The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Sam Lake House
10 Hackleboro Road, Canterbury, NH 03224

Prepared for:

Town of Canterbury, NH

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3/30/2011

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 Canterbury 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 Canterbury.

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Canterbury and the Sam Lake House (hereinafter "the building" or "offices"). 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. A cost:benefit ratio can be determined for burning any of these fuels with a forced air system, a radiant floor system, hydro-air, baseboard radiators or various other heating systems. Any of these heating plants, 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.

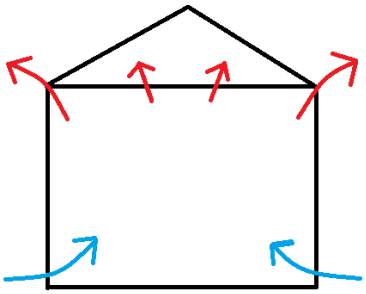
This DGA involves a quantification of energy consumption (electrical and heating fuel), a description of existing heating/cooling and distribution systems, thermal barrier inefficiencies, potential electric savings through lighting/appliances upgrades and behavior change, occupancy health and safety 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.

Many of an 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 conventional, alternative and renewable high-efficiency heating and cooling systems, has designed 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 specification 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.

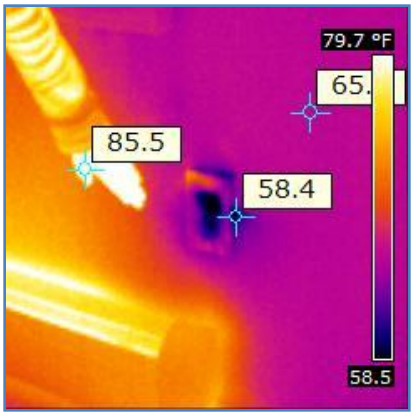
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



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.

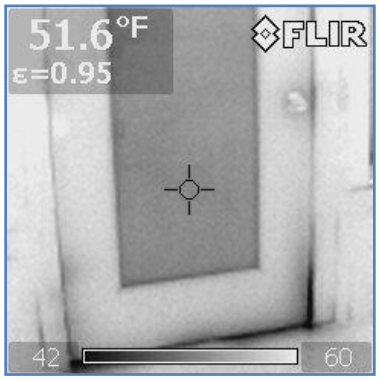
Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope 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 original section of the building was constructed in 1840. A new addition was constructed in the last 20 years to expand office space, and there has been extensive renovation work done to the rest of the building. The office space is located on the 1st floor. Only the space under the addition is suitable for storage. The 2nd floor space above the addition is also used for storage as well as the 2nd floor space above the original building.

Figure 1

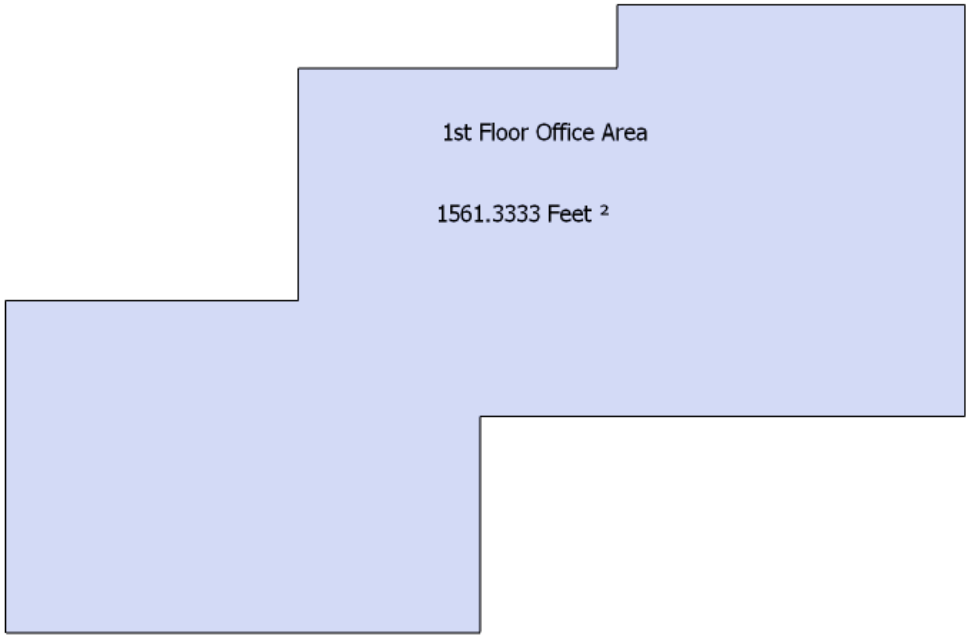


Figure 2

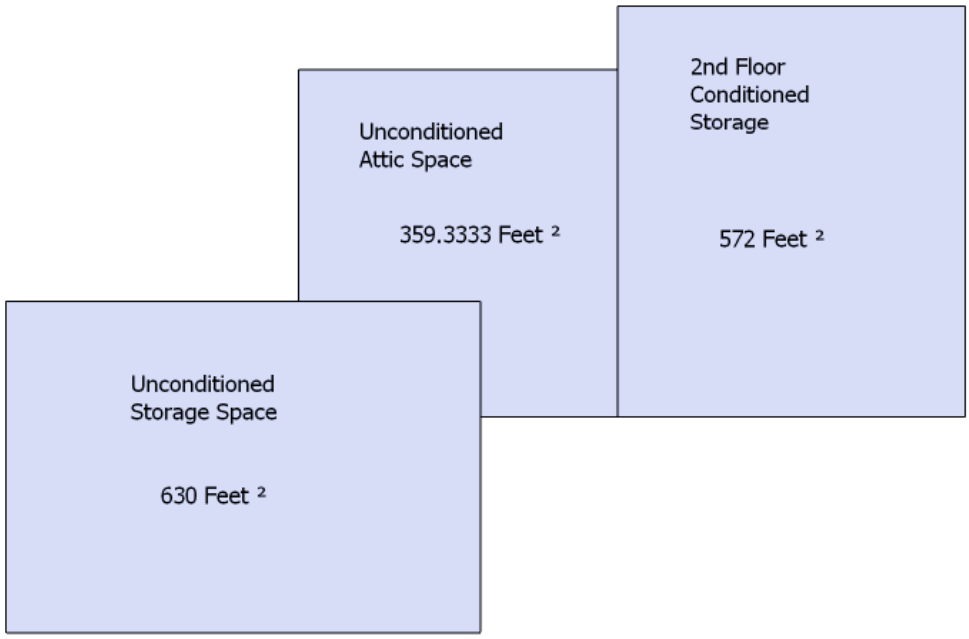
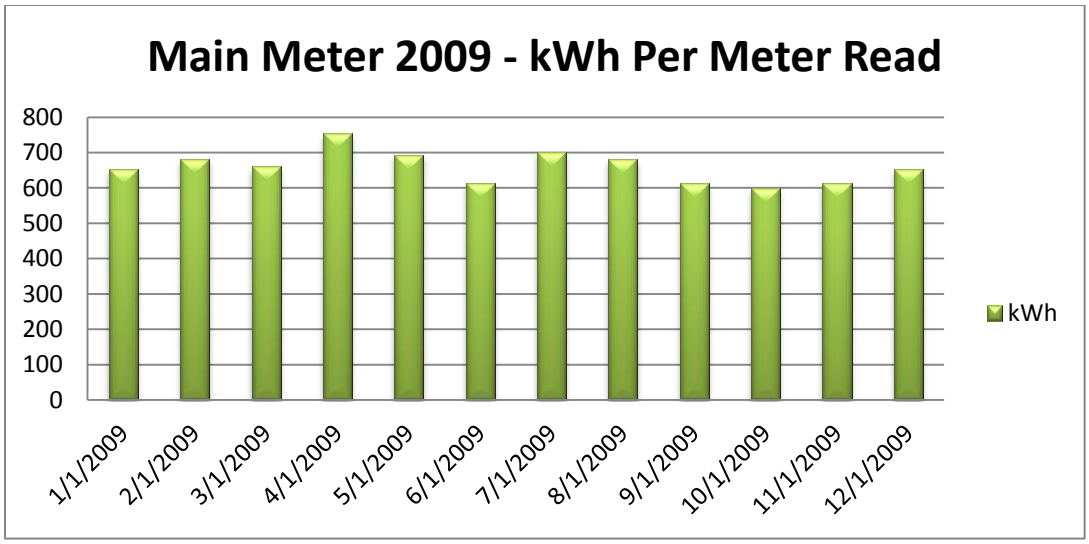


Figure 3

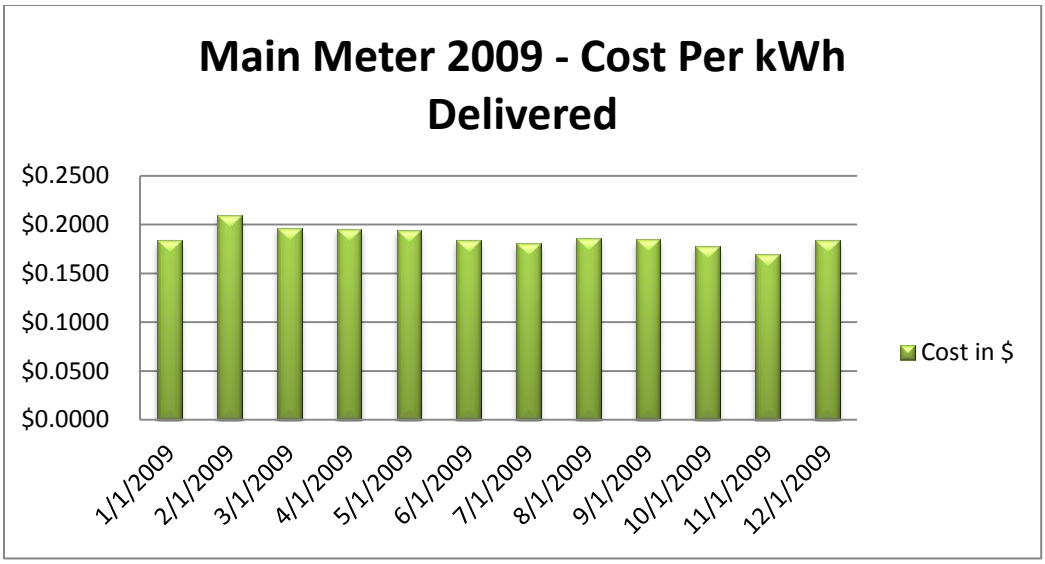
Energy Data Collection:
Analysis from provided utility bills for 2009 produced the following snapshot of electricity consumption. Monthly consumption is designated low to high, red being the lowest and green being the highest consumption months in the table below.

Electric -Main Meter – 2009			
Unitil			
Date	**KWH**	**Total $/Mo**	**Cost Per kWh**
12/1/2009	651	$119.88	$0.1841
11/1/2009	613	$103.94	$0.1696
10/1/2009	598	$105.97	$0.1772
9/1/2009	612	$112.98	$0.1846
8/1/2009	680	$126.68	$0.1863
7/1/2009	699	$126.13	$0.1804
6/1/2009	611	$112.33	$0.1838
5/1/2009	693	$134.63	$0.1943
4/1/2009	754	$147.56	$0.1957
3/1/2009	660	$129.79	$0.1967
2/1/2009	682	$143.03	$0.2097
1/1/2009	651	$119.88	$0.1841

Total kWh This Year =	**7904**
Total Paid For Year=	**$1,482.80**
Ave Cost Per kWh =	**$0.1872**



Annual electricity consumption for the Canterbury Town Offices



Cost of delivered electricity for the Canterbury Town Offices

Heat Source 1 - Oil Boiler			
NO.2 Oil			
Date	**Fuel Units**	**$**	**Cost Per Unit**
12/1/2009	261	$494.60	1.8950192
10/1/2009	24	$44.72	1.8633333
8/1/2009	76	$174.73	2.2990789
4/1/2009	246	$514.77	2.092561
3/1/2009	142	$297.41	2.0944366
2/1/2009	171	$340.69	1.9923392
1/1/2009	226	$494.50	2.1880531

Total Units Used =	**1146**
Total Paid For Year =	**$ 2,361.42**
Ave Cost Per Gal =	**$ 2.06**

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 Basements:

The older sections of this building sit on top of a stone foundation. This foundation has many gaps, cracks, and holes, which allow for bulk water, air, and pest intrusions. As this photo shows, chicken wire has been put in place to keep larger animals out, but this only addresses what is likely the least troubling of all problems.

This photo shows a small basement area under one corner of the building. The fallen fiberglass insulation represents decreased energy efficiency and comfort for those working in the space above, but this is not the greatest concern in this space

This photo shows a type of fungus growing on the floor joists. This is not only a structural concern, but more importantly, a health concern as the stack effect of this building can draw spores into the occupied 1st floor.

This photo indicates how the bulk moisture on the floor of this space is rotting the bottom of the wood support columns. As part of addressing the moisture concerns in this space, these support columns should be replaced with reinforced steel columns.

Seen in this photo is a drain coming from the hot water heater above. One of the first steps toward keeping this space dry will be to make sure that no internal sources of water are present.

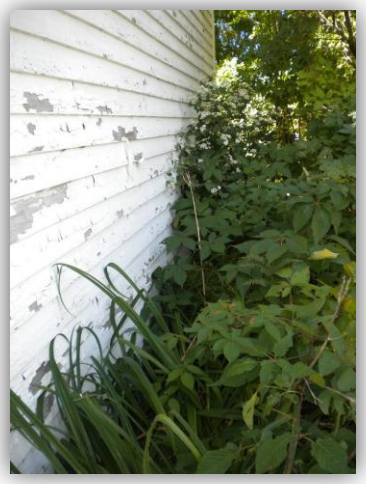
This is a photo of the crawl space between the basement area just discussed and the new basement of the addition. One can see how wet the sand is in this space. It would certainly be difficult to work in this area in order to perform moisture control and insulation work, but as all of the piping and wiring in this photo proves, it is quite possible.

This photo was taken from the basement under the new addition. The band joists have been insulated with pieces of fiberglass insulation. Not only does this offer little R-value, but this does little to impede air infiltration. The fiberglass should be removed, and the entire band joist should be sprayed with 2 inches of closed-cell spray foam insulation. The concrete walls are also a large source of heat loss and a source of water vapor. Insulating these walls with rigid foam board would be very beneficial.

The dehumidifier and the small electric space heater seen in the photos below are expensive ways to address some of the problems found beneath the offices, and neither actually address the sources of the problems. Controlling moisture, air infiltration, and heat loss from the basements and crawls spaces will not only create greater comfort, improve indoor air quality, increase structural durability, and save on the cost of oil, but will also reduce the electric load by eliminating the need for these intensive electrical devices.

Exterior Walls:

This building has wooded clap board siding. Much of the siding needs to be scraped and painted for preservation purposes, and some of the siding and trim may need to be replaced all together. In this photo, one sees a trim board that has pulled away from the building with the foam that was sprayed behind it exposed at the top. This is allowing for bulk water to get behind this trim, and could be rotting the band joist that this wall sits on.



All trees, shrubs, and other vegetation should be trimmed at least 1 foot away from the building. Not only does vegetation growth, as seen in this photo, not allow for moisture in the siding and trim to dry, but in almost all circumstances like this, ants or other insects will move into the structure.

Any siding and trim should be well away from sources of moisture. Whether it is trim next to the ground, or clap boards on the cheek of this dormer, the wood will absorb the moisture and begin to rot. The ends of these clap boards should be at least 1.5 inches above the roof line.

There is little to be done to increase the thermal efficiency of the addition walls. There may be an opportunity to increase the efficiency of the walls in the rest of the building. When the renovations were done, it appears as though new stud walls were constructed inside of the original exterior walls. We believe that the original walls may still be uninsulated. If this is true, it may be possible to increase the R-value of these walls by blowing in cellulose insulation.

Ceilings and Attic:

When the old sections of the building were renovated, new stud walls and ceiling joists were installed with fiberglass insulation before being finished with sheetrock. This photo shows the space between the new finished ceilings and the original 2nd floor joists. Note the kraft-face of the fiberglass batts facing the wrong direction. It may be possible to continue filling this space with loose-fill cellulose insulation. We recommend consulting with an insulation company who works with cellulose about this possibility, as well as the walls.

This picture shows the ceiling structure and minimal insulation of the space seen in Figure 3 labeled "Unconditioned Attic Space."

The two photos below show clear indications of bats living in the attic, and one of the ways in which they can enter. Mice and bats are an important part of our ecosystem. Bats in particular are very beneficial and have been faced with many human-made challenges, and their numbers are dwindling as a result. As beneficial as they are, they do not belong in our buildings, which need to be sealed or well screened in order to keep them out. Bat boxes on the property are a great option for keeping these important creatures on the grounds of this building.

The roof of the original building is old, worn, and in need of replacement. The photo below and to the right was taken of the eve of a different section of roof. The drip flashing was not installed well, and it may be possible for water to drip behind the fascia trim. If water does get into the space, it can then drip behind the siding and into the wall cavity. When work to the roof is done, the entire roof should be examined and issues like this should also be addressed.

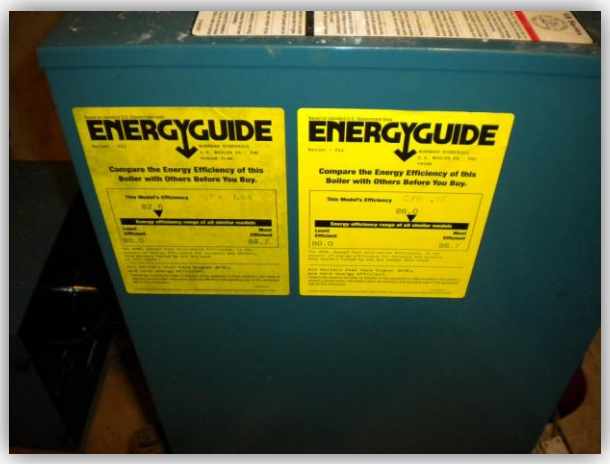
Doors and Windows:

Any missing trim, like that seen in this photo, should be filled in, properly flashed, and sealed from the elements.

A couple of the storm windows, like the one seen in this photo, seemed to be missing the bottom flange. Storm windows are an important way to help reduce air infiltration, but if they are not installed and maintained well, then they will lose their benefit.

Replacing windows in a building usually is fairly low on a prioritized list of energy improvement recommendations, and this holds true for this building. This is because the cost of window replacement projects tend to be substantial, while the amount of energy saved is less significant. The result can be a 20 or more year return on such an investment. The historic value of the current windows may also place limits on this option. However, it is important to make sure that the current windows perform as well as possible. This means making sure that they are well sealed when they are closed. One important measure for accomplishing this is with high efficiency storm windows. High efficiency storm windows, which allow for minimal amount of air infiltration, can be ordered with a low-e coating to further increase efficiency by reflecting some of the radiant heat loss back into the building. Some high efficiency units will also be certified to use in airport zones for their ability to reduce noise pollution.

Mechanical:



This building is heated with a single oil-fired boiler that was installed 1990. There are two efficiency tags on this boiler, which we have never seen before, and relate to the nozzle sizes that could be installed in the burner. This boiler may be using a 1.05 GPH nozzle, which means it would be combusting oil at only around 82.6% efficient. If this is so, talk to the service technician about decreasing the nozzle size and increasing the oil pressure. Making adjustments like this could increase efficiency by as much a 5%.
There are some types of boiler controls that could be installed to help increase efficiency, such as an outdoor temperature 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 will also reduce stand-by losses. Installing one of these units is an affordable solution and can reduce fuel usage by 10%-20% on a yearly basis.

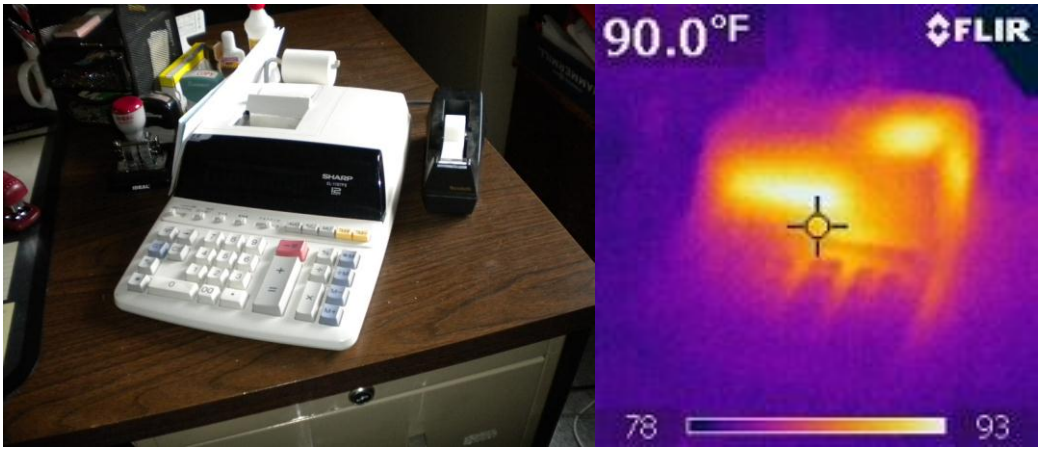
On the day of our inspection, we noticed that the flue damper was not functioning properly; it was not opening when it needs to be. As this photo indicates, it has been cut and taped in an effort to try and fix the problem. This is not just an efficiency issue but one of safety as well. This was brought to the attention of Town employees while we were there. This whole unit should be replaced with a new one that functions well.

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

In two of the photos on page 16 there are uninsulated pipes visible. Some of the lengths of pipe even have aluminum fin sections normally found in baseboard radiators. After the insulation work has been completed in the basements and crawl spaces, these radiant sections should be replaced with regular copper piping, and all pipes should be well insulated.

Electrical:

The electric usage for this building is not very high, and simple behavior changes could go a long way. For example, most modern electronic equipment draws a small amount of electricity, even when powered down, which can equal a sizable amount in cost at the end of the year. Using power strips and fully cutting the power to electronics will reduce this unintended electric usage.



Updating florescent tube fixtures while using T8 tubes instead of T12 and replacing any incandescent bulbs with compact florescent (CFL) or LED units is a great first step towards 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.

Health, Safety and Comfort:

There were signs of rodents and bats. Such 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.

Though we did not test for lead paint, this building, given its age, should be assumed to contain lead paint unless otherwise proven. Information about the risks of lead paint can be found at the EPA's website: http://www.epa.gov/lead/

Though we did not test for mold, there were obvious signs of mold growth in this building. Any moisture issues should be addressed right away, always beginning by eliminating the source of the moisture. More about addressing moisture problems can be discussed during the presentation of this report.

Make sure that there are an appropriate number of well-placed carbon monoxide and smoke alarms installed throughout this building.

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 Figure 4. 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.

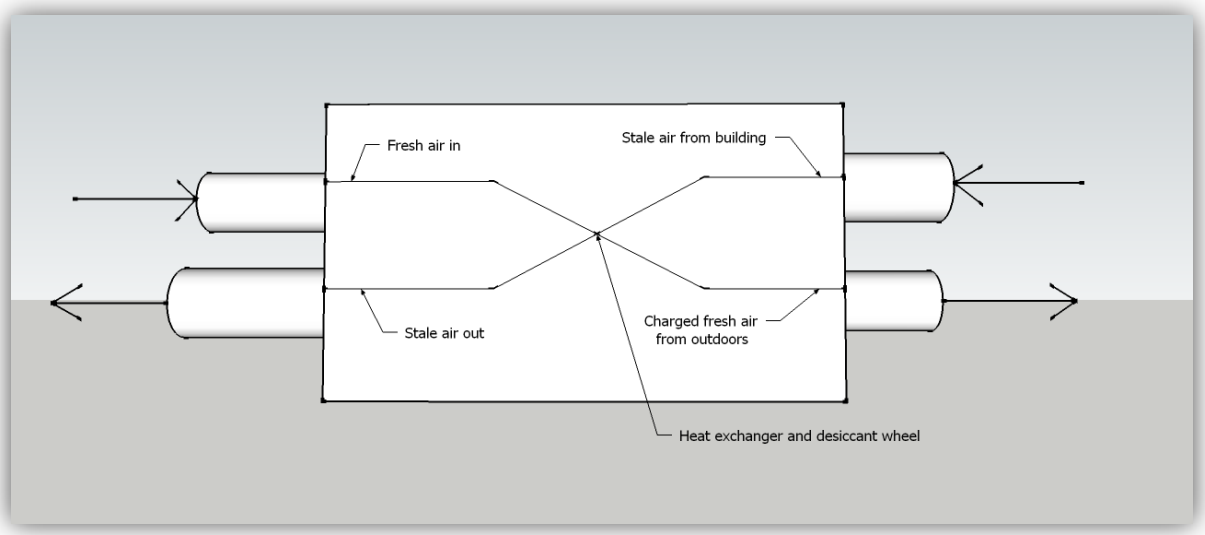


Figure 4

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.

Foundations and Slabs:

- Ensure that there are internal sources of moisture in the basement in crawl spaces. This would include moving the hot water heater drain.
- There is a sump pump in the floor of the addition. It may be beneficial to install a second sump pump in the basement space beneath the original building.
- Ensure that all gutters drain well away from the building.
- Trim any vegetation away from the building by at least 1 foot.
- Options for air sealing, insulating, and making the foundations water tight can be discussed during the presentation of this report.

Exterior Walls:

- Consult with an insulation company about the possibility of blowing cellulose insulation into the exterior walls of the original section of building.

Ceilings and Attic:

- Consult with an insulation company about the possibility of blowing cellulose insulation into the ceiling cavity above the offices in the original sections of the building.

Doors and Windows:

- Ensure that all the doors and windows provide a good air seal when closed. This should include sealing the trim surrounding each unit, inside and out.
- Install storm windows in the 2nd floor windows of the original building.

Mechanical:

- Replace the flue damper.
- Install an outdoor temperature reset.
- Replace the finned sections of piping in the crawl space with regular copper piping, and insulate all of the pipes.
- Replace thermostats with new digital/programmable units. Appropriate time and temperature settings can be discussed during the presentation of this report.
- There are many options for replacing the current boiler with alternative heating systems. These options can be discussed during the presentation of this report.

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 out dated 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 dehumidifiers, and refrigerators.

Health and Safety:

- After the basement and crawl spaces have been air sealed, talk to the service technician about ensuring adequate combustion air to the boiler.
- Address any pest or moisture issues that may arise, always by first eliminating the source or access of such unwanted problems.
- After the building has been well-sealed and insulated, have a blower door test conducted to determine ventilation needs. Install an HRV to ensure an adequate number of air exchanges per hour.

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 your Regional Planning Commission (RPC). A full list of NH RPC's is provided below.

Central New Hampshire RPC - 603.226.6020

Lakes RPC - 603.279.8171

Nashua RPC - 603.424.2240

North Country Council - 603.444.6303

Rockingham RPC - 603.778.0885

Southern New Hampshire RPC - 603.669.4664

Southwest RPC - 603.357.0557

Strafford RPC - 603.742.2523

Upper Valley Lake Sunapee RPC - 603.448.1680

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:

NH utilities may provide technical and financial assistance for various types of efficiency measures that can be carried out at the Town's municipal facilities. 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 National Grid Customers:

- Call - 1.800.843.3636
- Visit - https://www.powerofaction.com/newhampshirecigasnaturalgasheating/

For Unitil electric and/or gas Customers:

- For natural gas customers – 866.933.3820
- For electric customers – 800.582.7276
- Visit - http://www.unitil.com/energy-efficiency/commercial-industrial-programs-rebates-assistance

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

For NH Electric Coop Customers:

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

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

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.

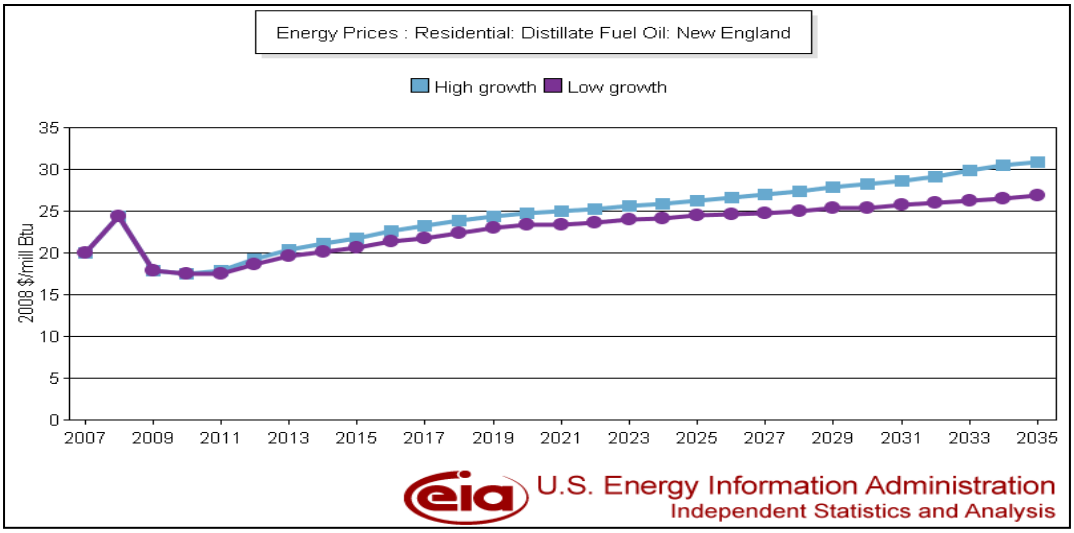
For more information on the history of energy prices and how energy cost projections are calculated, please visit: http://www.eia.doe.gov/analysis/

Price Summary

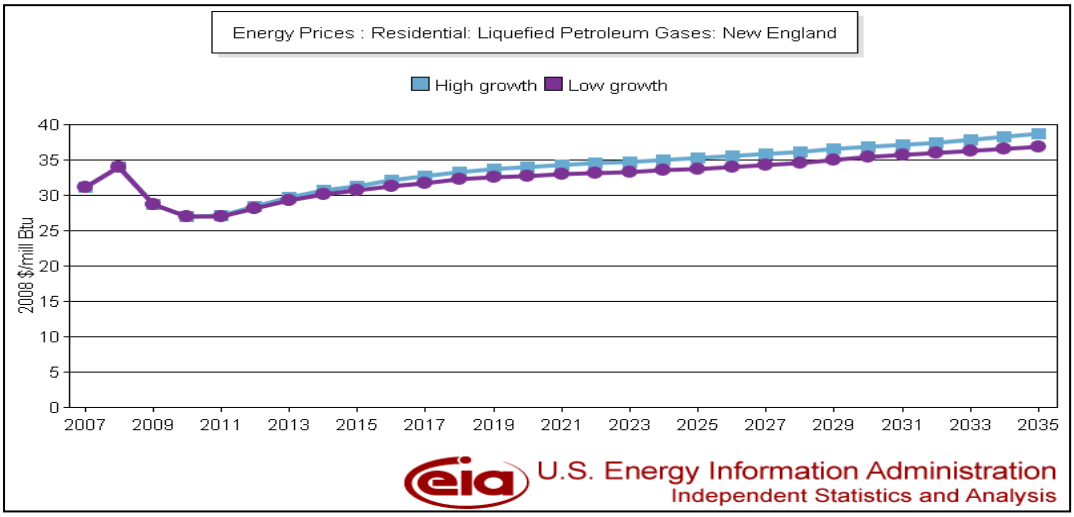
	Year				Percent Change		
	2009	2010	2011	2012	09-10	10-11	11-12
WTI Crude[a] ($/barrel)	61.65	79.40	93.26	97.50	28.8	17.5	4.5
Gasoline[b] ($/gal)	2.35	2.78	3.15	3.30	18.4	13.4	4.8
Diesel[c] ($/gal)	2.46	2.99	3.43	3.51	21.5	14.7	2.4
Heating Oil[d] ($/gal)	2.52	2.97	3.41	3.55	17.5	14.8	4.3
Natural Gas[d] ($/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.

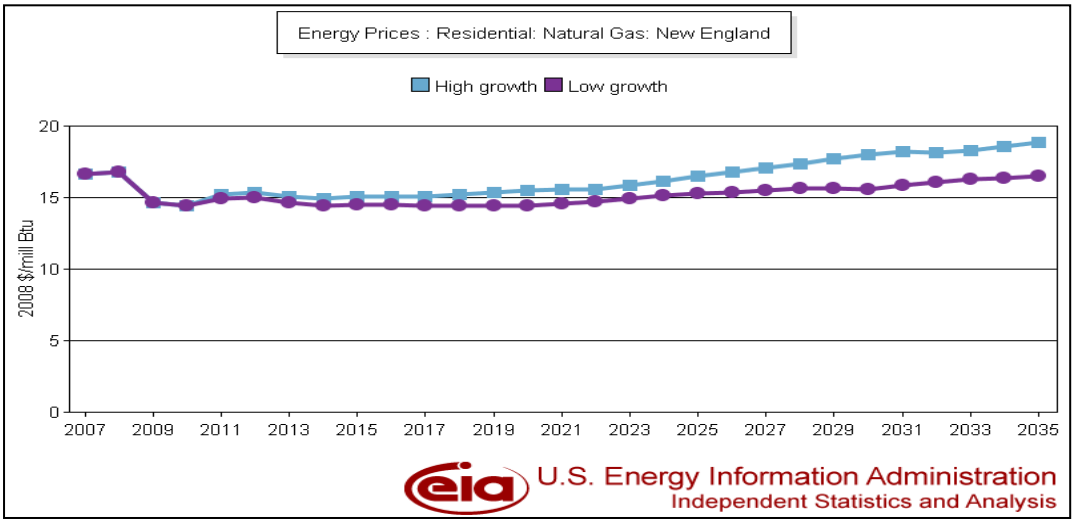
Table 1 – Retrieved from US EIA website



Graph 1 - Retrieved from US EIA website



Graph 2 - Retrieved from US EIA website



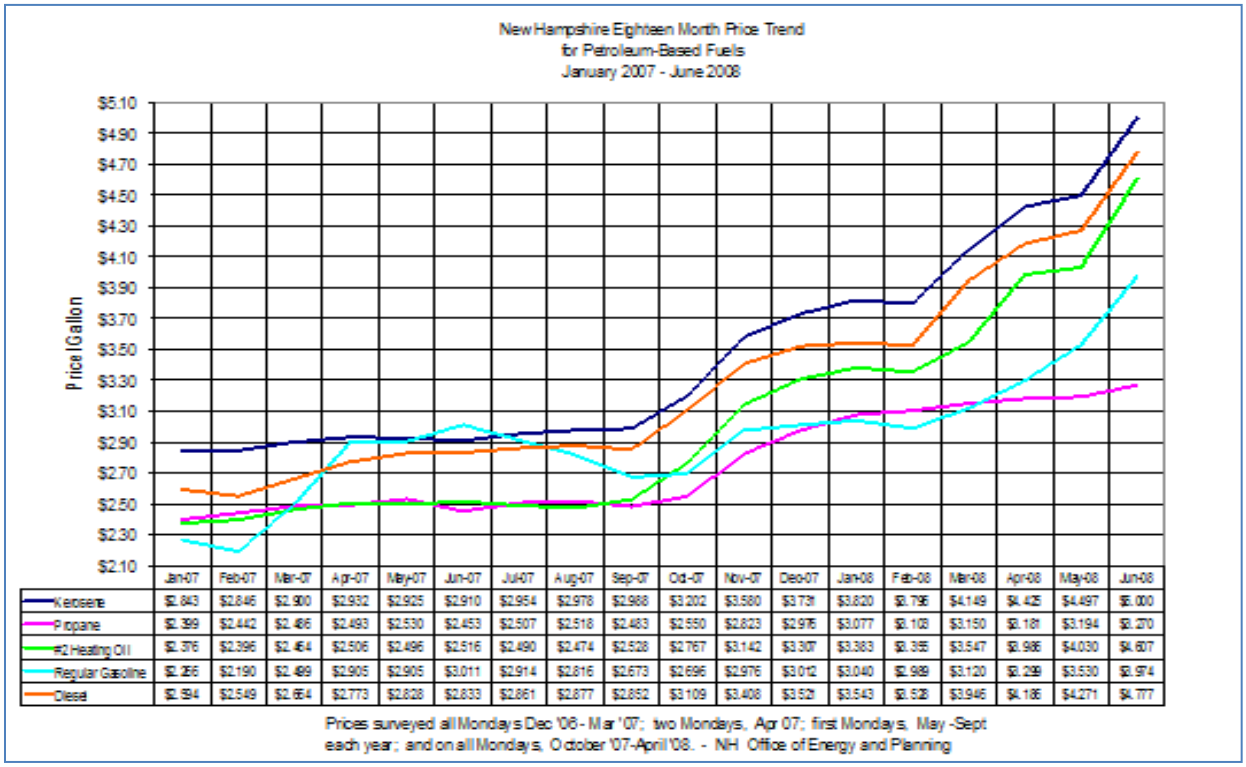
Graph 3 - Retrieved from US EIA website

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.

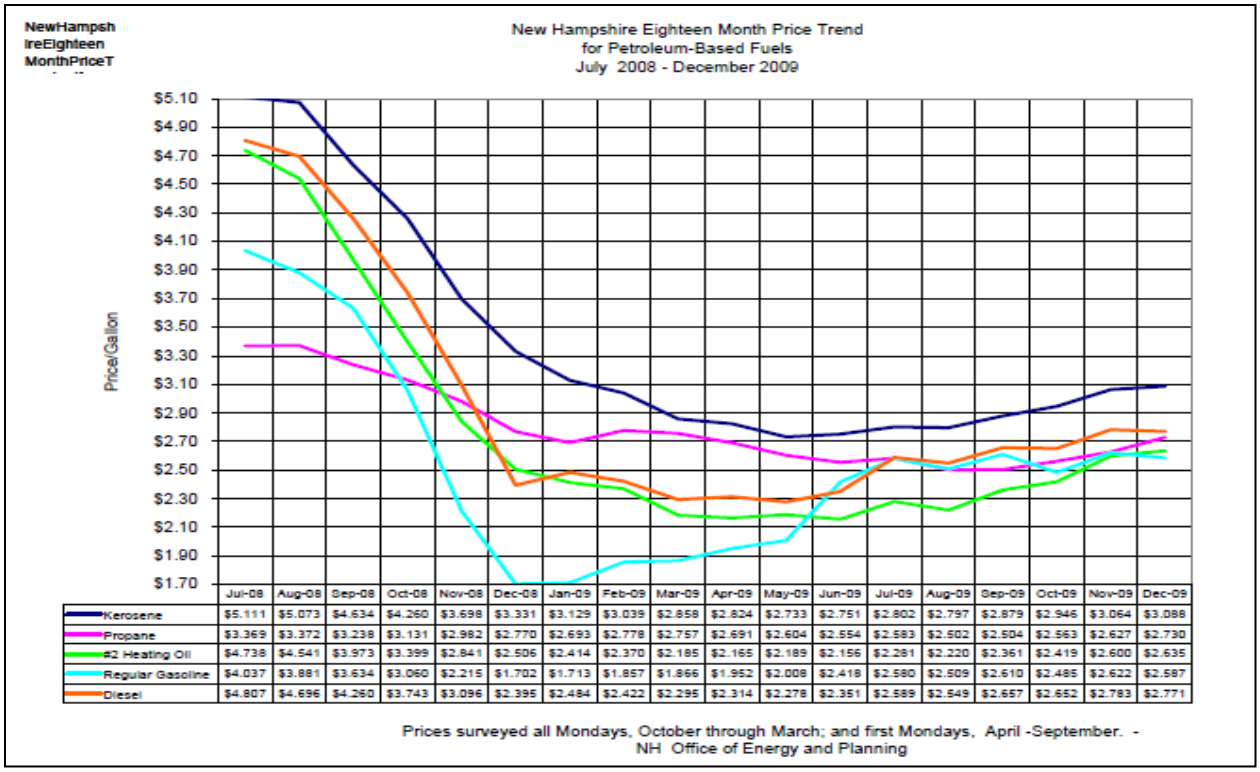
Projects such as air-sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler and a PV system 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.



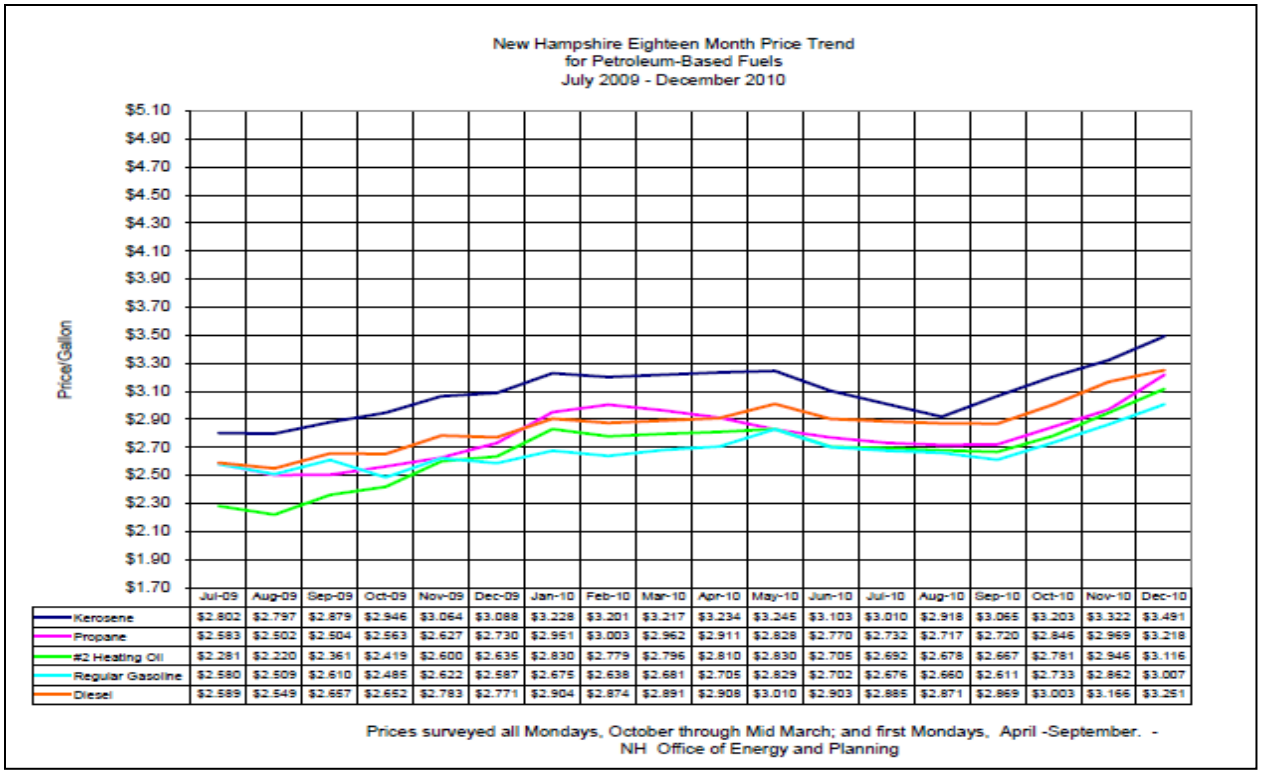
	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
Kerosene	$2.843	$2.846	$2.900	$2.932	$2.925	$2.910	$2.954	$2.978	$2.988	$3.202	$3.580	$3.731	$3.820	$3.796	$4.149	$4.425	$4.497	$5.000
Propane	$2.399	$2.442	$2.466	$2.493	$2.530	$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 5 - 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 tables and graph are provided to illustrate the potential savings for the Town if recommendations are carried out in the near future. The tables provide an assumed fuel escalation rate that is built into the savings model to show a fifteen year potential savings for the 30% reduced energy costs today as compared to the escalation of costs over fifteen years. (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 6 – 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.

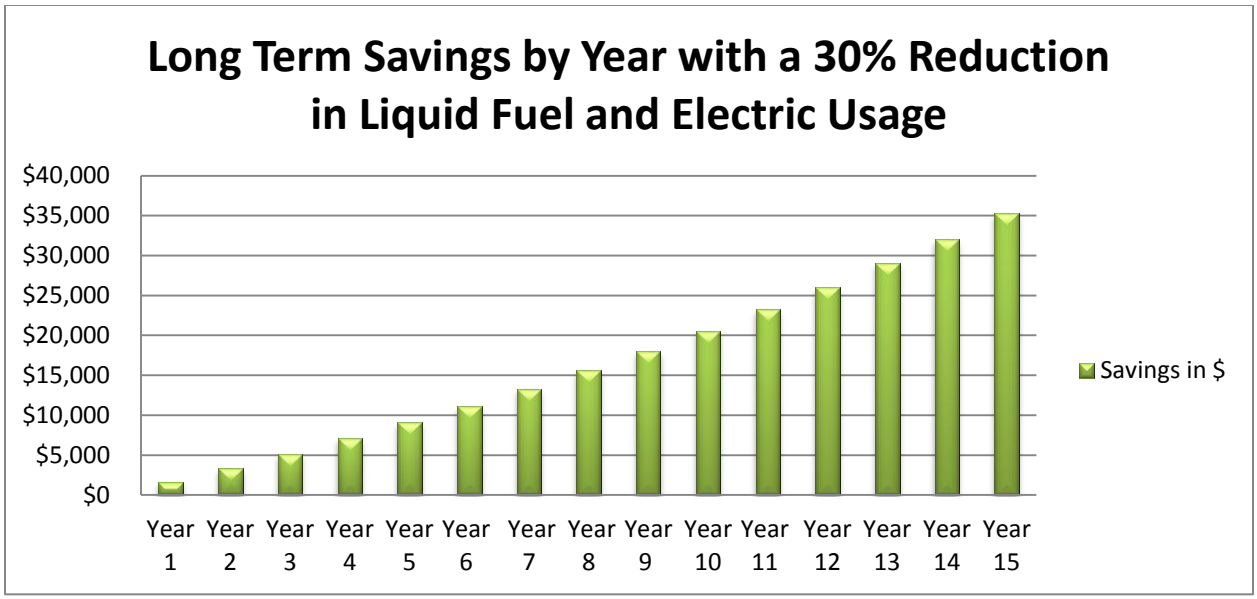
Current Fuel Usage				
Year	Energy Cost By Year	Yearly Increase	Total Accumulated Cost by Year	
		Escalation Rate	5.00%	
Year 1	$3,968.60	$198.43		$3,969
Year 2	$4,167	$208.35		$8,136
Year 3	$4,375	$218.77		$12,511
Year 4	$4,594	$229.71		$17,105
Year 5	$4,824	$241.19		$21,929
Year 6	$5,065	$253.25		$26,994
Year 7	$5,318	$265.92		$32,312
Year 8	$5,584	$279.21		$37,897
Year 9	$5,863	$293.17		$43,760
Year 10	$6,157	$307.83		$49,917
Year 11	$6,464	$323.22		$56,381
Year 12	$6,788	$339.38		$63,169
Year 13	$7,127	$356.35		$70,296
Year 14	$7,483	$374.17		$77,779
Year 15	$7,858	$392.88		**$85,637**

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 and cost, with a 2% cost increase per year.

Electric Use - Current Usage				
Year	**Energy Cost By Year**	**Yearly Increase**	**Total Accumulated Cost by Year**	
		Escalation Rate	**2.00%**	
Year 1	$1,482.80	$29.66		$1,483
Year 2	$1,512	$30.25		$2,995
Year 3	$1,543	$30.85		$4,538
Year 4	$1,574	$31.47		$6,112
Year 5	$1,605	$32.10		$7,717
Year 6	$1,637	$32.74		$9,354
Year 7	$1,670	$33.40		$11,024
Year 8	$1,703	$34.07		$12,727
Year 9	$1,737	$34.75		$14,464
Year 10	$1,772	$35.44		$16,236
Year 11	$1,808	$36.15		$18,044
Year 12	$1,844	$36.87		$19,887
Year 13	$1,881	$37.61		$21,768
Year 14	$1,918	$38.36		$23,686
Year 15	$1,957	$39.13		**$25,643**

The table below and graph are 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 Cost Avoidance - Liquid Fuels 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	$1,635	$81.77		$1,635
Year 2	$1,717	$85.86		$3,353
Year 3	$1,803	$90.15		$5,156
Year 4	$1,893	$94.66		$7,049
Year 5	$1,988	$99.39		$9,037
Year 6	$2,087	$104.36		$11,124
Year 7	$2,192	$109.58		$13,316
Year 8	$2,301	$115.06		$15,617
Year 9	$2,416	$120.81		$18,033
Year 10	$2,537	$126.85		$20,570
Year 11	$2,664	$133.20		$23,234
Year 12	$2,797	$139.86		$26,031
Year 13	$2,937	$146.85		$28,968
Year 14	$3,084	$154.19		$32,052
Year 15	$3,238	$161.90		**$35,290**



As you can see, the potential savings are significant and can provide supplemental funds to carry out further energy savings within this facility, or another Town facility. While these are assumed savings, current market trends indicate the potential for significantly more savings as a result of the increasing energy costs currently being seen within the region and country as a whole.

Conclusion:

As a result of this audit, the Town has several options available to increase the efficiency of the Sam Lake House. 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.