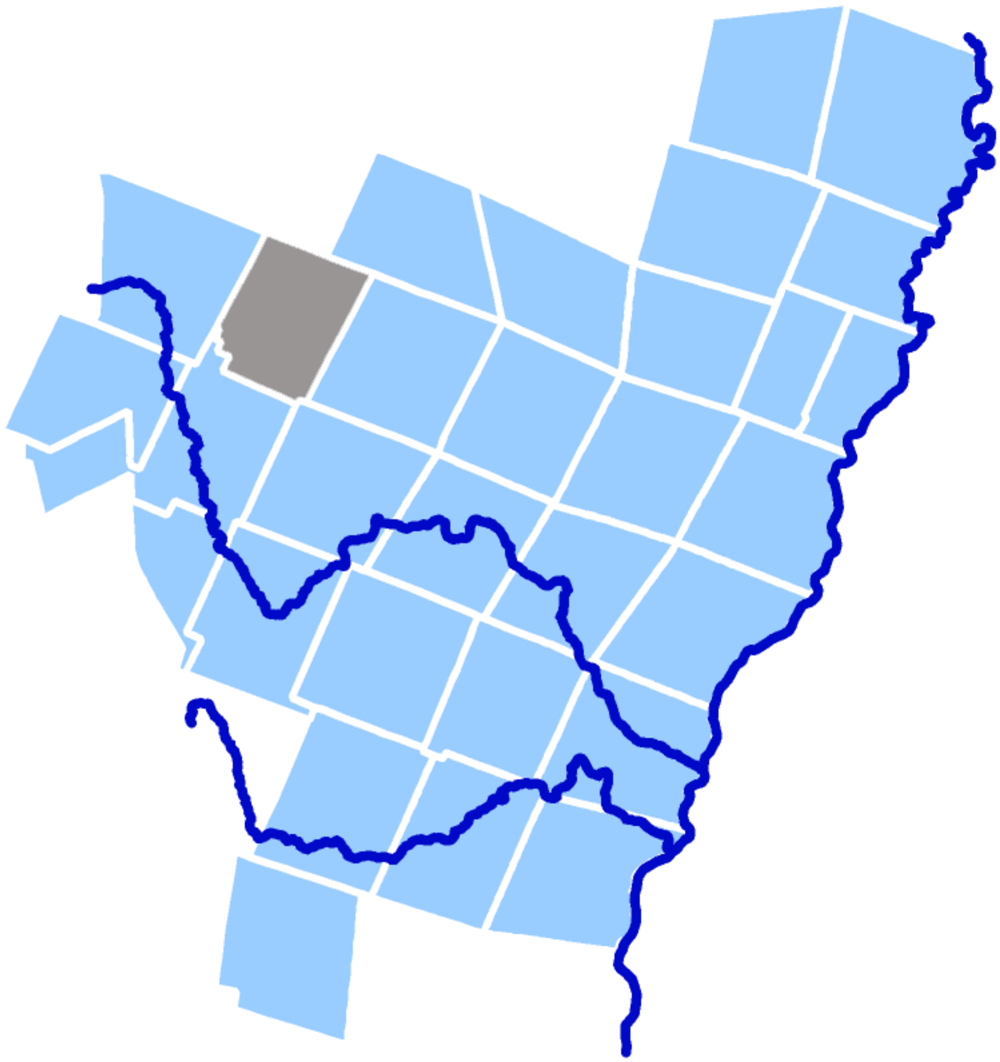
Two Rivers-Ottauquechee Regional Commission



Braintree Town Office

Building Energy Plan

Provided for the Town of Braintree by the Two Rivers-Ottauquechee Regional Commission's Energy Efficiency and Conservation Program.
Funded through a grant from the US Department of Energy.

This Building Energy Plan was provided for your community at no charge with help from an Energy Efficiency and Conservation Block Grant through the US Department of Energy.

For Questions about the Two Rivers Ottauquechee Energy Efficiency and Conservation Program, please contact:

Chris Sargent, AICP
Senior Planner
tel: 802-457-3188 extension #12
email: csargent@trorc.org

For Questions about the technical aspects of this Building Energy Plan, please contact:

Jon Haehnel
Zero by Degrees
tel: 802-522-9713
email: zerobydegrees@gmail.com

Building Energy Plan

December 4, 2010

To: Braintree Selectboard and Mr. Chris Sargent, TRORC
From: Jon Haehnel, Zero by Degrees LLC

RE: Energy Audit Conducted October 2, 2010 on the Braintree Town Offices and Garage

Thank you for inviting Zero by Degrees LLC to help with your building energy needs. The following report presents findings and recommendations from our diagnostic visit(s). It is our hope that this report can be the basis for a long term energy plan for the 2 buildings. The original audit application was just for the town office but since the town office and town garage are on the same electric meter TRORC approved auditing the town garage. With help from the following volunteers the additional building was audited at no extra cost: Holly Jarvis, Ann Howard, Eugenia Robbins, Charles Anthony, Sharon Liebert, and Ronald Wider. Z by D would also like to thank the volunteers for their help and enthusiasm.

