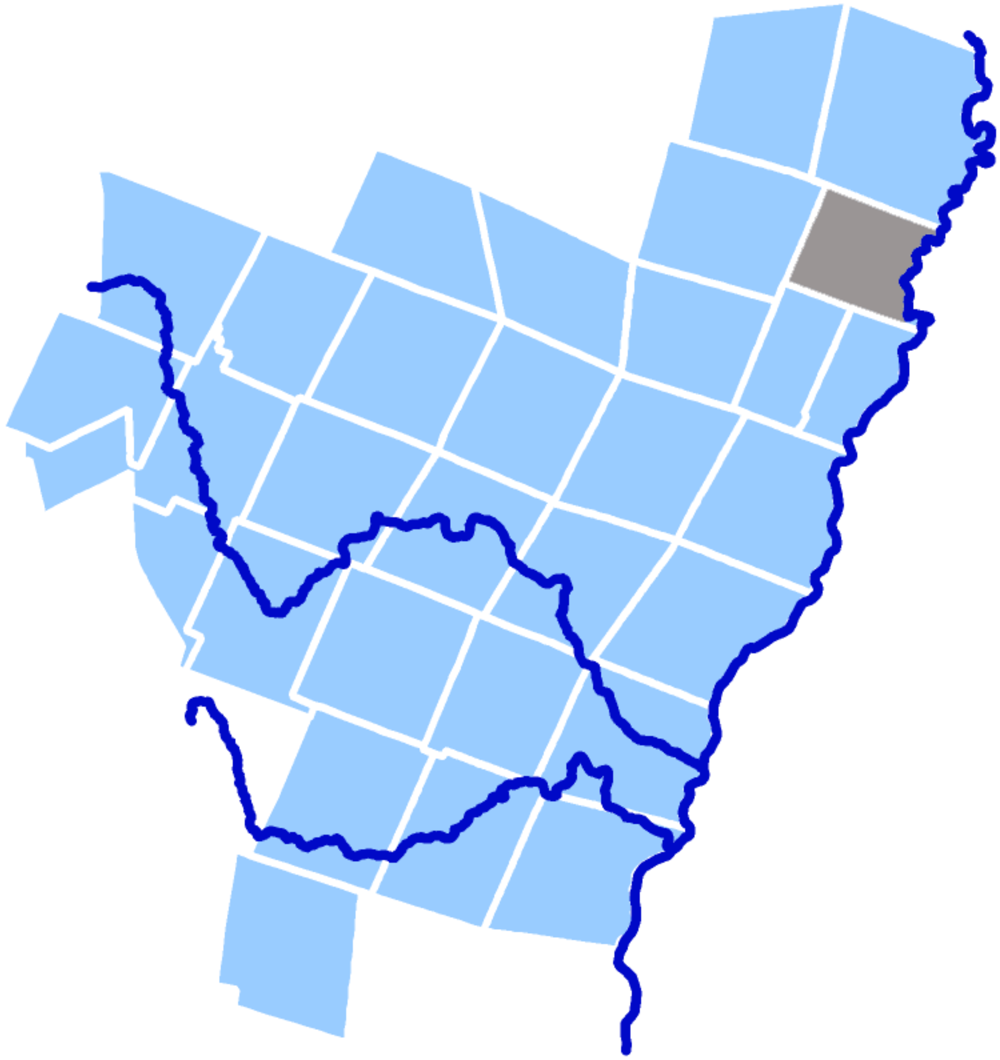
**Two Rivers-Ottauquechee Regional Commission**



# Bradford Town Garage

## Building Energy Plan

Provided for the Town of Bradford 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

# Zero by Degrees LLC

*Energy Independence in Affordable Steps*

## Building Energy Plan

March 18, 2011

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

***RE: Energy Audit Conducted February 23, 2011 on the Bradford Town Garage.***

Thank you for inviting Zero by Degrees LLC to help with your building energy needs. The following report presents our 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 building.

### *Purpose*

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

### *Executive Summary*

Overall energy consumption is low on this building so it was difficult to find quick payback energy saving measures. Philip Page has instituted some energy saving procedures such as shutting down pumps and compressors at night and leaving the thermostat set continually low that make a big difference in consumption. Still, energy saving opportunities were found in the furnace, air sealing- especially at the planks around the bay doors, in lighting, and in insulating the foundation walls and attic.

