The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Barnstead Town Hall
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Town of Barnstead, NH

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Sustainable Energy Resource Group

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The following report was generated as part of the NH 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 Barnstead 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 Barnstead.

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Barnstead and the Town Hall building (hereinafter "the building"). This report discusses the findings and subsequent recommendations for energy efficiency and occupant health and safety improvements at the building. Included within this report are details regarding the inspection of the building, and examples that illustrate recommended building alterations and improvements that can reduce energy costs, occupancy health risks, 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 making capital investments, and participating in Federal and State level funding opportunities for municipal energy projects.

Prior to receiving an energy audit, each selected municipality must carry out the MEAP Energy Inventory process. The Energy Inventory, and subsequent energy audit, reports relied on data provided to the MEAP team by municipally appointed /authorized elected officials, employees, or community volunteers. These initial findings, along with a further review by SDES staff, helped determine the most appropriate building to provide an energy audit. The intent of the building selection process is to maximizing the potential energy savings, while at the same time catering to municipal goals and objectives. Any municipally owned building that has received any level energy audit or energy assessment prior to this program will be considered ineligible to receive a MEAP energy audit.

The Audit

It is important to know that there a few types, or levels, of energy audit. This audit, described by SDES Group as a Decision Grade Audit (DGA) is a first step towards making investments in the examined building. It is entrenched within the SDES method to begin with this baseline understanding of "how" and "why" a given building is performing, and state some of the many approaches to reducing energy consumption, while increasing occupancy health and comfort. This, along with the Town's goals, objectives and project funding capabilities are the foundation of sorting through the many available technologies to form a solid Level II audit.

We have found that this approach eliminates wasted time estimating energy savings and project implementation costs for energy efficiency measures and/or alternative energy systems that may never fall within the objectives of the investor. This DGA serves to aid in "deciding," or sorting through, potential projects to be further examined for investment consideration.

Two examples of the many benefits to taking this approach are these: The classic case of a building owner funding a very expensive window replacement project under the mislead assumption that it will save a substantial amount of money in heating costs. The fact is, window replacement projects most often fall quite low on a prioritized list of recommended energy efficiency measures as they usually have high cost and low savings (unfavorable ROI). The benefit in this case is the basic guidance towards long term upgrades with a staged approach. The second example is the time (hourly rate) of an energy auditor to examine the cost benefit of replacing an inefficient oil-fired heating system with *all* the available options. Some of the

options may include (but not limited to) a high-efficiency LP gas boiler or furnace, a geothermal system, a biomass systems (pellet vs. cordwood vs. woodchip) an integrated solar thermal storage system, a cogeneration system of varying fuel types, etc. The distribution system could vary for all of these systems as well. One could provide the "cost/benefit" for burning any of these fuels with a forced air system, a radiant floor system, hydro-air, baseboard radiators, etc. Any of these heating plant, fuel types, and distribution system combinations will have a varying cost in installation, fuel price, efficiency, and maintenance. The benefit here is avoided consulting costs by using the DGA as a tool to hone in, or help define, the objectives needed to carry out intended goals.

A community's goals and objectives may be environmentally or economically based. Regardless of motivation, both goals can be reached in tandem by implementing any set of objectives aimed to reduce energy usage. Given that these are public buildings and facilities, comfort and safety are primary concerns that help guide our analysis and recommendations.

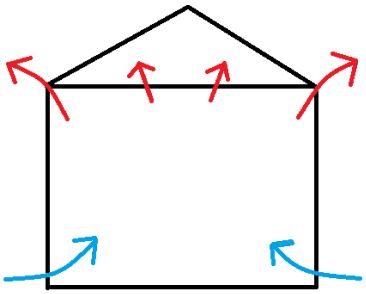
This DGA involves a quantification of energy usage (electrical and heating fuel), a description of existing heating/cooling and distribution systems, thermal barrier inefficiencies, potential electric savings through lighting/appliances upgrades and behavior change, occupancy health and safety concerns, a prioritized list of recommended improvements, and a look at current 15 year projected energy expenses vs. a 30% annual energy usage reduction for the examined building. This savings estimate is not based on a specific set of projects instead of a reasonable average goal for work and is used to illustrate the effectiveness of upgrades.

Many of any energy auditor's recommendations will be based on their knowledge and experience with particular products, techniques, and technologies. SDES has worked with all major forms of alterative/renewable/conventional high-efficiency heating and cooling systems, has planned for and constructed many types of different high-performance (super-insulated) building envelope systems in an effort to create some of the most healthy, comfortable and efficient private and public spaces in NH. Our prioritized list of recommendations is based on our "what works" experience. Our list will not include detailed "spec" information on how exactly each item should be carried out, nor will it include estimated energy savings. This type of detail would be presented in an IGA (Level II equivalent) in order to receive estimates for the cost of implementation, and return on investment. These details will be needed to participate and many of the State and Federal loan and incentive programs.

Basics of Heat Loss:

Though we are typically used to measuring heat in temperature, it can be measured in a variety of other 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 (BTUs). One BTU is roughly the same amount of heat produced from a kitchen match. Another good reference to have is that there are about 138,500 potential BTUs in 1 gallon of heating oil. During the winter months, we cannot keep BTUs 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.

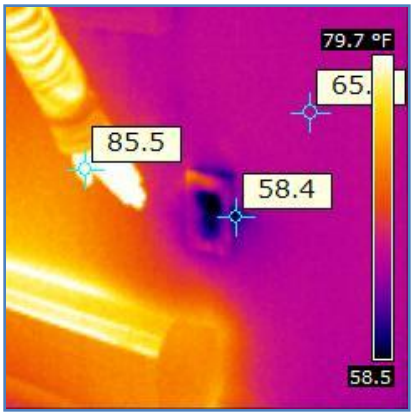
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



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 (heated and/or cooled) 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 also contributes to increased comfort and improved indoor air quality.

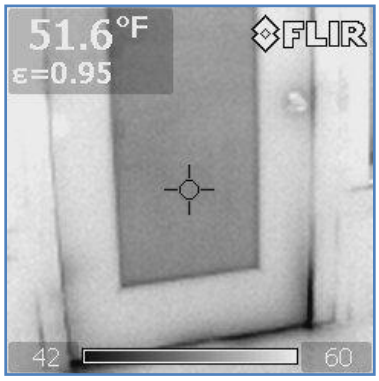
Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope where there is solid building material and no insulation, "**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 5-½ 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 any 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 built

environment 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. For example, the heat from a hot copper 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 significant 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 include mold growth, poor indoor air quality, and the early degradation of building materials and equipment. It can also contribute to potentially serious health issues for 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 ways to manage bulk moisture are to keep rain and ground water from entering the building and to quickly fix any water leaks from sources within the building, 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 at 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 system 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 BTUs conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and we use these to 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.

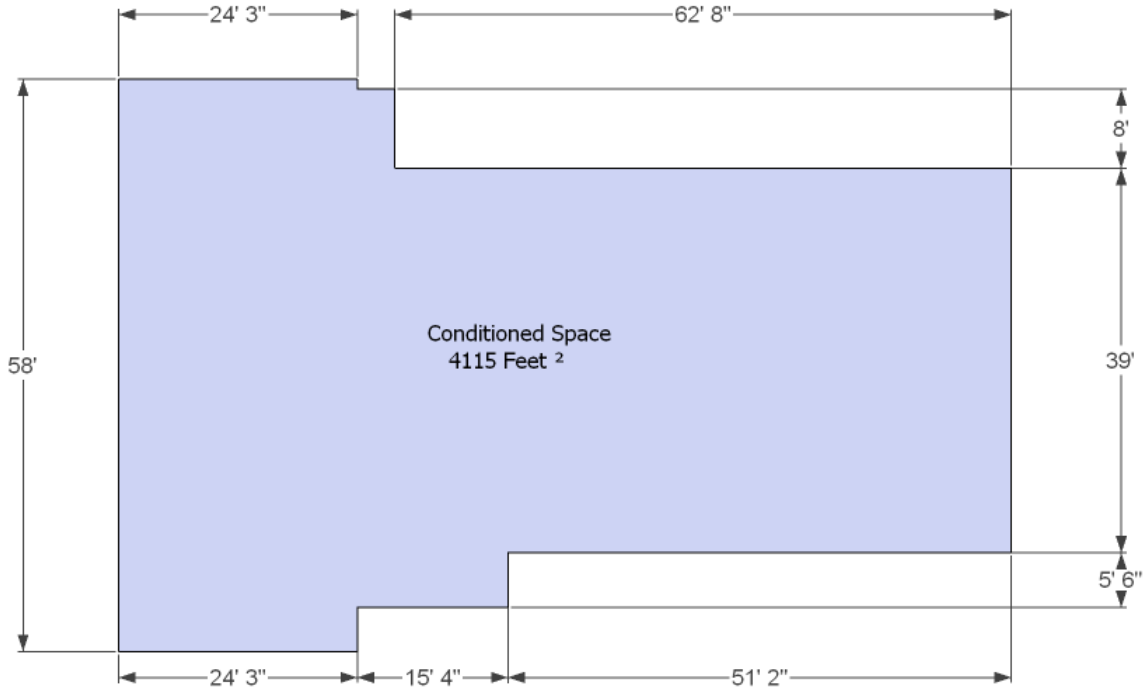
It is important to identify any current moisture problems and address them appropriately. This is always done by first finding and controlling the source of the moisture. Sometimes it can be quite difficult to see moisture damage, as it may be buried inside of wall cavities. It is also important to know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

Building Description:

The Barnstead Town Hall is a wooden structure, which was built in 1847. The original section of this building (see Figure 1) consists of one Town office, a community kitchen, a meeting hall, and a partial second floor used for storage.