Purpose

To identify potential building retrofits and operational practices to reduce energy use.

Executive Summary

The most significant energy saving opportunities at the Town office and Garage are in improving the insulation and air tightness of the walls of the town garage, replacing the garage furnace within the next 5 years, putting the school bus block heaters on timers, and replacing the garage water heater with an on-demand water heater. Even though the return on investment is longer replacing the T12 fluorescent lighting in both buildings with high performance T8 fluorescent lighting is also recommended in the near term because T12 lighting is being phased out next year and the lighting rebates are currently very good through 2011.

A measure that was analyzed but is not recommended is replacing the boiler in the town offices with a more efficient boiler. There is no cost effective reason to replace the unit until it is at the end of its useful life.

Finally, one measure that was noted but not explored in this analysis: the pipes on the hot water heater in the town office boiler room should be insulated. The water heater is not far from a cold air intake for the boiler and the pipes should be kept as warm as possible. This will save a little energy and it is inexpensive and easy to do.

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Summary of Analyzed Measures

Measure	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
ECM#1 - Lighting Upgrades	$416	$5,370	$1,860	$3,510	20	8	2.4
ECM#2 - Replace Town Office Boiler	$80	$5,000	$198	$4,802	20	60	0.3
ECM#3 - Upgrade Town Garage Heating	$1,560	$11,400	$480	$10,920	20	7	2.9
ECM#4 - Replace Town Garage Water Heater	$293	$800	$0	$800	10	3	3.7
ECM#5 - Improve Envelope of Town Offices	$200	$5,548	$1,176	$4,372	40	22	1.8
ECM#6 - Improve Envelope of Town Garage	$1,167	$13,612	$2,832	$10,780	40	9	4.3
ECM#7 - Timers on Block Heaters	195	800	0	800	10	4	2.4

O&M - Operation & Maintenance measure
ECM - Energy Conservation Measure
Simple Payback – The number of years the energy improvement will take to pay back the investment.
SIR - Savings to investment ratio, is the present value of savings divided by the cost. It is considered the most meaningful criteria for ranking measures. The higher the SIR the better the return on investment. Generally, an SIR less than 1 is considered a poor energy investment although there may be other reasons besides savings for going ahead with the measure.

Notes for Understanding this Report

1. Cost estimates in this report typically include the cost for materials and labor to implement the energy efficiency measure. There can be many hidden costs associated with any building improvement that are beyond the scope of this energy audit report. The following costs may apply to the energy efficiency measures listed but have not been specifically accounted for in this report: design, demolition, temporary staging or masking beyond the normal measures of the installation crew, temporary storage or moving costs, increased maintenance costs, historic preservation review, permitting, state and federal regulations for lead, asbestos, radon, and the like. There may also be salvage value for old equipment or reduced maintenance that could reduce the cost of an energy improvement. Salvage values and reduced maintenance are not accounted for in the cost estimates in this report. Cost predictions in this report are not estimates or fixed quotes. They only indicate the approximate cost for the recommended upgrade assuming that you hire an outside contractor for the upgrade and are meant to aid in making preliminary decisions. Especially for complex and large projects, a detailed review of the costs and maintenance implications is recommended.
2. There are several "wild cards" in predicting energy savings. Among them, the weather from year to year, occupant behavior, changes in levels of occupancy and environmental factors that are difficult to quantify. For these reasons, predicted savings are guidelines and not guarantees.

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

3. When viewing thermographs, lighter colors indicate higher surface temperatures than darker colors. What is considered "heat loss" is dependent upon the perspective from which it is viewed.
4. Some infrared images are taken under depressurization. Depressurization causes all outdoor air to flow inward and is not the normal operating state of the building. It is done to reveal conditions that would not normally be detected or to enhance thermographic images. Depressurization is also used to mimic the environment a building would be under in conditions of high wind or very cold temperatures. The building was depressurized to about –50 Pascals during the last part of the imaging.
5. Air leaks are detected by the infrared camera when cooler air "washes" across a surface. The pattern of air leakage is typically dark wispy lines emanating from the air leakage site.
6. I used $0.12817/kWh peak and $1.80/gallon of oil to predict cost savings. These are taken from the energy consumption information provided but do not include demand rates or administrative charges. Energy prices are volatile and difficult to predict year to year but the long term trend is that energy prices will continue to rise.
7. Rebates, incentives, and tax credits may change or have termination dates. Verify that the suggested rebates/credits in this report are still in effect and look for additional programs that may have come into effect at http://www.dsireusa.org/ and http://www.efficiencyvermont.org/pages/ when you are ready to implement your energy conservation measures. Lighting, motors, heating, cooling, and ventilation system rebates may be applied for directly through Efficiency Vermont's website http://www.efficiencyvermont.com/pages/. Insulation and air sealing rebates through Efficiency Vermont may require that the work be done through a certified home performance contractor and that all health and safety recommendations be completed in order to qualify for the rebate.