### *Summary of Analyzed Measures*

| Measure | Total Savings | Approx. Cost of Measure | Possible Rebate | Cost with Rebate | Lifecycle (Years) | Simple Payback (Years) | SIR |
|---|---|---|---|---|---|---|---|
| ECM #1 - Reduce Furnace Cycling | $154 | $700 | $0 | $700 | 15 | 4.5 | 3.3 |
| ECM #2 - Air seal and Weatherize | $142 | $1,275 | $500 | $775 | 15 | 5.5 | 2.7 |
| ECM #3 - Upgrade Lighting | $321 | $3,720 | $1,200 | $2,520 | 20 | 7.9 | 2.5 |
| ECM #4 - New Refrigerator | $42 | $500 | $0 | $500 | 15 | 12.0 | 1.3 |
| ECM #5 - Add Insulation to the Attic | $283 | $6,300 | $1,750 | $4,550 | 40 | 16.1 | 2.5 |
| ECM #6 - Insulate Foundation Wall | $310 | $5,510 | $315 | $5,195 | 30 | 16.7 | 1.8 |

***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.*

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

***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.
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 –30 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. 0.13386/kWh peak and $2.67/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/



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

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 the building. At least 1 should be installed per floor.
2. Under worst case depressurization the building becomes extremely negative because of the exhaust fan. The garage exhaust fan is wired so that when it is on the furnace shuts off. This is a good safety system to prevent back drafting and carbon monoxide poisoning. In addition, the furnace does not get its intake air from the inside. Even so, continue to open the bay doors when the exhaust fan is in use.
3. According to Building Performance Institute (BPI) protocols the present natural ventilation is not sufficient for the building and the occupants (see "Building Ventilation" below). Continuous mechanical ventilation equal to 52 CFM is required for proper ventilation of the building and must be included in any insulation or air sealing scope for the building. The BPI protocols that define the ventilation requirements are specifically designed for residential type structures, consult with a HVAC engineer to determine the proper ventilation of non residential structures.
4. According to Building Performance Institute (BPI) protocols the flue carbon monoxide (CO) level is too high in the furnace (see "Combustion Testing" below). Have the furnace serviced to reduce CO levels.
5. The furnace receives intake air form the attic. While this is safer than getting it from the heated space my inclination is that it would be best to extend the air intake all the way to the outside. Consult a heating expert to see if this is a better way to provide air to the burner.

***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



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

the most energy at the least cost if consulted at least once a year and before every renovation, addition, and equipment or building upgrade.

**1. ECM #1- Reduce Furnace Cycling**

I turned up the furnace for testing and the air handler cycled on and off frequently on each burn cycle. I am not sure that the furnace is operating efficiently. I wondered if the supply air was not enough to balance the return air and keep the combustion chamber cool but adjusting dampers on the supply air had no effect on the cycling. You may try adjusting the anticipator setting on the thermostat to see if that helps reduce cycling. Steps for making this adjustment are below:

1. Remove the thermostat cover
2. Make sure the thermostat is level. If it is not level the mercury switch will not work properly.
3. At the center or side of the thermostat find the small line or disc with calibration marks on it. It will probably have the word "longer" on it. There will be a lever arm on it indicating to the calibration marks. This is the heat anticipator adjustment lever arm.
4. If the furnace is cycling on and off too frequently, move the heat anticipator adjustment lever closer to the "longer" setting by one calibration mark.
5. If the furnace is exceeding or never reaching the desired set temperature, move the adjustment lever away from the "longer" setting by one calibration mark.
6. Once the appropriate adjustment is made let the furnace run and the temperature stabilize for a period of 2-3 hours.

If you find this does not reduce the cycling have a heating expert review the system to determine why it is cycling often. Let the expert know that you are interested in more than just keeping warm, but you want to optimize the performance for energy efficiency. At the same time ask his/her opinion about the burner intake air from the attic. The anticipated cost for this type of review is $700.

Because fuel consumption is already on the low side (see "Existing Energy Use" below) replacing the furnace immediately is still over a 10 year payback. However, the furnace will have reached the end of useful life probably within 5 years. Begin budgeting for a new 95% AFUE furnace with a high efficiency ECM blower motor to be installed within 5 years.