An addition to the rear of the building houses the rest of the Town offices and also has a partial second floor used for storage. Only the first floor areas of this building are intentionally conditioned.

Figure 1

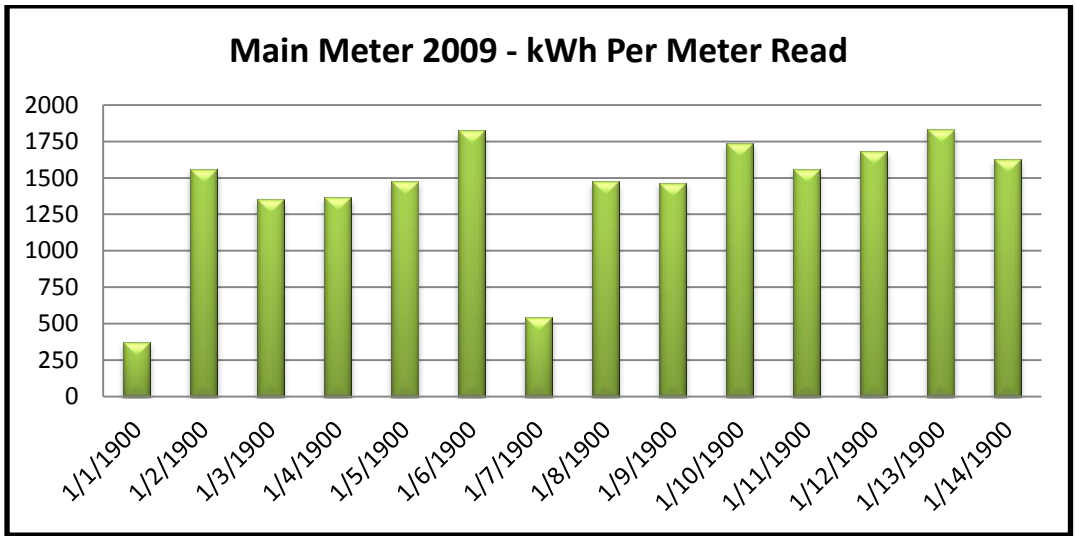


Energy Data Collection:

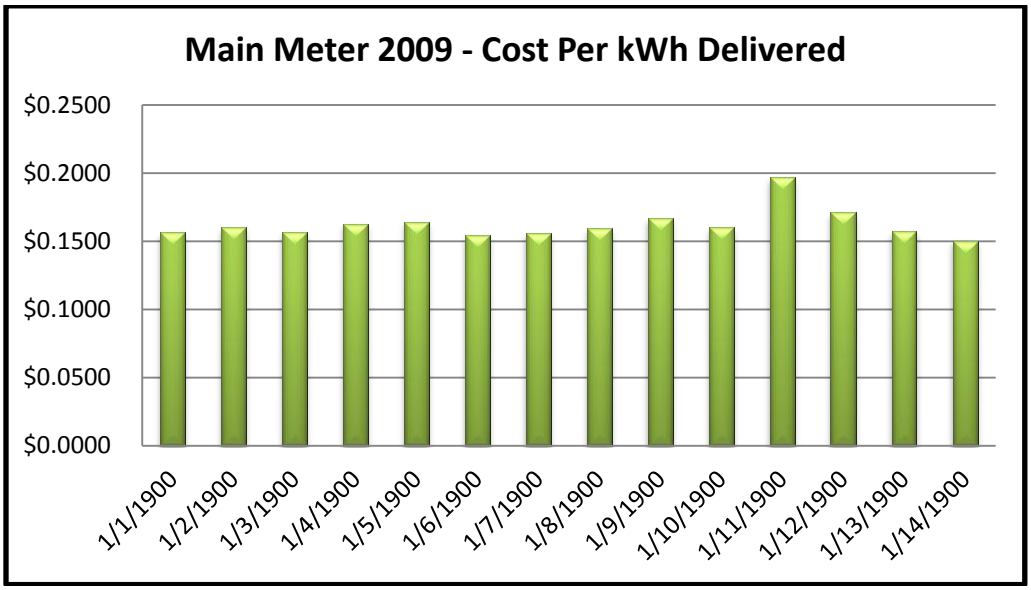
Analysis from provided electric utility for 2009 produces the following snapshot in electricity consumption. Monthly consumption is designated low to high, red being the lowest and green being the highest consumption months in the table below.

Electric -Main Meter			
PSNH			
Date	**KWH**	**Total $/mo**	**Cost Per kWh**
12/25/2009	371	$58.08	$0.1565
11/25/2009	1,560	$249.87	$0.1602
10/28/2009	1,356	$212.60	$0.1568
9/29/2009	1,368	$222.68	$0.1628
8/28/2009	1,476	$242.38	$0.1642
8/1/2009	1,824	$281.76	$0.1545
7/24/2009	540	$84.21	$0.1559
6/25/2009	1,476	$235.43	$0.1595
5/28/2009	1,464	$244.20	$0.1668
4/24/2009	1,740	$278.97	$0.1603
3/27/2009	1,560	$307.37	$0.1970
2/27/2009	1,680	$287.80	$0.1713
1/27/2009	1,836	$288.43	$0.1571
1/1/2009	1,630	$245.02	$0.1503

Average $/kWh: $0.1624
Total kWh: 16,415
Total paid for Year: $3,238.80



Annual electricity consumption for Barnstead Town Hall



Cost of delivered electricity for Barnstead

Heat Source 1			
No. 2 Oil			
Date	**Fuel Units**	**$**	**Cost Per Unit**
1/1/2009	2,177	$5,060.84	$2.325
	Total Units Used =		**2177**
	Total Paid For Year =		**$ 5,060.84**
	Ave Cost Per Gal =		**$ 2.32**
NH Average By Date - 1.31.2011			$3.463 $ Per Unit
	Cost at this price per gallon =		**$7,538.951**

Blower Door Test Results:

A blower door test was not performed on this building because of one or more of the following reasons.

- Hazardous building materials were found on site. SDES staff did not want to risk disturbing this material and potentially spreading it to occupied areas of the building.
- Mold was discovered in the building. SDES staff did not want to risk disturbing the mold or spreading spores to occupied areas of the building.
- Though lead paint tests were not performed, SDES felt there may be a threat of disturbing lead paint dust with the potential of spreading it to occupied areas of the building.
- Excessive amounts of bat and/or rodent droppings were discovered. SDES staff did not want to encourage the migration of hazardous gases and associated diseases to occupied areas of the building.
- The risk of spreading materials which are not considered to be hazardous such as fiberglass insulation, dust, etc., was too high. Exposure to such materials can cause respiratory, skin, eye and other irritations to individuals working in or conducting business in this building.
- For security purposes, it was logistically not possible during our building inspection to open all interior doors of the building in order to get accurate test readings.
- Business hours at this building conflicted with the scheduled SDES building inspection, rendering it not possible to keep exterior doors closed during the test.
- It was not possible to shut down heating equipment during the SDES building inspection.

Foundations, Floors, Crawl Spaces, and/or Basement:

The original section of this building was raised slightly for the new foundation and concrete floor (see Figure 2). The building itself sits on concrete blocks, which make up the top roughly two feet of the new foundation, and the steel support beams used to support the building during this process have been left in place with reinforced columns, which will be a key in adding longevity to the life of the structure.

Figure 2

Figure 3

We could not find evidence of insulation being used during the construction of this foundation or underneath the poured floor. This, in combination with the floor not being insulated, suggests that a great deal of the building's heat loss is occurring in this area of the building. Additionally, the beam around the perimeter supporting the exterior walls may be a substantial source of air infiltration. Although air sealing the higher areas of the building area is a priority, eliminating air infiltration in the lower regions of the building is essential to lowering the amount of convective heat loss.

Exterior Walls:

Figure 4

The walls of the original building have 5 ½ inch cavities, which were not insulated at the time of construction.
Loose fill fiberglass insulation was added to these walls, though this tends to be not be very effective. The outdoor temperature on the day of the building inspection made it difficult to determine with the IR camera how well this insulation was installed. One important thing to consider when looking at the next images in this section is that fiberglass insulation does little to impede air flow. In fact, when fiberglass insulation is installed in areas where there is not an effective air barrier in contact, the rated R-value diminishes substantially. This will also be an important fact when we look at the ceilings of this building—even when looking at the new addition.

The addition built on the back side of this building was constructed with 2x6 inch studs and was insulated with R-19 fiberglass batts. The exterior was sided with clap boards over ½ inch of plywood sheathing. The interior of the addition was finished with ½ inch drywall.

