 Insulate Building Envelope

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 150	7.5	MMBtu fuel per year
			Oil - No. 2
Total Annual Savings:	**$ 150**		
Project Cost:	**$ 3,086**		
Simple Payback:	**20.6**	**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:

Add additional insulation equal to or greater than R-31 to approximately 1,122 square feet of the attic floor.

This measure is not recommended due to the long payback.

EEM-3 Insulate Building Envelope

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 987	49.6	MMBtu fuel per year
			Oil - No. 2
Total Annual Savings:	**$ 987**		
Project Cost:	**$ 7,410**		
Simple Payback:	**7.5 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:

Add blown-in insulation equal to or greater than R-16 to approximately 2,117 square feet of the walls.

EEM-4 Insulate Heating Pipes

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 38	1.9	MMBtu fuel per year
			Oil - No. 2
Total Annual Savings:	**$ 38**		
Project Cost:	**$ 248**		
Simple Payback:	**6.5 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.

Recommendation:

Install 1-inch thick fiberglass insulation on approximately 40 feet of 1-inch diameter dull copper hot water pipe located in the basement.

EEM-5 Install Wi-Fi Thermostat

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 150	7.5	MMBtu fuel per year
			Oil - No. 2
Total Annual Savings:	**$ 150**		
Project Cost:	**$ 200**		
Simple Payback:	**1.3 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 weekdays.

Recommendation:

Install a Wi-Fi thermostat to control the space temperature.

Existing Conditions

The site is the Manse for the Church. The first floor has an office for the Pastor and one for an administrator.

The building consists of approximately 2,244 square feet on two floors. It was built in approximately 1920. The exterior walls have a wood structure with an exterior finish of vinyl and minimal insulation. The ridge roof has an asphalt shingle exterior surface, minimal insulation and an interior finished ceiling of gypsum board.

The windows are new double glazed, double hung vinyl sash. The exterior doors are wood with partial double glazing, with full weather-stripping.

Major energy end uses include lighting ang space heating. There are no air-conditioning systems.

The facility is occupied 7 days per week. The HVAC system maintains occupied conditions for 40 hours a week.

Winter space temperatures are normally maintained at 70°F and are setback to 60°F. Temperature control is provided by a manual thermostat.

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

Appendix A

Equipment Inventory

Heating and Air Conditioning Equipment									
Unit Type	Qty	Make/Model	Heating kBtuh	Heating Eff.	Cooling Capacity	Units	EER	Serves/Location	Year
oil fired boiler	1	Buderus G-115ES/5	136	86%				Entire building	2013

Domestic Hot Water									
Unit Type	Qty	Make/Model	Capacity	Units	Fuel Type	Storage Capacity (gal.)	Eff.	Serves/Location	Year
Storage	1	A.O. Smith	15,358	btuh	Electricity	40	100%	entire building	2013

Motors									
Unit Type	Qty	Make/Model	HP	Loading	Type	Hours/year	Eff.	Serves/Location	Year
circulators	4	n/a	1/5	75%	Prem.	1,487	70%		n/a

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	Pastor's office	1	18w CFL Twin Std. Mag. bal.	1	24	No Change	LED Relamp	1	A19 LED, 9W	1	9
2	floor lamp	2	18w CFL Twin Std. Mag. bal.	1	24	No Change	LED Relamp	2	A19 LED, 9W	1	9
3	office	1	4' 32w T8 Elec. bal.	4	112	No Change	LED Relamp	1	4' LED T8 2000 lu. 14W	4	56
4	table lamp	2	40 watt Incandescent	1	40	No Change	LED Relamp	2	A19 LED, 9W	1	9

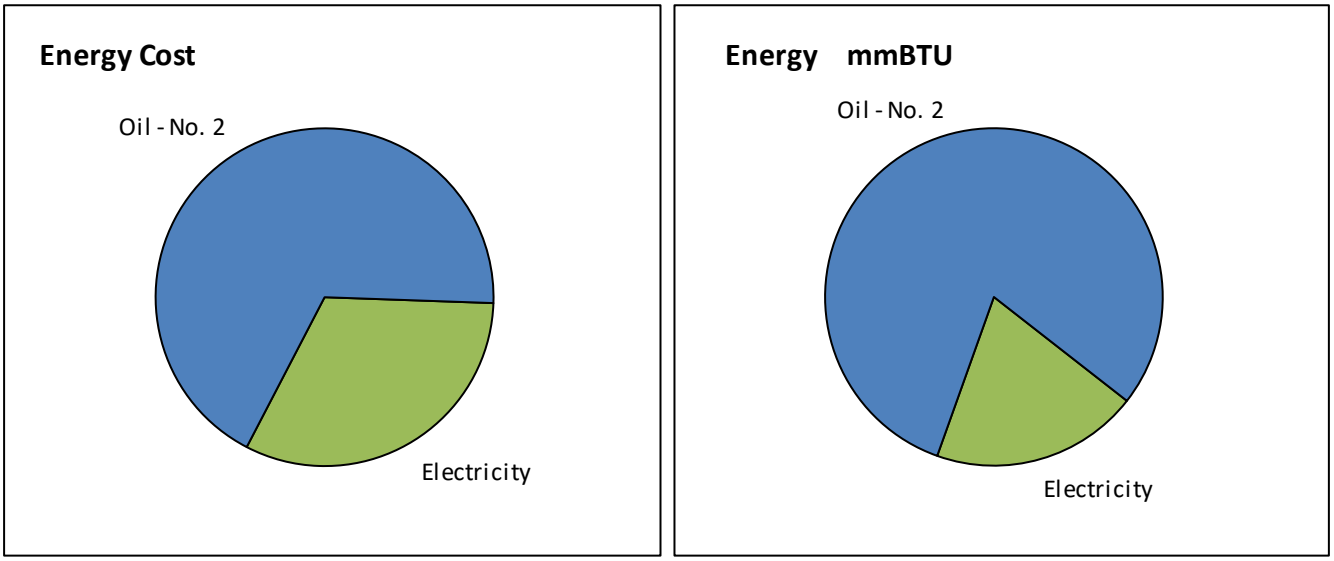
Exterior Lighting Fixtures											
Existing Fixtures						Recommended	Lighting Efficiency Improvements				
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
1	outdoor	2	A19 LED, 14W	1	14	No Change	No change	2	A19 LED, 14W	1	14

