The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Mittersill Fire Station
Mittersill Road Franconia, NH 03580

Prepared for:

Town of Franconia, NH

Prepared by:

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Clean Air Cool Planet

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6/14/2010

The following report was generated as part of the Municipal Energy Assistance Program (MEAP). MEAP is made possible through the New Hampshire Public Utilities Commission and the Greenhouse Gas Emissions Reductions Fund. The program is a collaborative effort to carry out a sequence of greenhouse gas emissions inventories and energy audits for between 24 and 48 geographically diverse communities in New Hampshire, setting the stage for these communities to perform renovations to selected buildings that would reduce energy consumption and greenhouse gas emissions. This report has been generated as a result of the Town of Franconia being selected to participate in this program.

To follow MEAP updates and activities please visit www.nhenergy.org.

Additionally, this report would not be possible without the assistance and input provided by municipal employees and volunteers. We are grateful for the time provided to us by the Town of Franconia.

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Franconia and the Mittersill Fire Station (hereinafter "the building"). This report discusses the findings and subsequent recommendations for energy efficiency improvements at the building. Included within this report are details regarding the walk-through and exploration conducted in the facility and examples that illustrate recommended building alterations and improvements that can reduce energy costs and the building's natural resource footprint. In this report we will provide a set of options that can help achieve real energy savings and carbon dioxide reductions. These recommendations should be viewed as initial avenues to participating in several State level funding opportunities for municipal energy projects. These funds distributed under the aegis of the ARRA (American Recovery and Reinvestment Act) are targeted specifically to towns and cities.

Prior to the audit process beginning, each selected municipality must carry out the MEAP energy inventory process. The inventory process is required in order to receive an energy audit. This report relied on those initial findings to help determine the most appropriate building to conduct an energy audit for, with the intent of maximizing the potential energy savings.

The Audit

The first stage of any audit process is understanding the nature of the system and the objectives of the audit. The use of the building and the Town's goals and objectives are the foundation of a solid audit. In most cases, these objectives combine environmental and economic goals. In the case of public buildings and facilities, comfort and safety are also primary concerns that help guide our analysis and recommendations.

A decision grade audit involves an inventory of heating systems, quantification of energy usage (electrical and heating fuel), and the process of coordinating this information with the goals and objectives of the Town into a decision tool. Under MEAP we look to provide recommendations that will, if carried out, help the Town achieve at least a 30% reduction in energy consumption. The level of detail provided herein is meant to create the basis upon which investment grade audits and decisions can be made. The decision grade audit is meant to filter options and expectations so that the Town can understand the fundamental building system, how changes to the system can result in economic and environmental benefits and how those changes can interact with other policy and philosophical objectives.

The following information will describe the characteristics witnessed during the walk-through and those areas of the building complex where improvements may be made. The objective of these recommendations is to create a series of options the Town can further explore.

Energy Data Collection:

Name of Building	Fuel Type(s)	Area (Sq. Ft.)	Energy Use: Electricity (million Btu)	Energy Use: Heating Fuel (million Btu)	Total Building Energy Use (million Btu)	Site energy intensity (kBtu/sq ft)[1]	EPA Average Site kBtu/sq ft for building type	NH Average Site kBtu/sq ft for building type
Mittersill Fire House	Oil	2,478	5.41	237.90	243	109.9	78	36.6

* The above chart was extrapolated from the Franconia Municipal Greenhouse Gas and Energy Use Baseline Report. Energy use data generated by STOCC software; energy intensity data generated by Portfolio Manager Software.

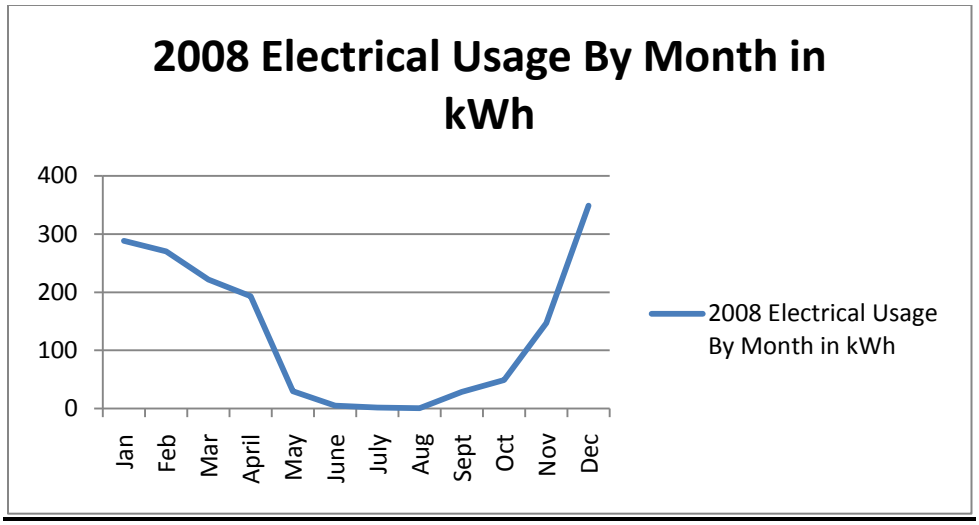
Meter: Electric			
Building: Franconia Mittersill Fire Station			
May 8, 2010 - 06:47:45 PM			
Fuel Type: Electricity, Grid Purchase (kWh (thousand Watt-hours)) **Space(s):** Entire Facility			
Start Date	**End Date**	**Energy Use**	**Cost - US Dollars**
12/1/2008	12/31/2008	349	$55.84
11/1/2008	11/30/2008	47	$7.52
10/1/2008	10/31/2008	49	$7.84
9/1/2008	9/30/2008	29	$4.64
8/1/2008	8/31/2008	1	$0.16
7/1/2008	7/31/2008	2	$0.32
6/1/2008	6/30/2008	5	$0.80
5/1/2008	5/31/2008	30	$4.80
4/1/2008	4/30/2008	193	$30.88
3/1/2008	3/31/2008	222	$35.52
2/1/2008	2/29/2008	270	$43.20
1/1/2008	1/31/2008	288	$46.08

*Note: The presented data was extrapolated from energy information entered into the EPA's Portfolio Manager.

