Green Jobs Green New York

Energy Study

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

Audit No: G-189-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.

NOTICE

This report was prepared pursuant to the Flexible Technical Assistance Program (Hereinafter "FlexTech") administered by the New York State Energy Research and Development Authority (hereinafter "NYSERDA"). The opinions expressed in this report do not necessarily reflect those of NYSERDA or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it by NYSERDA or the State of New York. Further, NYSERDA and the State of New York make no warranties or representations, expressed or implied, as to the fitness for a particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, energy savings, or other information contained, described, disclosed, or referred to in this report. NYSERDA and the State of New York make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately-owned rights and will assume no responsibility for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

State of New York

Andrew Cuomo, Governor

New York State Energy Research and Development Authority

Consultant Disclaimer

The opinions expressed in this report do not necessarily reflect those of L&S Energy Services, C.J. Brown Energy P.C., The Daylight Savings Company, or Taitem Engineering P.C. (the Consultants), and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it by the Consultants. Further, the Consultants make no warranties or representations, expressed or implied, as to the fitness for a particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, energy savings, or other information contained, described, disclosed, or referred to in this report. The Consultants make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately-owned rights and will assume no responsibility for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

This report was prepared by:

L & S Energy Services
58 Clifton Country Road, Suite 203
Clifton Park, NY 12065
(518) 383-9405

Table of Contents

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 lighting upgrades, envelope improvements and duct insulation.

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

- Upgrade the interior and exterior lighting with LED lamps. In-house labor will be used.
- Building envelope improvements include air sealing the tops of the foundation walls with foam insulation, installing one storm window in the storeroom, insulating the walls and weather-stripping the doors.
- Increasing the existing attic insulation is not recommended due to the long payback.
- Insulate the bare heating ducts in the basement with fiberglass insulation. Insulate three feet of domestic hot water pipe located at the hot water heater.
- Install two Wi-Fi thermostats to provide tighter temperature control.

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.

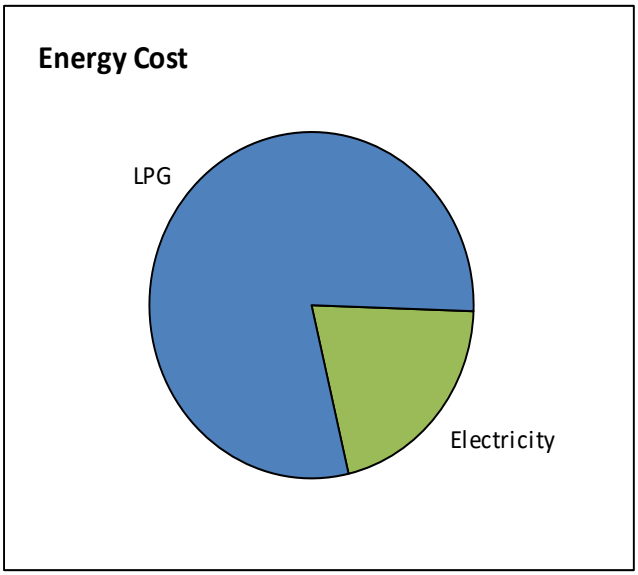
- The Energy Cost Index (ECI) is the total cost of energy divided by the conditioned floor area and is shown as dollars per square foot per year.
- The Energy Use Intensity (EUI) is the total heat content of energy divided by the conditioned floor area and is shown in units of one thousand Btus (kBtu)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

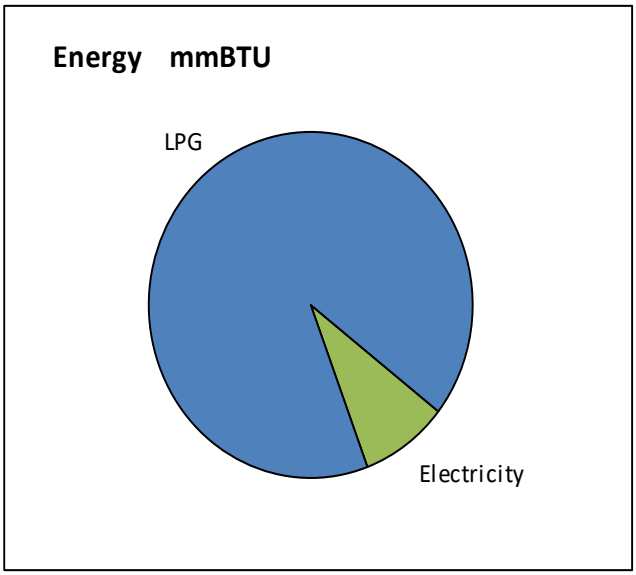
Energy Cost Index

Electricity	$ 804	$ 0.22	$/sq.ft./year
LPG	$ 3,064	$ 0.85	$/sq.ft./year
Total Cost	$ 3,868	$ 1.07	$/sq.ft./year

Energy Use Intensity

Electricity	21	mmBtu	5.9	kBtu/sq.ft./year
LPG	223	mmBtu	62.0	kBtu/sq.ft./year
Total Energy Use	245	mmBtu	67.9	kBtu/sq.ft./year





Energy Cost Index $ 1.07 /sf/yr. **Energy Use Intensity 67.9 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	1,807	1.6	$ 231	LPG	(2)	($ 30)	$ 202	$ 744	3.7
EEM-2	R	Lighting	Exterior Lighting Retrofit	993	0.0	$ 127		0	$ 0	$ 127	$ 22	0.2
EEM-3	R	Envelope	Weather-Stripping And Caulking	0	0.0	$ 0	LPG	9	$ 119	$ 119	$ 273	2.3
EEM-4	R	Envelope	Building Airflow Reduction	0	0.0	$ 0	LPG	9	$ 128	$ 128	$ 960	7.5
EEM-5	NR	Envelope	Insulate Building Envelope	0	0.0	$ 0	LPG	21	$ 282	$ 282	$ 9,900	35.1
EEM-6	R	Envelope	Insulate Building Envelope	0	0.0	$ 0	LPG	64	$ 881	$ 881	$ 11,309	12.8
EEM-7	R	Envelope	Install Storm Windows	0	0.0	$ 0	LPG	3	$ 36	$ 36	$ 300	8.4
EEM-8	R	HVAC	Install Duct Insulation	0	0.0	$ 0	LPG	12	$ 162	$ 162	$ 815	5.0
EEM-9	R	HVAC	Insulate Domestic Hot Water Pipes	77	0.0	$ 10		0	$ 0	$ 10	$ 20	2.0
EEM-10	R	Controls	Install Wi-Fi Thermostats	0	0.0	$ 0	LPG	23	$ 315	$ 315	$ 400	1.3
			Total of Recommended Measures:	2,877	1.6	$ 368		117	$ 1,612	$ 1,980	$ 14,842	7.5

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	2,877	kWh =	3,337	pounds CO2 equivalent
LPG	1,275	gal. =	18,913	pounds CO2 equivalent
			22,250	pounds CO2 equivalent
			51.5%	reduction

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

Assistance for Implementation of Recommendations

This study provides 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:	$ 231	1,807	kWh per year
		1.6	kW demand
Fuel Savings:	($ 30)	(2.2)	MMBtu fuel per year LPG
Total Annual Savings:	**$ 202**		
Project Cost:	**$ 744**		
Simple Payback:	**3.7 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 fixtures 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 Exterior Lighting Retrofit

Electric Savings:	$ 127	993	kWh per year
		0.0	kW demand
Fuel Savings:	$ 0	0.0	MMBtu fuel per year
Total Annual Savings:	**$ 127**		
Project Cost:	**$ 22**		
Simple Payback:	**0.2 years**		

Introduction:

Light Emitting Diode (LED) lamps can be used to replace exterior incandescent lamps.