Health and Safety Recommendations

All building systems interrelate and occasionally improvements to one building system can create problems in another. Measures to improve energy efficiency should be regarded in the context of the health and safety of occupants and in the long term durability of a building. Careful consideration of the following and testing before and after efficiency improvements will help to prevent conditions that could have a negative impact on the building.

1. There are no CO detectors in either building. At least 1 should be installed per floor.
2. Have the furnaces tuned to reduce CO levels (See "Combustion testing" below).
3. The combustion air intake damper in the town office boiler room is not functional and should be repaired. This damper allows fresh air in to feed the boiler when it is on and then closes when the boiler is off.
4. The furnace in the garage failed to properly draft under worst case conditions when the large exhaust fan was turned on. It appears that this fan is rarely used. When it is used the bay doors MUST be open in order to provide make up air for the fan and avoid dangerous back drafting of the furnace.

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

5. The present natural ventilation is NOT sufficient for the town garage and the occupants (see building ventilation below). Continuous mechanical ventilation equal to 291 CFM is required for proper ventilation of the building and must be included in any improvement scope for the building. The Building Performance Institute (BPI) protocols that define the ventilation requirements are specifically designed for residential type structures, consult with a HVAC engineer for the proper ventilation of non residential structures. Mechanical ventilation with heat recovery is advised to reduce heat loss.
6. The present natural ventilation is sufficient for the town office and the occupants (see building ventilation below). Continuous mechanical ventilation equal to 62 CFM may be required for proper ventilation of the building if the building air tightness is improved. A certified home performance contractor should provide options for air tightening and mechanical ventilation before any envelope work is performed.
7. Currently, there is no way to remove exhaust fumes from the building while a motor vehicle is running. A tube that can be attached to the exhaust pipe and vented outside should be installed.

Energy Plan - Energy Efficiency Measure Descriptions

The following measures with predicted savings, predicted costs, and implementation notes can be used as the foundation for a long-term energy plan for these buildings. The energy plan has the potential to save the most energy at the least cost if consulted at least once a year and before every renovation, addition, and equipment or building upgrade.

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

1. ECM#1 – Lighting Upgrades

Finding: Most of the lighting in the town office and garage is T12 fluorescent lighting. There are some incandescent bulbs in limited use spaces. There is also an outside light on the garage that is on all night. I was not able to confirm the wattage but I believe that it is a 250 watt high pressure sodium (HPS) bulb.

Recommendation: Replace all the T12 fluorescent lighting with high performance T8 lighting. Replace all incandescent bulbs with comparable light quality CFLs or LED bulbs when the bulbs are blown. Switch from a HPS light to a LED light with comparable light quality. LED lights don't have the same light levels as HPS so it may take 2 of them to get the same light level but the total wattage will still be lower. Verify the lumin output of the existing HPS light to find the best match in a LED replacement. Alternatively, you may consider using an incandescent flood light on a motion sensor for security at night so the lights does not have to remain on all night.

Implementation and timing: Implement immediately. The extra incentives for switching to T8 lighting are good through 2011 and T12 lighting is being phased out of production. T8 bulbs are readily available and have a longer life than most T12 bulbs. High performance T8 lighting with low ballast factor should be used for maximum energy savings.

Install a new outside light on the garage as soon as possible, this is a good energy saving opportunity because the light is on all night.

Replace the incandescent bulbs in the closets and boiler room when the old bulbs burn out. They are not used often enough to warrant immediate replacement.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
-31	3416	($55)	$471	$416	$5,370	$1,860	$3,510	20	8	2.4

2. ECM #2 – Replace the Town Office Boiler

Finding: The existing boiler has a steady state efficiency of 83%. The distribution seems adequate and the thermostat has a preprogrammed night setback.

Recommendation: Stay with the same boiler until it reaches the end of its useful life. At that time find install a boiler with an annual fuel utilization efficiency (AFUE) of 85% or higher. This is not a cost effective measure to implement at this time. I included it in my analysis only to point out that although there are many new high efficiency boilers on the market right now switching does not always make sense.

Implementation and timing: Replace when the boiler is at the end of life.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
45	4	$80	$0	$80	$5,000	$198	$4,802	20	60	0.3

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713

Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

3. ECM#3 – Upgrade Town Garage Heating

Finding: The existing furnace has a steady state efficiency of 80% and annual fuel utilization efficiency (AFUE) of 78%. I wondered about the heating distribution efficiency because there are no ducts to distribute heat for the main garage space but Tom Brown said the temperature distribution seems to be OK with the 2 ceiling fans going.