Total kWh in 2008: **1,485 kWh**

Total cost of electricity delivered in 2008: **$237.60**

[1] Site energy intensity = amount of energy expended per square foot *on site* to heat, cool, and electrify the area. This measure relates to how much is being used on site and fluctuates directly with how much lighting is being used, how thermostats are kept, etc.



*The above graph was generated based on data retrieved from the EPA Portfolio Manager account for Franconia, NH

Meter: Heating Oil			
Building: Franconia Mittersill Fire Station			
May 8, 2010 - 06:48:14 PM			
Fuel Type: Fuel Oil (No. 2), No fuel generation method associated with fuel type (Gallons) **Space(s):** Entire Facility			
Start Date	**End Date**	**Energy Use**	**Cost - US Dollars**
11/28/2008	12/27/2008	282.8	$721.14
10/28/2008	11/27/2008	108.4	$276.42
9/28/2008	10/27/2008	0	$0.00
8/28/2008	9/27/2008	0	$0.00
7/28/2008	8/27/2008	0	$0.00
6/28/2008	7/27/2008	0	$0.00
5/28/2008	6/27/2008	0	$0.00
4/28/2008	5/27/2008	0	$0.00
3/28/2008	4/27/2008	260.5	$664.28
2/28/2008	3/27/2008	368.8	$940.44
1/28/2008	2/27/2008	317.3	$809.12
12/28/2007	1/27/2008	709.9	$1,810.25

*Note: The presented data was extrapolated from energy information entered into the EPA's Portfolio Manager.

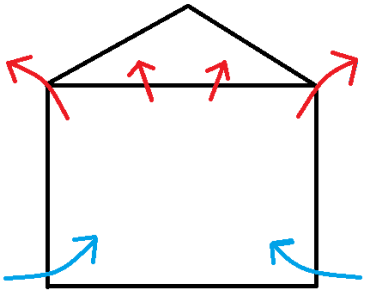
Total gallons of heating oil delivered in 2008: **2,047.7 gallons**

Total cost of delivered heating oil in 2008: **$5,221.65**

Basics of Heat Loss:

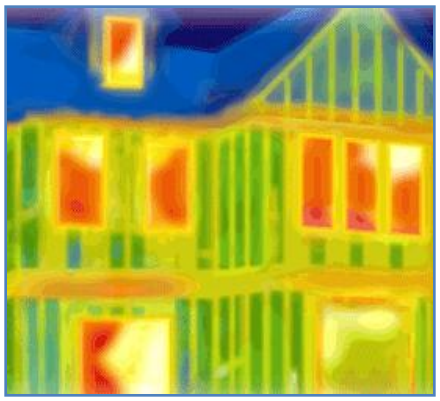
Though we are typically used to measuring heat in temperature, it can be measured in a variety of units. For the purpose of measuring how much heat is produced to condition a space, and how we measure the rate at which heat leaves a structure, we measure in British Thermal Units (BTU's). One BTU is about the same amount of heat produced from a kitchen match. Another good reference to have is that there are about 138,500 potential BTU's in 1 gallon of heating oil. During the winter months, we cannot keep BTU's from leaving our buildings. Hot always goes to cold, or, areas of high pressure are always trying to go to areas of low pressure. What we can do is try to slow the process. We do this by using an **air barrier** and **insulation** at the building envelope to create a thermal barrier.

Heat moves through and leaves a building by three different means; *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. Typically, heated air leaves through the higher areas of a building, and cold air infiltrates through the lower areas. One of the forces causing this to happen is the "stack effect."

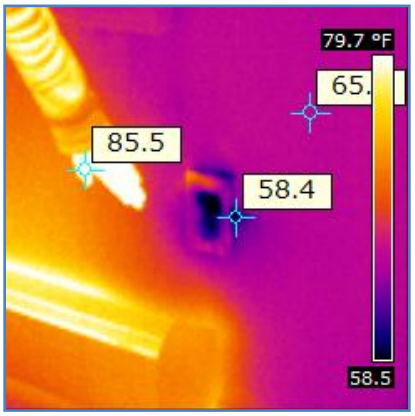


The stack effect describes, on a macro level, the natural way in which air moves through a building. As warmed air leaves through the upper levels of a building, cold air infiltrates through the lower sections. In most cases, this pulls air from less than desirable areas of a building, such as basements, crawl spaces and mechanical rooms, which are often damp and unmaintained. These spaces can be the source of exhaust fumes from heating equipment, mold and mildew, as well as a number of other air contaminants such as radon. Without an effective air barrier between the conditioned space and the attic, warm air will exit the building. For every 1 cubic foot of air that leaves a building, 1 cubic foot of air will infiltrate at a different location. Gaining control of the air movement through a building not only has a positive effect on efficiency, but contributes to increased comfort and improved indoor air quality.

Conduction is the foremost way in which heat travels through a solid building material. At any point in the building envelope where there is a solid building material and no insulation, what is known as "**thermal bridging**" will occur. For example, a 2x6 inch wood stud in an exterior wall has an R-value, or insulative value, of about R-7, while the 5.5 inch fiberglass insulation in the wall cavity is rated at R-19. Solid material in the exterior wall of a typical structure built with 2 inch stock, 16 inches on center (O.C.) will usually make up 20-25% of the wall surface area. This, in combination with all of the doors and windows, means that a significant percentage of the building envelope has an R-value of less than 10. Even a wall with a high R-value cavity insulation such as spray foam is subject to these weak points in the thermal boundary. Employing methods to reduce or eliminate thermal bridging in our new and existing buildings will dramatically reduce energy costs and emissions over the

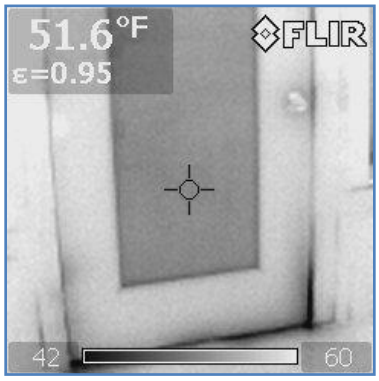


long term as we move towards a new generation of energy and environmental challenges.



Radiant heat loss describes how heat waves, or infrared radiation, pass through space from one surface to another within its view. For example, the heat from a hot cooper pipe will radiate towards cooler surfaces around it, like an exterior wall. The heat can then conduct through building materials to the exterior.

With regards to the building envelope, **gaining control of convective heat loss is the main priority, and usually the easiest to address through air sealing**. After this is done, increasing insulation levels, or R-value, of the building envelope is the next step to gain better control of conductive heat loss. In many cases, a large amount of a structure's radiant heat loss will be addressed with added insulation, either to ceilings, floors, walls, ductwork, or piping. Treating the whole building as a system, and addressing all the issues of heat loss will produce optimum savings and comfort.



<u>Basics of Moisture Control:</u>

The issue of moisture control in buildings is very complex and essential to maintaining structural durability and occupant health. The mismanagement of moisture can lead to a multitude of negative effects. Some of these are mold growth, poor indoor air quality, early materials and equipment degradation, and large negative health impacts on the people who live and work in our buildings.

The two basic forms of moisture in need of managing are bulk moisture (fluid), and water vapor. Two important ways to manage bulk moisture are to keep rain and ground water from entering our buildings, and to quickly fix any water leaks from sources within our buildings such as leaking pipes.

Managing relative humidity and water vapor is a challenge. At some points of the year, occupants want more humidity in the air to maintain comfort, and less in other times. For example, in the winter months we want more humidity indoors because it helps occupants experience greater comfort. In many situations, we increase the relative humidity mechanically with humidifiers. When indoor air is too dry during the winter, we feel colder, develop dry skin, and our upper respiratory can become dry causing discomfort.

Conversely, in the summer we want the air to be dry. Just as hot goes to cold, wet goes to dry. We cool ourselves by perspiring. As we produce this moisture on our skin, it evaporates into the air, drawing heat away from our bodies. The temperature of a room may not be very high, but if the relative humidity is high, we will feel hot because our perspiration is evaporating at a slower

rate. Much of the comfort we achieve from using an air conditioning system (AC) is by removing the moisture from the air, allowing our skin to dry more quickly.

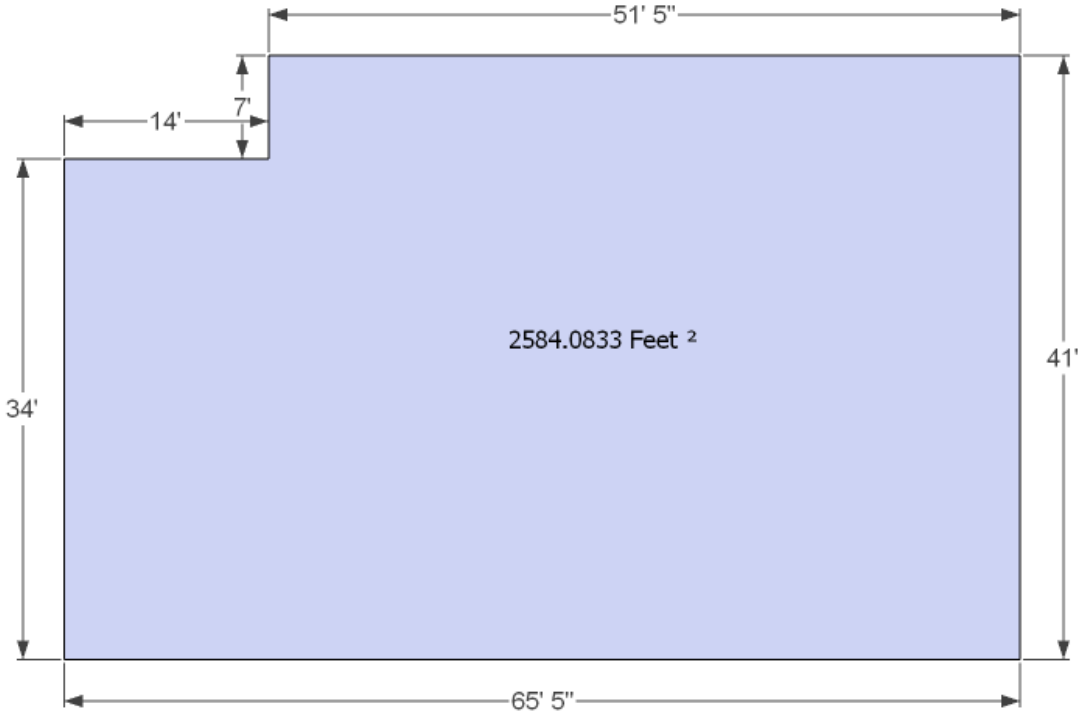
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable, and to keep the water vapor from causing damage within the building envelope.

Just as BTU's conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and so we use these to try and form a vapor barrier on the inside of the thermal boundary in an attempt to slow the amount of vapor diffusion. Small amounts of vapor traveling through a properly constructed building envelope will diffuse all the way to the exterior, and not cause any damage**. If a large amount of vapor is allowed to enter a wall cavity, the molecules will condense on the nearest cold surface.** When this happens, moisture can build up on the inside of the exterior wall sheathing, or on other surfaces. This will cause a number of problems including long term damage to insulation and structural components, as well as the promotion of mold growth.

It is important to try and identify any current moisture problems, and address them properly. This is always done by first finding and controlling the source of the moisture. Sometimes it can be quite difficult to see moisture damage, as it may be buried inside of wall cavities. It is also important to know that by making changes to a structure and its envelope, we can change the way, sometimes negatively, in which moisture affects the building.

Building Description:

This is a single story, cement block, structure built in 1975. There are three garage bays, with a small office area to the east side of the building.
This building is mostly used for storage, and is kept at 55°F in the winter with an oil fired furnace. It houses a diesel water tank truck used when extra water in needed in an emergency.



Foundation:

This is a single story building that sit on a concrete slab. We can only assume that the slab is not insulated. We inspected this building on a fairly warm day, and are therefore unable to demonstrate the amount of heat loss from the slab with infrared imagery, however, Figure 1 illustrates this substantial source of heat loss. Concrete has very little insulative value. For example, an 8 inch thick concrete wall only has an R-value of about 1, and about the same for an 8 inch concrete block. This means that as heat enters the material on the conditioned (heated) side of the wall, it conducts through the concrete and exits to the exterior very quickly.

Foundations and slabs are rarely insulated, though this is becoming more common, especially with the incorporation of Energy Star® and other high performance practices into our built environment. Experts say that insulating around a slab can save 10%-20% on heating cost.

Insulating the slab would require digging a 4-foot deep trench alongside the building and applying 2 inches of foam board with an exterior finish. This is an effective way in which to slow the heat loss from around the perimeter of the slab, though somewhat controversial. In some cases where this insulation method has been used, pests, such as ants, have found their way into the foam board and made nests. Given this, it is very important to create a strong barrier between the foam and any potential infestation. A thick cement scratch coat with a lime based plaster applied the entire depth of the foam is an ideal solution to this potential problem.

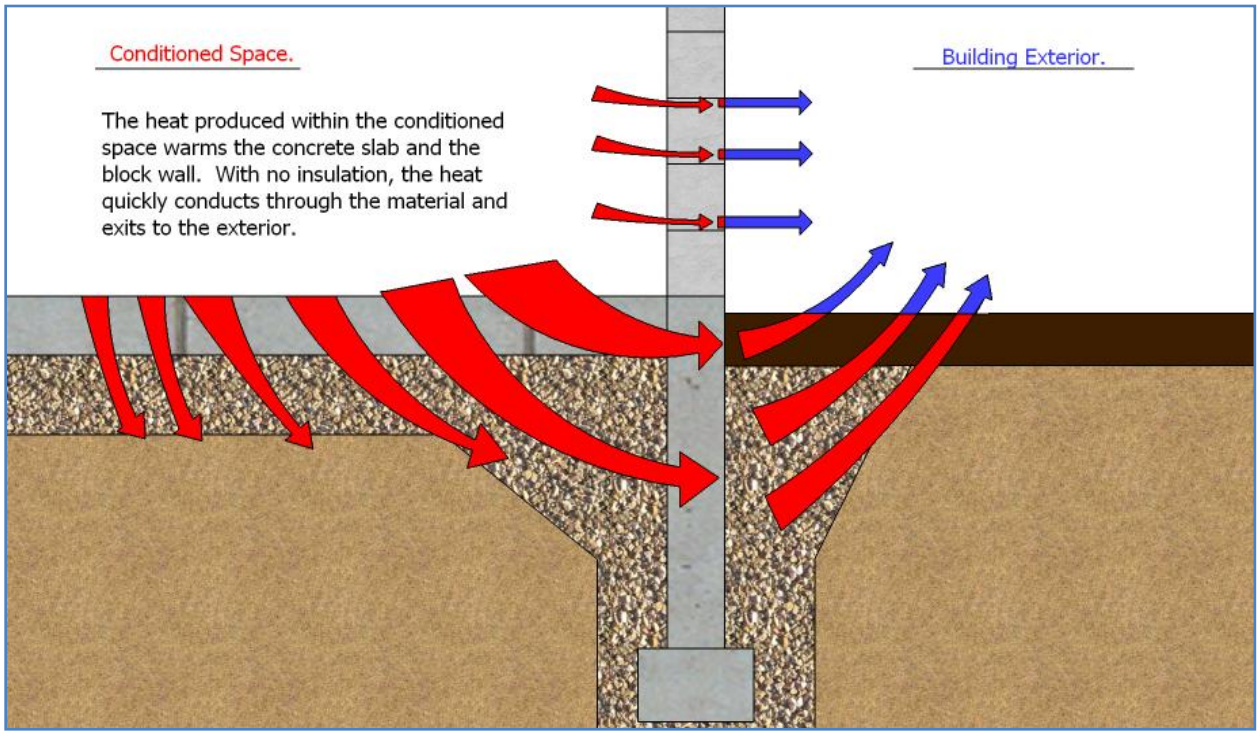


Figure 1

Recommendation:

- Insulate the foundation of this building. This should only be done after the more high priority recommendations have been carried out.

Exterior Walls:

The exterior walls are constructed with 8 inch concrete blocks. It's possible that the blocks have been filled with vermiculite or perlite insulation, but we were unable to see inside the blocks to tell if the blocks have been filled with any type of insulation.

There are five hollow/tapered columns on the corners of the building. We believe that they are non-structural, and only for aesthetics. When trying to determine the best method for insulating the exterior walls, the columns pose a large obstacle. It could be very difficult to insulate between the pillars and the block, and not very beneficial to insulate all of the main fields of each wall and not these large corner areas. One of the benefits of trying to make this work would be that the exterior insulation board could be buried, thusly insulating the edges of the slab also. This option could mean having to remove the corner columns, and replace them after.

Insulating the exterior wall from the inside may be the best option. This could be done in several ways. Our recommendation would be to build a wood or metal stud wall around the perimeter of the structure, setting the wall about 1 inch from the block wall. There are some electrical boxes that would have to be moved out, and the return plenum would have to be shortened a bit. The wall could then be sprayed with closed-cell spray foam insulation. Because the stud wall would be held away from the block wall, the foam insulation would expand between the framed wall and the blocks, eliminating any thermal potential thermal bridging. In this scenario, it would still be possible to insulate the edges of the slab with foam board, but it would mean bringing this exterior foam up above grade, which if done well, could make for a nice additional detail to the exterior look of the building.

It would certainly be very beneficial to insulate the exterior walls of the building. Making such an investment in this building would produce substantial savings of the long term. Given the current use of the building, we feel it would be best to insulate, for now, only one section of the building. More about this is discussed on pages 17 and 18.

Recommendation:

- Insulate the exterior walls of the building. There are several ways in which to do this. We would recommend constructing wood or metal stud walls on the inside of the block walls, making sure that they are 1 inch from the blocks. Perform any electrical work, then insulate with closed-cell spray foam insulation. Sheetrock may then be applied to the stud wall for fire protection, and a more finished look. See Figure 2 for a visual explanation.