Appendix B

Energy Use and Cost Summary

Energy		Units Used		BTU/unit	mmBTU	% of total	kBtu/sq.ft./year
	Electricity	6,834	kwh	3,412	23	20%	10.4
	Oil - No. 2	680	gal.	138,000	94	80%	41.8
	Total				117		52.2

Cost	Energy Cost	Unit Costs		% of total	$/sq.ft./year
Electricity	$ 883	$ 0.129	kwh	32%	$ 0.39
Oil - No. 2	$ 1,870	$ 2.749	gal.	68%	$ 0.83
Total	$ 2,752				$ 1.23



Energy Cost Index $ 1.23 /sf/yr. **Energy Use Intensity 52.2 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

Keene Valley Congregational Church - Manse

Gross Area: 2,244 s.f.
10,391 Btu/s.f./Yr
$ 0.39 /s.f.

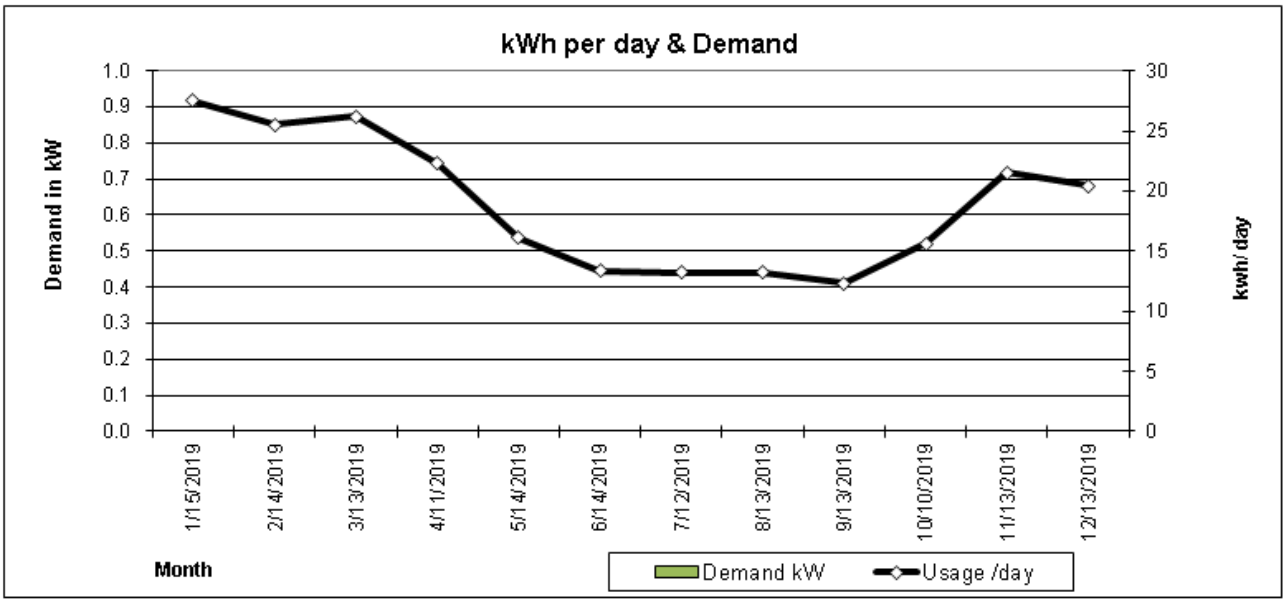
Utility: NYSEG
Account # ends w/ -604
Rate: SC 12001 NYSEG Supply Service
Meter Charge: $ 0.00 / month
Demand Charge: $ 0.00 / kW
Supplier:

Month Ending	Days	Usage Energy kWh	Usage Demand kW	Electricity Charges Utility Cost	Electricity Charges Supply Costs	Total Electricity Cost	Demand Cost	Energy $/kWh	Load Factor	Usage /day
1/15/2019	30	825	0.0	$ 53	$ 56	$ 109	$ 0	$ 0.132	N/A	28
2/14/2019	30	766	0.0	$ 50	$ 56	$ 105	$ 0	$ 0.137	N/A	26
3/13/2019	27	708	0.0	$ 48	$ 42	$ 90	$ 0	$ 0.127	N/A	26
4/11/2019	29	647	0.0	$ 47	$ 30	$ 77	$ 0	$ 0.119	N/A	22
5/14/2019	33	532	0.0	$ 43	$ 20	$ 62	$ 0	$ 0.117	N/A	16
6/14/2019	31	415	0.0	$ 37	$ 17	$ 54	$ 0	$ 0.130	N/A	13
7/12/2019	28	370	0.0	$ 34	$ 19	$ 53	$ 0	$ 0.144	N/A	13
8/13/2019	32	422	0.0	$ 37	$ 20	$ 57	$ 0	$ 0.135	N/A	13
9/13/2019	31	382	0.0	$ 34	$ 18	$ 51	$ 0	$ 0.135	N/A	12
10/10/2019	27	422	0.0	$ 35	$ 23	$ 58	$ 0	$ 0.138	N/A	16
11/13/2019	34	731	0.0	$ 50	$ 40	$ 90	$ 0	$ 0.123	N/A	22
12/13/2019	30	614	0.0	$ 45	$ 31	$ 76	$ 0	$ 0.123	N/A	20
	362	**6,834**	**0.0**	**$ 513**	**$ 370**	**$ 883**	**$ 0**	**$ 0.129**	**N/A**	**19**

Annual Energy: 6,834 kWh / year $ 883 /year
Peak Demand: 0 kW Peak
Average Demand: 0 kW