Recommendation: Install a programmable thermostat and program in a night setback of 55F. Replace the furnace with a unit that has an AFUE of 85% or better and a high efficiency blower motor when this furnace is at the end of life. The savings estimate below is based on both a new furnace and a night setback.

Implementation and timing: Install a programmable thermostat immediately and budget for a new furnace within the next 5 years.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
859	103	$1,546	$14	$1,560	$11,400	$480	$10,920	20	7	2.9

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauqueechee Regional Commission

4. ECM#4 – Replace Town Garage Water Heater
Finding: The 50 gallon water heater is on standby year round even when consumption is low, primarily for hand washing. It reportedly fires about 3 times a work day in the winter which isn't much if the water is regularly used but is wasteful if it is just to maintain standby temperature.
Recommendation: Replace the water heater with an electric on-demand hot water heater to supply hot water for hand washing and other limited uses. An oil or gas fired on demand heater is much more efficient but also several times the cost of an electric heater and the costs are not justified for such limited use.
Implementation and timing: Implement immediately.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
175	-168	$316	($23)	$293	$800	$0	$800	10	3	3.7

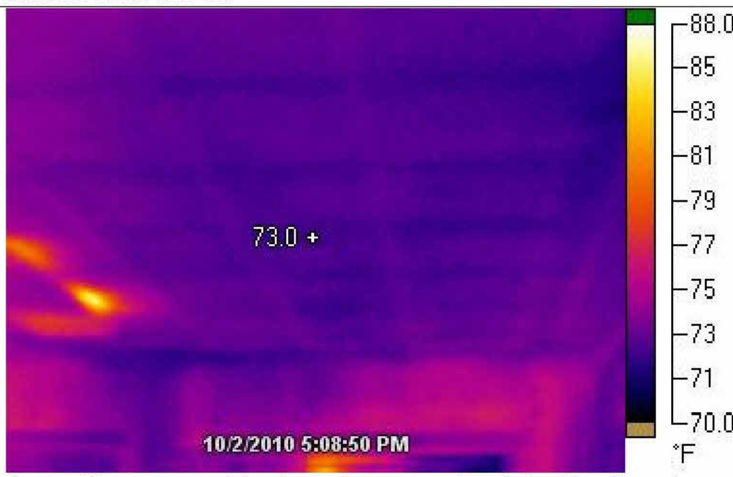
287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

5. ECM #5 – Improve Envelope of the Town Offices

Broken attic hatch

Attic insulation with strapping below



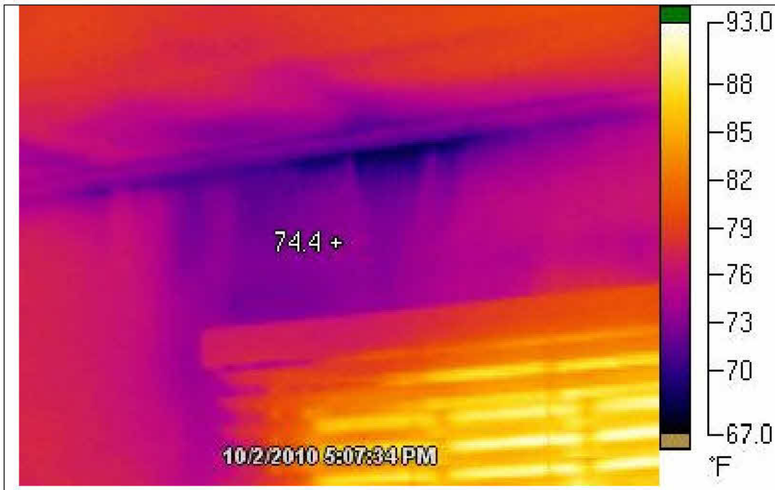
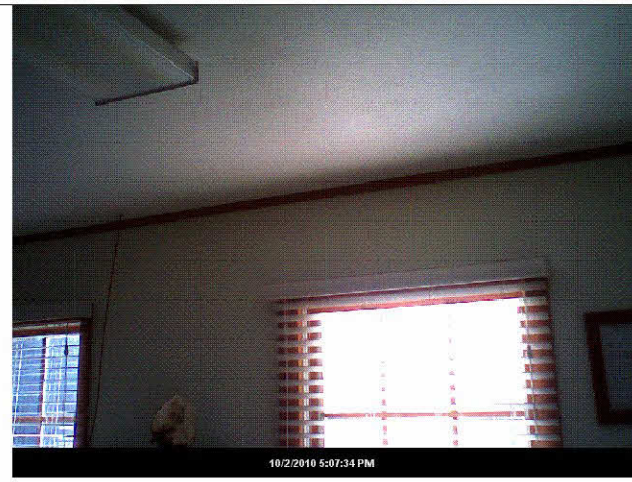
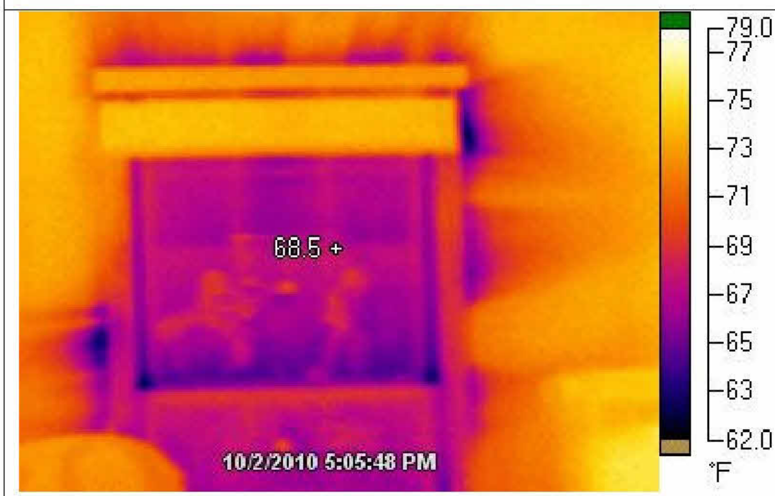
The ceiling got cold when depressurized, indication that outside air can travel under the insulation.

