The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Laconia Central Fire Station
848 Main St., Laconia, NH 03246

Prepared for:

City of Laconia, 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 City of Laconia 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 City of Laconia.

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the City of Laconia and the Central Fire Station (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 City'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.

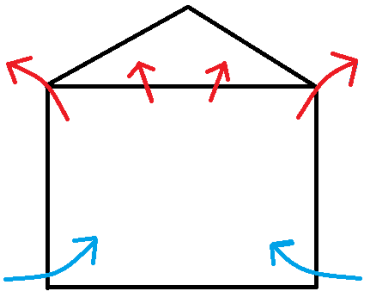
This DGA involves a quantification of energy consumption (electrical and heating fuel), a description of existing heating/cooling and distribution systems, thermal barrier inefficiencies, potential electric savings through lighting/appliances upgrades and behavior change, occupancy health and safety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

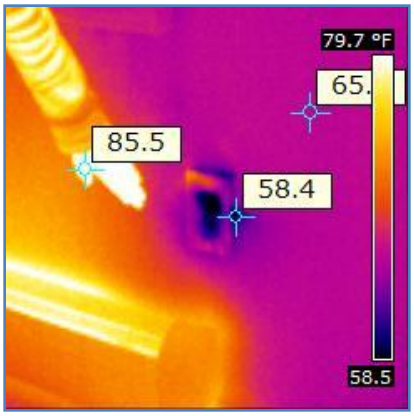
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



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.

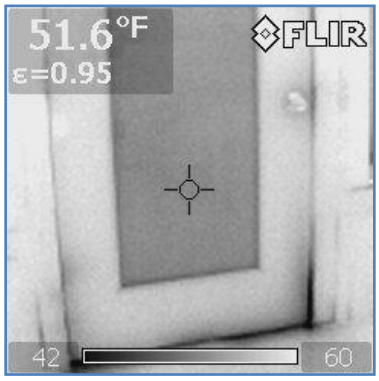
Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope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

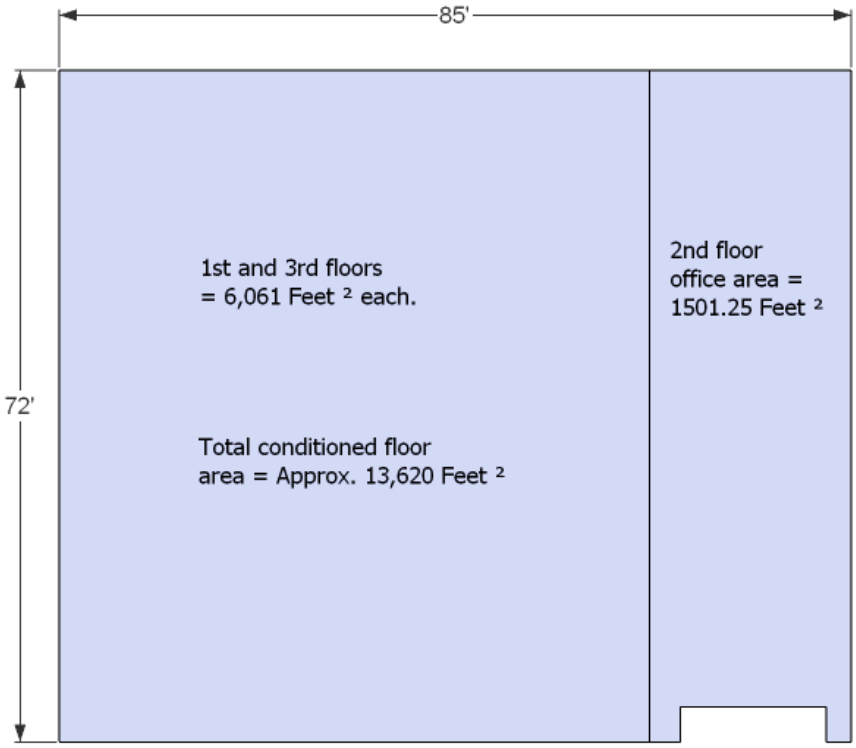
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable and to keep the water vapor from causing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