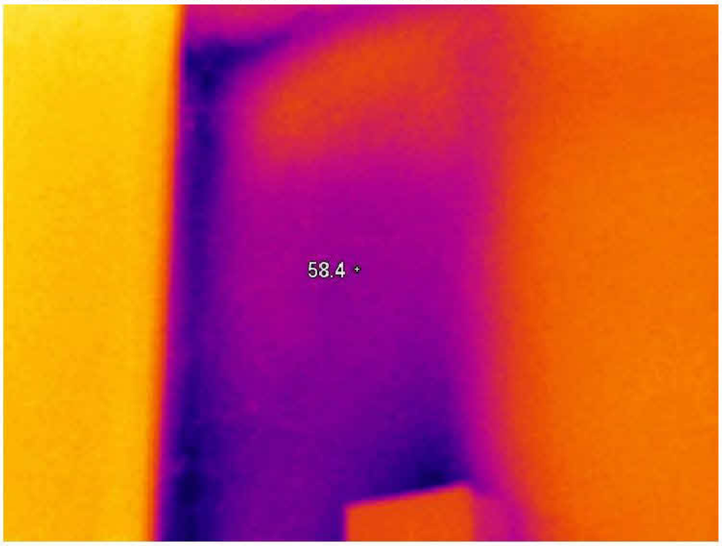
| Gallons saved | kWh saved | Savings Heating | Savings Electricity | Total Savings | Approx. Cost of Measure | Possible Rebate | Cost with Rebate | Lifecycle (Years) | Simple Payback (Years) | SIR |
|---|---|---|---|---|---|---|---|---|---|---|
| 56 | 40 | $149 | $6 | $154 | $700 | $0 | $700 | 15 | 4.5 | 3.3 |

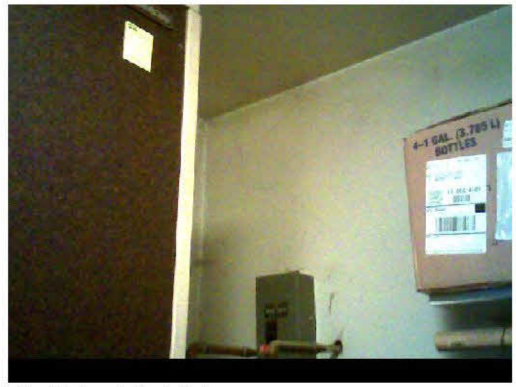


287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

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

**2. ECM#2- Air Seal and Weatherize**



**Visible Light Image**

**IR003476.IS2**

2/23/2011 9:39:37 AM

The interior wall corner has missing or damaged insulation in the wall. It is not uncommon to find corner bays not as well insulated because there is more framing in the way.


**Visible Light Image**

**IR003478.IS2**

2/23/2011 9:39:53 AM

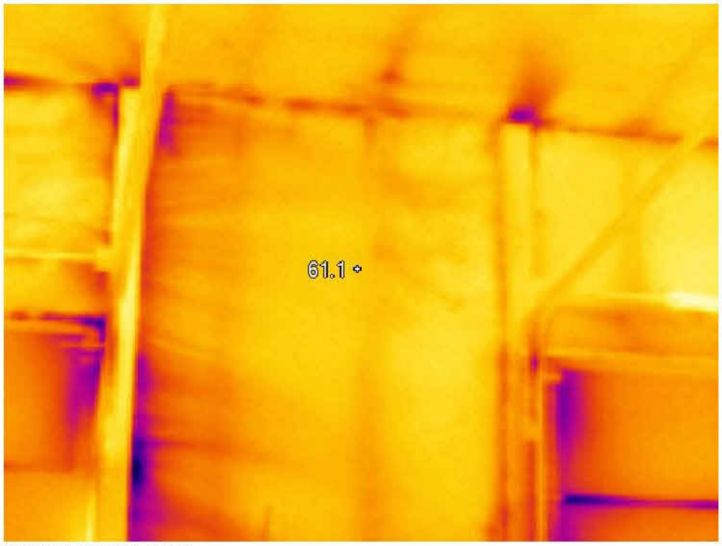
The opposite corner of the bathroom has the same problem.



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

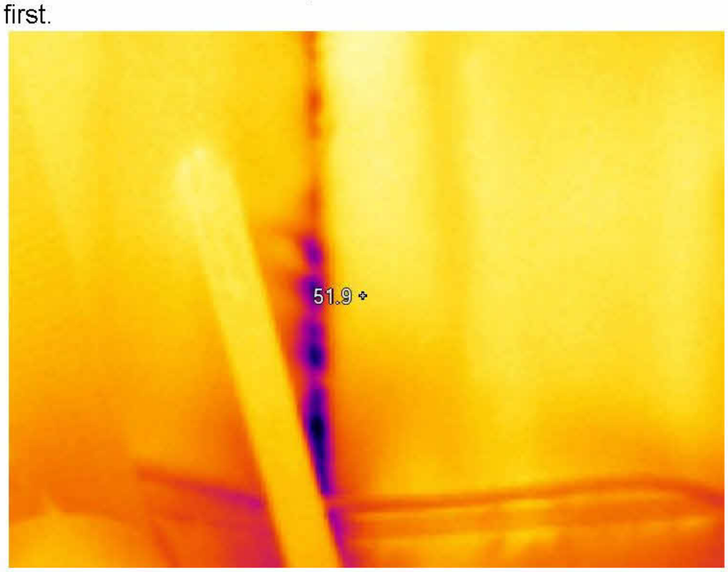
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

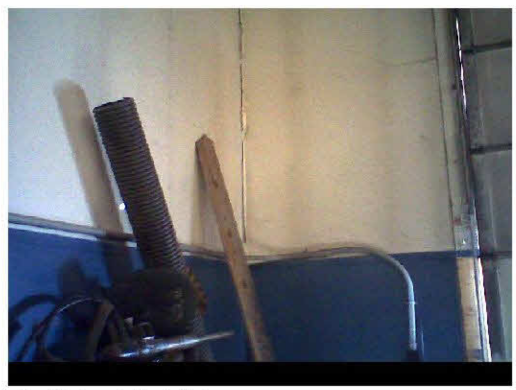
Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauquechee Regional Commission




Visible Light Image

**IR003516.IS2**
2/23/2011 10:13:09 AM
Air leakage along the bay door and especially at the planks on either side of the door. Notice that not all the planks leak the same, close visual inspection will reveal which ones to fix first.



Visible Light Image

**IR003566.IS2**
2/23/2011 10:32:10 AM
The NE corner has been damaged by trucks and the wall has opened some air leaks.



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


**Visible Light Image**

**IR003441.IS2**
2/23/2011 9:10:58 AM
This is a wiring penetration in the attic floor. In the visual image note the frost on the truss braces. This is warm air condensing moisture on the truss as it escapes.

Holes through the insulation at the base of the gable end wall. There is frost lining the holes indicating warm air leakage. Infared images did not indicate that the tops of the walls are open into the attic, I assume these are isolated leakage sites.

There is debris on the insulation that follows the ridge vent. This is sign that snow and rain can also get in through the ridge cap.



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 attic hatch is a panel of broken sheetrock.


Similar to the truss brace above, warm air is keeping the bottom of this intake pipe warm and depositing frost on the cooler part above. This pipe needs to be foam sealed at the sheetrock.

Re secure the planks on either side of the bay doors to the walls and air seal the planks with one-part foam for large gaps and caulk for gaps under 1/8" wide. These are significant air leakage sites that are easy to see and repair.

Adjust the bay door closers so the top of the door goes 100% vertical and meets the weather-stripping when closed. Check the weather-stripping on all sides of each door to make sure it is in good repair and in close contact with the door and check the rubber gasket at the bottom of the door for damage. Check the gasketing between each door segment to make sure it is in good repair, replace as needed. When the door is closed, and with the lights off, look at the door from all sides for daylight. If you see daylight the weather stripping needs to be adjusted or replaced. Given the number of large doors on this building it will be worth it in energy savings to check the doors each year for optimal air tightness. When it is time to replace a bay door replace it with a door that has 3" or 4" thick insulated panels so you get a higher total R-value out of the door, target R15 or better.

In the attic pull back the insulation and foam seal around the isolated penetrations through the sheetrock ceiling and along the top of the gable end walls (shown above). Make sure the foam seals directly to the sheetrock.

Install a new attic hatch with weather-stripping and at least 6" of rigid polyisocyanurate (foil faced foam board) insulation attached. Use ¾" plywood and sheetrock for strength and weight so the hatch presses



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

down on the weather-stripping when closed. Use wide foil tape to cover and protect the edges of the insulation and then glue or screw the rigid foam insulation to the plywood so it remains affixed to the hatch indefinitely.

There is a minor problem with the ridge vent on the roof. It is not properly baffled so debris can blow in from outside and land on the insulation. The debris is not a significant problem, there is not much of it, but it is an indicator that snow and rain can come in also and it is best to avoid wetting the insulation. A roofer can recommend a better ridge baffle that will allow air flow but block water and debris.

At the NE corner of the building where the wall has been damaged. Seal the visible cracks and openings in the wall with one-part foam.

Finally, remove the metal siding panels from outside the bathroom and install the missing insulation behind the corner bays in the bathroom. At the same time insulate any hot water lines found in the exterior walls with properly fitted polypropylene pipe insulation.

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 53 | 3 | $142 | $0 | $142 | $1,275 | $500 | $775 | 15 | 5.5 | 2.7 |

## 3. ECM #3- Upgrade Lighting

Most of the lighting in the building is T12 fluorescent lighting. Replace all the 4’ and 8’ T12 fluorescent lighting with high performance T8 lighting. 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.

The 2 outside wall pack lights are 400W high pressure sodium (HPS) lights on photo sensor controls. If the outside lights need to remain on all night for security switch the HPS lights to an LED light with comparable light quality. Check the rated lumen output of the existing HPS light to find the best match in a LED replacement. The LED incentives available through Efficiency VT now may reduce over time so there is reason to act sooner than later on the outside lights. If they are not needed for security, consider shutting one or both of them off so they do not come on automatically at night.

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| -8 | 2411 | ($21) | $342 | $321 | $3,720 | $1,200 | $2,520 | 20 | 7.9 | 2.5 |



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

**4. ECM #4- New Refrigerator**

Replace the existing refrigerator with a new energy star refrigerator. Get as small a model as will be needed to further reduce energy use. Since the payback on this measure is relatively long it makes sense to wait to replace the refrigerator at the end of useful life. In the meantime, keep the setting as low as possible.

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| -3 | 342 | ($7) | $49 | $42 | $500 | $0 | $500 | 15 | 12.0 | 1.3 |

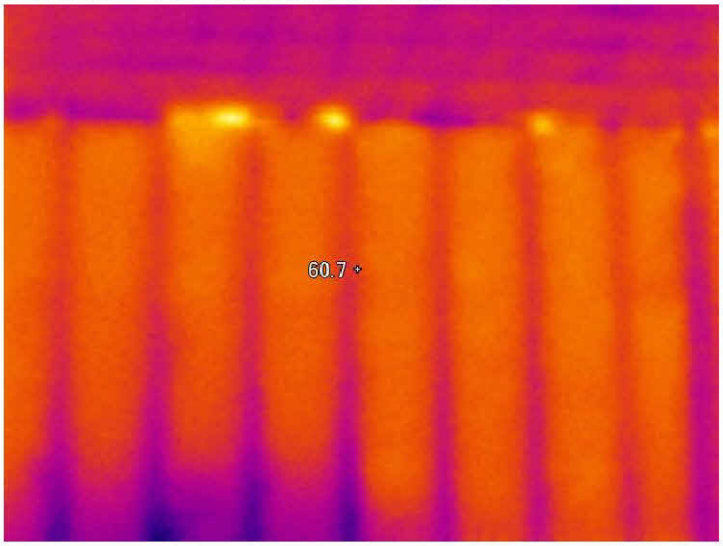


287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713

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

## 5. ECM#5- Add Insulation to the Attic

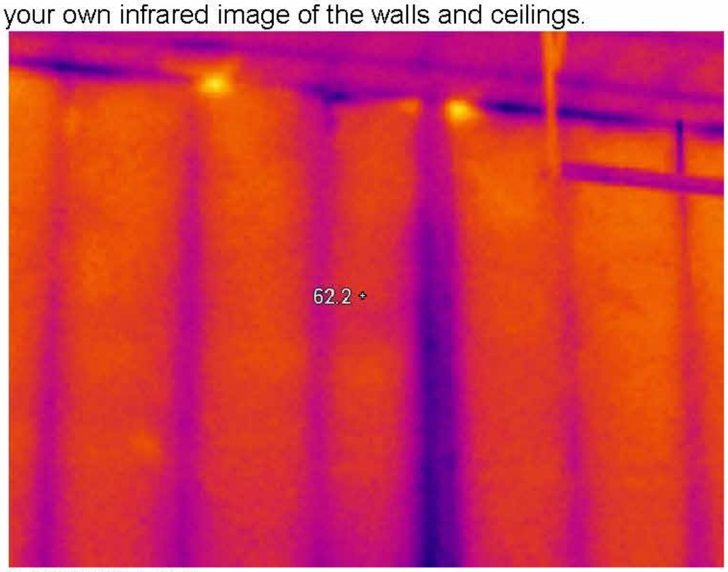



**Visible Light Image**

**IR003458.IS2**

2/23/2011 9:36:48 AM

The ceiling viewed under normal pressure. The strapping and truss chords can be seen as a grid pattern. Note that the framing pattern is faintly visible on the ceiling and walls in the visible light image, this is called shadowing and is caused by the exhaust from equipment. It is diagnostic in that every dark area is a location of heat loss, like having your own infrared image of the walls and ceilings.




**Visible Light Image**

**IR003507.IS2**

2/23/2011 10:12:29 AM

The ceiling under depressurization. The ceiling looks about the same indicating that air leakage in the ceiling is minor.



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

The insulation appears matted down by water. This could be caused by condensation on the roof deck "raining" down or slow air infiltration through the insulation from below. There are indicators of both conditions in this attic.

The fiberglass is dark on the bottom, an indication that at least some air is moving through the insulation.

The ceiling layers are sheetrock, ¾" strapping, 3" unfaced fiberglass batt between 2x4 truss chords on 24" centers, all of this covered in about 3" of compacted cellulose. I estimate the effective R-value to be R23 and saw no significant signs of air movement around or through the insulation with the infrared camera. The attic insulation has a matted appearance as if it has had water sprinkled on it occasionally. I believe the fiberglass was originally 6" thick and the cellulose may have been 6" or 8" thick when it was installed. The reason for the matted appearance is small amounts of water that condense on the underside of the metal roofing and "rain" down onto the insulation in the colder weather and warm moisture laden air slowly rising through the insulation.

I recommend installing an additional R30 fiberglass batt insulation over the exiting insulation perpendicular to the existing batt insulation. This work needs to be done carefully so the new insulation is cut and fit around the truss braces, inspect the installation as the job progresses to insure the proper fit. Use UNFACED fiberglass so water vapor does not get trapped between insulation layers. I am recommending fiberglass batt as the additional insulation because it is resilient to moisture. Blown in fiberglass or cellulose would be faster to install but will mat down over time in this attic. Complete removal of the insulation, air sealing, and reinstallation to make the ceiling airtight would reduce the amount of warm air that escapes and condenses but the cost is not justified in energy savings.

Adding more attic insulation is a cost effective step but be sure to verify that the rebate structure with Efficiency Vermont will apply to this work. The attic has just enough insulation that it is on the border not to qualify for rebates even though it is under insulated. There is some discretion in the determination of effective R-value so others may disagree with my opinion. A home performance contractor would have to do this work in order to access the rebate and they would be able to make the determination if the present R-value was low enough to qualify.

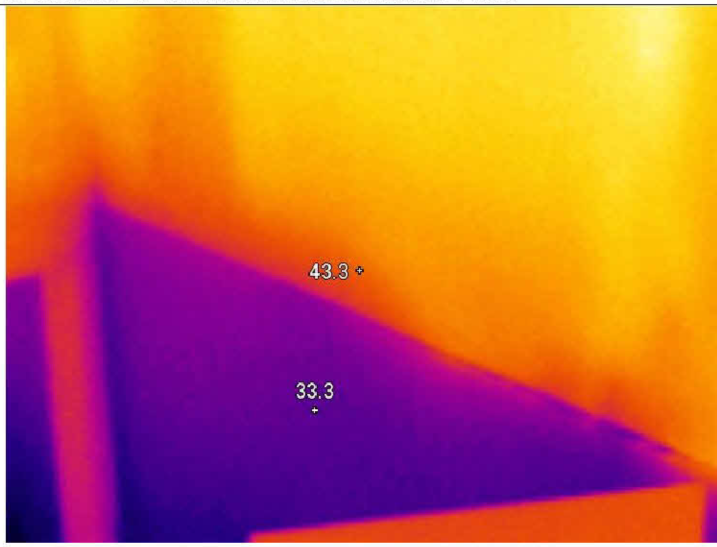


287 Fairview Sq., Fairlee VT 05045
Phone: 802. 522. 9713
Web: www.insulation-guide.com
Email: zerobydegrees@gmail.com

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 106 | 6 | $282 | $1 | $283 | $6,300 | $1,750 | $4,550 | 40 | 16.1 | 2.5 |

**6. ECM# 6- Insulate Foundation Wall**




**IR003569.IS2**
2/23/2011 10:32:43 AM
The foundation wall is exposed 2' high all the way around the building. In the image you can see it reads a full 10˚ F cooler than the wall above.

**Visible Light Image**

Insulate the foundation wall from outside (preferred method):

1. From outside dig down into the soil around the foundation and expose 12" to 18" of the foundation wall. Wash off the soil and allow the walls to dry completely.
2. Glue at least 2" thickness of rigid expanded polystyrene (XPS) foam board (blue or pink board) to the wall by setting it in the bottom of the trench and going up to the top of the foundation. 3 or 4 inch thickness will save more but the largest payback will come from the first 2" of foam. Be cautious about the glue you select, get a construction adhesive that is formulated for XPS insulation, the other types will eat the foam.
3. Cover the above grade XPS insulation with metal sheeting (break metal), vinyl coil stock, or stucco.
4. Backfill the trenches in the soil.