Recommendation:

Replace exterior incandescent lamps 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-3 Weather-Stripping and Caulking

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 119	8.7	MMBtu fuel per year LPG
Total Annual Savings:	**$ 119**		
Project Cost:	**$ 273**		
Simple Payback:	**2.3 years**		

Introduction:

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

Recommendation:

Clean and inspect surfaces for damage or moisture, in order to ensure that they are in good enough condition to accept weather-stripping or caulk. Tighten door or window hardware. Remove old weather-stripping and caulk. Cut weather-stripping carefully to length and apply it to the surface. New weather-stripping should be snug and should completely fill gaps without buckling or otherwise deforming. Open and close window or door and inspect for interference, weather-stripping damage, or other problems. Windows and doors should be able to close without excessive force.

Approximately 91 feet of the exterior door perimeter needs to be weather-stripped.

EEM-4 Building Airflow Reduction

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 128	9.3	MMBtu fuel per year LPG
Total Annual Savings:	**$ 128**		
Project Cost:	**$ 960**		
Simple Payback:	**7.5 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:

The tops of the foundation walls should be sealed with expanding foam to reduce heat loss.

EEM-5 Insulate Building Envelope

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 282	20.5	MMBtu fuel per year LPG
Total Annual Savings:	**$ 282**		
Project Cost:	**$ 9,900**		
Simple Payback:	**35.1 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 fiberglass insulation equal to or greater than R-31 to approximately 3,600 square feet of the attic floor.

This measure is not recommended due to the long payback.

EEM-6 Insulate Building Envelope

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 881	64.1	MMBtu fuel per year LPG
Total Annual Savings:	**$ 881**		
Project Cost:	**$ 11,309**		
Simple Payback:	**12.8 years**		

Introduction:

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

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 3,231 square feet of the walls.

EEM-7 Install Storm Windows

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 36	2.6	MMBtu fuel per year LPG
Total Annual Savings:	**$ 36**		
Project Cost:	**$ 300**		
Simple Payback:	**8.4 years**		

Introduction:

Single pane windows have a high rate of heat loss from the building. Heat losses due to infiltration through loose fitting window frames are also significant. These losses can be reduced by installing storm windows to the single glazed windows. Storm windows reduce heat loss during the heating season by creating an additional air space between the window and the exterior of the building.

Recommendation:

The window located in the back storeroom near the kitchen is missing an exterior storm window. Install a new storm window similar to the existing storms.

EEM-8 Install Duct Insulation

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 162	11.8	MMBtu fuel per year LPG
Total Annual Savings:	**$ 162**		
Project Cost:	**$ 815**		
Simple Payback:	**5.0 years**		

Introduction:

Sheet metal ducts located in basement, attic or other unconditioned spaces lose energy and reduce overall system efficiency. The heating and cooling systems must operate longer to compensate for this energy loss. Adding insulation to supply and return air ducts will reduce this energy loss and improve system efficiency.

Ducts in conditioned spaces experience minimal conductive losses and gains since they are exposed to indoor spaces that must be conditioned in any event. However, these ducts may also require some insulation to prevent condensation on duct walls and to ensure that conditioned air is delivered at the desired temperature.

Recommendation:

Insulate the 8" x 24" supply air duct located in the basement with an R-5 (1.5" thick) fiberglass insulating jacket. There is approximately 40 linear feet (213 square feet) of duct to be insulated.

Install insulation following the directions of the manufacturer, taping all seams.

EEM-9 Insulate Domestic Hot Water Pipes

Electric Savings:	$ 10	77	kWh per year
		0.0	kW demand
Fuel Savings:	$ 0	0.0	MMBtu fuel per year
Total Annual Savings:	**$ 10**		
Project Cost:	**$ 20**		
Simple Payback:	**2.0 years**		

Introduction:

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 the first three feet of domestic hot water piping after the water heater using pre-formed fiberglass pipe insulation with protective jacketing. The rest of the piping is already insulated.

EEM-10 Install Wi-Fi Thermostats

Electric Savings:	$ 0	0	kWh per year
		0.0	kW demand
Fuel Savings:	$ 315	22.9	MMBtu fuel per year LPG
Total Annual Savings:	**$ 315**		
Project Cost:	**$ 400**		
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 two Wi-Fi thermostats to control the heating system. Program the thermostats to reduce the unoccupied temperature to 55ºF.

Existing Conditions

The site is a Church. In the winter, about 50 people attend on Sunday. In the summer, about 80 people attend on Sunday. There are evening activities 3 to 4 times a week that have 5 to 10 people.

The building consists of approximately 3,600 square feet on one floor. It was built in approximately 1890. The exterior walls have a wood structure with an exterior finish of vinyl. Foam insulation was applied before new siding was installed. The ridge roof has an asphalt shingle exterior surface. It is estimated that there is 6 inches of fiberglass insulation on the attic floor. The interior has a plaster finish.

The windows are double glazed double hung vinyl sash. The exterior doors are solid wood and metal with partial double glazing. Some weather-stripping exists but some gaps can be seen.

Major energy end uses include lighting and heating.

The facility is occupied 6 days per week for a total of 18 hours per week. The HVAC system maintains occupied conditions for 18 hours per week.

Winter space temperatures are normally maintained at 74°F and are setback to 58°F during unoccupied periods. Temperature control is provided by programmable thermostats. There are no air conditioning systems.

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
furnace	1	Ducane 95GLWH45B	145	95%				entire building	2015

Domestic Hot Water									
Unit Type	Qty	Make/Model	Capacity	Units	Fuel Type	Storage Capacity (gal.)	Eff.	Serves/Location	Year
Storage	1	A.O.Smith EEST-30	15,358	BTUH	Electricity	30	100%	kitchen and restrooms	2015

Motors									
Unit Type	Qty	Make/Model	HP	Loading	Type	Hours/year	Eff.	Serves/Location	Year
furnace	1		1/2	75%	Prem.	1,487	68%		2015

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	kitchen	2	4' 32w T8 Elec. bal.	4	112	No Change	LED Relamp	2	4' LED T8 2200 lu. 17W	4	68
2	mud room	3	40 watt Incandescent	1	40	No Change	LED Relamp	3	A15 LED, 5W	1	5
3	Christian Ed	2	4' 32w T8 Elec. bal.	4	112	No Change	LED Relamp	2	4' LED T8 2200 lu. 17W	4	68
4	store room	1	60 watt Incandescent	1	60	No Change	LED Relamp	1	A19 LED, 9W	1	9
5	restrooms	3	A19 LED, 9W	1	9	No Change	No change	3	A19 LED, 9W	1	9
6	front room	12	CA11 LED Candle, 2.5W	1	3	No Change	No change	12	CA11 LED Candle, 2.5W	1	3
7	vestibule	1	40 watt Incandescent	1	40	No Change	LED Relamp	1	A19 LED, 9W	1	9
8	music gathering	3	60 watt Incandescent	1	60	No Change	LED Relamp	3	A19 LED, 9W	1	9
9	storage	1	4' 40w T12 EE Mag. bal.	1	50	No Change	LED Relamp	1	4' LED T8 2000 lu. 14W	1	14
10	Sanctuary candelabra	36	25 watt Incandescent	1	25	No Change	LED Relamp	36	CA11 LED Candle, 4.5W	1	5
11	Sanctuary floods	12	40 watt Incandescent	1	40	No Change	LED Relamp	12	A19 LED, 11W	1	11