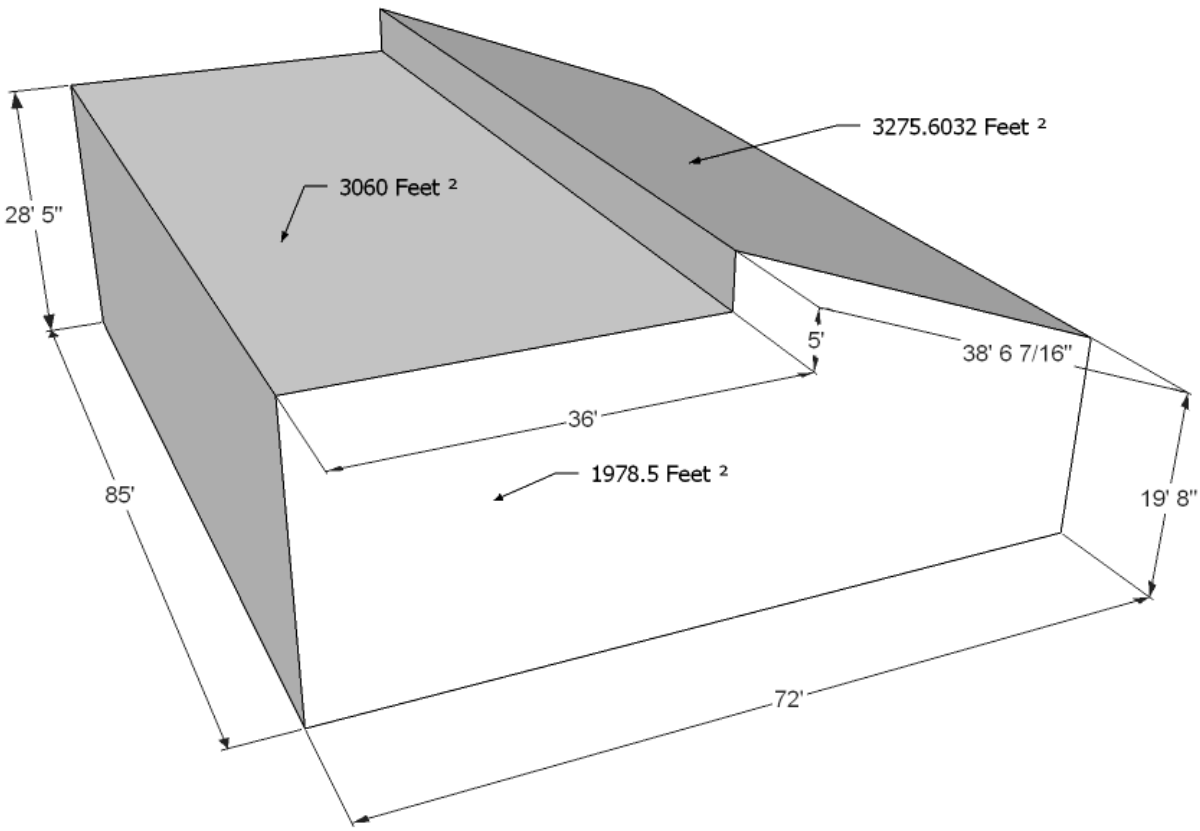
It is important to identify any current moisture problems and address them appropriately. This is always done by first finding and controlling the source of the moisture. Sometimes it can be quite difficult to see moisture damage, as it may be buried inside of wall cavities. It is also important to know 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 Laconia Central Fire Station was constructed in 1969. This is a masonry built structure that has a large garage, reception/dispatch office, mechanical rooms, and storage rooms on the 1st floor. There is an approximately 1500ft² 2nd floor on the North side of the building that is dedicated office space. The 3rd floor is made up of living quarters, a large rec. room/training/meeting room, and storage closets along the front of the building. The total conditioned floor area (measured from outside corners) is approximately 13,620ft².



With respect to energy usage, it is typical to include the building envelope when measuring floor area and volume of conditioned space. This is likely the difference between our ft² measurement, and the ft² of the building listed in the 2009 Inventory Report.
Including the building envelope, this building has approximately 168,130 cubic feet (ft³) of conditioned space. The garage area contains about one half of the total volume of conditioned space in this building.



Energy Data Collection:

Electric usage and cost by month was not available.

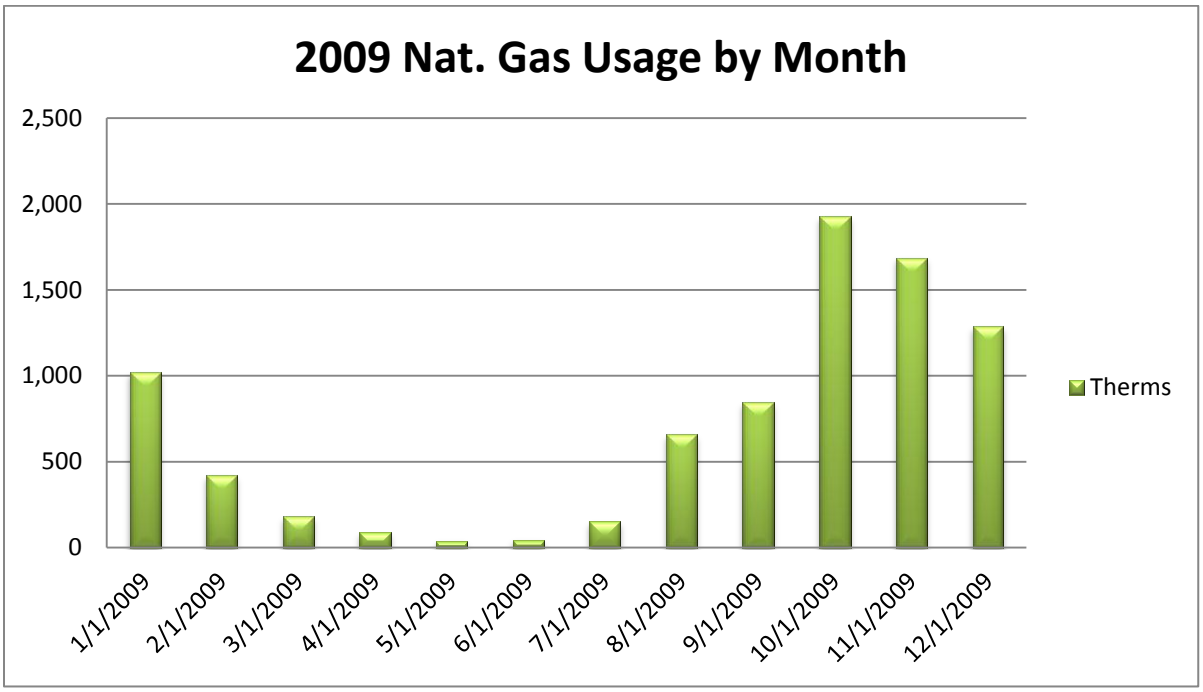
Electric Usage - 2009			
Date	**KWH**	**Total $/Mo**	**Cost Per kWh**
2009	91,752	$13,406.41	$0.1461