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. Remove the bottom row of screws on the metal siding so a flexible membrane flashing can be slid under the siding that will lap over the top of the new XPS insulation. Install a metal cap that covers the flashing and the top of the XPS and then reinstall the siding screws.

This method is more durable and it brings the mass of concrete inside the insulation which makes the energy performance of the wall a little better than if the concrete is trapped on the outside of the insulation. It is also easier to access the whole wall from outside and allows the slab edge to be covered. Unfortunately, this method costs more and makes the payback longer.

Insulate the foundation wall from inside (less cost)

1. Clear as much of the walls as possible. Remove shelving if possible.
2. Glue at least 2" thickness of rigid expanded polystyrene (XPS) foam board (blue or pink board) to the wall by setting it on the floor and going up 8-12" into the framed wall (since they are flush). 3 or 4 inch thickness will save more but the largest payback will come from the first 2" of foam. Be cautious about the glue you select, get a construction adhesive that is formulated for XPS insulation, the other types will eat the foam.
3. Since the insulation is inside it will not need to be covered but high traffic areas should have protective plywood put over the XPS to keep it from being damaged.

This method is much less expensive and will capture 80-90% of the savings as the method above.

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 116 | 7 | $309 | $1 | $310 | $5,510 | $315 | $5,195 | 30 | 16.7 | 1.8 |



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

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

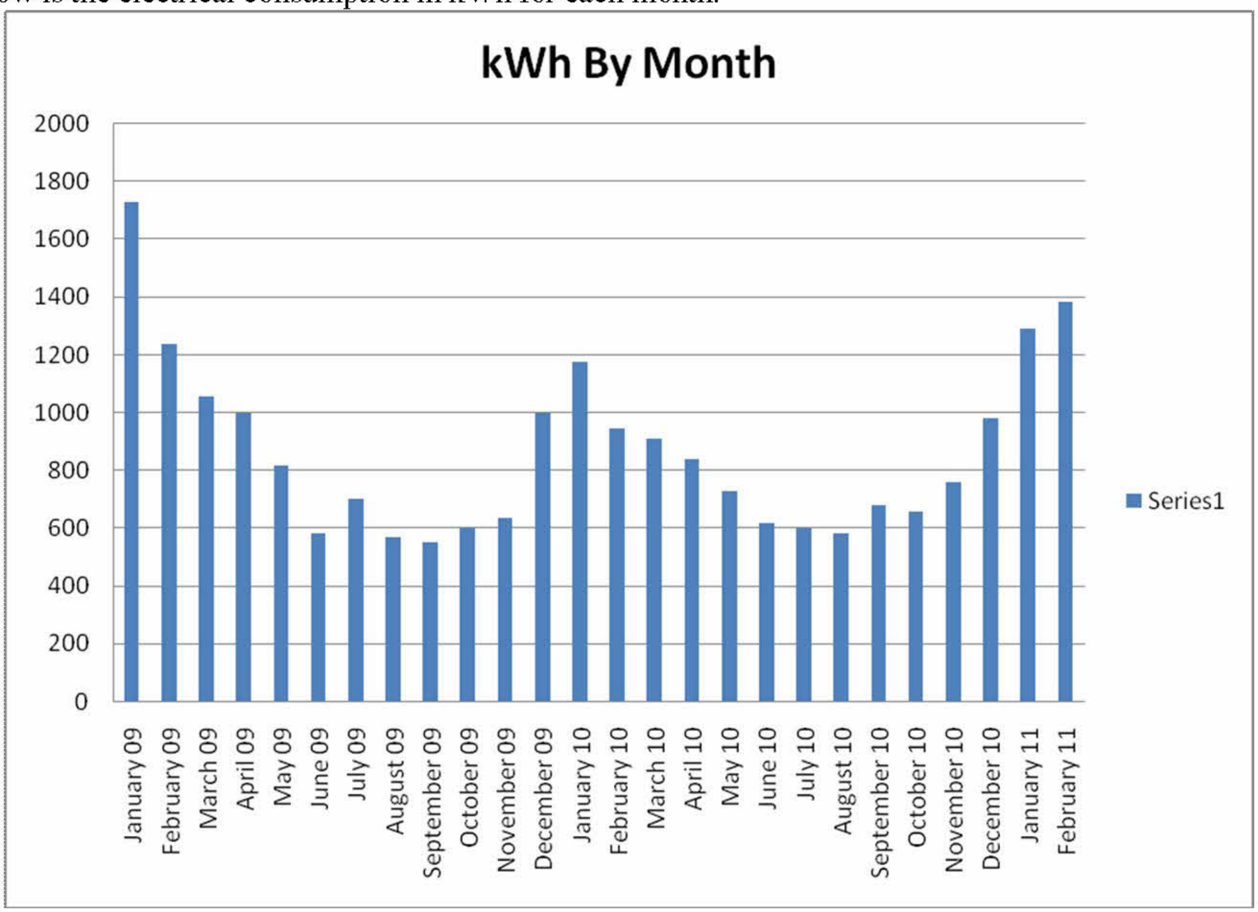
Funded by an Energy Efficiency and Conservation Block Grant from the Two Rivers-Ottauqueechee Regional Commission