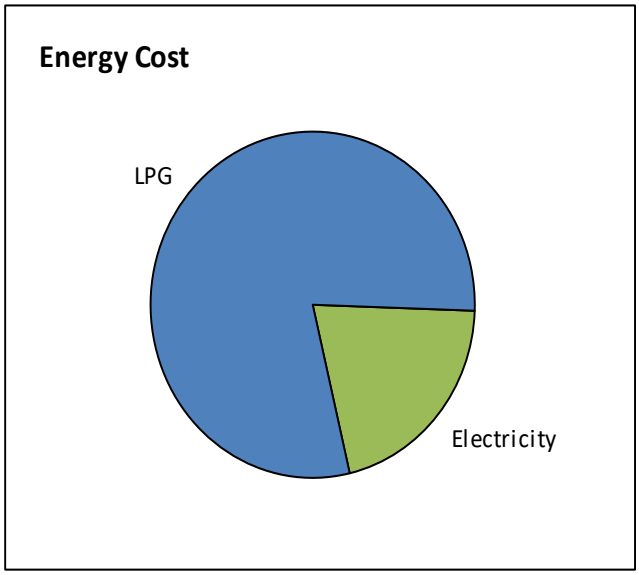
Exterior Lighting Fixtures											
Existing Fixtures						Recommended	Lighting Efficiency Improvements				
Line #	Area	Qty	Present Lighting Type	Lamps /fixt	Watts /Fixt	Control Type	Measure Type	Qty	Proposed Lighting Type	Lamps /fixt	Watts /Fixt
1	back porch	1	100 watt Incandescent	1	100	No Change	LED Relamp	1	A19 LED, 15W	1	15
2	entrance	1	100 watt Incandescent	1	100	No Change	LED Relamp	1	A19 LED, 15W	1	15
3	Sanctuary entrance	2	100 watt Incandescent	1	100	No Change	LED Relamp	2	A19 LED, 15W	1	15

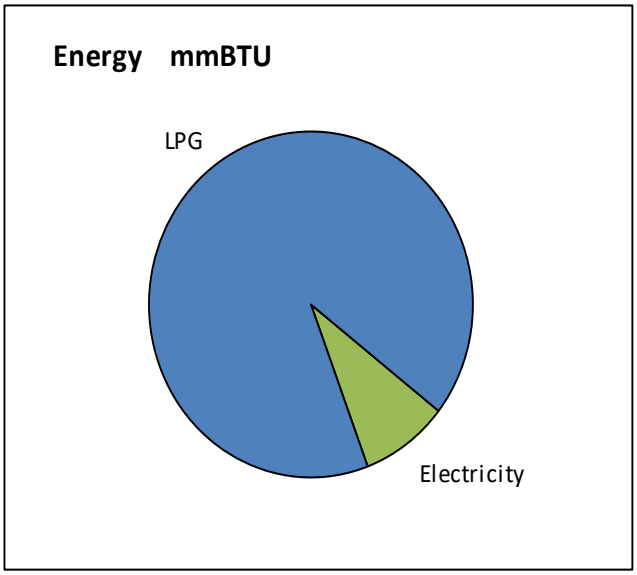
Appendix B

Energy Use and Cost Summary

Energy		Units Used		BTU/unit	mmBTU	% of total	kBtu/sq.ft./year
	Electricity	6,270	kwh	3,412	21	9%	5.9
	LPG	2,425	gal.	92,000	223	91%	62.0
	Total				245		67.9

Cost		Energy Cost	Unit Costs		% of total	$/sq.ft./year
	Electricity	$ 804	$ 0.128	kwh	21%	$ 0.22
	LPG	$ 3,064	$ 1.264	gal.	79%	$ 0.85
	Total	$ 3,868				$ 1.07





Energy Cost Index $ 1.07 /sf/yr. **Energy Use Intensity 67.9 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 - Main Building

Gross Area: 3,600 s.f.
5,943 Btu/s.f./Yr
$ 0.22 /s.f.

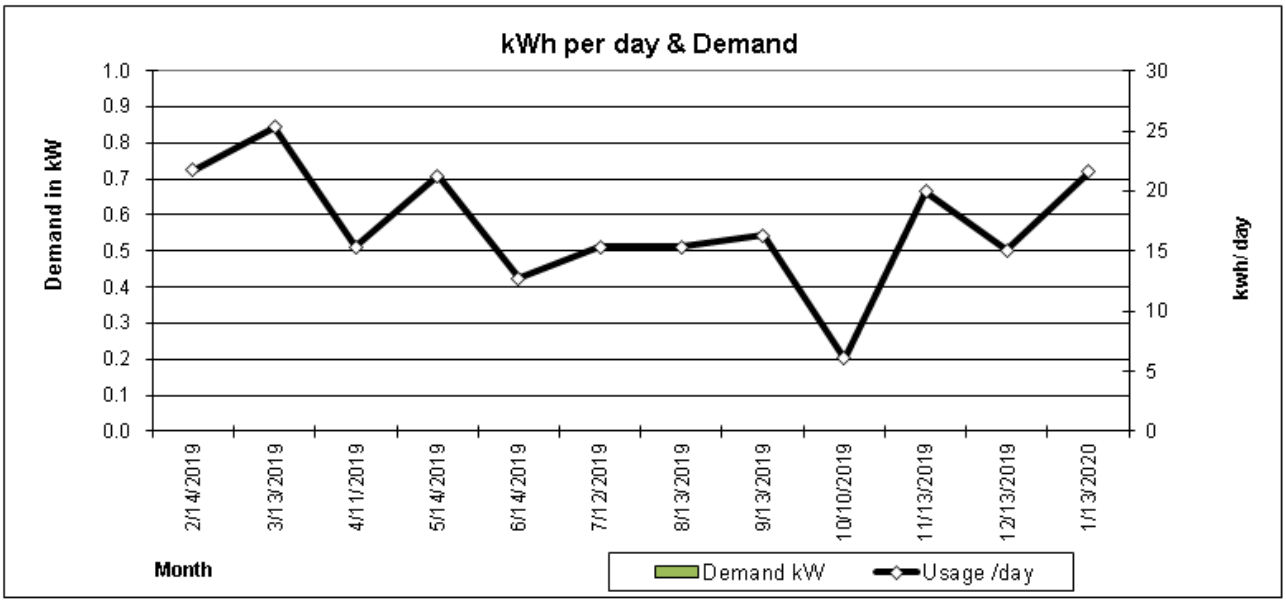
Utility: NYSEG
Account # ends w/ -562
Rate: SC 12001 NYSEG Supply Service
Meter Charge: $ 0.00 / month
Demand Charge: $ 0.00 / kW
Supplier:

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
2/14/2019	30	653	0.0	$ 45	$ 47	$ 91	$ 0	$ 0.140	N/A	22
3/13/2019	27	683	0.0	$ 47	$ 39	$ 86	$ 0	$ 0.126	N/A	25
4/11/2019	29	446	0.0	$ 37	$ 20	$ 57	$ 0	$ 0.128	N/A	15
5/14/2019	33	701	0.0	$ 51	$ 24	$ 76	$ 0	$ 0.108	N/A	21
6/14/2019	31	394	0.0	$ 36	$ 15	$ 51	$ 0	$ 0.130	N/A	13
7/12/2019	28	430	0.0	$ 37	$ 21	$ 59	$ 0	$ 0.136	N/A	15
8/13/2019	32	491	0.0	$ 41	$ 22	$ 63	$ 0	$ 0.128	N/A	15
9/13/2019	31	506	0.0	$ 40	$ 23	$ 62	$ 0	$ 0.123	N/A	16
10/10/2019	27	165	0.0	$ 23	$ 9	$ 32	$ 0	$ 0.192	N/A	6
11/13/2019	34	679	0.0	$ 48	$ 36	$ 83	$ 0	$ 0.123	N/A	20
12/13/2019	30	452	0.0	$ 37	$ 22	$ 59	$ 0	$ 0.130	N/A	15
1/13/2020	31	670	0.0	$ 48	$ 36	$ 84	$ 0	$ 0.125	N/A	22
	363	**6,270**	**0.0**	**$ 489**	**$ 314**	**$ 804**	**$ 0**	**$ 0.128**	**N/A**	**17**

Annual Energy: 6,270 kWh / year $ 804 /year
Peak Demand: 0 kW Peak
Average Demand: 0 kW

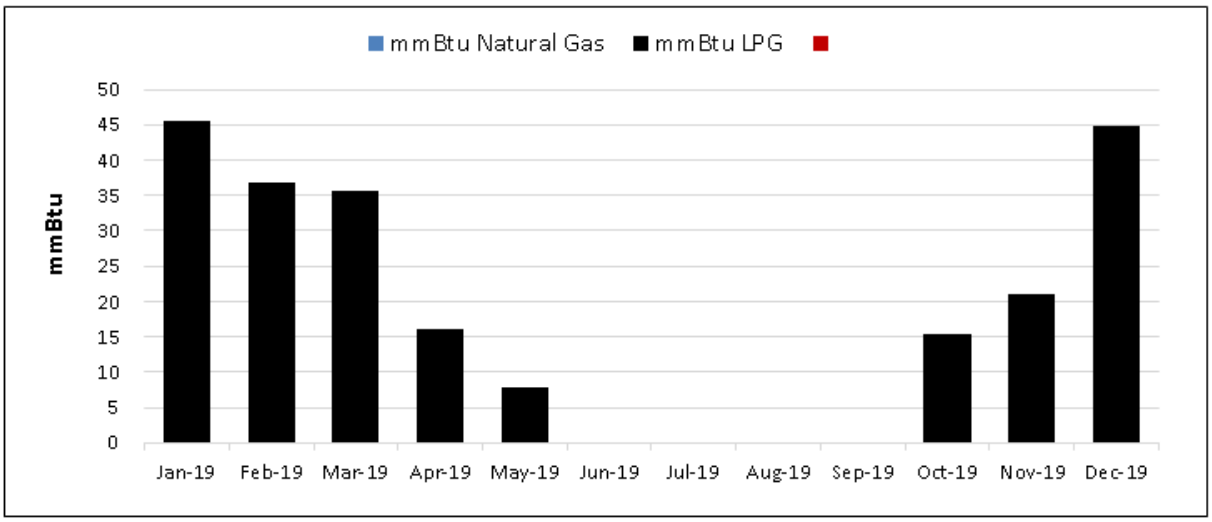
Unit Costs

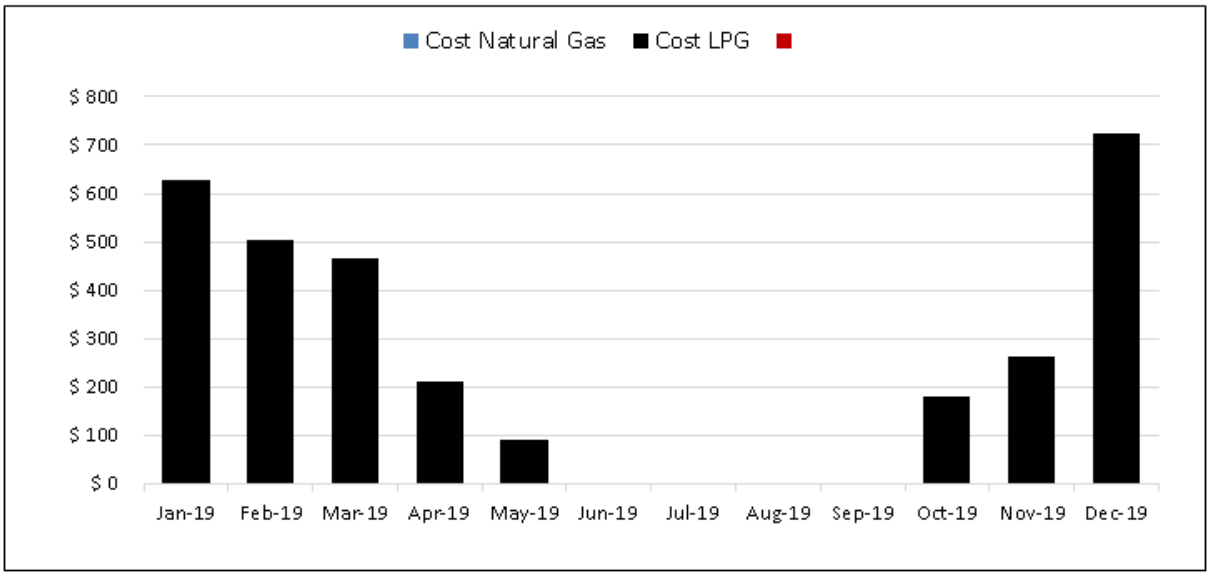
Demand	$ 0.00	$/kW
Energy	$ 0.128	$/kWh Incremental
Blended	$ 0.128	$/kWh Blended



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

Month	mmBtu Natural Gas	mmBtu LPG		All Fuel mmBtu	Cost Natural Gas	Cost LPG		All Fuel Cost
Jan-19	0	46	0	46	$ 0	$ 628	$ 0	$ 628
Feb-19	0	37	0	37	$ 0	$ 503	$ 0	$ 503
Mar-19	0	36	0	36	$ 0	$ 466	$ 0	$ 466
Apr-19	0	16	0	16	$ 0	$ 212	$ 0	$ 212
May-19	0	8	0	8	$ 0	$ 91	$ 0	$ 91
Jun-19	0	0	0	0	$ 0	$ 0	$ 0	$ 0
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	15	0	15	$ 0	$ 179	$ 0	$ 179
Nov-19	0	21	0	21	$ 0	$ 261	$ 0	$ 261
Dec-19	0	45	0	45	$ 0	$ 724	$ 0	$ 724
Total	0	223	0	223	$ 0	$ 3,064	$ 0	$ 3,064
$/mmBtu		$ 13.73		$ 13.73				
BTU/unit	100,000	92,000	138,000			1 mmBtu =	1,000,000	Btus
kBtu/SF/Yr.	0.0	62.0	0.0	62.0		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 - Main Building**

Type:	Units:	Unit cost:	BTU/unit	
LPG	gal.	$ 1.264	92,000	
Electricity	kwh	$ 0.128	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
7.80%	20.00%	-1.20%

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	Payback (Years)
kitchen	2	4' 32w T8 Elec. bal.	4	112	No Change	0%	1,040	1,040	0	LED Relamp	2	4' LED T8 2200 lu. 17W	4	N	68	$ 80	$ 12	92	6.8
mud room	3	40 watt Incandescent	1	40	No Change	0%	1,040	1,040	0	LED Relamp	3	A15 LED, 5W	1	N	5	$ 90	$ 14	109	6.4
Christian Ed	2	4' 32w T8 Elec. bal.	4	112	No Change	0%	1,040	1,040	0	LED Relamp	2	4' LED T8 2200 lu. 17W	4	N	68	$ 80	$ 12	92	6.8
store room	1	60 watt Incandescent	1	60	No Change	0%	899	899	0	LED Relamp	1	A19 LED, 9W	1	N	9	$ 3	$ 6	46	0.5
restrooms	3	A19 LED, 9W	1	9	No Change	0%	899	899	0	No change	3	A19 LED, 9W	1	N	9	$ 0	$ 0	0	
front room	12	CA11 LED Candle, 2.5W	1	3	No Change	0%	1,040	1,040	0	No change	12	CA11 LED Candle, 2.5W	1	N	3	$ 0	$ 0	0	
vestibule	1	40 watt Incandescent	1	40	No Change	0%	899	899	0	LED Relamp	1	A19 LED, 9W	1	N	9	$ 3	$ 4	28	0.8
music gathering	3	60 watt Incandescent	1	60	No Change	0%	1,040	104	0	LED Relamp	3	A19 LED, 9W	1	N	9	$ 9	$ 24	184	0.4
storage	1	4' 40w T12 EE Mag. bal.	1	50	No Change	0%	104	104	0	LED Relamp	1	4' LED T8 2000 lu. 14W	1	N	14	$ 11	$ 0	4	23.0
Sanctuary candelabra	36	25 watt Incandescent	1	25	No Change	0%	1,040	1,040	0	LED Relamp	36	CA11 LED Candle, 4.5W	1	N	5	$ 432	$ 98	768	4.4
Sanctuary floods	12	40 watt Incandescent	1	40	No Change	0%	1,040	104	0	LED Relamp	12	A19 LED, 11W	1	N	11	$ 36	$ 62	485	0.6
	76			2.3	kW				0		76				0.7	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	61		1,807	1.6	$ 744	$ 231	3.2	Screw-in or Socket based LED lamps
		61	0	1,807	1.6	$ 744	$ 231		

Gross Energy Savings	1,807	kwh		
Net Energy Savings	**1,807**	**kwh**	**1.6**	**-24 gal.**	**$ 202 net**

PAYBACK PERIOD:

Estimated Cost Interior Lighting:	$ 744	= 3.7 year payback
Annual Energy Savings (kWh + kW):	$ 202	

CALCULATIONS FOR EXTERIOR LIGHTING RETROFIT

EEM-2 Keene Valley Congregational Church - Main Building

Electricity
Unit cost: $ 0.128 /kwh
kW demand $ 0.00
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	back porch	1	100 watt Incandescent	1	100	No Change	0%	2,920	2,920	0	LED Relamp	1	A19 LED, 15W	1	N	15	$ 6	$ 32	248	0.2
2	entrance	1	100 watt Incandescent	1	100	No Change	0%	2,920	2,920	0	LED Relamp	1	A19 LED, 15W	1	N	15	$ 6	$ 32	248	0.2
3	Sanctuary entrance	2	100 watt Incandescent	1	100	No Change	0%	2,920	2,920	0	LED Relamp	2	A19 LED, 15W	1	N	15	$ 11	$ 64	496	0.2
		4			0.4 kW					0		4				0.1 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
LED Relamp	4		993	0.0	$ 22	$ 127	0.2	
	4	0	993	0.0	$ 22	$ 127	0.2	
		993 kwh						

PAYBACK PERIOD:

Estimated Cost Exterior Lighting: $ 22 = 0.2 year payback
Annual Energy Savings (kWh + kW): $ 127

CALCULATIONS FOR WEATHER-STRIPPING AND CAULKING

EEM-3 **Keene Valley Congregational Church - Main Building**

INPUT DATA:

Crack Method	Crack Length lineal feet	Leakage Rate - cfh		Leakage - net cfh		
		Present	New	Present	New	Savings
Roof - Wall Joint						
Window Jamb to Wall						
Operable Window WS						
Door Sweeps & WS	91	60	5	2,730	228	2,503
other						
Air Change Method	Bldg. Volume cubic feet	Air changes/Hour		Cubic feet/hour		
		Present	Proposed	Present	Proposed	Savings
Air Sealing Occupied	54,000	0.45	0.45	24,300	24,300	0
Air Sealing Unoccupied	54,000	0.45	0.45	24,300	24,300	0
Total Infiltration Reduction		**Occupied**		**27,030**	**24,528**	**2,503**
		Unoccupied		**27,030**	**24,528**	**2,503**

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:	74	58	°F
Q internal gains:	12,578	1,596	Btuh
BLC:	1,099	1,294	Btuh/°F
T Balance:	62.6	56.8	°F. T Balance = T Setpoint - (Q internal gains / BLC)
Bin Data for Adirondack, 18 hrs./week			
Accumulated Hours	755	5,613	below balance temp.
Avg. OAT	36.2	30.5	°F below balance temp.
(T Set- Avg OAT)	37.8	27.5	°F difference

Type:	LPG	
Units:	gal.	
Unit cost:	$ 1.264	/gal.
CF1	92,000	Btu/gal.
Efficiency:	95%	
CF2	0.018	Btu/hr-°F-cfh

	Energy Savings - Btu/year			Total Savings	
	Occupied	Unoccupied	Total	gal. / yr	$
Total Infiltration Reduction	1,284,100	6,948,300	8,232,400	94	$ 119

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Matl. & Labor ($ / lin ft)	Quantity (lin ft)	Total
Weather-stripping	$ 3.00	91	$ 273
	Implementation Cost:		$ 273
	Annual Energy Savings:		$ 119

= 2.3 year payback

CALCULATIONS FOR BUILDING AIRFLOW REDUCTION

EEM-4 **Keene Valley Congregational Church - Main Building**

INPUT DATA:

Crack Method	Crack Length lineal feet	Leakage Rate - cfh		Leakage - net cfh		
		Present	New	Present	New	Savings
Roof - Wall Joint						
Window Jamb to Wall						
Operable Window WS						
Door Sweeps & WS	0	0	0	0	0	0
other						
Air Change Method	Bldg. Volume cubic feet	r changes/Hour		Cubic feet/hour		
		Present	Proposed	Present	Proposed	Savings
Air Sealing Occupied	54,000	0.45	0.40	24,300	21,600	2,700
Air Sealing Unoccupied	54,000	0.45	0.40	24,300	21,600	2,700
Total Infiltration Reduction		**Occupied**		**24,300**	**21,600**	**2,700**
		Unoccupied		**24,300**	**21,600**	**2,700**

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:	74	58	°F
Q internal gains:	12,578	1,596	Btuh
BLC:	1,099	1,294	Btuh/°F
T Balance:	62.6	56.8	°F. T Balance = T Setpoint - (Q internal gains / BLC)
Bin Data for Adirondack, 18 hrs./week			
Accumulated Hours	755	5,613	below balance temp.
Avg. OAT	36.2	30.5	°F below balance temp.
(T Set- Avg OAT)	37.8	27.5	°F difference

Type:	LPG	
Units:	gal.	
Unit cost:	$ 1.264	/gal.
CF1	92,000	Btu/gal.
Efficiency:	95%	
CF2	0.018	Btu/hr-°F-cfh

	Energy Savings - Btu/year			Total Savings	
	Occupied	Unoccupied	Total	gal. / yr	$
Total Infiltration Reduction	1,385,500	7,496,600	8,882,100	102	$ 128

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Matl. & Labor ($ / lin ft)	Quantity (lin ft)	Total	
Ai seal tops of foundation	$ 4.00	240	$ 960	
	Implementation Cost:		$ 960	= 7.5 year payback
	Annual Energy Savings:		$ 128	

CALCULATIONS TO INSULATE BUILDING ENVELOPE

EEM-5 Keene Valley Congregational Church - Main Building

INPUT DATA:

Surface to be insulated:	Roof			
Area:	3,600	sq ft		
Present R value:	20.3			
Revised R value	51.3			
Present U factor::	0.049	Btuh/sq ft-deg F		
Revised U factor:	0.019	Btuh/sq ft-deg F		
Present U x Area	177		177	UA Total present
Proposed U x Area	70		70	UA Total proposed

CALCULATIONS:

	Occupied	Unoccupied
Heating Setpoint:	74	58
Cooling Setpoint:	74	
Q internal gains (Btuh):	12,578	1,596
BLC (Btuh/degree F):	1,099	1,294
T Balance (°F.):	62.6	56.8

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

Fuel Data	Heating	Cooling
Type:	LPG	
Units:	gal.	
Unit cost:	$ 1.264	
BTU/unit	92,000	
Efficiency/ COP:	95.0%	
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	10,877	9,163	0	0
(22.5)	0	9	10,341	8,627	1	0
(17.5)	0	12	9,806	8,091	1	0
(12.5)	2	28	9,270	7,555	3	0
(7.5)	7	66	8,734	7,019	6	0
(2.5)	10	117	8,198	6,483	10	0
2.5	16	137	7,662	5,948	11	0
7.5	14	176	7,126	5,412	12	0
12.5	28	234	6,591	4,876	15	0
17.5	50	451	6,055	4,340	26	0
22.5	74	593	5,519	3,804	30	0
27.5	55	692	4,983	3,269	29	0
32.5	110	834	4,447	2,733	32	0
37.5	62	616	3,912	2,197	18	0
42.5	73	560	3,376	1,661	13	0
47.5	75	561	2,840	1,125	10	0
52.5	55	523	2,304	589	5	0
57.5	57	509	1,768	(6,162)	1	0
62.5	67	619	1,232	(6,698)	0	0
67.5	67	458	0	(7,234)	0	0
72.5	42	278	0	(7,769)	0	0
77.5	21	231	(375)	(8,305)	0	0
82.5	2	150	(911)	(8,841)	0	0
87.5	0	13	(1,447)	(9,377)	0	0
	8,758	hours		Energy Savings:	223	0
					$ 282	$ 0

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
attic blown in insulation R-31	$ 2.75	3,600	$ 9,900

Implementation Cost:	$ 9,900	= 35.1 year payback
Annual Energy Savings:	$ 282	

CALCULATIONS TO INSULATE BUILDING ENVELOPE

EEM-6 Keene Valley Congregational Church - Main Building

INPUT DATA:

Surface to be insulated:	Walls		
Area:	3,231	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	477	477	UA Total present
Proposed U x Area	142	142	UA Total proposed

CALCULATIONS:	Occupied	Unoccupied	**Fuel Data**	Heating	Cooling
Heating Setpoint:	74	58	Type:	LPG	
Cooling Setpoint:	74	78	Units:	gal.	
Q internal gains (Btuh):	12,578	1,596	Unit cost:	$ 1.264	
BLC (Btuh/degree F):	1,099	1,294	BTU/unit	92,000	
T Balance (°F.):	62.6	56.8	Efficiency/ COP:	95.0%	
T Balance = T Setpoint - (Q internal gains / BLC)			EER:		

Bin Mid-Pt.	Occupied Hours	Unoccupied Hours	Change in Occupied Heat	Change in Unoccupied Heat	Heating Savings gal.	Cooling Savings
(27.5)	0	4	33,986	28,629	1	0
(22.5)	0	9	32,312	26,954	3	0
(17.5)	0	12	30,638	25,280	3	0
(12.5)	2	28	28,963	23,606	8	0
(7.5)	7	66	27,289	21,932	19	0
(2.5)	10	117	25,615	20,258	30	0
2.5	16	137	23,941	18,584	34	0
7.5	14	176	22,267	16,909	38	0
12.5	28	234	20,593	15,235	47	0
17.5	50	451	18,918	13,561	81	0
22.5	74	593	17,244	11,887	95	0
27.5	55	692	15,570	10,213	91	0
32.5	110	834	13,896	8,538	99	0
37.5	62	616	12,222	6,864	57	0
42.5	73	560	10,547	5,190	42	0
47.5	75	561	8,873	3,516	30	0
52.5	55	523	7,199	1,842	16	0
57.5	57	509	5,525	0	4	0
62.5	67	619	3,851	0	0	0
67.5	67	458	0	0	0	0
72.5	42	278	0	0	0	0
77.5	21	231	0	0	0	0
82.5	2	150	0	0	0	0
87.5	0	13	0	0	0	0
	8,758 hours			Energy Savings:	697	0
					$ 881	$ 0

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor ($ / sq ft)	Quantity	Total
blown in wall	$ 3.50	3,231	$ 11,309
R-16 insulation			

Implementation Cost:	$ 11,309	= 12.8 year payback
Annual Energy Savings:	$ 881	

CALCULATIONS TO INSTALL STORM WINDOWS

EEM-7 Keene Valley Congregational Church - Main Building

Type:	LPG	
Units:	**gal.**	
Unit cost:	**$ 1.264**	/gal.
Heat Content of Fuel	**92,000**	Btu/gal.
Combustion Efficiency:	95%	

DATA:

	Occupied	Unoccupied	
T Setpoint:	**74**	**58**	degrees F
Q internal gains:	**12,578**	**1,596**	Btuh
BLC:	**1,099**	**1,294**	Btuh/degree F
T Balance:	62.6	56.8	degrees F

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

Glazing Information

	Glazing 1		Glazing 2	
Present Conditions	single glazed windows			
Present Area:	**10**	sq ft		sq ft
U factor:	**1.10**	Btuh/sq ft-deg F		Btuh/sq ft-deg F
Crack Length:	12	feet		feet
Present Infiltration:	60	cfh		cfh
Proposed Condition:	Double glazed casement windows			
Proposed Area:	**10**	sq ft		sq ft
New U factor:	0.40	Btuh/sq ft-deg F		Btuh/sq ft-deg F
New Crack Length:	12	feet		feet
Proposed Infiltration:	0	cfh		cfh

Bin Data for Adirondack, 18 hrs./week

	T Setpoint	T Balance	Accum Hours	Average O.A. Temp below T Balance	Temp Difference (T Set- Avg OAT)
Occupied	74	62.6	**755**	**36.2**	37.8
Unoccupied	58	56.8	**5,613**	**30.5**	27.5

CALCULATIONS:

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

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

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

Winter	Conduction Savings (Btu/year)	Infiltration Savings (Btu/year)	Total Savings (Btu/year)	Total Annual Fuel Savings (gal./year)	Energy Cost Savings ($/year)
Occupied	200,000	185,000	385,000	4	$ 6
Unoccupied	1,080,000	1,000,000	2,080,000	24	$ 30
Annual Savings:	1,280,000	1,185,000	2,465,000	28	$ 36

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material & Labor $ / sq. ft.	Quantity	Total
install exterior storm	$ 30	10	$ 300
	Implementation Cost:		$ 300
	Annual Energy Savings:		$ 36

= 8.4 year payback

CALCULATIONS TO INSTALL DUCT INSULATION
EEM-8 Keene Valley Congregational Church - Main Building

Input

Fuel Information

Type	Units	Unit cost	BTU/Unit	Efficiency
LPG	gal.	$ 1.264	92,000	95%

Present Annual Heating Fuel Consumption:	2,425	gal.
% of Building Served by Furnace	100%	
Furnace Fuel Use	2,425	gal./ year
Furnace input capacity (firing rate):	150,000	Btu per hour
Duct location:		
Duct length 1:	40	feet
Duct perimeter 1:	64	inches
Duct length 2:		feet
Duct perimeter 2:		inches
Duct temperature:	100	F
Ambient temperature:	55	F
Furnace run time:	1,487	hours per year
Hours per year duct is hot:	1,636	hours per year
Proposed insulation thickness	1.5	inches

Calculations

Furnace run time = heating fuel use / furnace input capacity
Hours per year duct is hot = Furnace run time * 110%
Heat Loss = Heat Loss Factor * (Duct Temp - Ambient Temp) * Duct Area * Hours Per Year Duct Is Hot
Energy Savings = Existing Heat Loss - Proposed Heat Loss
Energy Cost Savings = (Energy Savings / Conversion Factor) x (Unit cost / Efficiency)
Natural convection heat transfer coefficient: 0.90 Btu/hr/SF/F
Assumes fiberglass insulation, k =.35 Btu-in/hr/F/ft2

Duct area	213	square feet		
Existing heat loss factor	0.90	Btuh/SF/°F	R-value:	1.1
Existing heat loss	14,136,199	Btu per year		
Proposed heat loss factor	0.19	Btuh/SF/°F	R-value:	5.4
Proposed heat loss	2,910,394	Btu per year		
Energy savings	11,225,805	Btu per year		
Fuel savings	128	gal.s		
Energy cost savings	$162			

Implementation Cost and Payback Period

Item	Material & Labor ($ / sq ft)	Quantity	Total
1.5" fiberglass duct insulation	$3.82	213	$815
		Implementation Cost:	$815

Cost	$815	=	5.0 years
Annual Savings	$162		

CALCULATIONS TO INSULATE DOMESTIC HOT WATER PIPES

EEM-9 Keene Valley Congregational Church - Main Building

Input Data

Fuel Information	Type:	Units:	Unit cost:	BTU/unit	Efficiency
Heating System	LPG	gal.	$ 1.264	92,000	95%
DHW System	Electricity	kwh	$ 0.128	3,412	100%

	Type #1	Type #2	Type #3	Type #4	Type #5
Fluid				DHW	
Pipe Material				Dull Copper	
O.D., inches (d)				0.50	
Total Length, ft				3	
Fluid Temperature Inside Pipe, °F (Ts)				110	
Ambient Temperature, °F (Ta)				55	
Annual Operating Hours				8,760	
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)				0.25	
h convection, Btu/hr - s.f. pipe surface area -°F				1.52	
h radiation, Btu/hr - s.f. pipe surface area - °F				0.48	
h total				2.01	
Pipe area, sq ft/lin ft of pipe				0.131	
Q bare, Btu/hr-lin ft				**14**	
Heat Loss - Insulated Pipe					
Outside Radius Insulation, inches (Rs)				1.25	
Q i, Btu/hr-sq ft of outer area of insulation				6.8	
Insulation Area - sq ft/lin ft of pipe				0.7	
Q insul, Btu/hr-lin ft				**4.5**	
Avoided Energy Loss					
Existing Loss - mmBtu/year				0.4	
Proposed Loss - mmBtu/year				0.1	
Avoided Loss - mmBtu/year				0.3	
Total Avoided Fuel Consumption					
-				77 Units Saved	
LPG				Electricity Fuel Type	
$ 10				$/year	
				$ 10	

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:	$ 20	= 2 years payback
Annual Energy Savings:	$ 10	

CALCULATIONS TO INSTALL Wi-Fi THERMOSTATS

EEM-10 Keene Valley Congregational Church - Main Building

INPUT DATA: 100% of Building to be Setback

		Current	Proposed	
Heating T Setpoint:	Occupied	74	74	deg. F.
	Unoccupied	58	55	deg. F.
Cooling T Setpoint:	Occupied	74	74	deg. F.
	Unoccupied	78	78	deg. F.
HVAC Schedule	Occupied	18.0	18.0	Hours per week
	Unoccupied	150.0	150.0	Hours per week
Q internal gains:	Occupied	12,578	12,578	Btuh
	Unoccupied	1,596	1,596	Btuh
Q internal gains:	Schedule	18	18	Hours per week
BLC:	Occupied	1,099	1,099	Btuh/deg. F.
(excludes DOAS)	Unoccupied	1,294	1,294	Btuh/deg. F.

Fuel Data	Heating	Cooling	
Type:	LPG	Electricity	Economizer?
Units:	gal.	kwh	Yes
Unit cost:	$ 1.264		
BTU/unit	92,000		
Efficiency/ COP:	95.0%		Avg. COP. EER: 0.0

CALCULATIONS: 0.0% of bldg. is cooled

Current — Adirondack, 18 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	99,021	108,999	5	0
(22.5)	0	9	93,523	102,531	11	0
(17.5)	0	12	88,026	96,064	13	0
(12.5)	2	28	82,528	89,596	31	0
(7.5)	7	66	77,031	83,129	69	0
(2.5)	10	117	71,534	76,661	111	0
2.5	16	137	66,036	70,193	122	0
7.5	14	176	60,539	63,726	138	0
12.5	28	234	55,041	57,258	171	0
17.5	50	451	49,544	50,790	290	0
22.5	74	593	44,046	44,323	338	0
27.5	55	692	38,549	37,855	324	0
32.5	110	834	33,051	31,388	341	0
37.5	62	616	27,554	24,920	195	0
42.5	73	560	22,056	18,452	137	0
47.5	75	561	16,559	11,985	91	0
52.5	55	523	11,061	5,517	40	0
57.5	57	509	5,564	(951)	4	0
62.5	67	619	66	(550)	0	0
67.5	67	458	(5,431)	(550)	0	0
72.5	42	278	(10,929)	(550)	0	0
77.5	21	231	(16,426)	(1,597)	0	0
82.5	2	150	(21,924)	(7,418)	0	0
87.5	0	13	(27,421)	(13,886)	0	0
	8,758	hours			2,430	0

Proposed — Adirondack, 18 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	99,021	105,119	5	0
(22.5)	0	9	93,523	98,651	10	0
(17.5)	0	12	88,026	92,183	13	0
(12.5)	2	28	82,528	85,716	29	0
(7.5)	7	66	77,031	79,248	66	0
(2.5)	10	117	71,534	72,780	106	0
2.5	16	137	66,036	66,313	116	0
7.5	14	176	60,539	59,845	130	0
12.5	28	234	55,041	53,378	161	0
17.5	50	451	49,544	46,910	270	0
22.5	74	593	44,046	40,442	312	0
27.5	55	692	38,549	33,975	293	0
32.5	110	834	33,051	27,507	304	0
37.5	62	616	27,554	21,039	168	0
42.5	73	560	22,056	14,572	112	0
47.5	75	561	16,559	8,104	66	0
52.5	55	523	11,061	1,637	17	0
57.5	57	509	5,564	(550)	4	0
62.5	67	619	66	(550)	0	0
67.5	67	458	(5,431)	(550)	0	0
72.5	42	278	(10,929)	(550)	0	0
77.5	21	231	(16,426)	(550)	0	0
82.5	2	150	(21,924)	(7,418)	0	0
87.5	0	13	(27,421)	(13,886)	0	0
	8,758	hours			2,181	0

	Present	Proposed	Savings	
Heating	2,430	2,181	249	gal.
Annual Energy $			$ 315	

IMPLEMENTATION COST & PAYBACK PERIOD:

Item	Material $/unit	Labor $/unit	Quantity	Total
Wi-Fi thermostats	$ 150	$ 50	2	$ 400
				$ 400

Implementation Cost:	$ 400	= 1.3 year payback
Annual Energy Savings:	$315	

Appendix D

Assumptions/Data Used to Develop Energy and Dollar Savings Figures

Building and Occupancy Information

Floor Area: 3,600 square feet

	Avg. # of occupants	Heating Setpoint	Cooling Setpoint	% of base electricity use resulting in internal heat gains	
days /occupied	15	74	74	days	90%
nights/unoccupied	0	58	78	nights	80%
# of computers	0				

Interior lighting, people and occupied levels of internal loads occur for 18 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: Forced Air serving 100% of the building

Default Efficiencies: 0.95 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

Fuel Efficiency

Boiler system for water source HP or VRF systems: 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	1.0	gallons per	person	/ day for	15	persons on	312	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: Religious Worship

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	9:00 AM	11:59 AM	3.0
Mon	2	6:00 PM	9:00 PM	3.0
Tue	3	6:00 PM	9:00 PM	3.0
Wed	4	6:00 PM	9:00 PM	3.0
Thu	5	6:00 PM	9:00 PM	3.0
Fri	6	6:00 PM	9:00 PM	3.0
Sat	7	12:00 AM	12:00 AM	-
Adirondack, 18 hrs./week				18.0
				150.0

Proposed Schedule for Occupied/Day HVAC setpoints

Day of week	Start	End	Hours
1	9:00 AM	11:59 AM	3.0
2	6:00 PM	9:00 PM	3.0
3	6:00 PM	9:00 PM	3.0
4	6:00 PM	9:00 PM	3.0
5	6:00 PM	9:00 PM	3.0
6	6:00 PM	9:00 PM	3.0
7	12:00 AM	12:00 AM	-
Adirondack, 18 hrs./week			18.0

Bin Data for Adirondack, 18 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	0	9		(5.1)
-17.5	-3.8	0	12		(3.8)
-12.5	-2.7	2	28	(2.3)	(2.7)
-7.5	-1.2	7	66	(1.2)	(1.3)
-2.5	0.2	10	117	0.5	0.2
2.5	1.4	16	137	1.2	1.5
7.5	2.8	14	176	2.8	2.8
12.5	4.2	28	234	4.2	4.2
17.5	6.0	50	451	6.1	6.0
22.5	7.8	74	593	7.7	7.8
27.5	9.4	55	692	9.5	9.4
32.5	11.4	110	834	11.4	11.4
37.5	13.3	62	616	13.2	13.3
42.5	15.3	73	560	15.1	15.3
47.5	18.0	75	561	18.0	18.0
52.5	20.3	55	523	20.0	20.4
57.5	22.7	57	509	23.2	22.6
62.5	26.0	67	619	26.3	26.0
67.5	28.0	67	458	28.0	28.0
72.5	28.9	42	278	30.1	28.8
77.5	30.4	21	231	32.3	30.2
82.5	32.4	2	150	35.0	32.4
87.5	36.1	0	13		36.1
		887	7,871		

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

Keene Valley Congregational Church - Main Building
1791 NY-73
Keene, NY 12943

Building Information

Width (typical)	60	feet	Building Floor Area	3,600	sq. ft.
Equivalent Length	60	feet	Roof Area	3,600	sq. ft.
Number of Floors	1.0	floors	Gross Wall Area	3,600	sq. ft.
Avg. Floor to Floor Height	15	feet per floor	Building Volume	54,000	cubic feet
Roof or Ceiling rise is	0	feet in 12' run			

Estimate of Conductive Heat Loss

Surface			Area	R-value	U Factor	U x A Btuh/deg. F.	% of BLC w/o ventilation
Roof	n/a		3,600	20.3	0.049	177	16%
Walls	89.8%	of GWA	3,231	6.8	0.147	477	43%
Glazing 1	7.0%	of GWA	252	1.7	0.588	148	13%
Glazing 2	0.0%	of GWA	0	0.9	1.111	0	0%
Doors 1	3	4x8 doors	96	2.0	0.500	48	4%
Doors 2	1	3x7 doors	21	3.5	0.286	6	1%
	Total Exterior Surface Area		7,200	sq.ft.		856	78%

		ACH	equiv. cfm	Btuh/deg. F.	BLC (without ventilation)	
Est. Infiltration Rate	Occupied	0.45	405	437	1,099	Btuh/deg. F. Occupied
Est. Infiltration Rate	Unoccupied	0.45	405	437	1,294	Btuh/deg. F. Unoccupied

		cfm	Fraction	Btuh/deg. F.	**Total BLC with Ventilation**	
Est. Ventilation Rate	Occupied		100%	0	**1,099**	**Btuh/deg. F. Occupied**
Est. Ventilation Rate	Unoccupied		100%	0	**1,294**	**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	**2.6**	**15**	12,578	18.0
	Unoccupied	**0.5**	**0**	1,596	150.0

Heat Loss Study - continued

Keene Valley Congregational Church - Main Building
1791 NY-73
Keene, NY 12943

		Current	
Heating T Setpoint:	Occupied	74	deg. F.
	Unoccupied	58	deg. F.
Cooling T Setpoint:	Occupied	74	deg. F.
	Unoccupied	78	deg. F.
HVAC Schedule	Occupied	18	Hrs. per week
	Unoccupied	150	Hrs. per week
Q internal gains:	Occupied	12,578	Btuh
	Unoccupied	1,596	Btuh
Q internal gains:	Schedule	18	Hrs. per week
BLC:	Occupied	1,099	Btuh/deg. F.
	Unoccupied	1,294	Btuh/deg. F.

Fuel Data	Heating	Cooling	
Type:	LPG	Electricity	Economizer?
Units:	gal.	kwh	Yes
Unit cost:	$ 1.264	$ 0.13	
BTU/unit	92,000	3,412	
Nom. Eff, COP	0.950	3.66	COP
Avg. Eff, COP	0.950	5.22	Avg. COP
		12.5	EER
		0%	of bldg. cooled

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

Current Adirondack, 18 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	99,021	108,999	5	0	0	0
(22.5)	0	9	93,523	102,531	11	0	0	0
(17.5)	0	12	88,026	96,064	13	0	0	0
(12.5)	2	28	82,528	89,596	31	0	0	0
(7.5)	7	66	77,031	83,129	69	0	0	0
(2.5)	10	117	71,534	76,661	111	0	0	0
2.5	16	137	66,036	70,193	122	0	0	0
7.5	14	176	60,539	63,726	138	0	0	0
12.5	28	234	55,041	57,258	171	0	0	0
17.5	50	451	49,544	50,790	290	0	0	0
22.5	74	593	44,046	44,323	338	0	0	0
27.5	55	692	38,549	37,855	324	0	0	0
32.5	110	834	33,051	31,388	341	0	0	0
37.5	62	616	27,554	24,920	195	0	0	0
42.5	73	560	22,056	18,452	137	0	0	0
47.5	75	561	16,559	11,985	91	0	0	0
52.5	55	523	11,061	5,517	40	0	0	0
57.5	57	509	5,564	(951)	4	0	0	0
62.5	67	619	66	(550)	0	0	0	0
67.5	67	458	(5,431)	(550)	0	0	0	0
72.5	42	278	(10,929)	(550)	0	0	0	0
77.5	21	231	(16,426)	(550)	0	0	0	0
82.5	2	150	(21,924)	(7,418)	0	0	0	0
87.5	0	13	(27,421)	(13,886)	0	0	0	0
	8,758	hours			2,430	0	DOAS fuel use	0
							DOAS cool use	0

Cross Check Against Historic Consumption

	Historic		Calculated	Difference
Present Annual Heating Fuel Use is	223	mmBTU	224	100% of present fuel use