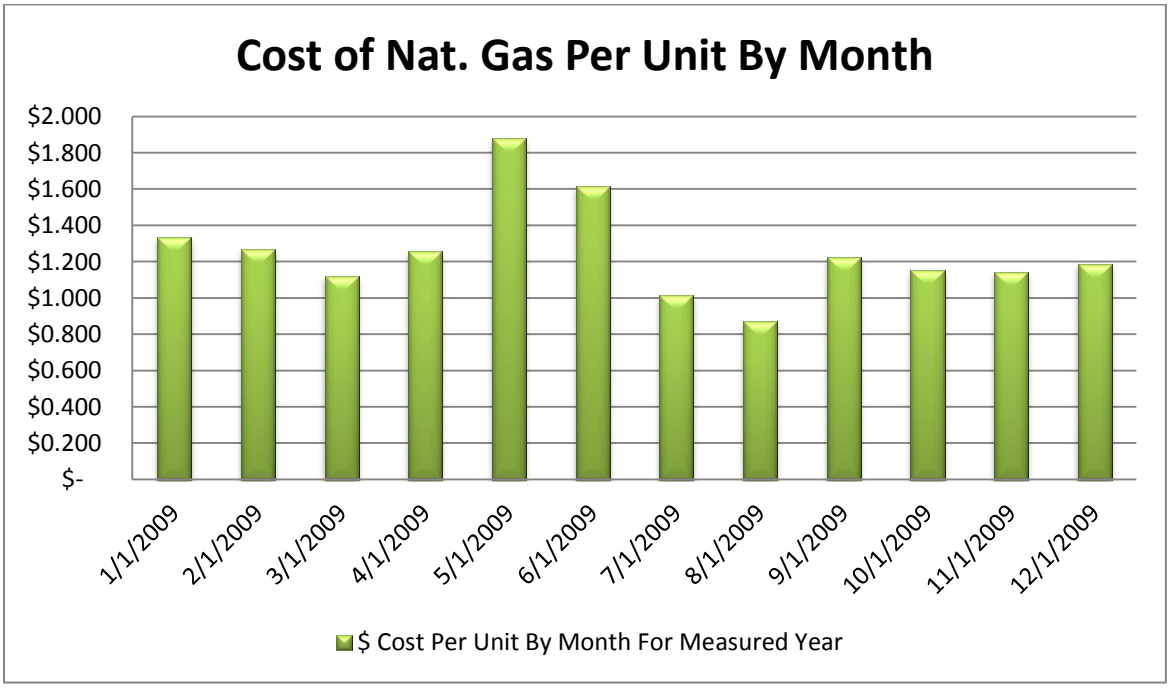
Data for individual readings were not available.

Total kWh This Year =	**91752**
Total Paid For Year=	**$13,406.41**
Ave Cost Per kWh =	**$0.1461**

Heat Source 1 - Nat. Gas Boiler			
Natural Gas			**Cost Per Unit**
Date	**Fuel Units**	**$**	
12/1/2009	1,287	$1,530.14	$ 1.189
11/1/2009	1,687	$1,923.12	$ 1.140
10/1/2009	1,926	$2,224.91	$ 1.155
9/1/2009	845	$1,036.40	$ 1.227
8/1/2009	658	$574.44	$ 0.873
7/1/2009	153	$155.76	$ 1.018
6/1/2009	45	$72.79	$ 1.618
5/1/2009	39	$73.38	$ 1.882
4/1/2009	91	$114.62	$ 1.260
3/1/2009	180	$201.94	$ 1.122
2/1/2009	422	$536.64	$ 1.272
1/1/2009	1,020	$1,363.84	$ 1.337

Total Units Used =	**8353**
Total Paid For Year =	**$ 9,807.98**
Ave Cost Per Gal =	**$ 1.17**


2009 Nat. Gas Usage by Month
2,500
2,000
1,500
1,000
500
0
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
7/1/2009
8/1/2009
9/1/2009
10/1/2009
11/1/2009
12/1/2009
Therms


Cost of Nat. Gas Per Unit By Month
$2.000
$1.800
$1.600
$1.400
$1.200
$1.000
$0.800
$0.600
$0.400
$0.200
$-
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
7/1/2009
8/1/2009
9/1/2009
10/1/2009
11/1/2009
12/1/2009
$ Cost Per Unit By Month For Measured Year

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.

Foundation and Floors:

This building sits on an uninsulated concrete foundation. As the below photo and IR image indicate, the amount of heat loss radiating from the slab is much greater than the exterior wall, even though this type of wall does not resist heat loss well.

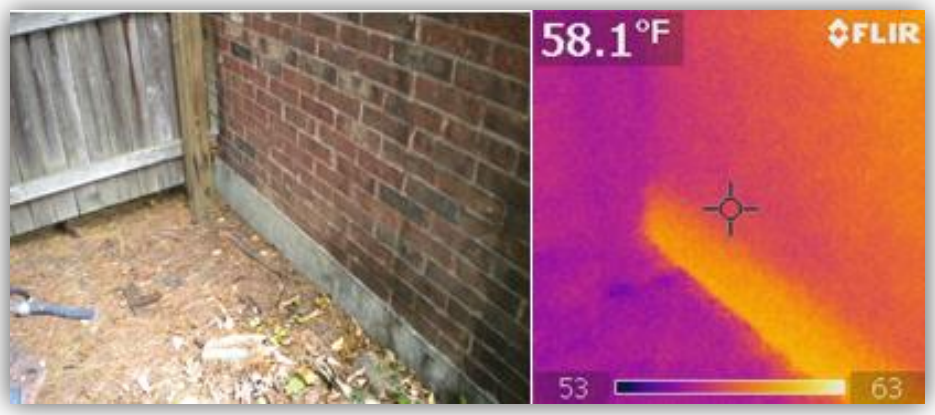


Figure 1 illustrates the process of slowing the heat loss from the foundation. Insulating the foundation would need to be done with 2 inch extruded polystyrene foam board, which would run a minimum of 2 feet below grade, though 4 feet would be preferred in this climate. The insulation would have to be protected from the elements and from pests with a durable finish. Ideally, the foam board would overlap the first few rows of brick and would need to be capped with flashing, which could be set into the mortar between two rows. A continuation of weep holes would also need to be set through the foam to the exterior on the bricked walls. This project would coincide well with a recommendation to insulate the exterior walls, as the process for insulating the exterior wall would need to start with this process.