Visual reference for the IR picture

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713

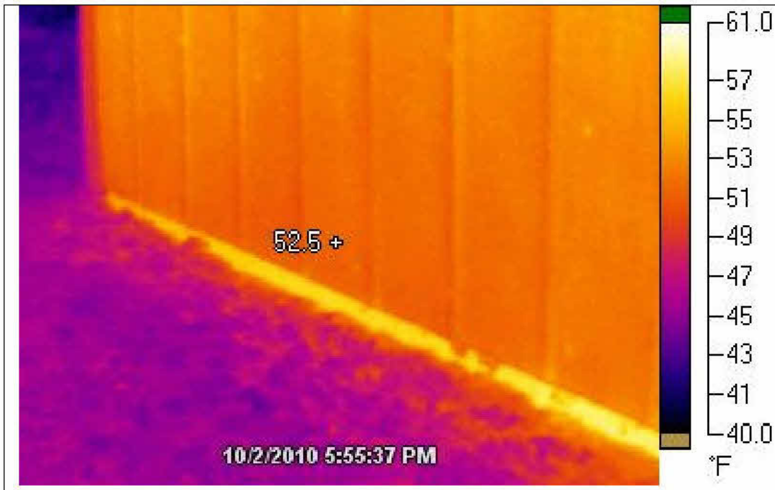
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

 Air leakage at the wall to ceiling connection. I suspect that there is no mud or sheetrock tape behind the wood trim.	 Visual reference for the IR picture
 Air leakage at the window is shown by the dark spots that fan out from the window trim. Most	 Visual reference for the IR picture

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission



The exposed slab edge radiates heat to the outside.

Visual reference for the IR picture

Finding: The attic insulation is insufficient (R19 fiberglass batt) and air leakage in the strapping space under the insulation degrades its performance. Air leakage into the attic was also found at the wall to ceiling connection. I believe the wood trim at the ceiling perimeter is hiding a gap between the sheetrock on the wall and the sheetrock on the ceiling. The attic hatch is a broken piece of sheetrock with no insulation or weather stripping. Air leaks are also common at the window trim boards. Finally, there is no insulation at the perimeter of the slab and heat is being radiated to the outdoors.

Recommendation: Air seal the attic at the perimeter and at all other penetrations with spray foam. The goal is to block the air bypass that allows outside air into the strapping space below the batt insulation and to seal the leaks at the wall to ceiling connection. Add vent chutes at the eaves in preparation for increasing the attic R-value to R50 with additional blown in cellulose. The foam seal at the perimeter should seal to the bottom of the vent chutes so that outside air has no pathway to get beneath the insulation layer. Install a new attic hatch with weather stripping and at least 6" of rigid insulation attached.

Remove the window trim boards and the fiberglass chinking between the rough opening and the window frame. Use one part foam to seal between the window frame and the rough opening and reinstall the trim boards.

If there is space so the siding will cover it, add at least 1 inch of rigid foam board to cover the edge of the slab. Dig down beside the slab and frost wall for 8-10" so the foam can be glued tight to the frost wall, then backfill against the rigid and cover the foam that is above grade with stucco for protection against sunlight. The rigid foam thickness should be narrower than the existing siding so water cannot get behind the foam.