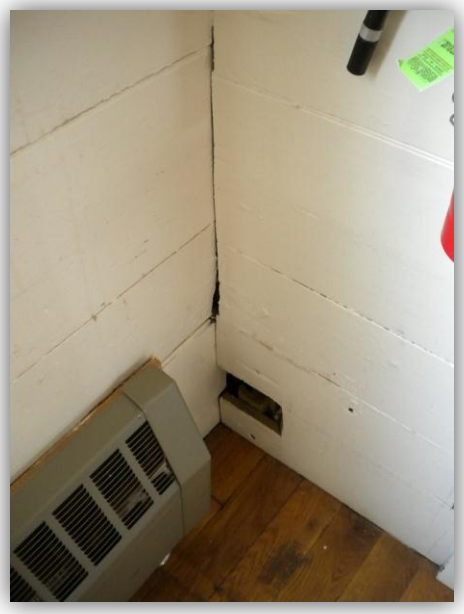


Figure 5

The siding on the original structure seems to have been replaced. This was likely done when the new foundation was constructed. We assume that the original sheathing boards were left in place during this process owing to the loose fill fiberglass still being there.
On the inside of the first 4 feet of the exterior walls are 1 inch thick boards, which are positioned horizontally. Above this there was likely lath boards nailed to the beams and studs before the decorative metal panels were fasted.

Much of the perimeter of the building where the flooring meets the walls has a sizable gap. Gaps like this will easily allow for air from the basement or from any exterior passages to rise up through the building. Though gaps like this are usually covered with baseboard trim, even then a large amount of air movement can occur. It is important to seal these gaps, even before the installation of trim.

Figure 6

Figure 7

There are also many gaps where the exterior walls meet the ceilings. This, along with all of the other air passage ways mentioned previously in this section, will naturally aid in a strong stack effect in this structure. Though a blower door test has not yet been performed at this building, these areas should prove to be some of the largest sources of convective heat loss.

Figures 8 and 9 show areas of interior walls that abut unconditioned attic areas and which have no insulation and should therefore be considered exterior walls.

On the day of the building inspection, the outside temperature was considerably warmer than that of the interior of the building. The IR images below reveal areas of extreme heat (orange to yellow), which is amounting in the attic spaces under the summer sun. Though this main room is

not cooled in the summer months, it is heated in the winter. Moreover, in the winter, an IR image of these same areas would show dark blue, indicating that these areas are cold in comparison to areas where there is insulation.

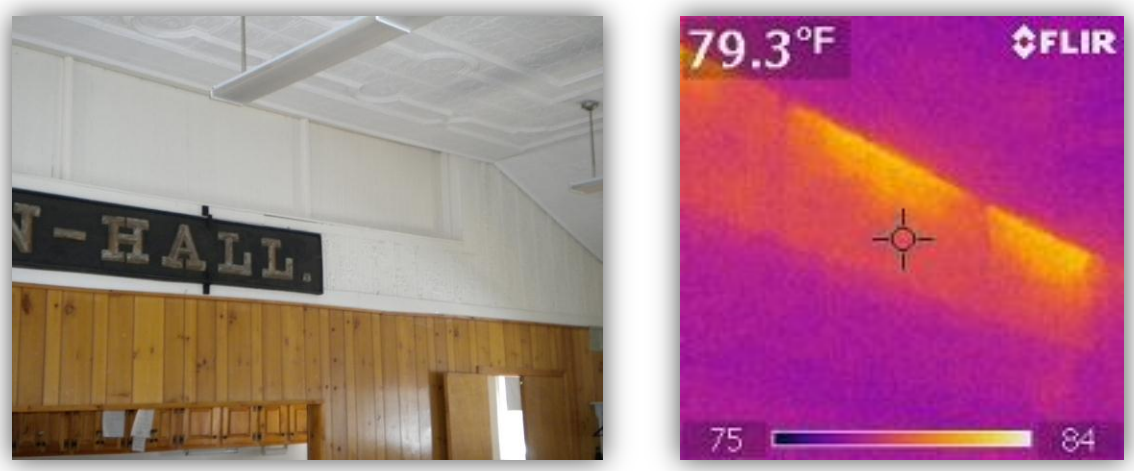


Figure 8

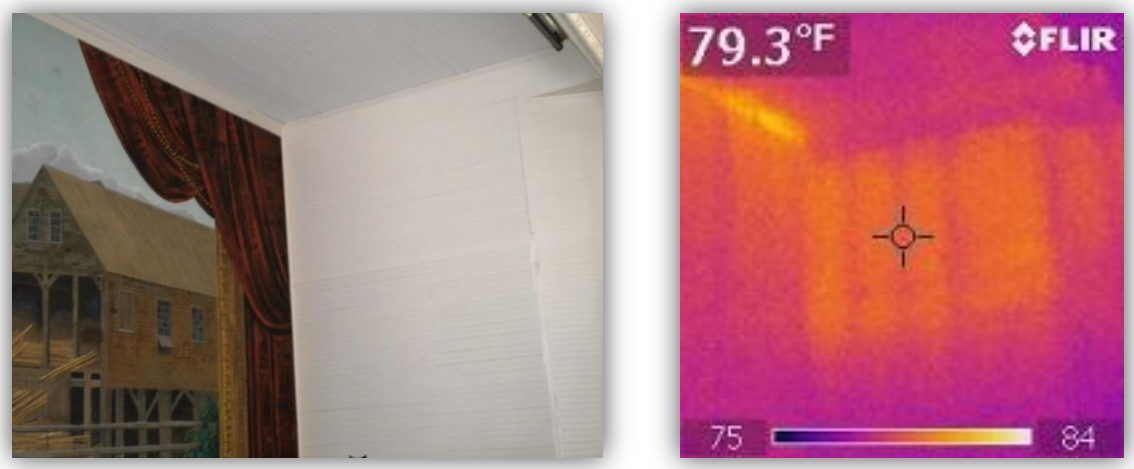


Figure 9

Figure 10 reveals two of the inefficiencies previously mentioned. To the left is a top view looking down into one of the exterior wall's cavities, which was insulated with loose fill fiberglass. As one can see, this insulation has settled quite a bit over the many years since it was installed and is now leaving the top few feet of this wall exposed.

The image to the right shows the attic side of the wall seen in Figure 9. Both of these images reveal why uninsulated walls in older buildings can have a greater negative effect because of how the walls have been framed. It is typical in buildings with balloon frames to have wall cavities exposed to the attic space. As heat conducts through the wall finish below or as warm air enters the wall cavity through gaps the cavity acts like a chimney, pouring the heated air into the attic space.

Figure 10

Ceilings and Attic:

Although there many inefficient aspects of the exterior walls of the original building, these are not the highest priority issues of the building envelope. The first priority for this building, and any other building of this type, is to address issues with the ceilings because of the following reasons: (1) the ceiling surface area of a building usually accounts for the largest amount of heat loss, (2) this is the part of the building envelope that is often the easiest to work on, because most of the work can usually take place from the attic.

Figure 11 shows the section of ceiling above the bathrooms. In this area there is both opportunity for air sealing and insulation.

Figure 11

Figure 12

This image shows a large opening into one of the attic spaces, exposing a large chase way for heat to escape.

This photo and IR image show the same chase way seen in Figure 10. The dark blue/purple color in the IR image is cold air from the space below being produced with an air conditioning unit. This, and other images of this type found within this report, are great examples of how air sealing and insulation projects will not only have a positive effect on reducing the oil bill but the electric bill as well.

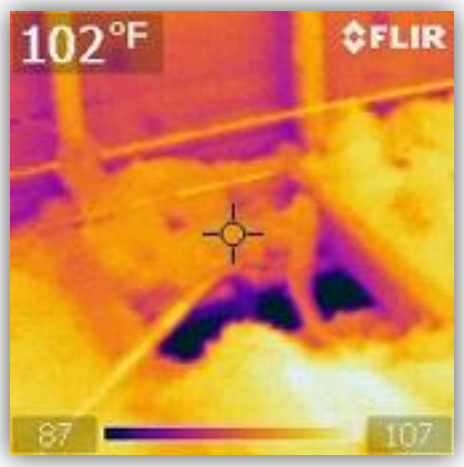


Figure 13

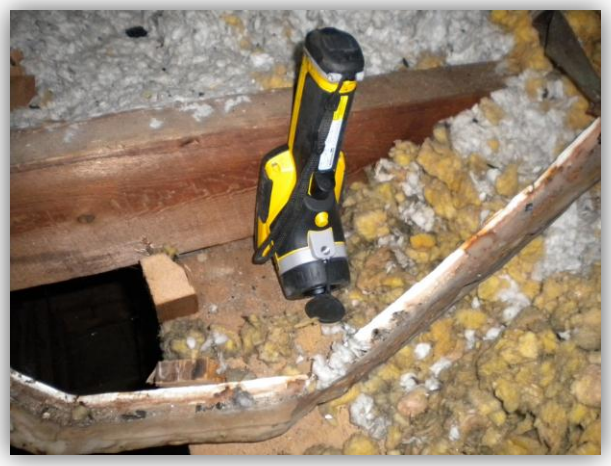


Figure 14

Figure 14 reveals how deep the ceiling cavities are over this section of the building. Given that some areas may be filled only to the top of this framing, while others may have a bit more depth, the weighted R-value of this ceiling may only be around R-20.

This section of the attic is above the small second floor area of the original building and shows a fairly consistent thickness of insulation (see Figure 15). What is also visible is one of two large passage ways from the space below into the attic. It is difficult to say whether or not this insulation is at all effective in this situation.
There is some insulation in the floor of the space below (the ceiling of the entry way), but this is also not an effective thermal barrier.

Figure 15

Figure 16

There are three attic spaces in the addition: one above the 2nd floor storage room, and one on either side. Figure 16 shows that there is only about 2-3 inches between the suspended ceiling and the framing. In the upper right corner of this photo, one sees the pink, un-faced, R-19 fiberglass insulation, which is situated between the floor joists under the storage room. The R-30 fiberglass with the craft face is beneath an unconditioned attic space.