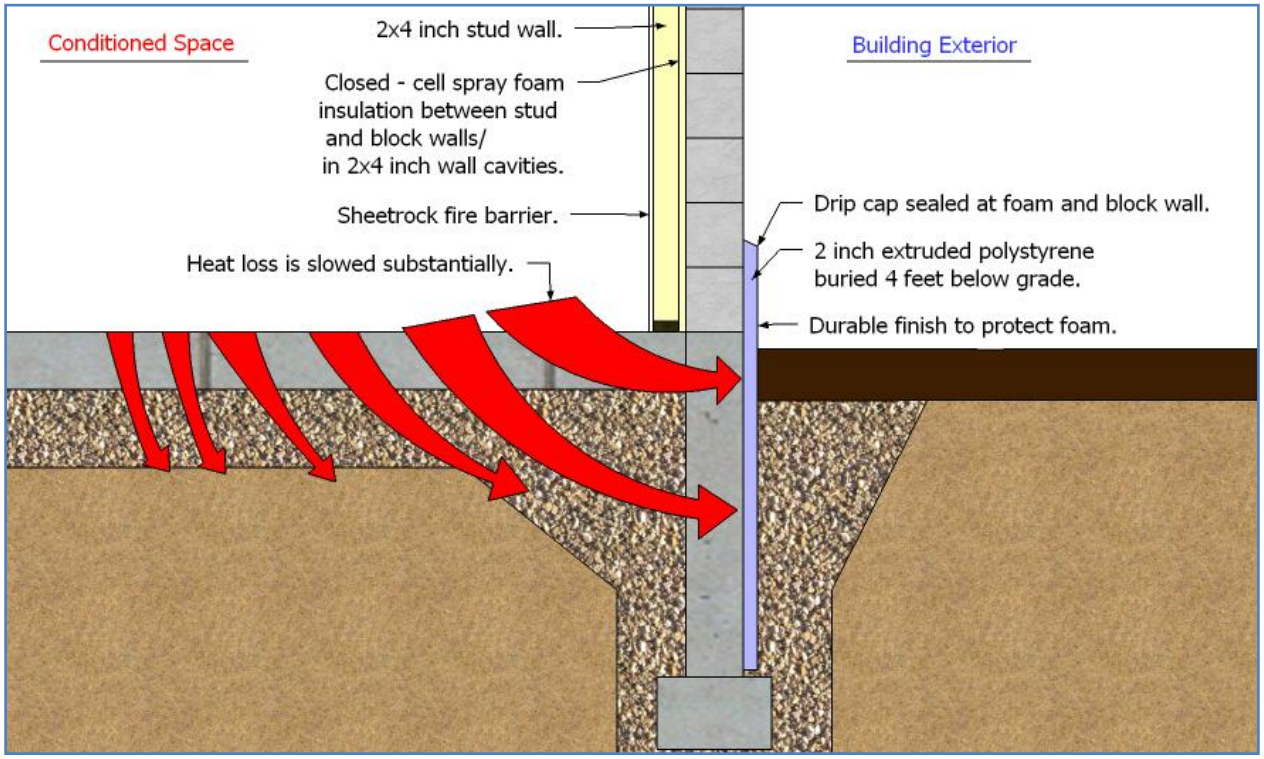


Figure 2

Ceilings:

This building has a truss rafter system over the main section of the building that is insulated with an average of about 4 inches of loose fill cellulose insulation. Figure 3 shows the bottom of the truss system. One can see that the cellulose insulation does not even rise to the top of the 2x6 inch stock. This attic space shows strong evidence of a large amount of mice living in the space. They have borrowed holes through the insulation, and have displaced large amounts of it, leaving areas where there is but a dusting of insulation over the sheetrock. We estimate the weighted R-value of the ceiling to be around R-20 at best. This is well below current energy codes, and offers substantially opportunity for improving insulation levels.

Figure 3

There is also opportunity for air sealing. The ceiling has ½ inch sheetrock screwed to the ceiling strapping. None of the sheetrock seams have been finished, and there is no vapor barrier present. This, in combination with several rodent holes and other penetrations presents ample opportunity for savings through air sealing. After the ceiling has been finished, vapor barrier paint could be applied to offer moisture protection.

There are 2x10 inch rafters over the office section of the building, insulated with R-30 fiberglass batts. There is s storage area above the office space where sheetrock has been applied to the rafters, with a 1st finish coat (tape and joint compound). Though there is room for improvement here, we would not recommend taking action at this time. If in the future the town wishes to improve the R-value of this ceiling, the drywall joints could be cut, the screws and sheets remove, 1-2 inches of foam board insulation adhered to the rafters, and the sheetrock replaced.

Figure 4

There are two side-by-side gable attic vents in the north side of the building. These are offering some attic ventilation, and could prove to be more adequate if the ceiling of the garage was air sealed and had more insulation. The purpose of attic ventilation is to evacuate excess moisture and heat that passes into the attic space from the conditioned space. When there is a large amount of moisture (water vapor) in the attic, and inadequate ventilation, the moisture will tend to condense on the underside of the roof sheathing and rafters. This will cause the early deterioration of the roof structure, and can drip down onto the insulation, degrading it, and rendering it less effective. If the there is a large amount of heat escaping into the attic space, and inadequate ventilation, the heat warms the sheathing and roofing material causing the snow on top of the roof to melt. Water then runs down the warmed roof and freezes when it eventually comes in contact with the cold eves. This then forms ice dams, which can back up under the shingles, and cause leaking within the building.

Adding more ventilation, after the ceiling of the condition space has been upgraded is recommended. This could be done by adding a ridge vent to the peak of the roof, adding another gable vent to the south side of the building, and improving soffit ventilation.

Figure 5

The roof is leaking in a couple of areas. Figure 5 shows the approximate location of one of the leaks which has damaged ceiling and wall sheetrock in the garage. This particular roof leak is known, as we did find an overflowing 5-gallon bucket placed directly underneath. The other leak we found appears to be a much slower leak, but is still causing damage to the truss system and insulation below.

Figure 6 shows the same side of the roof, and the rough condition that it is in. This roof is in need of replacement, and should be done so fairly soon. We would recommend that the new roof also be light in color, and encourage the town to consider installing metal roof. A quality metal roof will last much longer than an asphalt roof, and metal roof allow for snow to slide off reducing the weight load.

Figure 6

In addition to the roof, the gable eve trim needs to be replaced. As is seen in Figure 6 the trim in many areas has rotted and broken off. One of the main reasons this has happened is because of the way in which these details have been installed. Notice in both Figures 5 and 6 how the shingles do not cover the trim as they rises 2 to 4 inches above the roof line. When this trim is redone, the highest part of the trim should be only about 1/8 of an inch above the surface plane of the roof sheathing. Whatever roofing material is used, it should slightly overhang all of the eves, and eve flashing should be installed beneath. Properly flashed and protected eve trim along with a maintained roof can last well more than 100 years.

Recommendations:

- To start, repair any leaks to the roof and install a ridge vent cap. When funds become available, replace the roof. When this is to be done, also replace the eve trim on either gable. Make sure that the new roof overhangs the gable trim.
- Air seal any penetrations into the attic space. This would include applying a first coat of drywall tape and joint compound to all the sheetrock seams of the garage ceiling. Also, insulate the access to the attic, making sure that the hatch also provides a good air seal.
- Paint the ceiling of the garage with "vapor diffusion retarder" (vapor barrier) paint.
- Blow in additional inches of loose fill cellulose insulation into the attic to achieve R-60.
- Install a gable attic vent on the south gable for additional ventilation.

Envelope Efficiency:

The single largest area for improvement in building efficiency involves the building envelope. The best ways to increase an envelope's performance is to complete air-sealing and insulation work. Although it would be a major undertaking to air-seal and insulate the building, the resulting benefit would be equally significant.

From a building efficiency standpoint, air sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler may only last 20 years, or 40 years before possibly needing to replace a PV array, but building envelope efficiency has a lasting positive impact long after equipment need to

be replaced. This is an important consideration when factoring in the true life cycle cost of the implemented solution.

Insulation and other building envelope projects are investments that are permanent, require little or no active maintenance, and will stand with the building during its lifetime. These investments secure baseline improvements that in turn provide a foundation for other investments. Lowering the amount of heat needed for a building is the best way to insure that a new and efficient heating plant provides the most savings.

Doors:

This building has no windows. There are three large garage bay doors on the front of the building, two hinged exterior door on either side of the garage area, and one leading into the office area.

The two hinged garage doors are the same type of door, and are relatively old, inefficient units. Figure… 7 shows a large gap in one of the doors allowing for a significant amount of air infiltration. We would only recommend replacing these doors after much of the other more high priority recommendations have been carried out, including exterior wall insulation. In the interim, these doors should be fitted with whether stripping and made air tight when closed.

Figure 7

Figure 8

The overhead garage doors are 1 ½ inches thick and have a foam insulation core. We estimate the R-value of these doors to be between R-8 and R-10 only at the core of each panel. A large determinant of their overall effectiveness to resist heat loss is based on how tight of an air seal these doors provide.

Seen here in Figure 8, there is a vinyl weather strip fastened to the garage door opening under a piece of wood strapping. This weather stripping has fallen off in many areas, and where it has not, it is no longer pressing against the doors.

Figure 9 shows how the door rails are anchored to the frame of the door. This bolt, circled in the photo, should be able to be loosened, allowing to slide the rail closer to the frame, this would help close the gap between the door and the frame, and allow new weather stripping to better function. Note that it may be possible to slide the rail too close to the frame, making the fit too tight, disrupting the operability of the door. Replacing this weather stripping, while making sure the bottom of the doors are well sealed, will reduce the amount of air infiltration, thereby improving the overall performance of the doors.

Figure 9

During our site visit, we were asked if there were any ways to increase the R-value of the doors. One question was whether or not it would work to adhere sections of foam board insulation to the garage door panels. It was difficult to see how this could be done effectively, without disrupting the operability of the doors. If a system for doing so was developed that would not disrupt their operability, we would certainly recommend this. Another option to consider might be to install a more flexible insulation material like reflective bubble wrap insulation.

Recommendation:

- Replace the weather stripping on the sides and tops of the garage doors. Examine the weather stripping on the bottom of the doors, and replace if in poor condition, or it's not providing a good air seal.
- Replace the two metal doors to the garage area. Note that this alone will not provide a large amount of savings. The greatest benefit would be realized by having the door replacement as a part of a larger insulation project. If budget will not currently allow for this, carefully apply weather stripping to all the doors to ensure so that they provide a good air seal.

Mechanical:

This building is heated with an oil fired horizontal furnace suspended from the ceiling of the garage bay area. See Figure 10. There is unsealed, uninsulated ductwork running from the furnace to either side of the garage with several registers. The ductwork continues through to the storage space above the office area where it turns down and ends with a section of 8-inch round ductwork protruding from the ceiling of the office, supplying this area with hot air. There are no

Figure 10

return grills from the office area. There is one return trunk that runs from the furnace down the exterior wall with a return grill towards the floor of the garage are.

We would recommend replacing this unit in the future with a more efficient heating system, but would suggest taking no action at this time. Instead, we recommend following our "primary recommendation" for the building, which involves not using the furnace at all.

Recommendation:

- Discontinue the use of this furnace, and follow the set of recommendations in the following section of this report labeled "Primary Recommendation."

Primary Recommendation:

During our site visit, we interviewed a town employee about the use of the building. The building, for the most part, is used as a storage facility. There is a water tank truck that is kept in the center garage bay, and is full of water in case extra water is needed in an emergency. It seems as though this is the only space in town to fit this tanker truck, and therefore needs to remain at this site and be kept above freezing temperatures. The only other concern for items in this building freezing is a couple of water spigots. What we recommend is isolating the tanker truck, insulating around it, and preferably, heating the insulated space with a smaller more efficient heat source.

Figure 11 shows the west bay of the garage. The water tank truck is currently kept in the middle garage bay. We recommend moving the truck to the west bay and sectioning off this bay from the rest of the garage. Visible in this photo is a stud wall already in the recommended location, which would need to be extended to the ceiling, insulated and finished.

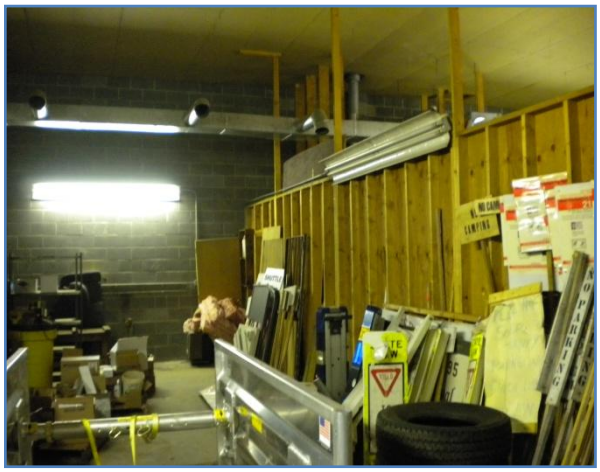


Figure 11

Recommendation:

- Remove the ductwork from the west garage bay area, and cap it on the other side of the stud wall.
- Extend the existing 2x4 inch stud wall up to the ceiling.
- Insulate the 2x4 inch stud wall separating the garage bays. This could be done with a variety of insulation types. In this situation, we would recommend insulating this wall with R-13 un-faced fiberglass blanket insulation. The fiberglass insulation should have a very tight fit to the wood structure without compressing the material. Next, 4x8 foot

sheets of 2-inch foil-faced polyisocyanurate foam board insulation should be tacked to the inside of the stud wall with 3-inch roofing nails. Preferably, these sheets would be adhered to the stud wall with construction adhesive. The seams of the insulation board should also have a tight fit. If there are any gaps between the foam board insulation, they should be filled with spray foam. All seams of foam board insulation should be taped with a metalized tape. The wall would then be finished with 5/8-inch sheetrock, fastened to the studs with 3-½ inch sheetrock screws, with a minimum of a first coat finish for fire protection.

- The exterior block walls should be insulated by constructing a wood or metal stud wall, held away from the blocks 1 inch, any desired electrical work installed, then insulated with closed-cell spray foam insulation. This wall can then be finished with sheetrock.
- The sheetrock ceiling of this space to be a minimum of 1st coated with sheetrock tape and joint compound. The surface should be free of excess joint compound. The ceiling is then to be painted with "vapor diffusion retarder" (vapor barrier) paint.
- The attic space above this bay is then to be insulated with additional inches of loose-fill cellulose insulation to achieve an R-60.
- High-efficiency, commercial grade, hinged, foam core doors should be installed at the exit to the exterior, and the door leading to the rest of the garage. The garage door should be adjusted to ensure that is closes as tightly as possible, without disrupting its operability. The exterior of the garage door should be fitted with new weather stripping on the sides and top of the door, and the bottom to be fitted with a rubber, foam rubber, or vinyl strip.
- Many types of efficient heat sources could be used, from a high efficiency propane fired furnace to a propane fired overhead radiant heat system. These, as well as other options can be further discussed during the presentation of this report.
- Keep the oil furnace turned off.
- Keep the propane system in the insulated garage bay on a digital/programmable thermostat, and keep it set at the lowest possible temperature needed to prevent the water tank from freezing, and to ensure that the diesel engine starts quickly.
- Monitor the relative humidity in this space to determine how much, if any, mechanical ventilation is need to maintain a healthy environment for the truck or any other equipment being stored in this room.

Taking these measures will require a bit of an initial investment. Though this building is currently kept at low temperatures during the winter, it still takes a sizable amount of energy to maintain even 55°F ($5,221.65 in 2008). Energy modeling to determine rates of heat loss, along with contractor estimates of cost would reveal an estimated return on this investment. Our "at a glance" estimates of the project cost vs. energy cost savings show that this project could reduce the cost of overall energy needed to operate this building by 60%, and give this project about a 5 year payback period at current average NH energy costs.

Electrical:

The electric usage in this building is not very high. The graph on page 5 suggest that much of the electric use takes place during the heating season, and is likely associated with the furnace blower, and the pumps that supply oil from the buried oil tank to the furnace. Figure 12 shows the primary pump that draws oil from the underground tank, and then sends the oil to a smaller, secondary tank seen in figure 13. There is a smaller pump seen in Figure 13, which presumably adds addition pressure to this secondary tank. By discontinuing the use of the oil furnace, a good portion of the building electrical usage should be reduced.

Figure 13

Figure 12

Financial Considerations and Options:

A common occurrence across many communities within New Hampshire is the challenge of obtaining the necessary capital funds to carry out the recommended retrofits found within the audit. The following information is an attempt to provide some assistance with understanding some concepts and pathways to acquiring public or private funds to carry out an energy efficiency or generation project. Also, portions of the following information have been taken from the New Hampshire Handbook on Energy Efficiency and Climate Change – Volume II.

Life Cycle Costing –

The National Institute of Standards and Technology (NIST) Handbook 135, 1995 edition, defines Life Cycle Cost as "the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or a building system" over a period of time. Life
Cycle Cost Analysis is an economic evaluation technique that determines the total cost of owning and operating a facility over period of time.

Since municipal buildings are funded in their initial year through bonds and/or capital outlays, they generally fall victim to an inordinate focus on the bottom line cost of construction instead of the lifetime cost to operate the building. This is a critical misstep in particular with energy

concerns for municipal buildings because they are placed in service for a significant period and are subject to extended energy pricing. A more efficient building could save the costs of initial investments several times over during its lifespan.

Energy Price Stability –

The second most important concern about energy costs is the volatility. Municipalities budget on a yearly cycle and must predict energy costs over the year – sometimes over pricing the cost in the case of high lock in prices or subjecting the municipality to risk where a cost (+ some percentage) contract is used for the year. When prices go up budgets go up, when the go down, budgets tend to go down. Changes result is wide variation in predictability and thus lead to fund shortages or balances, and general frustration on all sides of the discussion.

The concept of stability in the context of energy prices is achieved through on-site distributed generation with effective predictive modeling and most importantly, efficiency. The cheapest energy available is the energy you don't need. The less you buy the less amount of appropriations are subject to the price swings.

"Green" Building Cost Myths –

A perception that all energy-efficient construction costs more than conventional construction persists. We have been unable to find valid research that supports this conclusion - especially where choices made about efficiency are evaluated in a realistic context considering the life cycle cost to operate the facility. To the contrary, we have found several sources, from government facility agencies, that show not only that in most cases costs are in fact lower but that any increased cost is almost immediately realized through lower operating expenses.
A terrific resource to understand what type of incentives are available for both energy efficiency and generation is the "Database of State Incentives for Renewables & Efficiency", or DSIRE. This site, funded by the US Department of Energy, provides a list of the potential financial incentives found within New Hampshire and the Federal Government. To see what is available within New Hampshire go to www.dsireusa.org and click on New Hampshire.

Utility Programs:

Many utilities provide rebates for various types of efficiency measures that can be carried out at a municipal facility. PSNH offers the Municipal Smart Start Program. This program offers the opportunity for municipalities to go forward with the installation of approved measures at no up front cost to the municipality. A town simply pays for the energy improvements with the savings from reduced energy usage until the project is paid off.

For more information please contact Kathleen Lewis, (603) 436-7708 ext. 5628, or visit http://www.psnh.com/Business/Efficiency/Paysave.asp

Third-Party Financing Options

The most important part to understanding the potential in third-party is the ability to address up front capital costs and access tax benefits. Additional benefits are potential operations and maintenance savings where the implementation is owned by a third-party. In the three-party model, new businesses create an income stream and take over the insurance, performance assurance, and maintenance of the renewable energy system. New jobs and local investment follow. The business secures stable and long-term funding enabling expansion to other facilities for similar projects.

There are several benefits that appear for the municipality that is considering a third-party financing strategy.

Ability to Monetize Federal Tax Incentives. Federal tax incentives for some projects can equal 30% of the installed capital cost. Under the current law, this 30% is payable in the form of a grant from the Department of Treasury. In addition, businesses can accelerate the depreciation of the cost of a some systems and installations using a five-year schedule. Together, these two incentives can have a tremendous impact on both the cost of and the financial returns on a project. Local governments, however, cannot directly benefit from these incentives. The third-party ownership model introduces a taxable entity into the structure that can benefit from the federal tax incentives, lowering the overall cost to the non-taxable entity.

*Low/No Up-front Cost*s. Even with programs to provide support to municipalities, such as rebates and grants, the need to reduce this amount, the up-front cost is significant. Given the current economy and budget constraints, a large initial investment is difficult to achieve regardless of the return on the investment. A third-party structure places the responsibility of the increased initial cost on to the investor/developer of the project.

Predetermined Energy Pricing. In a project that involves efficiency or distributed generation, the portion of conservation or generation that is met by the project can be considered "fixed" at a particular price in the terms of the contract. This can be in the form of a fixed-priced power purchase agreement (with a predetermined escalation rate).
This predictability offers stable pricing for the portion of the entity's load served by the project. In most cases, the price of electricity in power purchase agreement is usually set at or below the customer's current retail rate for the first year, and then escalates annually for term of the contract (in a solar PPA, these terms are usually 20 – 25 years). For solar projects, an annual price escalator of 3-3.5% is common.

Operations and Maintenance. Another attractive feature of the third-party ownership structure is the fact that new equipment can result in lower operation and maintenance expenses and in the case of some systems, the entire cost and responsibility can shift to the project developer.

Eventual Ownership. As a final issue, third-party structures can be pre-crafted to permit and even encourage local government buyout provisions. This allows the municipality to consider advanced purchase options if circumstances change in a way that makes this pathway more beneficial. If for instance a grant program becomes available, such funds can be used to

accelerate the ownership path and provide for a more immediate "vesting" of full savings opportunities.

Otherwise, these arrangements usually provide for a number of options at the end of the term, the three likely scenarios for the host would be to: 1) extend the arrangement, 2) purchase the facility, or 3) ask that the improvements be removed.

Summary of Recommendations:

- Repair any leaks to the roof and install a ridge vent cap. When funds become available, replace the roof. When this is to be done, also replace the eve trim on either gable. Make sure that the new roof overhangs the gable trim.
- Carefully examine the exterior shell of the building for any passage ways for mice, other pests, and air to enter the building. For building thermal performance, any cracks which could allow for air passage (between the board and batten siding for example) should be sealed. A major priority should be to keep the mice population out. Mice can sometimes fit through a hole as small as ¼ of an inch.
- Implement the "primary recommendation" discussed in pages 17 and 18 of this report. More about his option can be discussed during the presentation of this report.

If the town wishes to focus on the entire building, and not creating a single insulated garage bay, the following could be implemented. Note that it would take much longer to recoup the investment given the current usage of the building.

- Air seal any penetrations into the attic space. This would include applying a first coat of drywall tape and joint compound to all the sheetrock seams of the garage ceiling. Also, insulate the access to the attic, making sure that the hatch also provides a good air seal.
- Paint the ceiling of the garage with "vapor diffusion retarder" (vapor barrier) paint.
- Blow in additional inches of loose fill cellulose insulation into the attic to achieve R-60.
- Install a gable attic vent on the south gable for additional ventilation.
- Try adjusting the garage doors to see if it is possible to bring the door rail closer to the door frame while maintaining smooth operability.
- Replace the weather stripping on the sides and tops of the garage doors. Examine the weather stripping on the bottom of the doors, and replace if in poor condition, or its not providing a good air seal.
- Replace the two metal doors to the garage area. Note that this alone will not provide a large amount of savings. The greatest benefit would be realized by having the door replacement as a part of a larger insulation project. If budget will not currently allow for this, carefully apply weather stripping to all the doors to ensure so that they provide a good air seal.
- Insulate the exterior walls of the building as described on Page 11.
- Insulate the foundation of this building.
- Replace the current furnace with a more efficient system. Many options are available, and can be discussed during the presentation of this report.
- Install a grid-tied photovoltaic (PV) system to offset the electric usage of the building.

Conclusion:

As a result of this audit, the Town has several options available to increase the efficiency of the Fire Station. We highly encourage the that the Town pursue these recommendations described in this report and to utilize the further assistance provided under this program to help develop plans for implementation – including possible identification of contractors who will provide the services needed to carry out the recommendations. SDES Group will provide the Town an additional twenty-five hours of Community Energy Advocate service to assist with further efforts under the MEAP program in an effort to bring the recommendations outlined in the report to fruition.