Implementation and timing: Implement these improvements over time starting with the attic. The payback will make more sense only when oil prices climb. In order to get rebates through efficiency VT you will have to use a certified home performance contractor for this work. Ask the contactor to price the cost for air sealing the windows and insulating the slab edge at the same time and proceed with that

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

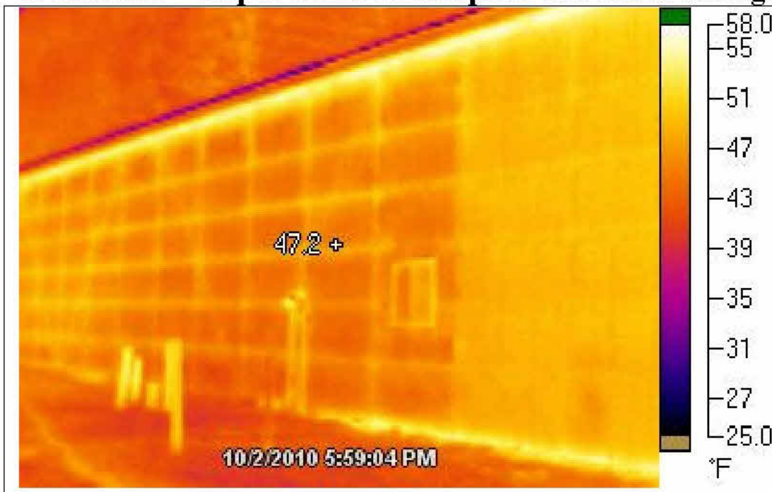
part of the work only if the costs are low. The bulk of the energy savings come from improvements to the attic.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
110	9	$199	$1	$200	$5,548	$1,176	$4,372	40	22	1.8

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauqueechee Regional Commission

6. ECM #6 – Improve the Envelope of the Town Garage



The horizontal strapping below the siding is easily seen in this infrared image. The strapping creates an air space that allows air to move around and through the fiberglass insulation, degrading its performance. There is a similar strapping layer on the inside also.

Visual reference for the IR picture

Finding: The wall cavities are about 8" thick comprised of wood posts with horizontal 2x4 strapping on either side of the posts to hold the metal siding and plywood interior. Fiberglass batts about 5" thick run up the middle of these walls but air can move easily around it because of the strapping on either side. The effective R-value of the wall is estimated to be about R9.

Recommendation: Add more insulation to the walls and make the walls as airtight as possible. This can be done in several ways but the simplest approach would be to remove the metal siding and existing insulation so closed cell spray foam can be installed from outside (to at least R21 value) against the back of the plywood. The spray foam is costly so this approach increases the payback term. Other methods could be employed at a lower cost but need to meet the same goals of increased R-value and airtight construction in order to be effective.

Implementation and timing: This measure has a reasonably good payback so it can be implemented at any time. The cost for removal and reinstallation of the metal siding is not accounted for in the budget cost so it would be to best advantage to implement this measure with other regular maintenance of the siding.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
644	53	$1,160	$7	$1,167	$13,612	$2,832	$10,780	40	9	4.3

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauqueechee Regional Commission

7. ECM #7 – Timers on Block Heat

Finding: Block heaters for 2 school buses are used when the temperature gets 20F or lower. The block heaters are necessary to keep the diesel fuel from gelling in the engine but they may not need to run all night.

Recommendation: In actuality the block heaters may only need to run between 2 and 4 hours a night to get all the fluids up to temperature. The heaters could be set on an inexpensive timer switch to engage 2-4 hours before the busses are needed. You will need and electrician to wire in industrial level timers but the cost should be low. The larger cost is in experimentation, paying someone on a weekend to find out exactly how much block heating time is really necessary without having to rely on the bus if they miscalculated. There are many good resources in the internet about setting the proper time for the block heaters to warm up the engine but there is no substitute for running your own experiments.

Implementation and timing: Implement immediately.

Gallons saved	kWh saved	Savings Heating	Savings Electricity	Total Savings	Approx. Cost of Measure	Possible Rebate	Cost with Rebate	Lifecycle (Years)	Simple Payback (Years)	SIR
0	1500	0	195	$195	800	$0	$800	10	4	2.4