There are a few inefficiencies seen in Figure 16. Whenever there are gaps around fiberglass insulation, it reduces the rated R-value of the product substantially. Like many types of insulation, fiberglass is only effective when it is in contact with a well-sealed air barrier. Neither the suspended ceiling nor the craft face of the insulation is providing an adequate air barrier. Furthermore, the gaps between the framing are allowing air flow. The other problem with this is that it lacks a vapor barrier. The combination of these not only translates to energy inefficiency, but if the attic space above is not well ventilated, the heat and moisture building up could cause condensation on the inside of the roof assembly and cause ice dams to form, which can lead to yet another moisture issue. The result is the degradation of the wooden frame, but it could also cause damage to the insulation over time and lead to mold growth.

Figure 17 shows the insulation from the attic space described in Figure 16. One can see that there is another layer of insulation, which gives the appearance of a very well insulated ceiling. However, the IR image to the right indicates the gaps and lack of air/vapor barrier earlier described. The dark purple is cold air from the air conditioned space below. In the winter months, an IR image of these same areas would be glowing orange, yellow, and white with heat loss.

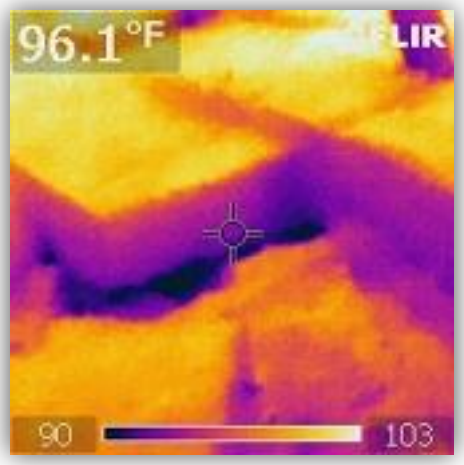


Figure 17

Yet another source of heat loss from the ceilings is the ductwork, which is still in place from a previous heating system (see Figure 18). Not only is the insulative value of this flexible duct work minimal, but the fiberglass insulation fits around it loosely. What's more, there are gaps around the registers in the suspended ceiling.

Figure 18

Figure 19 shows the attic space above the 2nd floor. The two major issues found here are as follows: (1) the proper vents leading from the attic spaces on either side of the storage room were found to be compressed and likely not allowing for adequate air flow, and (2) the sheetrock on the ceiling below has not been finished and may be allowing air flow in this space if a well-sealed vapor barrier is not in place.

Figure 19

Doors and Windows:

For the most part, the doors and windows in this building are not of great concern and like most buildings, are a low priority. Figure 20 does show gaps in the trim, which will allow air infiltration unless all of the gaps in the framing behind the trim have been well sealed with spray foam. Even if this is done, air movement from the wall cavities on all sides of the framing could allow for infiltration; therefore, the trim should be sealed with caulking.

Figure 20

With regards to the windows of the addition, seen here in Figure 21, the most important thing is to make sure that they are providing a good air seal—not just the windows but the trim around the windows as well. Making sure that any exterior doors are sealed well when closed is also important. This is easily accomplished with carefully installed weather stripping.

Figure 21

Mechanical:

The building is heated with a single oil fired boiler, which supplies hot water to radiators in several zones throughout the building. The indirect water heater, seen to the right of the boiler in Figure 22, is heated by the boiler and supplies hot water to the lavatories.

Figure 22

The service tags (see Figure 23) indicate that the combustion efficiency of the boiler has been consistently around 83%. A new oil boiler may offer a combustion efficiency of around 87%-88%, and this small increase of efficiency does not by itself warrant replacing this unit. As the useful life of this boiler may reach 5 or more years from now, there are ways in which to make this boiler run more efficiently: making adjustments to the nozzle size/oil pressure, making sure a flue damper is installed and functioning properly, and using some automated controls.

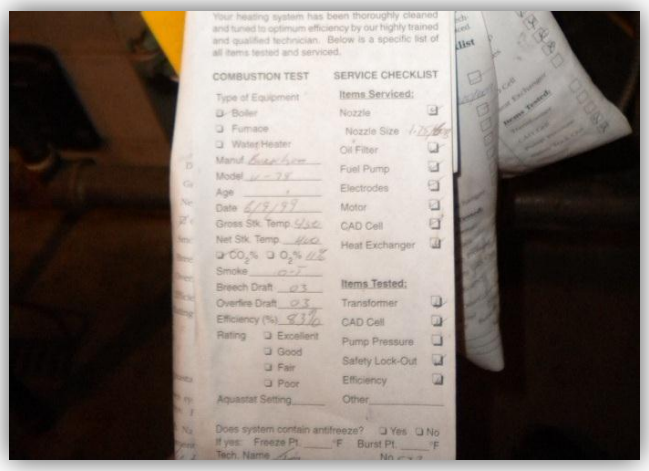


Figure 23

A common type of boiler control is an Outdoor Reset. An outdoor reset, or modulating aquastat, functions by monitoring the outdoor temperatures and automatically adjusts the temperature set points of a boiler. For example, on the coldest days of a NH winter, the temperature of the water sent to baseboard radiators will most often not need to be greater than 180°F. If the outdoor temperature is only 50°F, the boiler may only have to send 160°F water to the baseboard. Many types can also stage multiple boilers and help reduce short cycling. Outdoor Resets, in conjunction with an indirect hot water heater, can reduce fuel usage by 10%-20% on a yearly basis.

Most of the heating pipes in the basement do have insulation, though as Figure 24 shows, there could be a bit more care taken to ensure that all lengths of pipe are covered. Also, the pipes directly around the boiler are not insulated (see figure 22). Insulating these pipes will not only help to save on heating costs in the winter months but will help to reduce stand-by losses during the non-heating months as the boiler is always maintaining its core temperature.

Figure 24

Another easy way to save on heating cost is to install digital/programable thermostats and keep them set at an appropriate schedule for each zone.

Electrical:

The electric usage of this building is not extremely high, but there is always room for improvement.
Updating florescent tube fixtures while using T8 tubes instead of T12 and replacing any incandescent bulbs with compact florescent (CFL) or LED units are great first steps toward addressing electric tied to lighting needs. Also, invest in outdoor LED options for safety lights that are left on during the night year round. The more a light is used, the more important it is to use the most efficient source available.

Figure 25

Figure 26

There are several small air conditioning units in the office areas of this building. Turning these units off at night, keeping them at reasonable temperatures, keeping them clean, and replacing them with the highest efficiency units available when need be are the first measures for reducing this electric usage.
It is also important to remember that there are two forms of heat that these units work to expel, internal and external heat gains, and that making improvements to other aspects of the building helps to lighten both loads.
Most people think of external heat gains when thinking about air conditioning. This can be hot/humid air infiltrating the building, the heat from the building shell conducting toward the interior (opposite of winter), or even strong sunlight radiating in through the windows. Making improvements to the building shell will not only reduce the heating bill but the cost of cooling as well.

Some internal gains come from the occupants of a space, while other sources of heat are lighting, computers, appliances, and so forth. The more efficient these things are, the less heat they emit, thus reducing the cost to keep a space cool.

Consider unplugging the water bubbler seen here in Figure 27. As the IR image shows, this unit is constantly keeping the water cold and hot, even though this office may only be occupied for 12 out of 24 hours daily. If hot water is needed for a hot beverage, consider purchasing an electric tea pot, which will only be heating water when need be.

Figure 27

Health, Safety, and Comfort:

There were no major health or safety concerns found in this building. The exhaust system in Figure 28 was installed when the new foundation was constructed to help relieve the risk of radon gas from beneath the building.

There were no signs of rodents or bats. Such unwanted animals can emit harmful gases from their droppings and are common in a building like this. It is important to address such issues immediately should they arise. The first line of defense is always to eliminate access points into the building.

There are no signs of mold growth in this building. Any moisture issues that should occur need to be addressed right away, always beginning by eliminating the source of the moisture.

Figure 28

Any building, whether a residence or a place of business, needs to offer regular fresh air to the people living and working in these structures. The standards for how much fresh air to introduce vary depending on the use, size, and number of occupants in the structure. In some cases, this means introducing a continuous amount of air measured in cubic feet per minute (CFM). Other cases require a measured number of times per hour that the total volume of air is changed. If air-sealing and insulation work is completed on an existing building, it may leave the building providing inadequate amounts of fresh air. If an existing fresh air supply system was designed and installed well, meeting the requirements for the particular building based on square feet, use type, and number of occupants, than air-sealing projects should only serve to eliminate excessive ventilation. A blower door test would determine how tight the building is as a result of the efficiency upgrades, if there is a need for additional fresh air, and how much air to introduce.