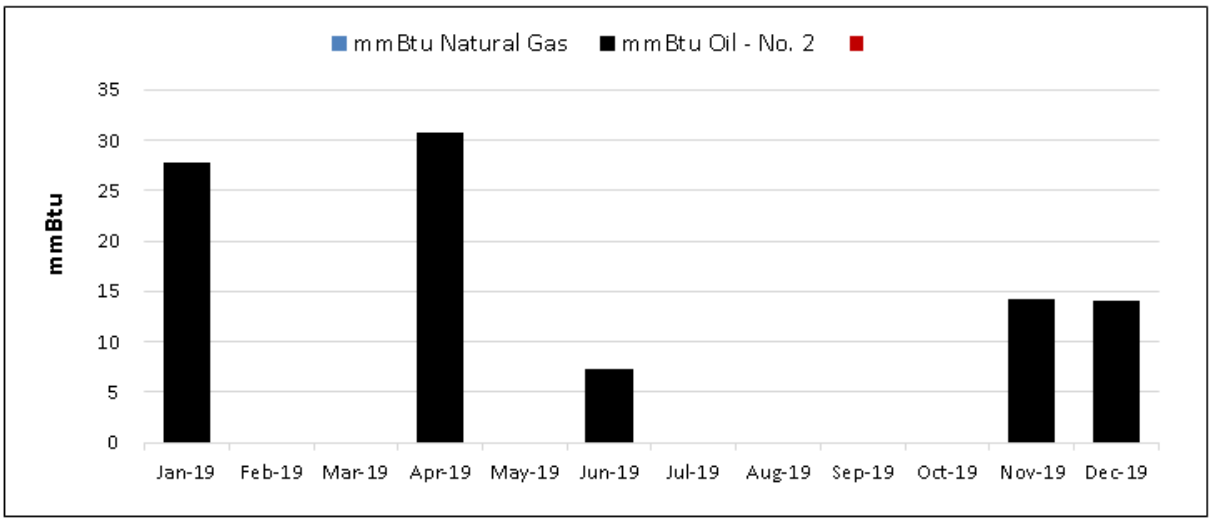
Unit Costs

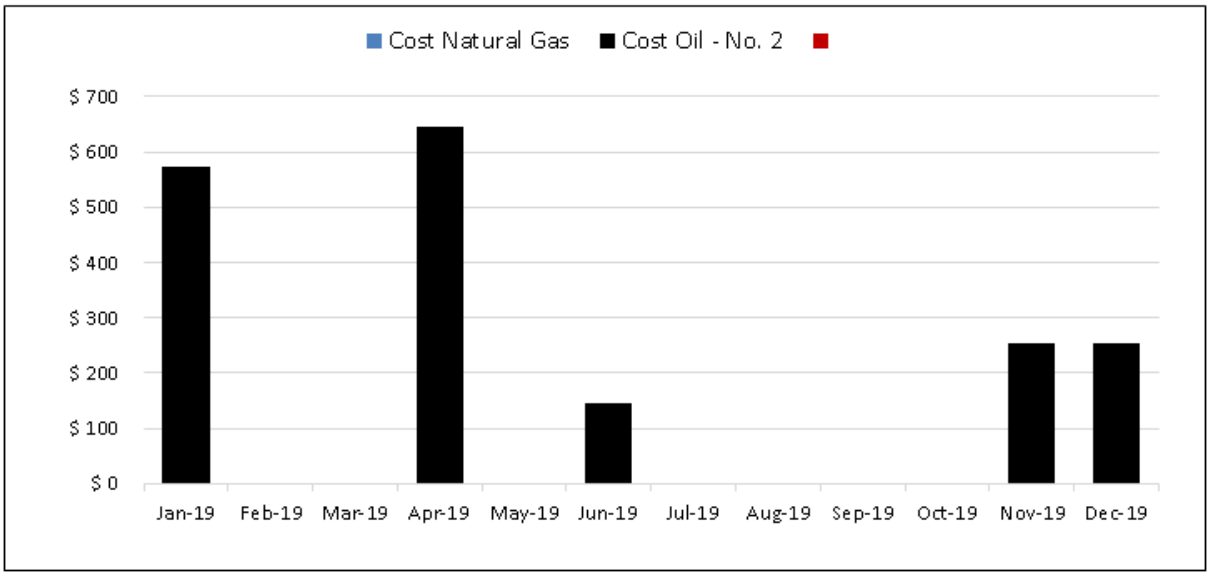
Demand	$ 0.00	$/kW
Energy	$ 0.129	$/kWh Incremental
Blended	$ 0.129	$/kWh Blended



ALL FUELS CONSUMPTION AND COST ANALYSIS **Keene Valley Congregational Church - Manse**

Month	mmBtu Natural Gas	mmBtu Oil - No. 2		All Fuel mmBtu	Cost Natural Gas	Cost Oil - No. 2		All Fuel Cost
Jan-19	0	28	0	28	$ 0	$ 573	$ 0	$ 573
Mar-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
Apr-19	0	31	0	31	$ 0	$ 644	$ 0	$ 644
May-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
May-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
Jun-19	0	7	0	7	$ 0	$ 145	$ 0	$ 145
Jul-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
Aug-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
Sep-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
Oct-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
Nov-19	0	14	0	14	$ 0	$ 255	$ 0	$ 255
Dec-19	0	14	0	14	$ 0	$ 252	$ 0	$ 252
Total	0	94	0	94	$ 0	$ 1,870	$ 0	$ 1,870
$/mmBtu		$ 19.92		$ 19.92				
BTU/unit	100,000	138,000	92,000			1 mmBtu =	1,000,000	Btus
kBtu/SF/Yr.	0.0	41.8	0.0	41.8		1 kBtu =	1,000	Btus





Appendix C

EEM Calculations

Interactions

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

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

CALCULATIONS FOR INTERIOR LIGHTING RETROFIT

EEM-1 **Keene Valley Congregational Church - Manse**

Type:	Units:	Unit cost:	BTU/unit	
Oil - No. 2	gal.	$ 2.749	138,000	
Electricity	kwh	$ 0.129	3,412	
Demand	kW	$ 0.00	12	Months of demand savings/year

0% of building is air conditioned

HVAC Adjustment Factors		
Cooling	Demand	Fuel
HVACc	HVACd	HVACg
10.00%	20.00%	-1.90%

Existing Interior Lighting Systems					Recommended Lighting Controls					Recommended Interior Lighting Efficiency Improvements								
Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	% Reduction	Present Hrs./yr.	Proposed Hrs./yr.	# Controls required	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Reflect or ?	Watts /Fixt	Project Cost	Annual Savings	kWh/yr. Savings
Pastor's office	1	18w CFL Twin Std. Mag. bal.	1	24	No Change	0%	520	520	0	LED Relamp	1	A19 LED, 9W	1	N	9	$ 3	$ 1	8
floor lamp	2	18w CFL Twin Std. Mag. bal.	1	24	No Change	0%	520	520	0	LED Relamp	2	A19 LED, 9W	1	N	9	$ 6	$ 2	16
office	1	4' 32w T8 Elec. bal.	4	112	No Change	0%	2,003	2,003	0	LED Relamp	1	4' LED T8 2000 lu. 14W	4	N	56	$ 44	$ 14	112
table lamp	2	40 watt Incandescent	1	40	No Change	0%	2,003	2,003	0	LED Relamp	2	A19 LED, 9W	1	N	9	$ 6	$ 16	124
	6			0.3 kW					0		6				0.1 kW			

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	6		260	0.2	$ 59	$ 34	1.8	Screw-in or Socket based LED lamps
		6	0	260	0.2	$ 59	$ 34		
	Gross Energy Savings		260 kwh						
	Net Energy Savings		**260 kwh**		**0.2**	**-4 gal.**		**$ 24 net**	

PAYBACK PERIOD:

Estimated Cost Interior Lighting:	$ 59	= 2.5 year payback
Annual Energy Savings (kWh + kW):	$ 24	

CALCULATIONS TO INSULATE BUILDING ENVELOPE

EEM-2 Keene Valley Congregational Church - Manse

INPUT DATA:

Surface to be insulated:	Roof			
Area:	1,122	sq ft		
Present R value:	20.3			
Revised R value	51.2			
Present U factor::	0.049	Btuh/sq ft-deg F		
Revised U factor:	0.020	Btuh/sq ft-deg F		
Present U x Area	55		55	UA Total present
Proposed U x Area	22		22	UA Total proposed

CALCULATIONS:	Occupied	Unoccupied
Heating Setpoint:	70	60
Cooling Setpoint:	78	78
Q internal gains (Btuh):	7,954	1,569
BLC (Btuh/degree F):	447	526
T Balance (°F.):	52.2	57.0

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

Fuel Data	Heating	Cooling
Type:	Oil - No. 2	
Units:	gal.	
Unit cost:	$ 2.749	
BTU/unit	138,000	
Efficiency/ COP:	86.0%	
EER:		

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat Loss	Change in Unoccupied Heat Loss	Heating Savings gal.	Cooling Savings
(27.5)	0	4	3,252	2,919	0	0
(22.5)	1	8	3,086	2,752	0	0
(17.5)	0	12	2,919	2,585	0	0
(12.5)	1	29	2,752	2,418	1	0
(7.5)	3	70	2,585	2,252	1	0
(2.5)	10	117	2,418	2,085	2	0
2.5	23	130	2,252	1,918	3	0
7.5	30	160	2,085	1,751	3	0
12.5	55	207	1,918	1,584	4	0
17.5	130	371	1,751	1,418	6	0
22.5	130	537	1,584	1,251	7	0
27.5	153	594	1,418	1,084	7	0
32.5	174	770	1,251	917	8	0
37.5	192	486	1,084	751	5	0
42.5	141	492	917	584	4	0
47.5	154	482	751	417	3	0
52.5	148	430	0	250	1	0
57.5	139	427	0	0	0	0
62.5	151	535	0	0	0	0
67.5	175	350	0	0	0	0
72.5	131	189	0	0	0	0
77.5	143	109	0	0	0	0
82.5	96	56	0	0	0	0
87.5	10	3	0	0	0	0
	8,758 hours			Energy Savings:	55	0
					$ 150	$ 0

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
attic blown in	$ 2.75	1,122	$ 3,086
insulation R-31			$ 0
			$ 0

Implementation Cost:	$ 3,086	= 20.6 year payback
Annual Energy Savings:	$ 150	

CALCULATIONS TO INSULATE BUILDING ENVELOPE

EEM-3 Keene Valley Congregational Church - Manse

INPUT DATA:

Surface to be insulated:	Walls		
Area:	2,117	sq ft	
Present R value:	6.8		
Revised R value	22.8		
Present U factor::	0.147	Btuh/sq ft-deg F	
Revised U factor:	0.044	Btuh/sq ft-deg F	
Present U x Area	312	312	UA Total present
Proposed U x Area	93	93	UA Total proposed

CALCULATIONS:	Occupied	Unoccupied	**Fuel Data**	Heating	Cooling
Heating Setpoint:	70	60	Type:	Oil - No. 2	
Cooling Setpoint:	78	78	Units:	gal.	
Q internal gains (Btuh):	7,954	1,569	Unit cost:	$ 2.749	
BLC (Btuh/degree F):	447	526	BTU/unit	138,000	
T Balance (°F.):	52.2	57.0	Efficiency/ COP:	86.0%	
T Balance = T Setpoint - (Q internal gains / BLC)			EER:		

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat Loss	Change in Unoccupied Heat Loss	Heating Savings gal.	Cooling Savings
(27.5)	0	4	21,388	19,194	1	0
(22.5)	1	8	20,291	18,098	1	0
(17.5)	0	12	19,194	17,001	2	0
(12.5)	1	29	18,098	15,904	4	0
(7.5)	3	70	17,001	14,807	9	0
(2.5)	10	117	15,904	13,710	15	0
2.5	23	130	14,807	12,613	17	0
7.5	30	160	13,710	11,517	19	0
12.5	55	207	12,613	10,420	24	0
17.5	130	371	11,517	9,323	42	0
22.5	130	537	10,420	8,226	49	0
27.5	153	594	9,323	7,129	48	0
32.5	174	770	8,226	6,033	51	0
37.5	192	486	7,129	4,936	32	0
42.5	141	492	6,033	3,839	23	0
47.5	154	482	4,936	2,742	18	0
52.5	148	430	0	1,645	6	0
57.5	139	427	0	0	0	0
62.5	151	535	0	0	0	0
67.5	175	350	0	0	0	0
72.5	131	189	0	0	0	0
77.5	143	109	0	0	0	0
82.5	96	56	0	0	0	0
87.5	10	3	0	0	0	0
	8,758 hours			Energy Savings:	359	0
					$ 987	$ 0

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
blown in wall R-16 insulation	$ 3.50	2,117	$ 7,410

Implementation Cost:	$ 7,410	= 7.5 year payback
Annual Energy Savings:	$ 987	

CALCULATIONS TO INSULATE HEATING PIPES

EEM-4 Keene Valley Congregational Church - Manse

Input Data

Fuel Information	Type:	Units:	Unit cost:	BTU/unit	Efficiency
Heating System	Oil - No. 2	gal.	$ 2.749	138,000	86%
DHW System	Oil - No. 2	gal.	$ 2.749	138,000	86%

	Type #1	Type #2	Type #3	Type #4	Type #5
Fluid	Hot Water				
Pipe Material	Dull Copper				
O.D., inches (d)	1.00				
Total Length, ft	40				
Fluid Temperature Inside Pipe, °F (Ts)	180				
Ambient Temperature, °F (Ta)	55				
Annual Operating Hours	747				
New Insulation Thickness, inches	1.0				
Thermal Conductivity - "k" (Btu-in/hr-sq ft-°F)	0.250				
Heat Loss - Bare Pipe					
C factor	1.016				
emissivity based on pipe material	0.44				
Outside Radius Pipe, inches (Ri)	0.50				
h convection, Btu/hr - s.f. pipe surface area -°F	1.55				
h radiation, Btu/hr - s.f. pipe surface area - °F	0.59				
h total	2.14				
Pipe area, sq ft/lin ft of pipe	0.262				
Q bare, Btu/hr-lin ft	**70**				
Heat Loss - Insulated Pipe					
Outside Radius Insulation, inches (Rs)	1.50				
Q i, Btu/hr-sq ft of outer area of insulation	19.0				
Insulation Area - sq ft/lin ft of pipe	0.8				
Q insul, Btu/hr-lin ft	**14.9**				
Avoided Energy Loss					
Existing Loss - mmBtu/year	2.1				
Proposed Loss - mmBtu/year	0.4				
Avoided Loss - mmBtu/year	1.6				
Total Avoided Fuel Consumption					
14 Units Saved	14				
Oil - No. 2 Fuel Type	Oil - No. 2				
$ 38 $/year	**$ 38**				

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:	$ 248	= 6.5 years payback
Annual Energy Savings:	$ 38	

CALCULATIONS TO INSTALL Wi-Fi THERMOSTAT

EEM-5 Keene Valley Congregational Church - Manse

INPUT DATA: 50% of Building to be Setback

		Current	Proposed	
Heating T Setpoint:	Occupied	70	70	deg. F.
	Unoccupied	60	55	deg. F.
Cooling T Setpoint:	Occupied	78	78	deg. F.
	Unoccupied	78	78	deg. F.
HVAC Schedule	Occupied	40.1	40.1	Hours per week
	Unoccupied	127.9	127.9	Hours per week
Q internal gains:	Occupied	3,977	3,977	Btuh
	Unoccupied	784	784	Btuh
Q internal gains:	Schedule	40	40	Hours per week
BLC:	Occupied	224	224	Btuh/deg. F.
(excludes DOAS)	Unoccupied	263	263	Btuh/deg. F.

Fuel Data	Heating	Cooling	
Type:	Oil - No. 2	Electricity	Economizer?
Units:	gal.	kwh	Yes
Unit cost:	$ 2.749		
BTU/unit	138,000		
Efficiency/ COP:	84.7%		Avg. COP. EER: 0.0

CALCULATIONS: 0.0% of bldg. is cooled

Current — Adirondack, 40 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
(27.5)	0	4	17,830	22,234	1	0
(22.5)	1	8	16,712	20,919	2	0
(17.5)	0	12	15,594	19,603	2	0
(12.5)	1	29	14,476	18,288	5	0
(7.5)	3	70	13,358	16,973	11	0
(2.5)	10	117	12,240	15,657	17	0
2.5	23	130	11,122	14,342	18	0
7.5	30	160	10,004	13,027	20	0
12.5	55	207	8,886	11,711	25	0
17.5	130	371	7,768	10,396	42	0
22.5	130	537	6,650	9,081	49	0
27.5	153	594	5,532	7,765	47	0
32.5	174	770	4,414	6,450	49	0
37.5	192	486	3,296	5,135	27	0
42.5	141	492	2,178	3,819	19	0
47.5	154	482	1,060	2,504	12	0
52.5	148	430	(58)	1,189	4	0
57.5	139	427	(1,176)	(127)	0	0
62.5	151	535	(2,294)	(696)	0	0
67.5	175	350	(3,412)	(696)	0	0
72.5	131	189	(3,959)	(696)	0	0
77.5	143	109	(3,959)	(784)	0	0
82.5	96	56	(4,978)	(1,968)	0	0
87.5	10	3	(6,096)	(3,283)	0	0
	8,758	hours			348	0

Proposed — Adirondack, 40 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
(27.5)	0	4	17,830	20,919	1	0
(22.5)	1	8	16,712	19,603	1	0
(17.5)	0	12	15,594	18,288	2	0
(12.5)	1	29	14,476	16,973	4	0
(7.5)	3	70	13,358	15,657	10	0
(2.5)	10	117	12,240	14,342	15	0
2.5	23	130	11,122	13,027	17	0
7.5	30	160	10,004	11,711	19	0
12.5	55	207	8,886	10,396	23	0
17.5	130	371	7,768	9,081	37	0
22.5	130	537	6,650	7,765	43	0
27.5	153	594	5,532	6,450	40	0
32.5	174	770	4,414	5,135	40	0
37.5	192	486	3,296	3,819	21	0
42.5	141	492	2,178	2,504	13	0
47.5	154	482	1,060	1,189	6	0
52.5	148	430	(58)	(127)	0	0
57.5	139	427	(1,176)	(696)	0	0
62.5	151	535	(2,294)	(696)	0	0
67.5	175	350	(3,412)	(696)	0	0
72.5	131	189	(3,959)	(696)	0	0
77.5	143	109	(3,959)	(696)	0	0
82.5	96	56	(4,978)	(1,968)	0	0
87.5	10	3	(6,096)	(3,283)	0	0
	8,758	hours			293	0

	Present	Proposed	Savings	
Heating	348	293	55	gal.
Cooling	0	0	0	kwh
Annual Energy $			$ 150	

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material $/unit	Labor $/unit	Quantity	Total
Wi-Fi thermostat	$ 150	$ 50	1	$ 200
				$ 0
				$ 200

Implementation Cost:	$ 200	= 1.3 year payback
Annual Energy Savings:	$150	

Appendix D

Assumptions/Data Used to Develop Energy and Dollar Savings Figures

Building and Occupancy Information

Floor Area: 2,244 square feet

	Avg. # of occupants	Heating Setpoint	Cooling Setpoint	% of base electricity use resulting in internal heat gains	
days /occupied	2	70	78	days	90%
nights/unoccupied	1	60	78	nights	80%
# of computers	1				

Interior lighting, people and occupied levels of internal loads occur for 40 hours per week

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

(This results in an average daytime kW that is N/A of the peak metered kW)

Heating System Information

HVAC system type: Non-Condensing Boiler serving 100% of the building

Default Efficiencies: 0.86 COP heat 12.50 EER = 0.96 kW/ton or 3.66 COP cool

0% of building is air conditioned Does the cooling system have economizer? Yes

Boiler system for water source HP or VRF systems: Fuel Efficiency Et

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

cfm outside air, running hours / week 0% heat recovery efficiency

Domestic Hot Water

	Fuel	Efficiency						
DHW system energy type	Electricity	100%						
Hot Water usage is	10.0	gallons per	person	/ day for	2	persons on	365	days/year

Weather & Schedule Information:

Select nearest weather station for bin data: ADIRONDACK for TRM: Albany

Base temperature for heating degree days: 65 °F. yields 9,162 HDD base65 for TRM: Small Office

Base temperature for cooling degree days: 70 °F. yields 195 CDD base70 for TRM: AC with Gas Heat

Present Schedule for Occupied/Day HVAC setpoints

Day of week		Start	End	Hours
Sun	1	11:59 AM	12:01 PM	0.0
Mon	2	8:00 AM	4:00 PM	8.0
Tue	3	8:00 AM	4:00 PM	8.0
Wed	4	8:00 AM	4:00 PM	8.0
Thu	5	8:00 AM	4:00 PM	8.0
Fri	6	8:00 AM	4:00 PM	8.0
Sat	7	11:59 AM	12:01 PM	0.0
Adirondack, 40 hrs./week				40.1
				127.9

Proposed Schedule for Occupied/Day HVAC setpoints

Day of week	Start	End	Hours
1	11:59 AM	12:01 PM	0.0
2	8:00 AM	4:00 PM	8.0
3	8:00 AM	4:00 PM	8.0
4	8:00 AM	4:00 PM	8.0
5	8:00 AM	4:00 PM	8.0
6	8:00 AM	4:00 PM	8.0
7	11:59 AM	12:01 PM	0.0
Adirondack, 40 hrs./week			40.1

Bin Data for Adirondack, 40 hrs./week

Mid Point	Enthalpy all hours	Present Occupied Hours	Present Unoccupied Hours	Occ enthalpy	Unocc enthalpy
-27.5	-6.2	0	4		(6.2)
-22.5	-5.1	1	8	(5.0)	(5.1)
-17.5	-3.8	0	12		(3.8)
-12.5	-2.7	1	29	(3.2)	(2.7)
-7.5	-1.2	3	70	(1.7)	(1.2)
-2.5	0.2	10	117	0.1	0.2
2.5	1.4	23	130	1.4	1.4
7.5	2.8	30	160	2.9	2.8
12.5	4.2	55	207	4.1	4.3
17.5	6.0	130	371	5.9	6.0
22.5	7.8	130	537	7.6	7.8
27.5	9.4	153	594	9.1	9.5
32.5	11.4	174	770	11.3	11.4
37.5	13.3	192	486	12.8	13.5
42.5	15.3	141	492	14.4	15.6
47.5	18.0	154	482	16.8	18.3
52.5	20.3	148	430	19.1	20.7
57.5	22.7	139	427	21.2	23.1
62.5	26.0	151	535	24.3	26.5
67.5	28.0	175	350	27.1	28.5
72.5	28.9	131	189	28.3	29.4
77.5	30.4	143	109	30.2	30.7
82.5	32.4	96	56	32.4	32.5
87.5	36.1	10	3	36.0	36.2
		2,190	6,568		

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

Keene Valley Congregational Church - Manse
1791 NY-73
Keene, NY 12943

Building Information

Width (typical)	33	feet	Building Floor Area	2,244	sq. ft.
Equivalent Length	34	feet	Roof Area	1,122	sq. ft.
Number of Floors	2.0	floors	Gross Wall Area	2,412	sq. ft.
Avg. Floor to Floor Height	9	feet per floor	Building Volume	20,196	cubic feet
Roof or Ceiling rise is	0	feet in 12' run			

Estimate of Conductive Heat Loss

Surface			Area		R-value	U Factor	U x A Btuh/deg. F.	% of BLC w/o ventilation
Roof	n/a		1,122		20.3	0.049	55	12%
Walls	87.8%	of GWA	2,117		6.8	0.147	312	70%
Glazing 1	10.5%	of GWA	253		2.5	0.400	101	23%
Glazing 2	0.0%	of GWA	0		0.9	1.111	0	0%
Doors 1	2	3x7 doors	42		2.0	0.500	21	5%
Doors 2	0	3x7 doors	0		1.7	0.588	0	0%
	Total Exterior Surface Area		3,534	sq.ft.			490	110%

		ACH	equiv. cfm	Btuh/deg. F.	BLC (without ventilation)	
Est. Infiltration Rate	Occupied	0.10	34	36	447	Btuh/deg. F. Occupied
Est. Infiltration Rate	Unoccupied	0.10	34	36	526	Btuh/deg. F. Unoccupied

		cfm	Fraction	Btuh/deg. F.	**Total BLC with Ventilation**	
Est. Ventilation Rate	Occupied		100%	0	**447**	**Btuh/deg. F. Occupied**
Est. Ventilation Rate	Unoccupied		100%	0	**526**	**Btuh/deg. F. Unoccupied**

Heat Gain Estimation

Estimated Solar Gain — 15% of building heat loss during occupied periods will be met by solar gains

		kW	# People	Total BTUH	Hours/wk.
Loads & People	Occupied	**2.2**	**2**	7,954	40.0
	Unoccupied	**0.4**	**1**	1,569	128.0

Heat Loss Study - continued

Keene Valley Congregational Church - Manse
1791 NY-73
Keene, NY 12943

Fuel Data	Heating	Cooling	
Type:	Oil - No. 2	Electricity	Economizer?
Units:	gal.	kwh	Yes
Unit cost:	$ 2.749		
BTU/unit	138,000		
Nom. Eff, COP	0.860		COP
Avg. Eff, COP	0.847		Avg. COP
			EER
			0% of bldg. cooled

		Current	
Heating T Setpoint:	Occupied	70	deg. F.
	Unoccupied	60	deg. F.
Cooling T Setpoint:	Occupied	78	deg. F.
	Unoccupied	78	deg. F.
HVAC Schedule	Occupied	40	Hrs. per week
	Unoccupied	128	Hrs. per week
Q internal gains:	Occupied	7,954	Btuh
	Unoccupied	1,569	Btuh
Q internal gains:	Schedule	40	Hrs. per week
BLC:	Occupied	447	Btuh/deg. F.
	Unoccupied	526	Btuh/deg. F.

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

Current — Adirondack, 40 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.
(27.5)	0	4	35,660	44,468	2	0	0	0
(22.5)	1	8	33,424	41,837	3	0	0	0
(17.5)	0	12	31,188	39,207	4	0	0	0
(12.5)	1	29	28,952	36,576	9	0	0	0
(7.5)	3	70	26,716	33,945	21	0	0	0
(2.5)	10	117	24,480	31,315	33	0	0	0
2.5	23	130	22,244	28,684	36	0	0	0
7.5	30	160	20,008	26,053	41	0	0	0
12.5	55	207	17,772	23,423	50	0	0	0
17.5	130	371	15,536	20,792	83	0	0	0
22.5	130	537	13,300	18,161	98	0	0	0
27.5	153	594	11,064	15,531	93	0	0	0
32.5	174	770	8,828	12,900	98	0	0	0
37.5	192	486	6,591	10,269	54	0	0	0
42.5	141	492	4,355	7,639	37	0	0	0
47.5	154	482	2,119	5,008	23	0	0	0
52.5	148	430	(117)	2,377	9	0	0	0
57.5	139	427	(2,353)	(253)	0	0	0	0
62.5	151	535	(4,589)	(1,392)	0	0	0	0
67.5	175	350	(6,825)	(1,392)	0	0	0	0
72.5	131	189	(7,918)	(1,392)	0	0	0	0
77.5	143	109	(7,918)	(1,392)	0	0	0	0
82.5	96	56	(9,955)	(3,936)	0	0	0	0
87.5	10	3	(12,191)	(6,567)	0	0	0	0
	8,758	hours			696	0	DOAS fuel use	0
							DOAS cool use	0

Cross Check Against Historic Consumption

	Historic		Calculated	Difference
Present Annual Heating Fuel Use is	94	mmBTU	96	102% of present fuel use