Existing Energy Use

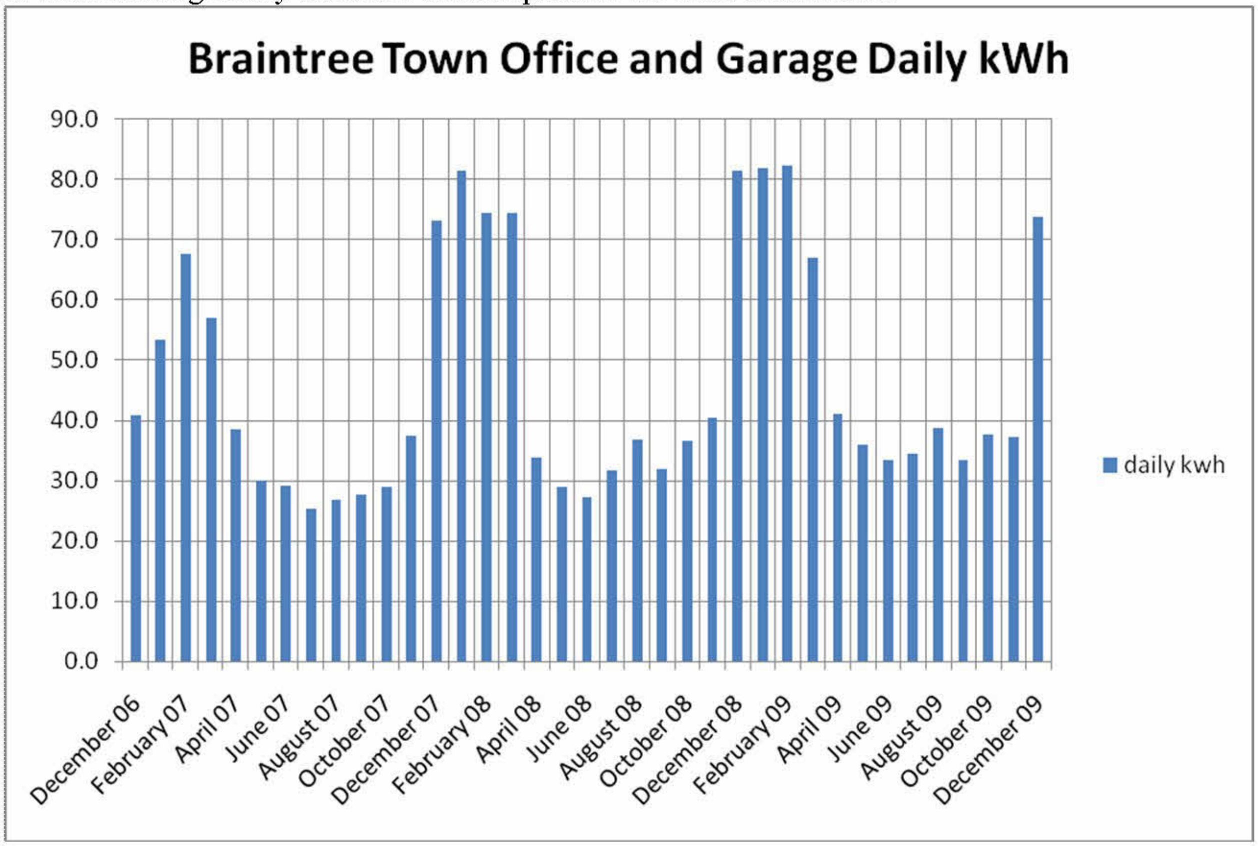
Below is a summary of the energy use for the building in recent years. When possible, the total loads are divided into base load (energy loads that are consistent month to month) and seasonal load (energy loads that vary seasonally). The designation "NA" indicates data that was not made available for this study.

Energy Use Summary for Braintree Town Office and Garage							
Energy type	Unit	Total 2009	Total 2008	Total 2007	Average	Annual Base load	Annual Seasonal load
Electricity	kWh	17990	17806	15307	17034.33	11804	5230
Heating Oil	Gallons	2333.2	2212.37	NA	2272.785	NA	NA

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Below is the average daily electrical consumption in kWh for each month.



As can be seen in the chart above, the daily electrical load doubles in the winter season. There are many small contributors that increase electrical use in the winter: furnace/boiler run time, additional lighting in the winter, (especially use of the halogen lights in the unheated part of the garage), and the small electric hot water heater in the town hall may be running more in winter because in is near the cold air intake for the boiler. All of these loads combined are not enough to explain the jump in daily kWh. The jump is caused by the block heaters for the 2 school buses in the winter.

Energy intensity is energy consumption per square foot of floor area. The table below compares the energy intensity of this building with buildings of similar size and type in the North East (NE). Energy intensity per square foot of floor area does not account for differences in building volume or shell surface area so comparisons cannot be precise.

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713

Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Energy Intensity Benchmarks					
Building Name	floor area sq. ft.	Electricity kWh/sf	Heating Oil gallons/sf	Heat Energy kBTU/sf	Total energy kBTU/sf
Braintree Town Office and Garage	4565	3.7	0.5	69.1	81.8
Similar use Buildings in NE		16.5	0.24	33.3	101.4
Similar Size buildings in NE		13.4	0.5	69.4	115.1

This table is showing that electrical consumption is well below average and heating consumption is about average for buildings of this size.

Combustion Testing

The table(s) below summarize the testing on each combustion appliance. Cells in red indicate carbon monoxide (CO) levels above 25ppm which is an indicator of incomplete combustion and a possible health risk if the chimney was not properly drafting. The tests show that most flues are properly drafting under normal and worst-case scenarios at present but the furnace flue is not properly drafting under worst case scenario. The N/A designation indicates that the test was not applicable to this combustion appliance either because the test data could not be obtained in a safe manner or testing could not be done in accordance with Building Performance Institute (BPI) protocols.