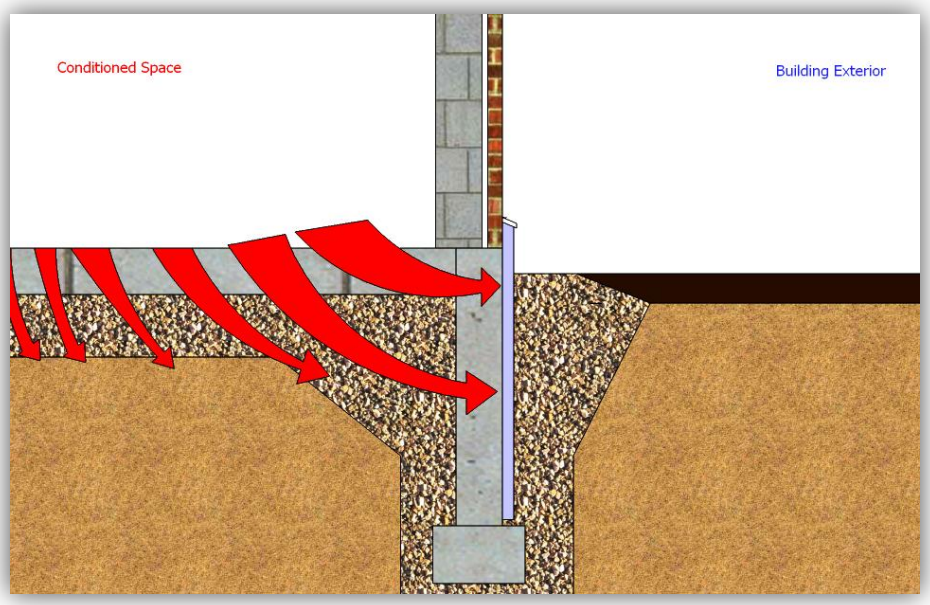


Figure 1

Exterior Walls:

With exception to the back side of the building, all of the exterior concrete block walls have a brick veneer, as is seen in this photo to the right. Also noted in this photo is a gap between the concrete blocks and the brick. This is normal for this type of wall system and is a key component in ensuring that moisture which infiltrates the wall has the ability to drain and dry before issues such as mold growth can occur. It is very important to ensure that this wall system has a proper amount of correctly dispersed weep holes along the bottom to avoid moisture build up. Also, holes in the wall like this should be properly sealed. This hole, for example, is for the generator exhaust pipe, which should have sealed metal flashing around it. In fact, for air quality and combustion safety, it may best to consider putting this generator in a shed outside of the building.

One of the other weak points in this wall system can be seen in the photo to the left. Deteriorated caulking can not only allow bulk moisture intrusion but can contribute to convective heat loss. Checking and resealing areas like this every few years should be a part of the building's regular maintenance schedule.

One great way to improve the performance of the exterior walls would be to install an exterior insulation and finish system (EIFS). Essentially, this would be a continuation of the foundation insulation recommended in the last section, which would cover the entirety of the exterior walls. Insulating the walls from the exterior of a masonry built structure would allow for the block and bricks to serve as a "thermal mass," holding heat and radiating it back towards the inside of the building. Insulating this building from the inside would not have this effect and could potentially cause moisture problems within the wall system. What is important about going with this option is ensuring proper humidity levels within the building. More about this option can be discussed during the presentation of this report.

Ceilings and Attic:

In this section of the report we will describe not only the conductive heat loss process from the roof areas of the building but also, and more importantly, the inefficiency and health risks of the stack effect, which is very strong in this building.

Air infiltrates the lower portions of the building where it is heated, and then it rises upward toward the roof. As heated air escapes the higher regions of the building, it draws more air in form the lower. This is a major source of heat loss in this building, but because most of the 1st floor is a garage area, mechanical room, generator room, and so forth, the air that rises is of very poor quality. One major force aiding in this process is the flow of air from vents and cracks in the soffit on the front of the building, which passes above the suspended ceiling on the 3rd floor, and exits via the vertical wall that separates the flat from the sloped roof.

The photo below, and to the left, shows one of these vents. The photo to the right was taken from one of the closets on the 3rd floor. What is seen are lengths of sheetrock placed, not fastened or sealed, at the top of the exterior wall in the front of the building. Outside air was pouring into this closet.

Below to the left shows what we found when we looked behind the sheetrock. There were pieces of rigid foam placed inside in an attempt to insulate, and stop air flow from the vents from entering the closets. As these are loose and not sealed, this insulation is rendered ineffective. The photo to the right looks between the sheetrock ceilings of the closet and the roof boards. After the air passes through this cavity, it enters the space above the 3rd floor suspended ceilings. Also noted in this photo is that the wood framing appears to have water damage. This could have been caused by past or present roof leaks or may be from condensation forming in the inside of the roof and steel beams, which would then drip or run down the inside of the cavity.

The photos below were taken from the space above the 3rd floor suspended ceilings. The vertical wall seen is the wall between the sloped roof of the front of the building and the flat roof of the rear. Air is able to exit the building through many areas of this wall including from around the windows, the exhaust fans, and as some of the preceding photos will indicate, from cracks between the beams, roof boards, and finished surfaces.

The suspended ceilings above the 3rd floor have fiberglass batts laid out directly on top of the tiles. Fiberglass insulation does little to impede air flow and is only ever effective when in contact with an air barrier. The suspended ceilings are not considered an air barrier, which is apparent in the photo below/left. Also apparent is that the fiberglass only serves as an air filter. The photo below/right was taken from the flat roof and looks at the exterior of the wall seen in the previous photos. The dust seen in the fiberglass, vent grills, and cracks in the exterior sheathing is almost black, which may suggest that it is particulate matter from combustion processes.

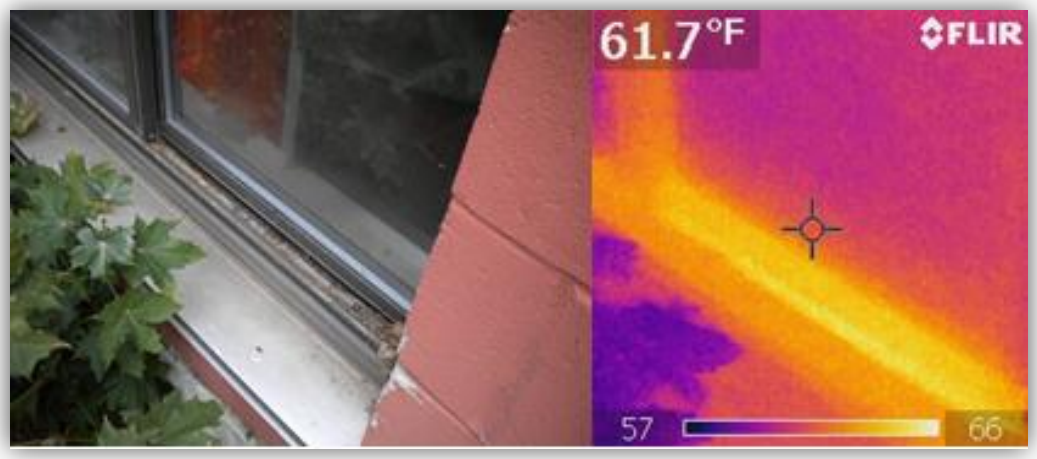
There are two major ways for air to pass from the garage area to the offices and living quarters. The obvious path is any air that is entering the shorter ceiling of the 1st floor, which then finds its way to the stairwell. The more hidden path is seen on the photo to the right. This is a large gap that runs the length of the garage wall that separates the garage area from the 2nd floor office space. This photo was taken from above the suspended ceilings of the 2nd floor offices and looks into the garage area. There was a large amount of air pouring from the garage into this space.

The priority with regards to ceilings in this building is slowing the stack effect, ensuring that no air movement can occur between the garage and the rest of the building and installing appropriate ventilation systems. There is, however, also an opportunity for increasing the insulation levels of the roof systems. Knowing that the fiberglass insulation above the suspended ceilings is doing little, it should be removed, and the new focus for insulation should be the underside of both roofs. There are several options for this, which can be discussed during the presentation of this report.

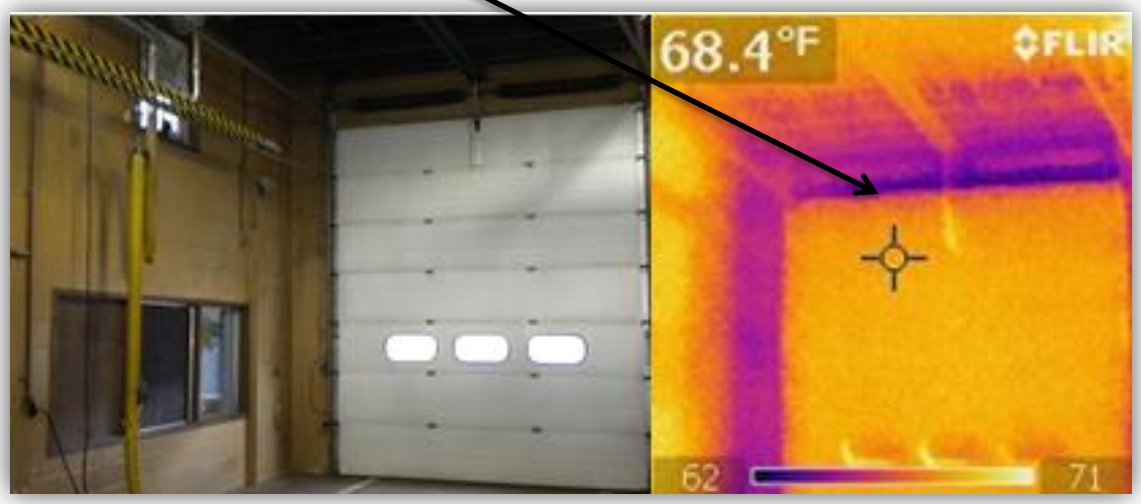
Doors and Windows:

The windows and doors of this building could be replaced with more efficient units, and the following photos and IR images will help illustrate this opportunity. Though replacing windows and doors would certainly help conserve energy and create greater comfort, this is a project that should wait until higher priority projects are carried out.

As the photo/IR images below indicate, the weakest point of these windows is actually the uninsulated aluminum frame not the glass. Higher efficiency windows would have insulated frames, double or triple glazing, should be gas filled, and have low-e coatings.



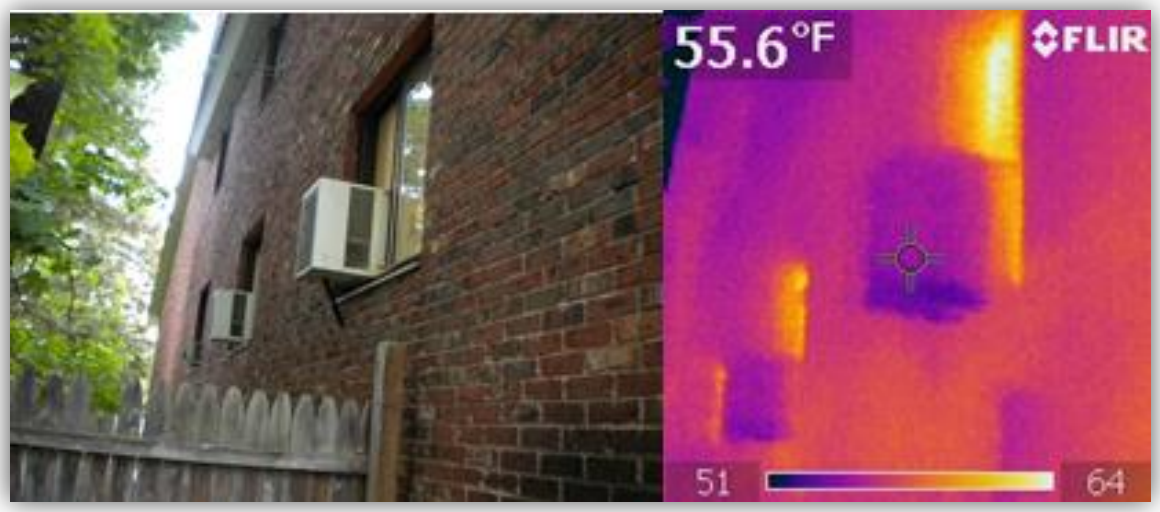
What is apparent in the images below is that the garage doors appear to offer greater thermal resistance than the surrounding walls. The darker purple strip in the IR image at the top of the door indicates air infiltration.



It is very important to ensure that all doors and windows create a good air seal when closed. Weather stripping does needs to be replaced from time to time. The photos below indicate worn weather stripping n some areas, and missing weather stripping along the top of the doors.

Any doors, whether fully glazed or solid doors such as those seen in the photo/IR images below, should only be replaced with the highest efficiency, foam core doors available.

Any window AC units should be removed from the windows at the end of the cooling season. Note the amount of heat radiating from the plywood inserts.



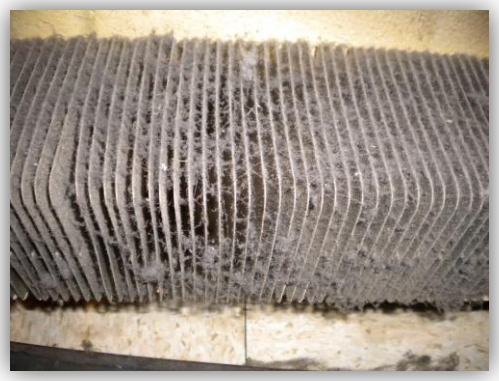
Mechanical:

The heat for this building is provided by a single natural gas-fired boiler. Seen to the right is an open combustion boiler installed in 2002 and has a rated combustion efficiency of 82%.

There has been water leaking from pipe fittings above the boiler, which has caused the rust damage to the boiler as seen in this photo to the left. Though only ten years old, this boiler should be replaced with a high efficiency, modulating/condensing gas boiler. Though there are other efficiency upgrades that could be made to the system as a whole, which would decrease fuel usage, just by swapping this unit with a high efficiency boiler could save 13%-15% annually on gas usage.

Hot water produced by the boiler is distributed to fan coils in the garage and to radiators in the rest of the building. There are large circulation pumps in the boiler room that send this water throughout the building, which likely run continuously during the heating season. This electric usage, along with the motors in the fan coils, could be substantial, though it is difficult to see this when looking at the energy usage for this building, as electric usage by month was not available for analysis. This usage could play a large role in determining the cost:benefit of making improvements to, or changing, the heat distribution system. Also note the residue on the wall above the radiator. This may be from particulate matter being channeled through the radiator after it is drawn in from gaps in the floor from around the piping, or it may be from dust and particulate matter that settles on the aluminum fins, which is then “cooked” off throughout the heating season.

We removed one of the panels covering the radiators and found that the piping and aluminum fins were covered in dust. This dust acts as insulation, as seen in the photo/IR image below. The result is that the boiler and circulation pumps need to run longer in order for enough heat to leave the radiator and satisfy the thermostats. These should be thoroughly cleaned at the beginning of every heating season.



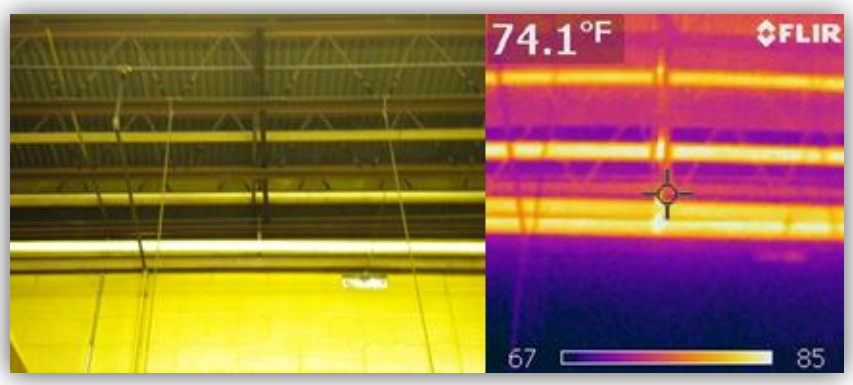
The photo/IR images below show sections of piping in the boiler room that have not been insulated. All piping in the building should be well insulated, even sections that are very challenging to insulate, such as piping around pumps and the many turns located in the boiler room.

This space heater was installed recently to help supplement the heating needs of the garage area on the colder days of the heating season. This unit did not turn on during our time in this building, and we did not perform a combustion analysis, though we suspect the efficiency of this unit to be around 82%.

The fan coils and space heater in the garage keep the space warm by heating the air, which in the winter months is lost very easily every time the garage doors are opened or exhaust systems are running. A more efficient type of system for this space could be gas-fired infrared tube heaters. Infrared tube heaters work by heating objects in the space, such as the slab, vehicles, personnel, and so forth. With more of the BTU's invested in objects, not the air, the amount of heat loss from opening the garage doors and exhausting air from this space would be greatly reduced. Analyzing the cost:benefit of this would be challenging, as the necessary heat load analysis would rely heavily on a fairly accurate number of times per hour (and the length of time) the garage doors are opened and closed throughout the heating season. Another large factor would be the amount of air that is expelled via the exhaust systems in this space.