***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 spike seasonally). The designation "NA" indicates data that was not made available for this study.

| Energy Use Summary for Bradford Town Garage | | | | | | | |
|---|---|---|---|---|---|---|---|
| Energy type | Unit | Total 2010 | Total 2009 | Total 2008 | Average | Annual Base load | Annual Seasonal load |
| Electricity | kWh | 9467 | 10465 | NA | 9966 | 6792 | 3174 |
| Heating Oil | Gallons | 862.8 | 955.7 | 1040.4 | 953 | 0 | 953 |

Below is the electrical consumption in kWh for each month.




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



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

intensity per square foot of floor area does not account for differences in building volume or shell surface area so comparisons cannot be precise.

| Energy Intensity Benchmarks | | | | | |
|---|---|---|---|---|---|
| Building Name | Floor Area sq. ft. | Electricity kWh/sf | Heating Oil gallons/sf | Heat Energy kBTU/sf | Total Energy kBTU/sf |
| Bradford Town Garage | 3500 | 2.8 | 0.27 | 37.8 | 47.5 |
| Similar TYPE Buildings in NE | | 6.9 | 0.24 | 33.3 | 79.8 |
| Similar SIZE buildings in NE | | 13.4 | 0.50 | 69.4 | 115.1 |

This table is showing that electrical consumption is below average for buildings of similar type and significantly below average for building of similar size in the North East (NE). This is in part because Philip and the highway crew are conscientious about shutting off the pumps and compressor when they are leaving, these are important energy saving measures to continue. Heating fuel consumption is about average although much less than buildings of similar size. This is probably due to the low thermostat setting (55F) that they maintain in the building all the time.

***Combustion Testing***

The table below summarizes the testing on the boiler and furnaces. Cells in red indicate failure to draft or 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 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 or the device does not receive intake air from the inside.

***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.*
***ppm****- parts per million, the unit of measurement for gases like carbon monoxide.*
***Pascals****- the SI unit for pressure.*


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- Furnace #1, Fuel #2 Oil | | |
|---|---|---|
| Baseline CAZ pressure | -3.2 | Pascals |
| Worst case CAZ pressure | -37 | Pascals |
| Worst Case Spillage | NA - direct vent | |
| Steady State Stack Temperature | 644 | ˚ F |
| Steady State Efficiency | 77 | % |
| Flue CO | 30 | ppm |
| Outside temp | 5 | ˚ F |
| Minimum Acceptable draft | -2.5 | Pascals |
| Draft | NA - direct vent | 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 building is not sufficiently ventilated by natural ventilation and will need mechanical ventilation or review by a HVAC engineer to determine the proper ventilation rate for the building.

| Minimum Building Airflow Standard (ASHRAE 62-89) | | |
|---|---|---|
| Conditioned space floor area | 3500 | square feet |
| Excluded areas | none | |
| Total conditioned volume | 56000 | cubic feet |
| # of regular occupants | 2 | people |
| # of stories above grade | 2 | stories |
| Zone and Location | 2 | Bradford, VT |
| N- factor and Adj. N- factor | 19 | 15.4 |
| Required Building ventilation | 327 | CFM |
| Required Occupant ventilation | 30 | CFM |
| Minimum airflow standard | 5027 | CFM50 |
| Blower door test result | 4230 | 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 2-23-11:
Outside temperature: 5 °F
Inside temperature: 55 °F
Wind conditions: calm
Time of day: 10:00 am

Notes:
1. All interior doors were open.
2. All exterior doors and windows were closed and latched.
3. The furnace was turned 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.

| Temperature adjusted CFM @ 50Pa. | Cubic feet of Building Volume | Air changes per hour @ 50Pa. | Square Feet of Building Shell | CFM50/sf of shell |
|---|---|---|---|---|
| 4,230 | 56,000 | 4.53 | 7,340 | 0.58 |

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 |
| **Bradford Town Garage** | **0.58** |
| 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

*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-Ottauqueechee Regional Commission