CAZ- combustion appliance zone, the area where a combustion appliance is and where pressure readings are taken to determine if conditions for back drafting may occur.

Worst case – turning on all fans and appliances that can make the building negatively pressurized to see if the potential for back drafting exists.

Combustion Testing- Town office boiler, #2 oil		
Baseline CAZ pressure	-1	Pascals
Worst case CAZ pressure	0	Pascals
Worst Case Spillage	passed	
Steady State Stack Temperature	440	˚ F
Steady State Efficiency	82.9	%
Flue CO	30	ppm
Outside temp	56	˚ F
Minimum Acceptable draft	-1.35	Pascals
Draft	-8	Pascals
Ambiant CO	0	ppm

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Combustion Testing- Town Garage Hot Water , #2 oil		
Baseline CAZ pressure	-0.4	Pascals
Worst case CAZ pressure	-24	Pascals
Worst Case Spillage	passed	
Steady State Stack Temperature	404	˚ F
Steady State Efficiency	84.6	%
Flue CO	41	ppm
Outside temp	60	˚ F
Acceptable draft	-1.25	Pascals
Draft	-6.8	Pascals
Ambiant CO	0	ppm

Combustion Testing- Town Garage Furnace , #2 oil		
Baseline CAZ pressure	-0.4	Pascals
Worst case CAZ pressure	-24	Pascals
Worst Case Spillage	failed at worst case	
Steady State Stack Temperature	590	˚ F
Steady State Efficiency	80	%
Flue CO	52	ppm
Outside temp	60	˚ F
Acceptable draft	-1.25	Pascals
Draft	-12	Pascals
Ambiant CO	0	ppm

Building Ventilation

The table below is a summary of the calculations to determine the minimum ventilation required for the building compared to the ventilation rate determined by blower door testing. Based on our testing the office is sufficiently ventilated at present but may need mechanical ventilation if air tightening measures are employed. The garage is not sufficiently ventilated by natural ventilation at present and will need continuous ventilation of 291 CFM or review by a HVAC engineer to determine the proper ventilation rate for the building.

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Minimum Building Airflow Standard (ASHRAE 62-89)		
Conditioned space floor area	1365	square feet
Excluded areas	none	
Total conditioned volume	10688	cubic feet
# of regular occupants	3	people
# of stories above grade	1	stories
Zone and Location	2	Braintree, VT
N- factor and Adj. N- factor	18	18.0
Required Building ventilation	62	CFM
Required occupant ventilation	45	CFM
Minimum airflow standard	1122	CFM50
Blower door test result	1711	CFM50
Minimum airflow standard met?		Yes

Minimum Building Airflow Standard (ASHRAE 62-89)		
Conditioned space floor area	3120	square feet
Excluded areas	none	
Total conditioned volume	49920	cubic feet
# of regular occupants	3	people
# of stories above grade	2	stories
Zone and Location	2	Braintree, VT
N- factor and Adj. N- factor	18	14.6
Required Building ventilation	291	CFM
Required occupant ventilation	45	CFM
Minimum airflow standard	4246	CFM50
Blower door test result	2605	CFM50
Minimum airflow standard met?		No

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713

Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Blower Door Test Results

Ambient conditions 10-2-10:
Outside temperature: 58 °F
Inside temperature: 68 °F
Wind conditions: calm
Time of day: 4:30 pm

Notes:

1. All interior doors were open except the vault.
2. 2 window AC units were in at the time of the test at the town offices.
3. All exterior doors and windows were closed and latched.
4. Heaters were tuned off.

Results:

Most buildings in the United States are tested at 50 Pascals (0.2" w.c. or 1.04 lbs./sq. ft) as a means of comparison. 50 Pascals is about 5 times the pressure a building might experience on a cold winter day. Temperature adjusted CFM50 accounts for the change in air density as it is drawn in through gaps and cracks from outside and is a more accurate measure of air flow under test conditions.

Building	Temperature adjusted CFM @ 50Pa.	Cubic feet of Building Volume	Air changes per hour @ 50Pa.	Square Feet of Building Shell	CFM50/sf of shell
Town Offices	1711	10,688	9.60	2590	0.66
Town Garage	2605	49,920	3.13	6896	0.38

Air Leakage Comparison to Other Buildings:

Building	**Air Leakage Rate (CFM50/sf of exposed shell)**
Ultra tight construction	<0.10
High performance construction	<0.25
Typical modern construction	0.60 to 0.90
Braintree Town Offices	**0.66**
Local ranch house on slab	0.60
Braintree Town Garage	**0.38**
Another Local Town Garage	1.00
Leaky construction	> 0.60

Acknowledgment: *"This material is based upon work supported by the Department of Energy under award number(s) DE-SC0003428"*

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission

Disclaimer: *"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warrantee, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."*

287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713

Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission