The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Thornton Highway Garage
3225 US Rt. 3, Thornton, NH 03285

Prepared for:

Town of Thornton, NH

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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 Thornton 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 Thornton.

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Thornton and the Highway Garage (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. 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.

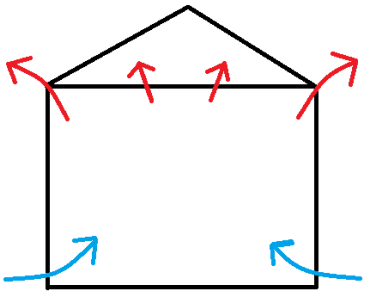
This DGA involves a quantification of energy consumption (electrical and heating fuel), a description of existing heating/cooling and distribution systems, thermal barrier inefficiencies, potential electric savings through lighting/appliances upgrades and behavior change, occupancy health and safety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

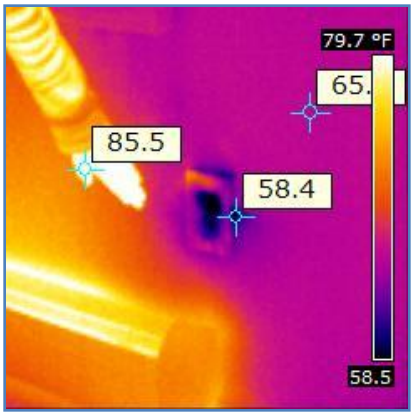
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of convective heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



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.

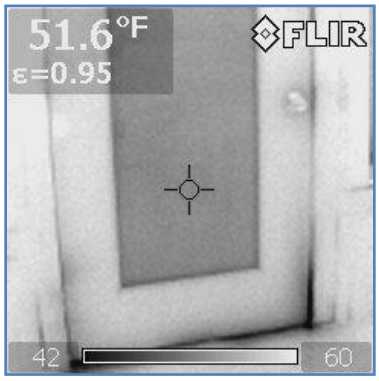
Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope 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.



Basics of Moisture Control:

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.

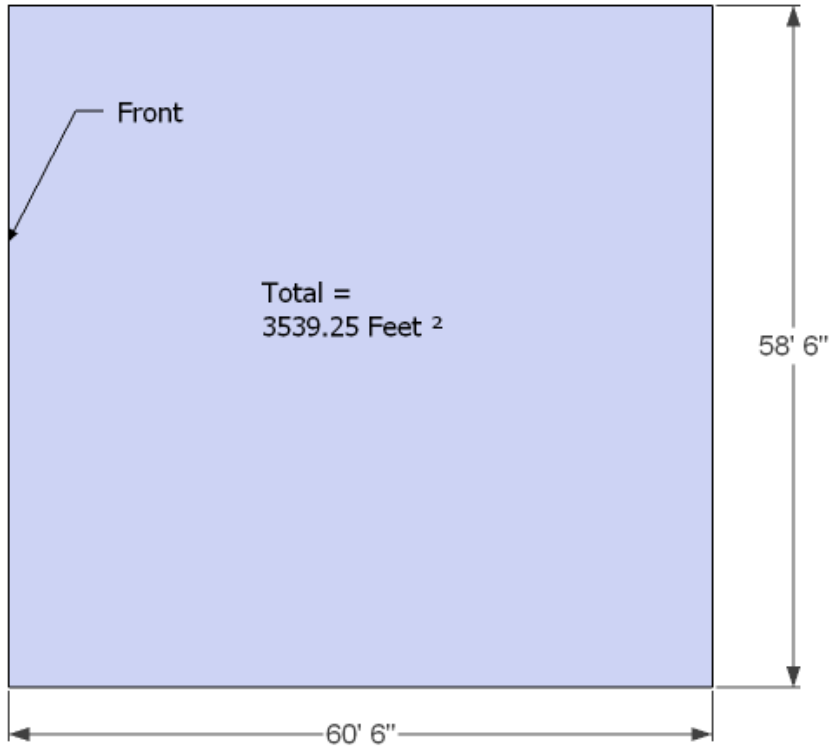
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable and to keep the water vapor from causing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

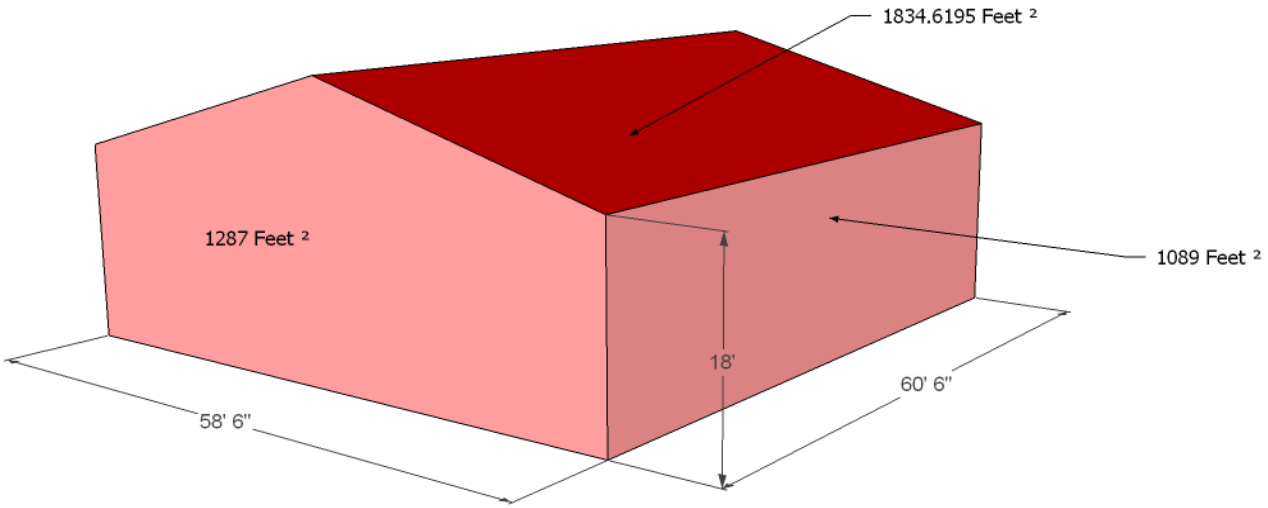
Just as BTUs conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and we use these to form a vapor barrier on the inside of the thermal boundary in an attempt to slow the amount of vapor diffusion. Small 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:

This building is a slab on grade metal structure built in 2003. One corner of the building contains a lavatory and storage room, with an office above.


Front
Total =
3539.25 Feet ²
58' 6"
60' 6"

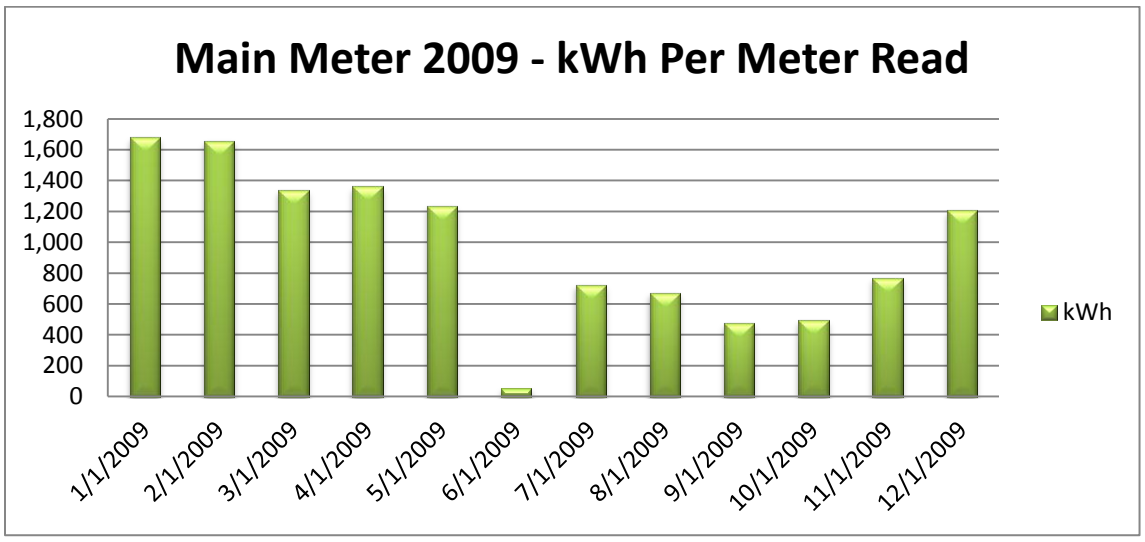

1834.6195 Feet ²
1287 Feet ²
1089 Feet ²
18'
60' 6"
58' 6"

Energy Data Collection:

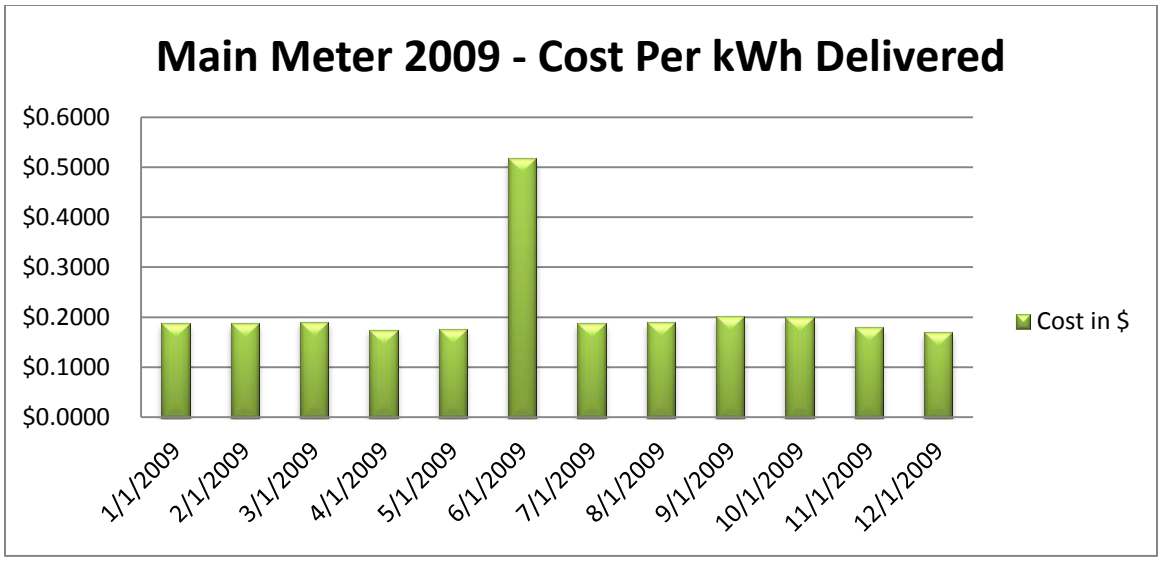
Analysis from provided utility bills for 2009 produces the following snapshot in electricity consumption. Monthly consumption is designated low to high, red being the lowest and green being the highest consumption months in the table below.

Electric -Main Meter			
NECC			
Date	**KWH**	**Total $/mo**	**Cost Per kWh**
12/1/2009	1,204	$204.57	$0.1699
11/1/2009	768	$138.24	$0.1800
10/1/2009	495	$98.97	$0.1999
9/1/2009	477	$96.11	$0.2015
8/1/2009	672	$127.21	$0.1893
7/1/2009	724	$135.35	$0.1869
6/1/2009	56	$28.94	$0.5168
5/1/2009	1,237	$217.37	$0.1757
4/1/2009	1,362	$237.30	$0.1742
3/1/2009	1,338	$254.76	$0.1904
2/1/2009	1,658	$310.90	$0.1875
1/1/2009	1,681	$314.92	$0.1873

Total kWh This Year-	**11672**
Total Paid For Year-	**$2,164.64**
Ave Cost Per kWh -	**$0.2133**



Annual electricity consumption for Thornton Highway Garage



Cost of delivered electricity for Thornton Highway Garage

Heat Source 1 - Oil Furnace			
NO.2 Oil			
Date	**Fuel Units**	**$**	**Cost Per Unit**
12/1/2009	611	$1,436.00	2.3502455
11/1/2009	108	$253.00	2.3425926
5/1/2009	135	$256.00	1.8962963
2/1/2009	596	$1,609.00	2.6996644
1/1/2009	817	$2,206.00	2.7001224
	Total Units Used =		**2267**
	Total Paid For Year =		**$ 5,760.00**
	Ave Cost Per Gal =		**$ 2.54**

Blower Door Test Results:

Date of Test: 9.28.2010
Test File: Thronton Highway Garage

Technician: Tobias Marquette

Customer: Town of Thornton
3225 US Rt. 3
Thornton, NH 03285
Phone

Building Address: 3225 US Rt. 3
Thornton, NH

Test Results

1. Airflow at 50 Pascals: (50 Pa = 0.2 w.c.)	2299 CFM (+/- 1.0 %) 1.77 ACH 0.65 CFM per ft2 floor area
2. Leakage Areas:	472.2 in2 (+/- 2.7 %) Canadian EqLA @ 10 Pa 371.4 in2 (+/- 4.6 %) LBL ELA @ 4 Pa
3. Minneapolis Leakage Ratio:	0.27 CFM50 per ft2 surface area
4. Building Leakage Curve:	Flow Coefficient (C) = 962.4 (+/- 7.4 %) Exponent (n) = 0.223 (+/- 0.021) Correlation Coefficient = 0.98726
5. Test Settings:	Test Standard: = CGSB Test Mode: = Depressurization Equipment = Model 3 Minneapolis Blower Door

Infiltration Estimates

1. Estimated Average Annual Infiltration Rate:		885.0 CFM 0.68 ACH
2. Estimated Design Infiltration Rate:	Winter:	641.4 CFM 0.49 ACH
	Summer:	331.6 CFM 0.26 ACH
3. Recommended Whole Building Mechanical Ventilation Rate: (based on ASHRAE 62.2)		0.0 CFM

Cost Estimates

1. Estimated Cost of Air Leakage for Heating:	$ 577 per year heating
2. Estimated Cost of Air Leakage for Cooling:	

Building Conditions

Inside Temperature:	65 deg F	Heating Fuel:	Oil
Outside Temperature:	63 deg F	Heating Fuel Cost:	$3.46/gallon
# of Stories	2.0	Heating Efficiency:	82.00
		Heating Degree Days:	7554
Wind Shield:	M	Cooling Fuel Cost:	
# of Occupants	0.0	Cooling SEER:	
		Cooling Degree Days:	96
# of Bedrooms:	0.0		
Volume:	77863 ft3	Ventilation Weather Factor:	0.76
Surface Area:	8420 ft2	Energy Climate Factor:	18.0
Floor Area:	3539 ft2		
Design Winter Wind Speed:	9.0 mph	Design Winter Temp Diff:	73 deg F
Design Summer Wind Speed:	7.0 mph	Design Summer Temp Diff:	12 deg F

Foundation and Slab:

This building sits on a concrete foundation that rises above grade 12-18 inches. We believe that the poured concrete slab inside the building is uninsulated. As the photos below indicate, some effort was made to insulate the foundation from the exterior. This insulation is falling apart and was only meant to cove r the above grade portion of the foundation. Even if this insulation was repaired, it would not be very effective unless it continued below grade at least 2ft, but 4ft would be preferred.

We performed our inspection of this building during a warm month and were therefore unable to take effective IR images. To help illustrate the amount of heat that is likely occurring from the foundation and slab of this building, we have included a photo and IR image of a slab on grade building in the same climate region as this building, taken during cold weather (see Figure 1). Heat loss from a slab or foundation, showing as orange in this IR image, can account for 20% of a building's total heat load. See Figure 2 for further illustration.

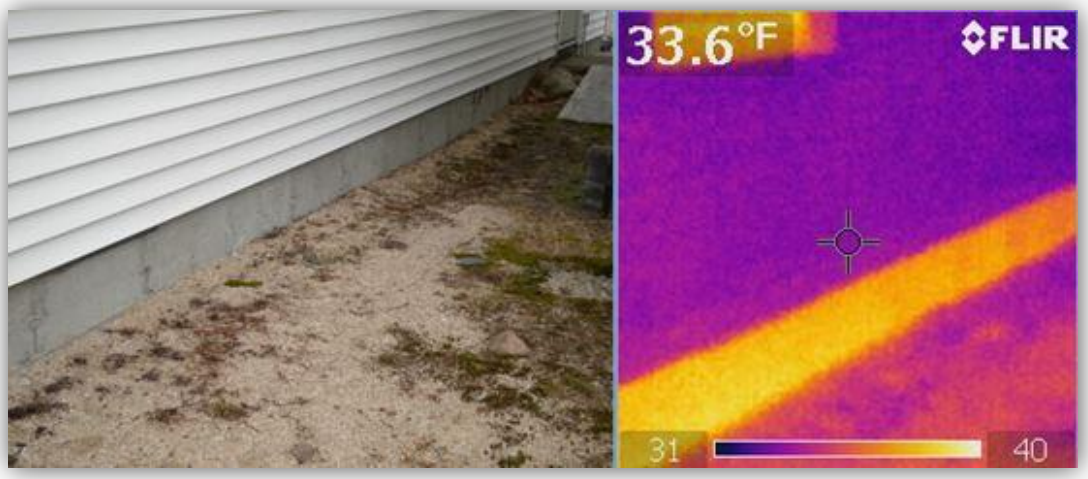


Figure 1

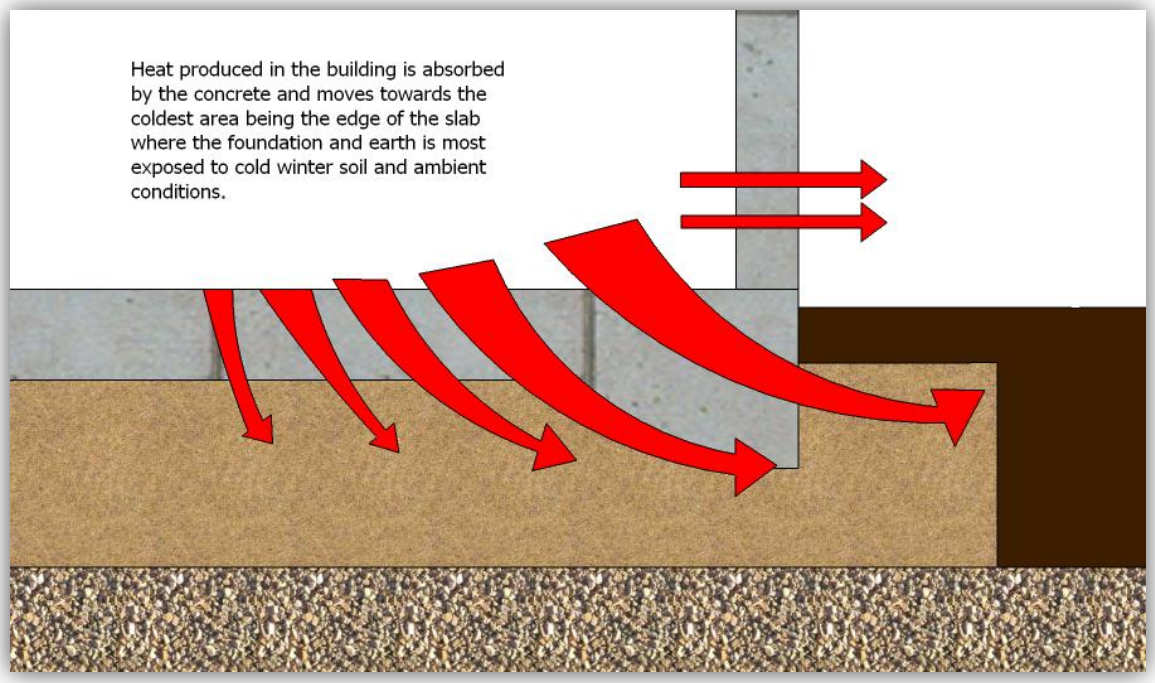


Figure 2

Insulating the foundation would need to be done with 2 inch extruded polystyrene foam board that would run a minimum of 2 feet below grade, though 4 feet would be preferred in this climate. The insulation would have to be protected from the elements and pests. Sealing the foam board where it meets the frame of the building would also be necessary and could be done in such a way as to eliminate the possibility of air infiltrating the building envelope.

Exterior Walls:

Also seen on page 15, the seam where the siding meets the foundation should be re-caulked. This should be checked approximately every two years. Regular maintenance of the structure, even small items like this, will help prolong the life of the building

There are areas where the siding has been damage slightly. This is not of great concern structurally unless water is able to get behind the siding. What this photo does help to illustrate is that each seam of the corrugated sheets is a weak point in terms ofair infiltration. As the blower door test results indicate, the building is fairly tight thanks to careful stapling of the fiberglass blankets. However, the convection currents behind the fiberglass insulation serve to usher heat away from the building faster.

What is also typical in this type of construction is to have condensation form behind the fiberglass, both on the walls and the underside of the roof.

This photo shows the thickness of the fiberglass blankets. Given that these blankets are compressed between the frame and the siding/roofing as often as they are, the walls likely have a weighted R-value of about R-13.

This photo shows how the face of the blankets are stapled together. Each one of these seams creates a weak point, not only in respect to R-value, but in terms of air movement as well. In addition, this picture shows where the insulation meets the foundation—daylight is clearly seen.

Ceilings and Attic:

The ceilings of this building have been insulated using the same type fiberglass blankets. The blankets used in the roof may or may not be slightly thicker. If they are, they potentially have a weighted R-value 19. Regardless of this possibility, the blankets are still being compressed at every steel purlin.

The images in Figure 3 are not of this building; instead, they are of a building of the same construction type in the same climate zone. These images were taken during warm weather; therefore, the IR image shows steel beams as hot (orange). During cold months, these beams would appear as dark purple revealing heat loss. At every point where the fiberglass blankets are compressed between the steel structure and the roofing, there is little insulative value. Only in the center of each bay is the fiberglass performing at its rated R-value.

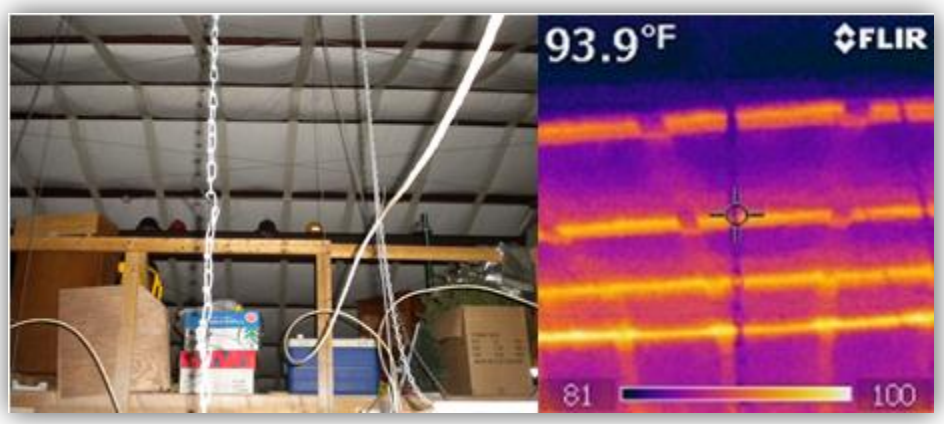


Figure 3

Figure 4 illustrates one of the best methods for maximizing the thermal envelope efficiency of a building of this type. Re-insulating the walls and ceiling with closed-cell spray foam would certainly be a large investment and could take some time to recoup the cost through energy savings, but the long terms saving over the life of the building would be equally substantial.

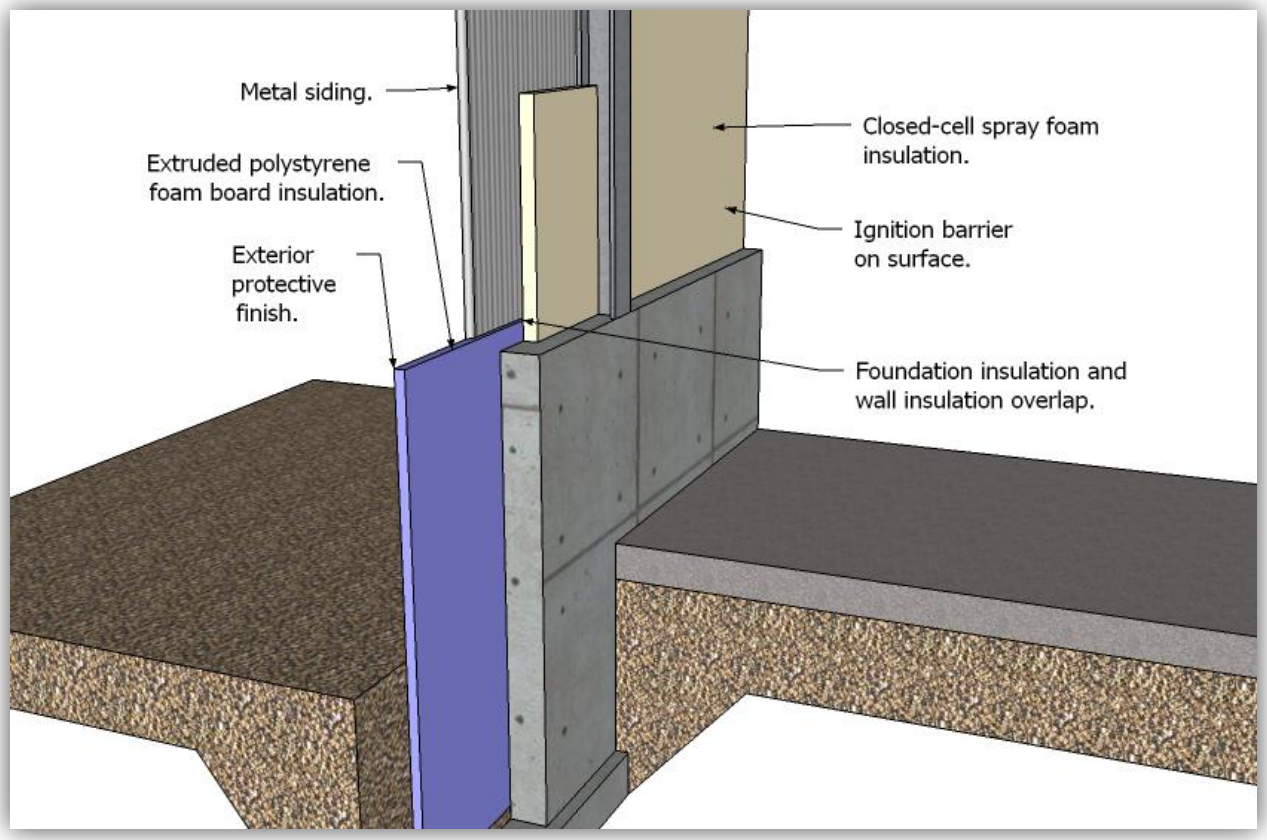


Figure 4

Doors and Windows:

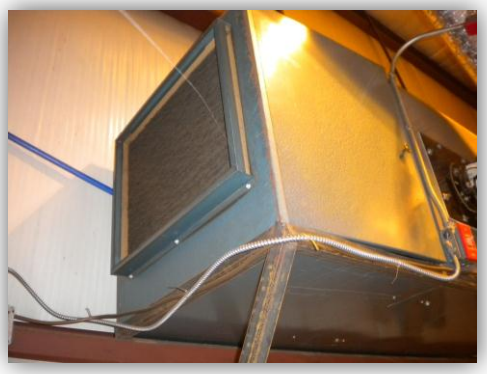
There are three garage bay doors in this building. These are relatively efficient units, and their replacement is not recommended at this time. Steps should be taken to make sure that they are as sealed as possible when closed. It is important to note that there is no weather stripping at the top of this door. Also, the steel structure seen here between the door and the siding is not insulated and is like this on every door. Finally, when foam board has been placed, greater care can be given to seal around the edges.

The same is true for the personnel doors—make sure they are sealed when shut.

This is the only window in this building. It does not need replacing, but do make sure that it is well-sealed. Not just the actual window, but also seal any cracks where the flashing meets the window and siding to prevent air and water infiltration.

Mechanical:

This building is heated with a single oil-fired furnace suspended from the corner of the building. This unit likely has a combustion efficiency of between 82% and 84% at most.



This picture shows the filter on the return plenum. Replacing this filter often will help ensure this equipment is operating as efficiently as possible.

The electric cut off switch was moved out of position when the new flue pipe was installed. This should be put back in position directly over the burner.

In 2009, about 88,000 BTU's per ft² of oil were delivered to this building. With respect to facilities of this type, using oil as a heat source, this could be considered average. Apart from making improvements to the shell of the structure, a more efficient heat source and distribution system could be installed to maximize long term energy savings.

Because this furnace heats the air of this space, when the garage doors open, the heat is lost quickly. Radiant heat systems work by heating objects and surfaces in a space. There are two major forms of radiant heat systems that would be appropriate for this space. The first is in-slab radiant heat. This would be a very expensive option, though would also offer flexibility in that many different types of fuel could be used as a source of heat, including solar thermal panels. If cost limitations do not allow for this preferred option, overhead LP gas fired infrared heaters would be the next options. These would be individual units installed above each working area and would radiate heat downward, heating personnel, vehicles, other items located in the space, and, most importantly, the concrete slab. Because solid mass in this case would be holding most of the BTU's, opening the garage doors will have much less effect on heat loss. Though the heat loss from the slab should be addressed regardless, the option of using the slab as a thermal mass in any capacity would mean insulating the slab—this would be crucial.

Electrical:

The baseline electric use for this building is relatively low and is largely contributed to by summer time lighting, the air compressor, power tools, and possibly a welding rod heater. The spike in usage during the winter months can be from less daylight, longer hours worked, the garage doors opening and closing more, and from the motor in the furnace.
The lights, seen in the photo to the right, could be replaced with high-bay LED options. This would be a substantial initial investment, but the long term savings potential would be equally significant. Not only do LED's use much less electricity, but they have a much longer life; they turn on to full brightness almost immediately, allowing them to be turned on and off more readily, which results in even further savings. Outdoor security lights are another great option for LED's as they are likely kept on all night throughout the year. The more a light is used, the more important it is to use the most efficient source.

It is important to make sure that compressors are operating as efficiently as possible—part of this is making sure that air lines and tool fittings hold pressure. A small air leak could make a compressor unnecessarily run for an hour a day. The savings from this reduced usage can really add up throughout the year.

The potable water for this building is provided by this small stand-alone electric hot water heater. This unit could be replaced with solar domestic hot water system. This would be a great option for reducing or replacing the current cost associated with hot water production.

Installing a photovoltaic solar system on site, either to meet the needs or supplement the costs of electricity, is always recommended. Options for funding such a project are given in the next section of this report.

Health, Safety and Comfort:

There are many safety concerns in a building of this type and use. Injuries can be a common occurrence in a mechanical garage; therefore, following all necessary safety procedures is a must.

The greatest health concern in most buildings of this type is poor air quality. Investing in air pollutant monitoring systems, which control building exhaust, in combination with individual overhead hose systems will help control this health concern.

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 5. 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.

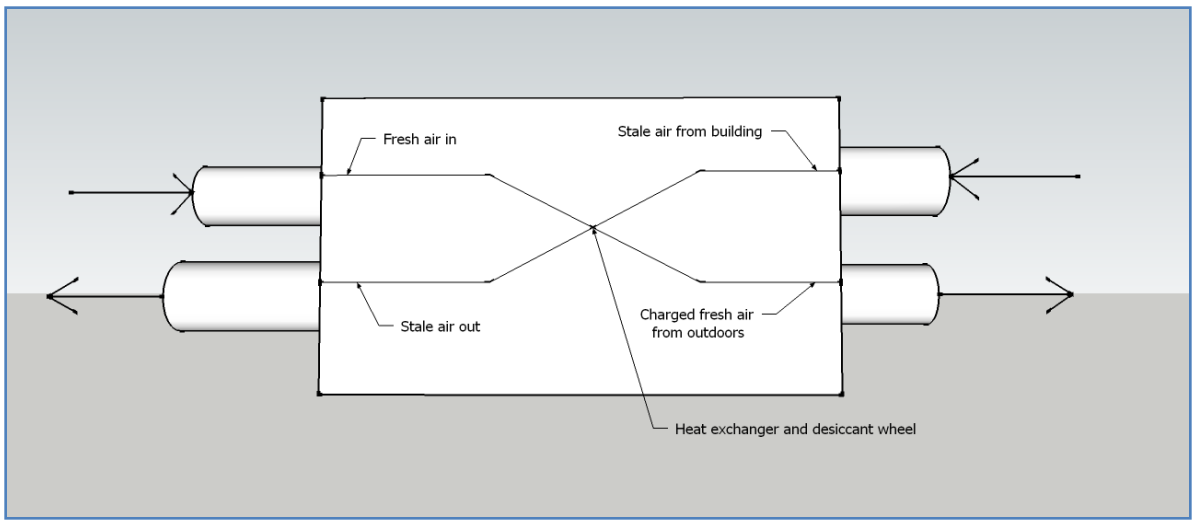


Figure 5

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:

- Reinsulate the entire perimeter of the foundation. This should be done with 2 inch extruded polystyrene foam board, which should extend below grade 2-4 feet. 4 Feet would be the preferred depth should conditions allow. The foam needs to be protected from the elements and pests with either a durable cement type finish or with coated sheet metal that is well sealed at all seams.

- Ensure that bulk water cannot infiltrate the corrugated siding or and flashing.

Exterior Walls:

- Consider reinsulating the exterior walls with closed-cell spray foam insulation.

Ceilings and Attic:

- Consider reinsulating the underside of the roof with closed-cell spray foam insulation.

Doors and Windows:

- Ensure that all the doors and windows provide a good air seal when closed, including the frame around each unit.

Mechanical:

- There are many options for reducing heating costs with full system replacements, including infrared heaters, or a wood pellet system. These options and more can be discussed during the presentation of this report.

Electrical:

- Consider replacing the metal halide fixtures with LED options. The initial investment would be substantial but so would the savings be over the long term.
- Install a photovoltaic system on site to help mitigate the cost associated with electric use.
- Replace the current hot water heater with a solar hot water system piped to a high efficiency storage tank that contains an electric element as back up.

Health and Safety:

- Consult with an air quality specialist to develop options for increasing the air quality of this facility.

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.

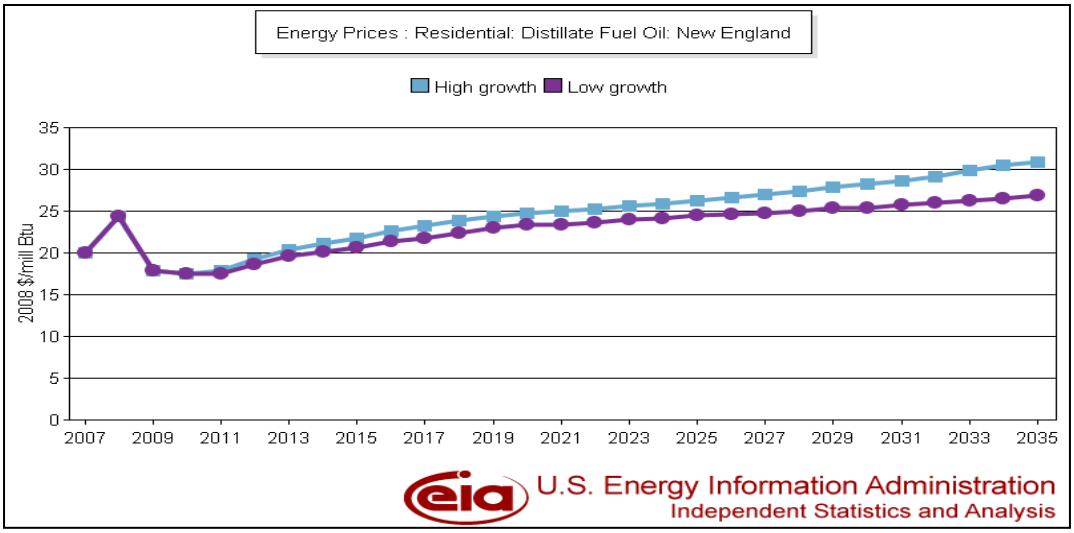
For more information on the history of energy prices and how energy cost projections are calculated, please visit: http://www.eia.doe.gov/analysis/

Price Summary

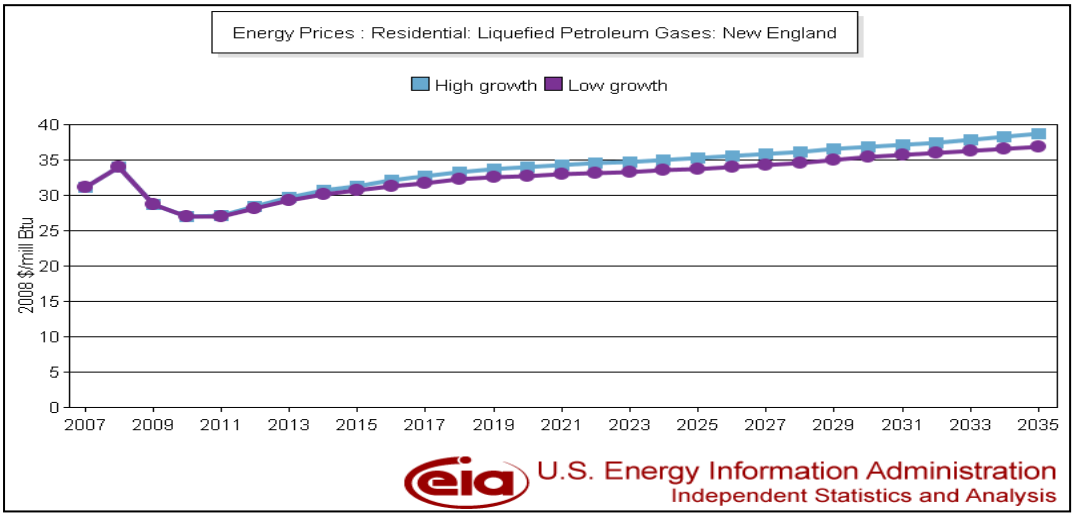
	Year				Percent Change		
	2009	2010	2011	2012	09-10	10-11	11-12
WTI Crude[a] ($/barrel)	61.65	79.40	93.26	97.50	28.8	17.5	4.5
Gasoline[b] ($/gal)	2.35	2.78	3.15	3.30	18.4	13.4	4.8
Diesel[c] ($/gal)	2.46	2.99	3.43	3.51	21.5	14.7	2.4
Heating Oil[d] ($/gal)	2.52	2.97	3.41	3.55	17.5	14.8	4.3
Natural Gas[d]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

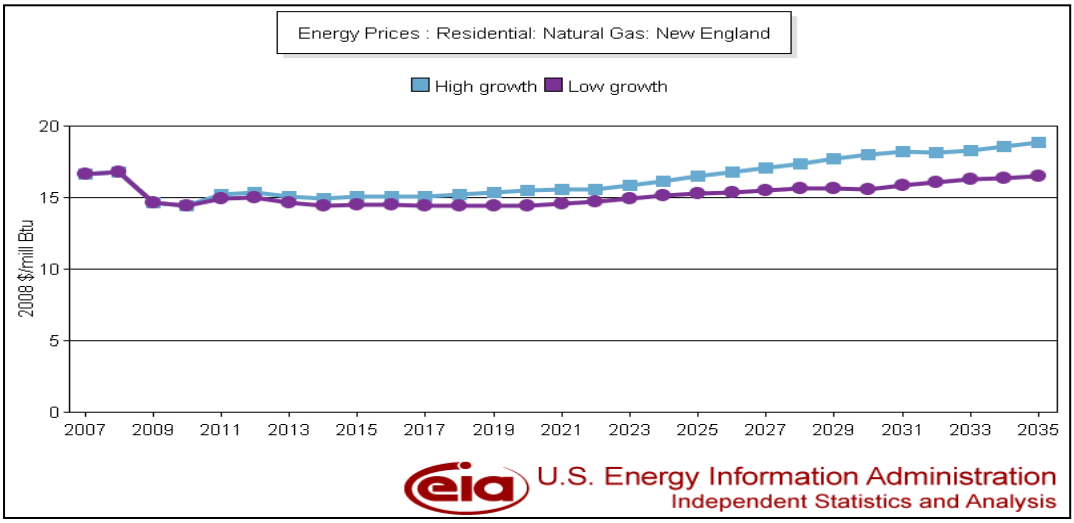
Table 1 – Retrieved from US EIA website



Graph 1 - Retrieved from US EIA website



Graph 2 - Retrieved from US EIA website



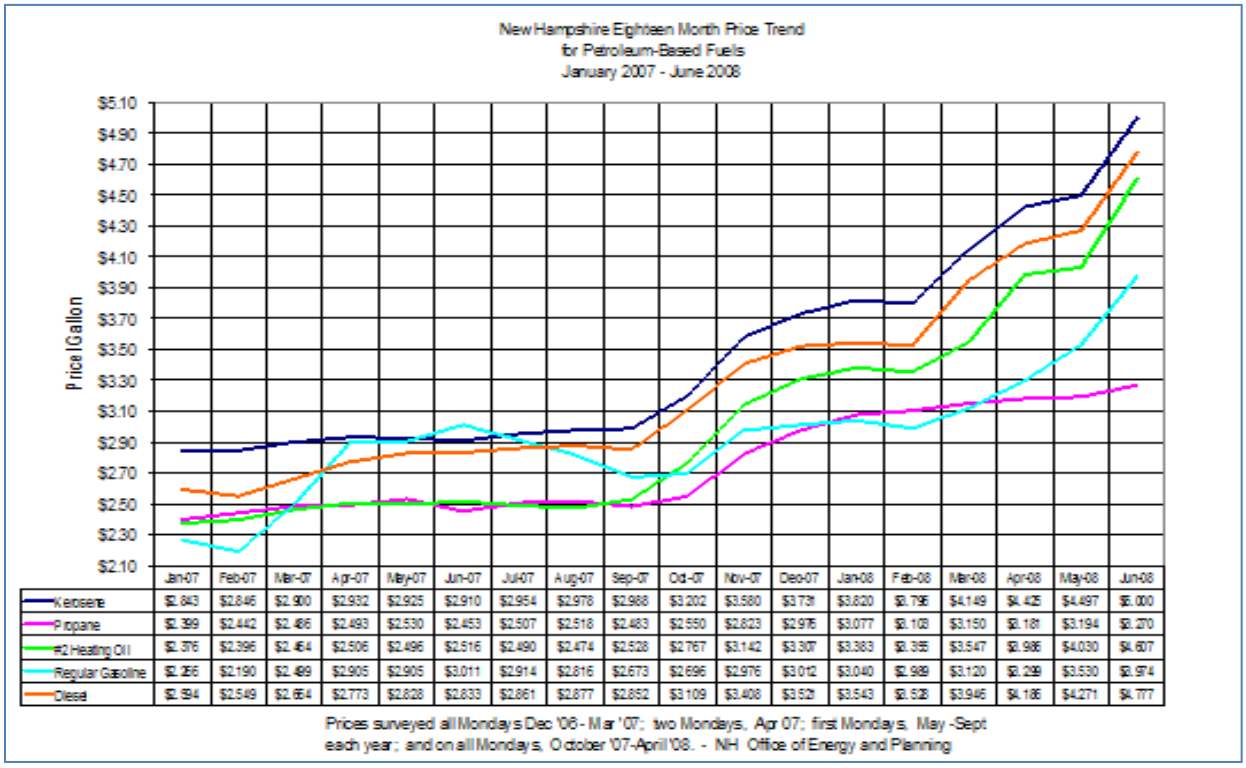
Graph 3 - Retrieved from US EIA website

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.

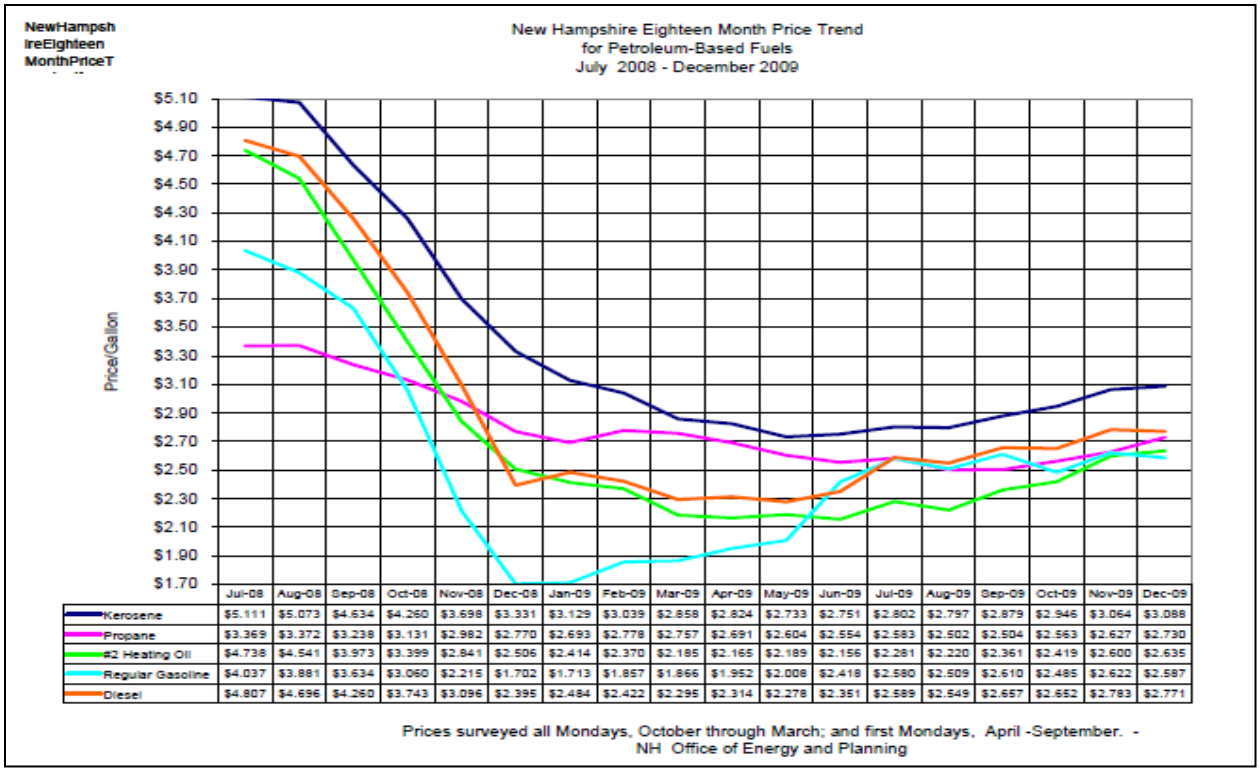
Projects such as air-sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler and a PV system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



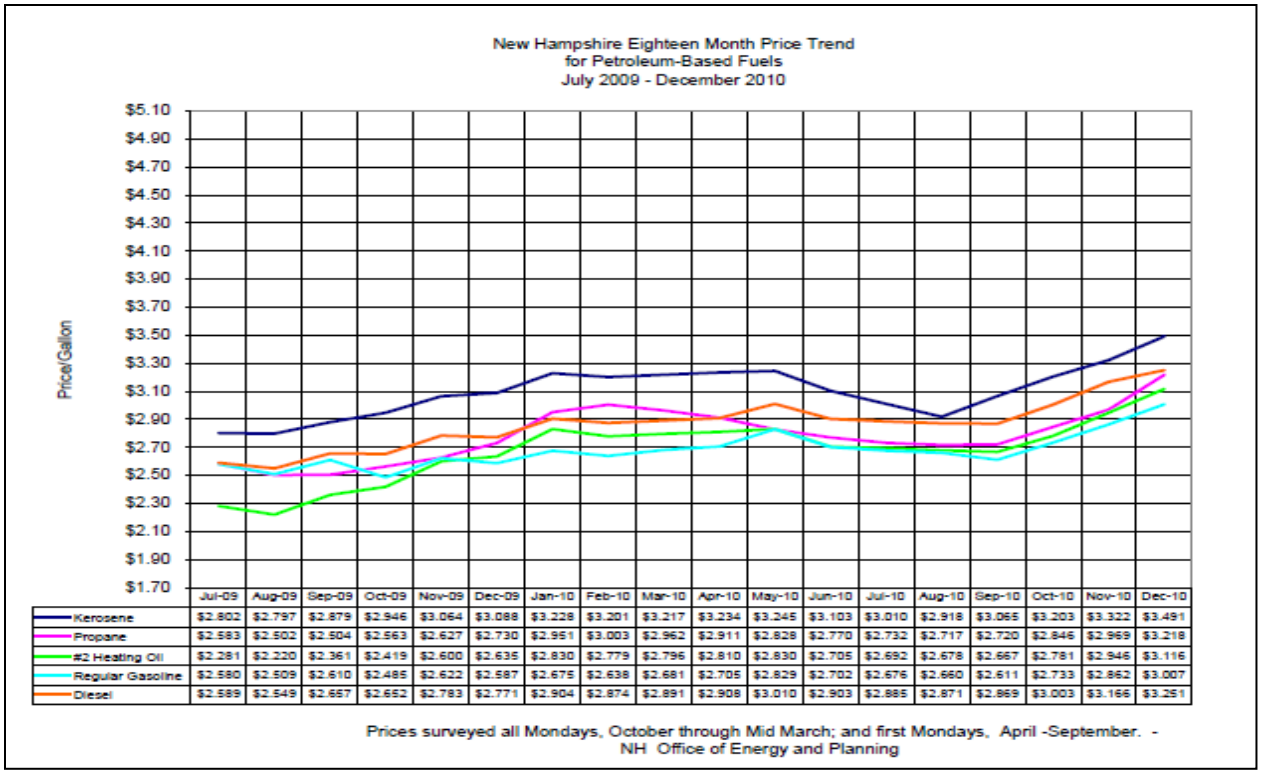
	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
Kerosene	$2.843	$2.846	$2.900	$2.932	$2.925	$2.910	$2.954	$2.978	$2.988	$3.202	$3.580	$3.731	$3.820	$3.796	$4.149	$4.425	$4.497	$5.000
Propane	$2.399	$2.442	$2.466	$2.493	$2.530	$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 6 - 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 7 – 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.

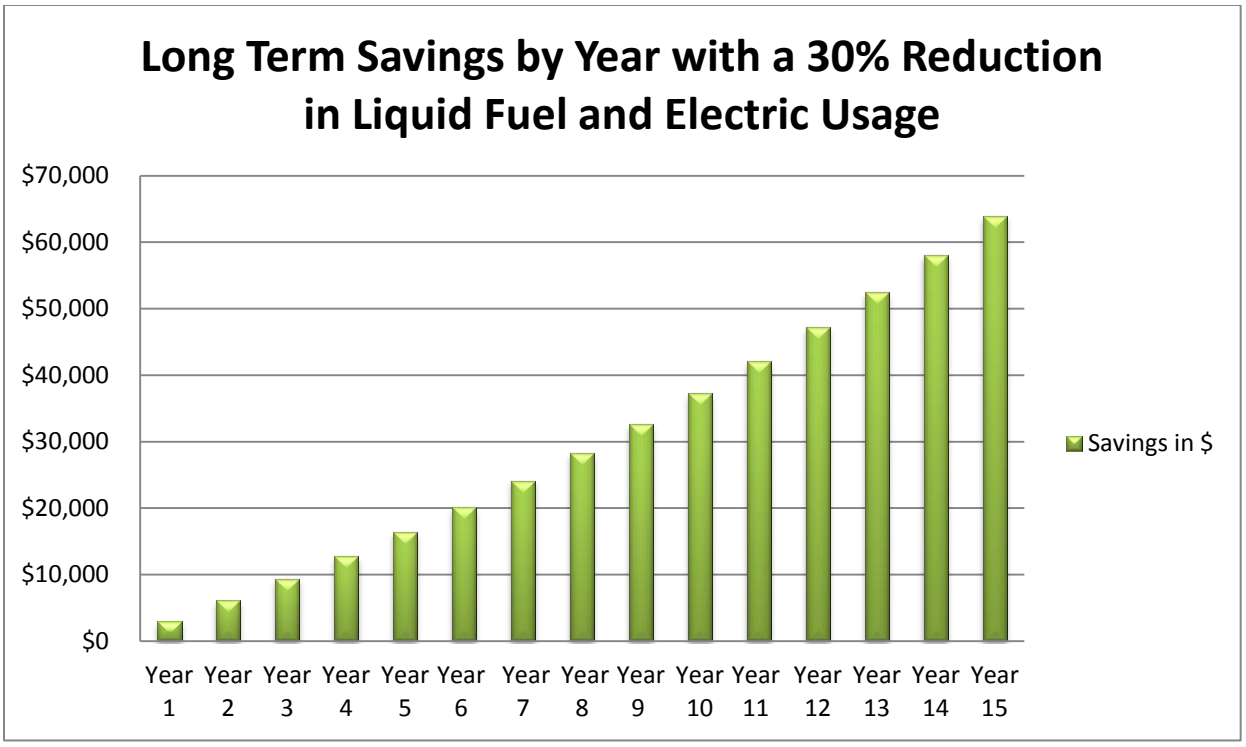
Current Fuel Usage				
Year	**Energy Cost By Year**	**Yearly Increase**	**Total Accumulated Cost by Year**	
		Escalation Rate	**5.00%**	
Year 1	$7,705.53	$385.28		$7,706
Year 2	$8,091	$404.54		$15,796
Year 3	$8,495	$424.77		$24,292
Year 4	$8,920	$446.01		$33,212
Year 5	$9,366	$468.31		$42,578
Year 6	$9,834	$491.72		$52,412
Year 7	$10,326	$516.31		$62,739
Year 8	$10,842	$542.12		$73,581
Year 9	$11,385	$569.23		$84,966
Year 10	$11,954	$597.69		$96,919
Year 11	$12,552	$627.58		$109,471
Year 12	$13,179	$658.95		$122,650
Year 13	$13,838	$691.90		$136,488
Year 14	$14,530	$726.50		$151,018
Year 15	$15,256	$762.82		**$166,274**

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, NH price averages for January 31st 2011, 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	$2,164.64	$108.23		$2,165
Year 2	$2,273	$113.64		$4,438
Year 3	$2,387	$119.33		$6,824
Year 4	$2,506	$125.29		$9,330
Year 5	$2,631	$131.56		$11,961
Year 6	$2,763	$138.13		$14,724
Year 7	$2,901	$145.04		$17,625
Year 8	$3,046	$152.29		$20,670
Year 9	$3,198	$159.91		$23,869
Year 10	$3,358	$167.90		$27,227
Year 11	$3,526	$176.30		$30,753
Year 12	$3,702	$185.11		$34,455
Year 13	$3,887	$194.37		$38,342
Year 14	$4,082	$204.09		$42,424
Year 15	$4,286	$214.29		**$46,710**

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 Fuel and Electric				
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	$2,961	$148.05		$2,961
Year 2	$3,109	$155.46		$6,070
Year 3	$3,265	$163.23		$9,335
Year 4	$3,428	$171.39		$12,763
Year 5	$3,599	$179.96		$16,362
Year 6	$3,779	$188.96		$20,141
Year 7	$3,968	$198.40		$24,109
Year 8	$4,166	$208.32		$28,275
Year 9	$4,375	$218.74		$32,650
Year 10	$4,594	$229.68		$37,244
Year 11	$4,823	$241.16		$42,067
Year 12	$5,064	$253.22		$47,131
Year 13	$5,318	$265.88		$52,449
Year 14	$5,584	$279.18		$58,033
Year 15	$5,863	$293.13		**$63,895**



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 Highway Garage. Achieving 30% savings in energy cost for this building is 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.