Whether installing a fresh air supply system for the first time in a building, or wanting to make an existing system more energy efficient, the most effective way to provide fresh air in either case would be with a heat recovery ventilator (HRV) or an energy recovery ventilator (ERV). These units can be installed in a few different ways which vary where they pull stale air from, and where the fresh air is introduced to. In the case of integrating HRVs or ERVs into an existing forced-air distribution system, they will function by removing a percentage of the stale air from the return plenum, and then introducing charged, fresh air to the return plenum right before the air-handler. In the winter, warm/stale air being removed from the building will charge the incoming fresh air with a heat exchanger located inside the device. Conversely, in the summer months the exhausted cool/stale air from the interior will cool down the hot/humid air from the exterior before entering the air-handler. An ERV has a desiccant wheel as well. This allows for the transfer of moisture and recovery of some of the latent energy otherwise lost by expelling the moisture in the air. In the winter months, some of the moisture in the exhaust air will be transferred to the incoming dry air to help maintain occupancy comfort. In the summer, dry/conditioned air from the interior will remove, at least a portion of, the moisture from the humid incoming air - see Figure29. Typically, the benefits of an ERV are best realized in areas of high summertime humidity such as in the Southern and Southeastern regions of the US. Subsequently, HRVs are usually installed in the Northeast where humidity levels are generally lower. There are however conditions that may warrant an ERV such as in cold climates if there are few occupants (sources of humidity) in a large drafty building. The ERV may help to maintain more comfortable humidity levels.

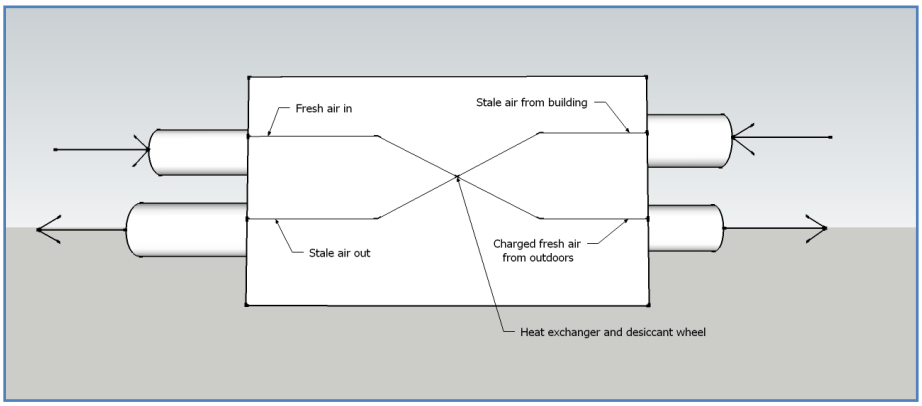


Figure 29

Recommendations:

The following list of recommendations will include steps for improving the performance of this building. Though further analysis is needed to give reasonable estimates of the effectiveness for the energy improvement recommendations, the health and safety concerns should be addressed regardless of whether or not they will reduce energy consumption. Some may in fact increase energy consumption.

This list will focus on each part of the building. Some sections may list the highest impact items first (large initial investment/large energy savings), others may be lower impact improvements that have a low implementation cost (may only require behavior change). These lists will be well explained during the presentation of this report.

Our prioritization is based on our "what works" experience. This list will not include detailed "spec" information on how exactly each item should be carried out. This type of detail would be presented in an IGA (Level II equivalent) in order to receive estimates for the cost of implementation, and return on investment.

Basement:

- At a minimum, eliminate air infiltration from the basement by air sealing the band joist around the entire perimeter of the building with closed cell spray foam.
- For greater long-term savings, continue the closed-cell foam down the interior of the foundation, applying at an average thickness of 2 inches.

Exterior Walls:

- Air seal all of the exterior walls from the inside of the building. This work should begin where the floor meets the wall and continue to the ceiling.
- Air seal and insulate any interior walls that extend into attic spaces.
- Fill any empty wall cavities will loose-fill cellulose insulation and air seal the tops of wall cavities where they meet the attic space.

Ceilings:

- Air seal cracks, gaps, mechanical penetrations (including old duct work), and large holes from the conditioned areas of the building to any attic spaces. This includes the ceiling of the main hall, the ceiling of the 2nd floor storage areas in the old and new sections of the building, lavatories and closets, and the ceilings of the addition office spaces. It will be difficult to address the ceilings above the addition office spaces with the suspended ceiling in place. In this case in particular, it is advised to seal above the suspended ceiling with a vapor diffusion retardant.
- Adjust or replace the proper vents which lead from the attic spaces on either side of the 2nd floor of the addition to the attic space above.
- Blow loose-fill cellulose insulation in the uninsulated areas of the attic (above the lavatories) and add this same insulation to all attic spaces with the goal of reaching an R-45 to R-60.

Doors and Windows:

- Make sure that all door and window units are sealed well when closed. Install high efficiency storm windows if needed.
- Make sure that the framing around the window and door units is well sealed. This may entail temporarily removing the trim and filling gaps and cracks with spray foam, then replacing the trim and seal with caulking.

Mechanical:

- Finish insulating all piping, including any corners and the piping directly around the boiler.
- Replace thermostats with new digital/programmable units. Appropriate time and temperature settings can be discussed during the presentation of this report.
- Install an outdoor reset on the boiler to control temperature output.
- Talk with the service technician about options to increase the combustion efficiency of the current boiler.
- Install a solar domestic hot water system, and turn off the boiler during none heating months.

Electrical:

- Make use of smart power strips, and be sure to cut the power to any equipment when it is not in use.
- Replace any outdated florescent tube fixtures, and only use T8 florescent tubes.
- Replace any incandescent bulbs with either CFL or LED units. Be sure to focus any investment in LED lights to those lights that are used the most.
- Be sure to invest in the highest efficiency, Energy Star rated equipment when buying new items or replacing the old. Pay special attention to the highest energy users like air conditioning units and refrigerators.
- After efficiency matters have been addressed, install a photovoltaic solar system to provide onsite generation of electricity in order to supplement or eliminate what electric needs remain.

Health and Safety:

- Install HRV or ERV units to ensure an adequate number of air exchanges per hour for those working or doing business in this building.
- Address any pest or moisture issues that may arise, always by first eliminating the source or access of such unwanted problems.
- Always keep the health and safety of the occupants of this building first on any list of priorities.

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.

New Hampshire Energy Technical Assistance and Planning (ETAP):

ETAP is a NH specific program funded by the American Recovery and Reinvestment Act (ARRA). This federally funded program is being administered by the NH Office of Energy and Planning, and is designed specifically to aid NH municipalities as they plan for and implement measures to reduce municipal energy costs.

The highly experienced ETAP team is eager to provide this assistance to your community, but you must sign into the program before mid-2012. Your community will not be required to write a proposal, and there are not charges for these services. It is important to remember that participating in any program will require time from municipal staff. The hours needed would likely run parallel to the size and complexity of the project your community wants to endeavor.

For inquiries on how your community can receive assistance from this valuable program, you will need to contact the ETAP Technical Assistance Coordinator, Eric Halter, at 603.225.3060. You can also get started by directly contacting the Lakes Regional Planning Commission (RPC). **Lakes RPC** - 603.279.8171

NH Community Development Finance Authority (CDFA) – Municipal Energy Reduction Fund:

The NH CDFA was awarded $1.5 million through the Regional Greenhouse Gas Initiative (RGGI) to establish a revolving loan program in order to aid NH municipalities wishing to make their building stock more energy efficient. These loans are structured based on the amount of energy a given project will reduce, and terms/rates are flexible.

Municipalities can register and apply online at:
www.nhcdfa.org/web/erp/merf/merf_overview.html

For questions regarding this program, contact Cassandra Bradley at 603.717.9114 – cbradley@nhcdfa.org

NH PUC – Commercial and Industrial Renewable Energy Rebate Program:

The NH Public Utilities Commission has created a rebate program for renewable energy systems that is available to Local Governments. Participants will need to have a "Level II" audit performed, and some of the energy efficiency measures implemented prior to being eligible for receiving the final rebate. This is a great opportunity for municipalities who are interested in installing a renewable energy system to receive a similar type of aid previously only available in residential and commercial applications.

There is a maximum incentive, and funding is limited, which means that municipalities will have to carry much of the cost. Participants need to fully understand and follow the project guidelines.

For questions regarding this program contact:
Kate Epsen
NH PUC
603.271.2431
kate.epsen@puc.nh.gov

More information can be found online at:
http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-CI.html

Utility Programs:

Barnstead is served by both PSNH and NH Electric Coop. Both utilities provide technical and financial assistance for various types of efficiency measures that can be carried out at a municipal facility. Some programs offer 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. Contact your utility provider to discover ways in which they can assist your municipality in reaching its energy efficiency goals.

For PSNH Customers - contact the PSNH representative for your region:

- Seacoast/Northern Region, Kathleen Lewis, 603.436.7708 ext. 5628 lewiskx@nu.com
- Southern Region, Elizabeth Larocca, 603.634.2380 larocel@nu.com
- Western/Central Region, Sue Blothenburg, 603.357.7309 ext. 5115 blothse@nu.com
- Visit - http://www.psnh.com/SaveEnergyMoney/For-Business/Municipal-Smart-Start-Program.aspx

From PSNH's Program website:
PSNH's municipal customers have the opportunity to install energy saving measures with no upfront costs - through our Smart Start Program. Payment for services and products are made over time with the savings obtained from lower energy costs.

Here's how it works:

- PSNH applies rebates for all eligible retrofit measures.
- PSNH finances the remaining costs associated with the purchase and installation of approved measures.
- A Smart Start Purchase and Installation Charge, calculated to be less than the monthly savings, is added to your monthly electric bill until all costs are repaid.
- The new energy efficient, environmentally friendly equipment you install through this program pays for itself over time.

For NH Electric Coop Customers:

- Contact Member Solutions at 1.800.698.2007
- Visit - www.nhec.com/energy_efficiency_programs.php

Additionally, a terrific resource for monitoring and 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.

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 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.

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.

The follow Table and three Graphs were retrieved from the U.S Energy Information Administration website, were included in the 2010 Annual Energy Outlook, and are a clear indications of the fact that energy costs will continue to rise over the long term. It is extremely difficult to predict how quickly the cost of energy will escalate as there are too many economic, political, resources, etc. variables that influence these prices. Some years energy cost may be much lower than predicted, and some years may be much higher. The one thing that appears to be certain is that the cost of energy in the decades to come will pose great financial burdens on NH municipalities and their tax payers if no steps are taken to prepare for this forecast.

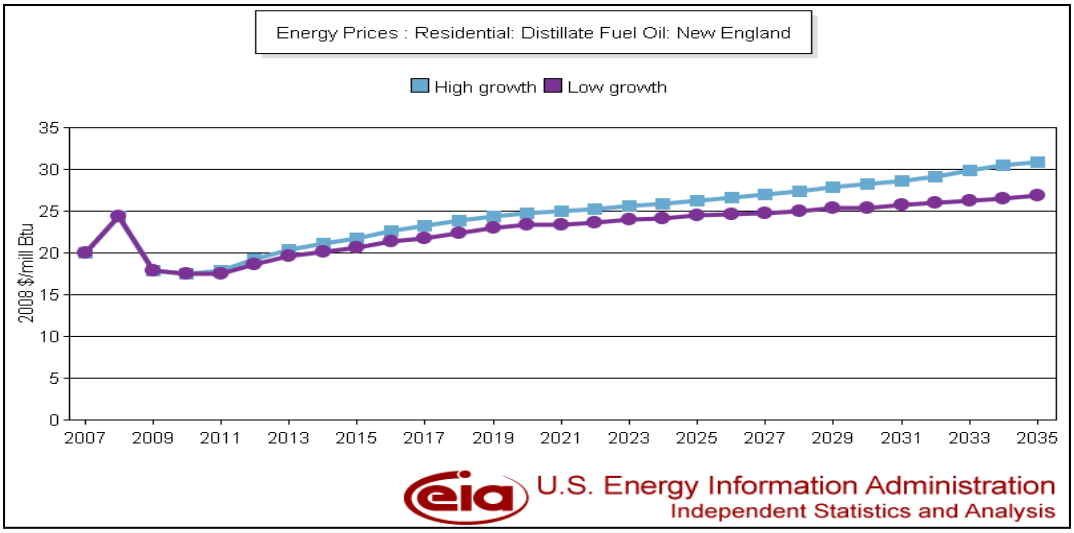
For more information on the history of energy prices and how energy cost projections are calculated, please visit: http://www.eia.doe.gov/analysis/

Price Summary

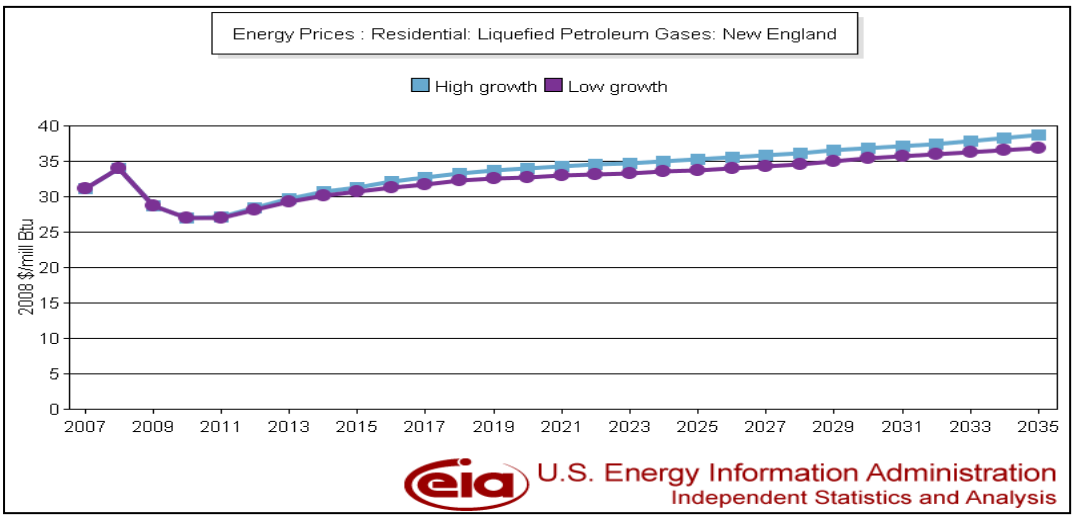
	Year				Percent Change		
	2009	2010	2011	2012	09-10	10-11	11-12
WTI Crude[a] ($/barrel)	61.65	79.40	93.26	97.50	28.8	17.5	4.5
Gasoline[b] ($/gal)	2.35	2.78	3.15	3.30	18.4	13.4	4.8
Diesel[c] ($/gal)	2.46	2.99	3.43	3.51	21.5	14.7	2.4
Heating Oil[d] ($/gal)	2.52	2.97	3.41	3.55	17.5	14.8	4.3
Natural Gas[d] ($/mcf)	12.12	11.17	11.29	12.01	-7.8	1.1	6.3
Electricity[d] (cents/kwh)	11.51	11.58	11.65	11.74	0.7	0.6	0.7

[a] West Texas Intermediate. [b] Average regular pump price.
[c] On-highway retail. [d] U.S. Residential average.

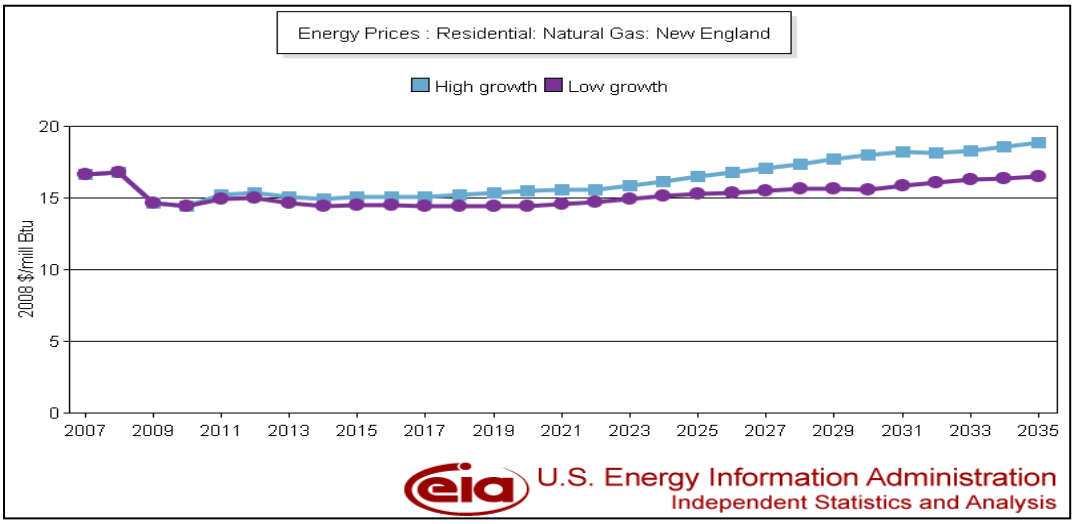
Table 1 – Retrieved from US EIA website



Graph 1 - Retrieved from US EIA website



Graph 2 - Retrieved from US EIA website



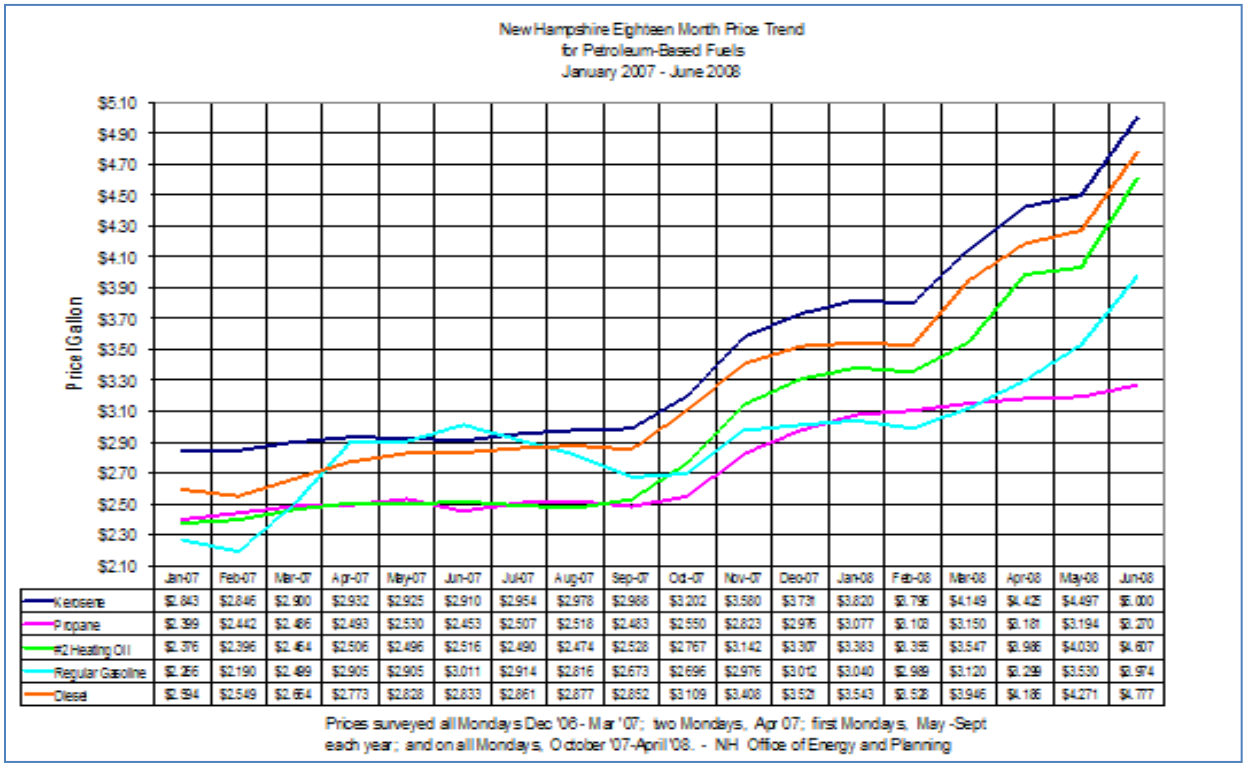
Graph 3 - Retrieved from US EIA website

The following three Graphs (retrieved from the NH OEP website) show average prices in NH for liquid fuels beginning in January of 2007 and end in December 2010. These graphs help to illustrate just how volatile the cost of energy is, and the steady rise of price regardless of occasional "spikes" or "dips" in the market. As unfortunate as the 2008 energy prices were, these types of events only serve to shorted the Return on Investment for those who implemented energy efficiency measure prior to their occurrence.

When considering the type of energy reduction project to implement, it is very important for Local Governments to look far into the future of energy costs, as municipalities will own and operate most of their building stock for as long as they may stand.

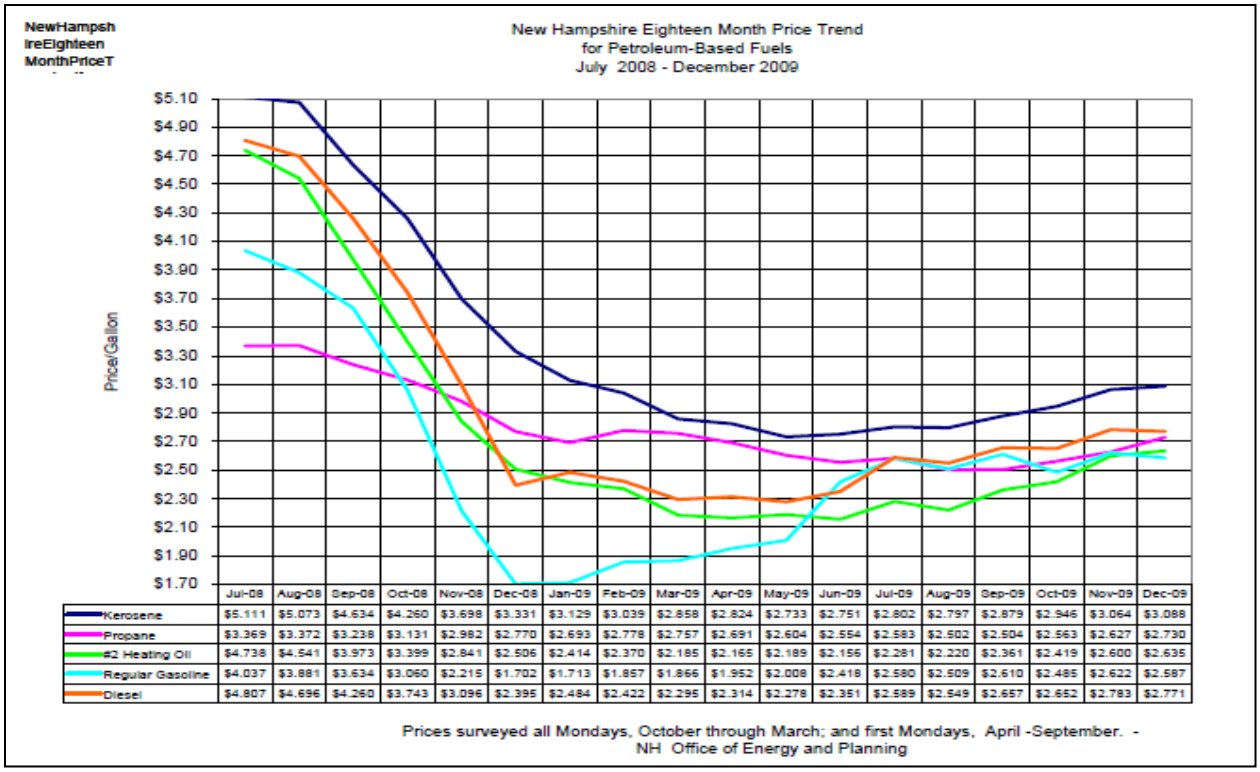
Projects such as air-sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler and a PV system may only last 30 years before it is time to replace them, even with careful maintenance and care. 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 is as small as it can be, providing the most savings.



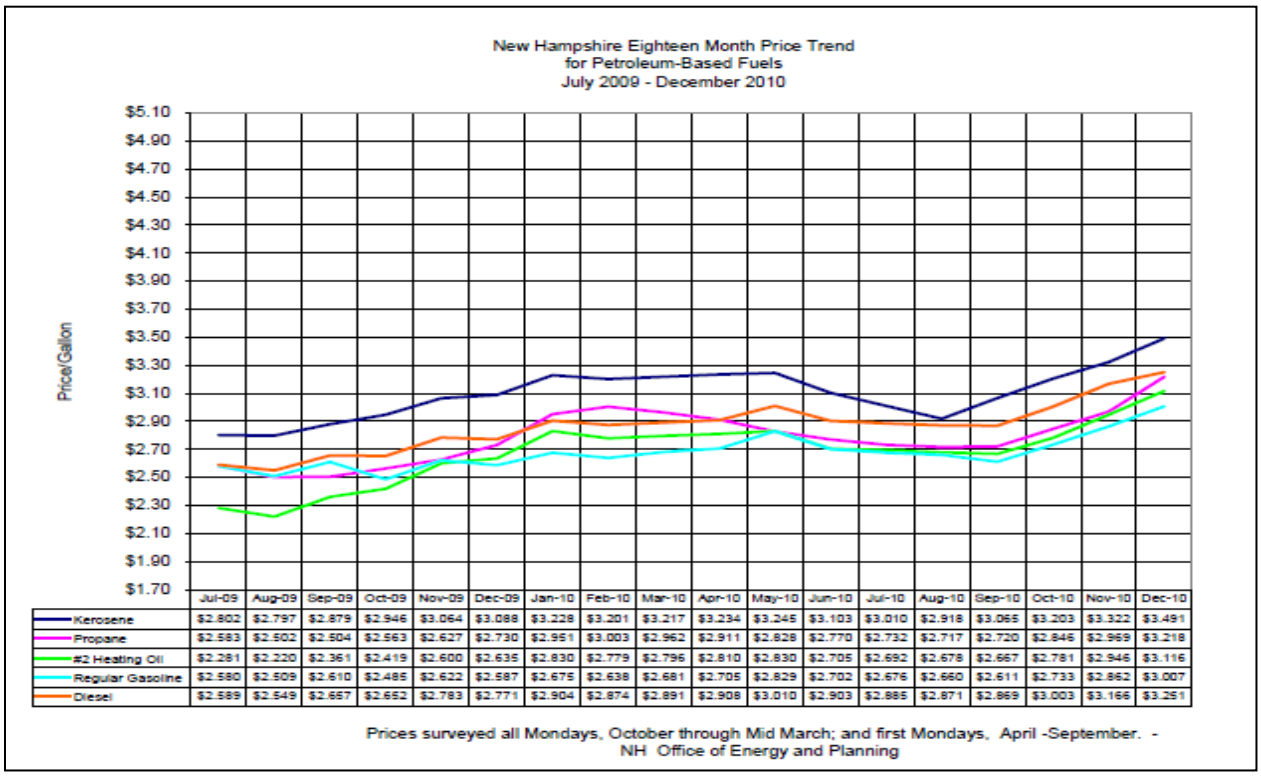
	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
Kerosene	$2.843	$2.846	$2.900	$2.932	$2.925	$2.910	$2.954	$2.978	$2.988	$3.202	$3.580	$3.731	$3.820	$3.796	$4.149	$4.425	$4.497	$5.000
Propane	$2.399	$2.442	$2.466	$2.493	$2.530	$2.453	$2.507	$2.518	$2.483	$2.550	$2.823	$2.975	$3.077	$3.103	$3.150	$3.181	$3.194	$3.270
#2 Heating Oil	$2.376	$2.396	$2.464	$2.506	$2.496	$2.516	$2.490	$2.474	$2.528	$2.767	$3.142	$3.307	$3.383	$3.355	$3.547	$3.986	$4.030	$4.607
Regular Gasoline	$2.266	$2.190	$2.499	$2.905	$2.905	$3.011	$2.914	$2.816	$2.673	$2.696	$2.976	$3.012	$3.040	$2.989	$3.120	$3.299	$3.530	$3.974
Diesel	$2.594	$2.549	$2.664	$2.773	$2.828	$2.833	$2.861	$2.877	$2.852	$3.109	$3.408	$3.521	$3.543	$3.528	$3.946	$4.186	$4.271	$4.777

Figure 30 - Retrieved from NH OEP website



	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Kerosene	$5.111	$5.073	$4.634	$4.260	$3.698	$3.331	$3.129	$3.039	$2.858	$2.824	$2.733	$2.751	$2.802	$2.797	$2.879	$2.946	$3.064	$3.088
Propane	$3.369	$3.372	$3.238	$3.131	$2.982	$2.770	$2.693	$2.778	$2.757	$2.691	$2.604	$2.554	$2.583	$2.502	$2.504	$2.563	$2.627	$2.730
#2 Heating Oil	$4.738	$4.541	$3.973	$3.399	$2.841	$2.506	$2.414	$2.370	$2.185	$2.165	$2.189	$2.156	$2.281	$2.220	$2.361	$2.419	$2.600	$2.635
Regular Gasoline	$4.037	$3.881	$3.634	$3.060	$2.215	$1.702	$1.713	$1.857	$1.866	$1.952	$2.008	$2.418	$2.580	$2.509	$2.610	$2.485	$2.622	$2.587
Diesel	$4.807	$4.696	$4.260	$3.743	$3.096	$2.395	$2.484	$2.422	$2.295	$2.314	$2.278	$2.351	$2.589	$2.549	$2.657	$2.652	$2.783	$2.771

Graph 4 – Retrieved from NH OEP website



	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Kerosene	$2.802	$2.797	$2.879	$2.946	$3.064	$3.088	$3.228	$3.201	$3.217	$3.234	$3.245	$3.103	$3.010	$2.918	$3.065	$3.203	$3.322	$3.491
Propane	$2.583	$2.502	$2.504	$2.563	$2.627	$2.730	$2.951	$3.003	$2.962	$2.911	$2.828	$2.770	$2.732	$2.717	$2.720	$2.846	$2.969	$3.218
#2 Heating Oil	$2.281	$2.220	$2.361	$2.419	$2.600	$2.635	$2.830	$2.779	$2.796	$2.810	$2.830	$2.705	$2.692	$2.678	$2.667	$2.781	$2.946	$3.116
Regular Gasoline	$2.580	$2.509	$2.610	$2.485	$2.622	$2.587	$2.675	$2.638	$2.681	$2.705	$2.829	$2.702	$2.676	$2.660	$2.611	$2.733	$2.862	$3.007
Diesel	$2.589	$2.549	$2.657	$2.652	$2.783	$2.771	$2.904	$2.874	$2.891	$2.908	$3.010	$2.903	$2.885	$2.871	$2.869	$3.003	$3.166	$3.251

Graph 5 – Retrieved from NH OEP website

Potential for Savings:

(The following numbers are not meant to be accurate estimates. Such estimates are only provided in an Investment Grade Audit (IGA). Instead, these numbers are only meant to give a rough idea of what potential for savings there may be in regards to the current energy expenditures given a 30% reduction).

Average cost of various energy types in NH
Date - January 31st 2011

Heating Oil, credit	$3.463 per Gallon
Propane, credit	$3.549 per Gallon[1]
Kerosene, credit	$3.841 per Gallon
Electricity	$0.14260 per kilowatt-hour[2]
Natural Gas, first tier	$1.1305 per therm[3]
Natural Gas, second tier	$1.0622 per therm[4]

Figure 31 – Retrieved from NH OEP website

The table below estimates the cost of liquid fuel for this facility over a 15 year period. This is only an estimate, and is based on current yearly usage, NH price averages for January 31st 2011, with a 5% cost increase per year.

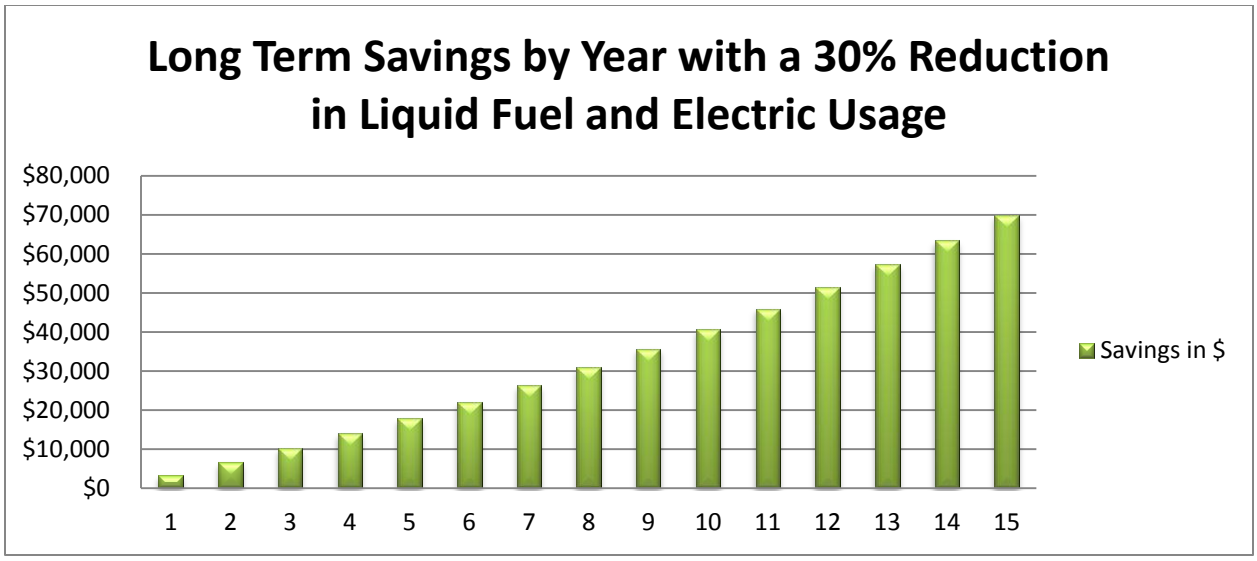
Current Fuel Usage				
Year	Energy Cost By Year	Yearly Increase	Total Accumulated Cost by Year	
		Escalation Rate	5.00%	
Year 1	$7,538.95	$ 376.95		$7,539
Year 2	$7,916	$ 395.79		$15,455
Year 3	$8,312	$ 415.58		$23,767
Year 4	$8,727	$ 436.36		$32,494
Year 5	$9,164	$ 458.18		$41,657
Year 6	$9,622	$ 481.09		$51,279
Year 7	$10,103	$ 505.15		$61,382
Year 8	$10,608	$ 530.40		$71,990
Year 9	$11,138	$ 556.92		$83,129
Year 10	$11,695	$ 584.77		$94,824
Year 11	$12,280	$ 614.01		$107,104
Year 12	$12,894	$ 644.71		$119,998
Year 13	$13,539	$ 676.94		$133,537
Year 14	$14,216	$ 710.79		$147,753
Year 15	$14,927	$ 746.33		**$162,680**

The table below estimates the cost of electricity for this facility over a 15 year period. This is only an estimate, and is based on current yearly usage, the average cost per delivered kWh for the measured year, with a 5% cost increase per year.

Electric Use - Current Usage				
Year	**Energy Cost By Year**	**Yearly Increase**	**Total Accumulated Cost by Year**	
		Escalation Rate	**5.00%**	
Year 1	$3,238.80	$ 161.94		$3,239
Year 2	$3,401	$ 170.04		$6,640
Year 3	$3,571	$ 178.54		$10,210
Year 4	$3,749	$ 187.47		$13,960
Year 5	$3,937	$ 196.84		$17,896
Year 6	$4,134	$ 206.68		$22,030
Year 7	$4,340	$ 217.02		$26,370
Year 8	$4,557	$ 227.87		$30,928
Year 9	$4,785	$ 239.26		$35,713
Year 10	$5,024	$ 251.22		$40,737
Year 11	$5,276	$ 263.78		$46,013
Year 12	$5,539	$ 276.97		$51,552
Year 13	$5,816	$ 290.82		$57,369
Year 14	$6,107	$ 305.36		$63,476
Year 15	$6,413	$ 320.63		**$69,889**

The table below is based on the previous two tables, and estimates the savings over a 15 year period if both fuel and electric usage is reduced by 30%.

Long Term Savings - Oil and Electricity				
Percent of Cost Reduction =			**30.00%**	
Year	**Avoided Cost By Year**	**Savings Gain By Year**	**Total Savings Over 15 Years**	
		Escalation Rate	**5.00%**	
Year 1	$3,233	$ 161.67		$3,233
Year 2	$3,395	$ 169.75		$6,628
Year 3	$3,565	$ 178.24		$10,193
Year 4	$3,743	$ 187.15		$13,936
Year 5	$3,930	$ 196.51		$17,866
Year 6	$4,127	$ 206.33		$21,993
Year 7	$4,333	$ 216.65		$26,326
Year 8	$4,550	$ 227.48		$30,875
Year 9	$4,777	$ 238.85		$35,652
Year 10	$5,016	$ 250.80		$40,668
Year 11	$5,267	$ 263.34		$45,935
Year 12	$5,530	$ 276.50		$51,465
Year 13	$5,807	$ 290.33		$57,272
Year 14	$6,097	$ 304.85		$63,369
Year 15	$6,402	$ 320.09		**$69,771**



Conclusion:

As a result of this audit, the Town has several options available to increase the efficiency of the Town Hall. Achieving 30% savings in energy cost for this building is well within reach, and as the above graph helps to illustrate, the initial investment for energy improvement projects can have an attractive return. Considering that this building will likely be owned and operated by the Town for a period much longer than the next 15 years, we highly encourage that the Town pursue these recommendations described in this report. More detail about our findings and recommendations can be given during the presentation of this report.