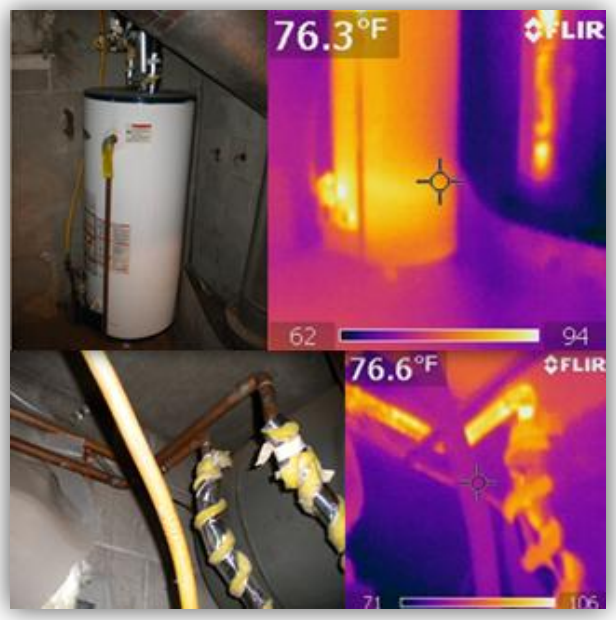
An additional potential benefit of doing this would be the reduction of the heat load on the boiler. This would allow for a smaller boiler to replace the existing model, which could reduce boiler replacement costs. Another benefit would be the reduced heat loss from the hot water piping that could be eliminated, and is visible in the photo/IR images below. Note, these pipes are insulated, and still radiate substantial amounts of heat.

The circulation pumps may be able to be reduced in size and possibly run less often, and with the elimination of the old fan coils, there could be electric usage reductions. As this list of potential benefits grows, it is clear to see how complicated this study would be, but also the potential for long term cost savings. More about performing such a study can be discussed during the presentation of this report.



There is a type of boiler control currently installed known 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 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. The capabilities and quality of current outdoor reset is unknown. As part of a boiler replacement project, it would be recommended to replace it with a potentially more sophisticated unit and potentially install an indirect water heater to replace the existing stand-alone gas water heater.

The stand-alone, gas-fire water heater, seen below, is very inefficient compared to other available technologies. Furthermore, this type of open combustion water heater can pose safety issues if there is an insufficient amount of combustion air. There are many options for replacing this water heater with a more safe and efficient system. These options can be discussed during the presentation of this report.



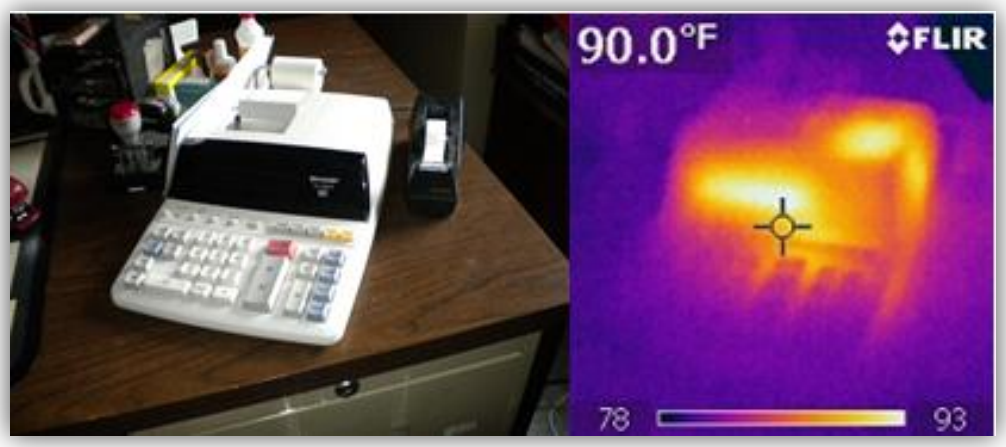
Another easy way to save on heating cost is to install digital/programmable thermostats and keep them set at an appropriate schedule for each zone.

Electrical:

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 toward addressing electric usage 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.
LED, or solid state, lighting has come a long way in the past several years, and the use of this very efficient light source is becoming more and more popular. Whether for high bay lighting, task lighting, and even flood and parking lot lighting, the LED market is ever expanding to meet all lighting needs. One of the largest deterrents for most potential LED buyers is the high initial cost. Regardless of the high initial cost, there are enormous benefits to choosing this option. Operational costs are decreased due to a much lesser electrical demand of LED lamps. If LED lights are to replace metal halide lamps, not only will they use less electricity, but also the hours of operation can be reduced because LED's do not need warm up time. When the light switch is turned on, they emit full lumen output almost immediately. This would allow for bay lighting to be turned off for smaller segments of time throughout a workday.

LED lamps also last much longer than any other lamp, reducing the cost of purchasing and installing new lamps more frequently as well as the cost of recycling the old lamps, which can contain hazardous materials.

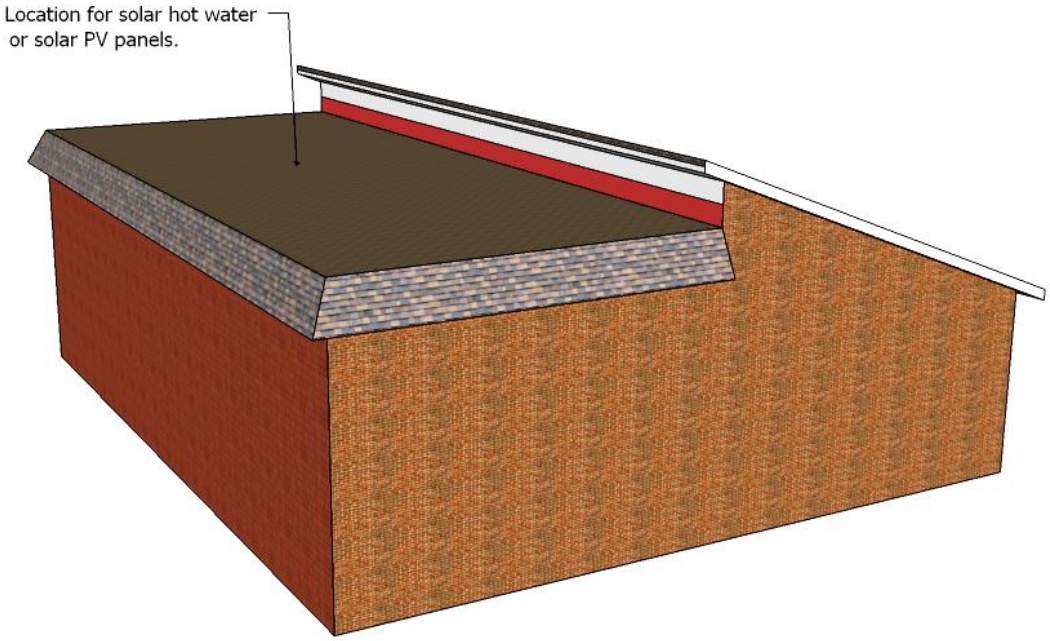
Most modern electronic equipment draws a small amount of electricity even when powered down, which can equal a sizable amount in cost at the end of the year. Using power strips and fully cutting the power to electronics will reduce this unintended electric usage. Also, as much of this building is cooled during warmer months, it is important to remember that internal heat gains in some buildings can be as great as or more than external heat gains. Some internal gains come from the occupants of a space, while other sources of heat come from lighting, computers, appliances, and so forth. The more efficient these things are, the less heat they emit, thus reducing the cost to keep a space cool.



Cooling needs of this building are being met by a series of individual window AC units. Replacing these with more efficient technology would be beneficial towards reducing this portion of the building's electric costs. Two options for replacing these would be to either install individual ductless split systems, or to install an air handler serviced by a high efficiency outdoor condensing unit. There are pros and cons to each, which can be discussed during the presentation of this report.

Consider discontinuing the use of this soda machine. The electrical cost of running these units year round can be substantial, and the refrigerator already running in this building could serve a similar purpose. A collection bucket can be located near the refrigerator for payment. Besides, the money saved in electric costs may just be able to provide free soda for all, eliminating the need to charge for it.

Installing a photovoltaic (PV) solar system on site to supplement the costs of electricity is always recommended. One, and possibly the only, location on site for installing such a system may be the flat portion of the roof system.



Options for funding such a project are given in the "Financial Considerations and Options" section of this report.

Health, Safety and Comfort:

It is very important to address comfort issues when they arise. Unbalanced heating and cooling zones can have negative effects on employee productivity and can add to the cost of heating and cooling. Unbalanced heating zones can, for example, encourage the use of items like small electric space heaters that are expensive to run or for windows to be open to cool overly heated spaces.

Seen in the photo below/right is a combustion supply duct powered with a fan. We suspect that the piece of sheet metal installed around it is there to keep this air from blowing out the open flames of the boiler and hot water heater. The sign on the door of the boiler room, seen to the left, suggests that there is not enough combustion air supplied to these appliances, even with this supply duct. Replacing the boiler and hot water heater with more efficient systems would therefore not only save on energy cost but, because any high efficiency systems will be closed-combustion systems, this combustion safety issue would be eliminated.

Though we did not test for mold, there were no obvious signs of mold growth in this building. It is always important to address moisture issues as they arise, first by eliminating the source of the moisture. Moisture problems can be a leaking roof or internal sources like leaky pipes, or the mop bucket seen in the photo below. A simple moisture reading in the block at the base of the walls surrounding this room indicates levels conducive to mold growth. Controlling interior sources of moisture would become even more important should the building be insulated from the exterior.

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

There are exhaust hoses for the vehicles in the garage now in place, so the residue mentioned earlier, and as seen in this photo to the right, may be from before the new exhaust system was installed. Regardless, it is extremely important to monitor air quality, and ensure that proper ventilation equipment is installed in all areas of the 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 2. 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.

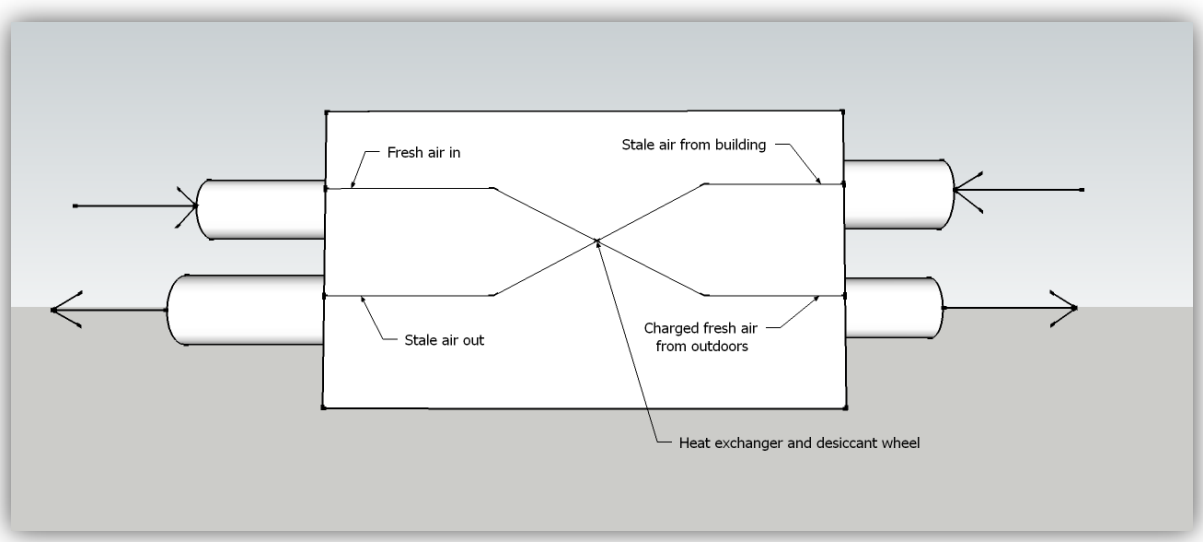


Figure 2

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.

We would also like to mention that it was brought to our attention that there could be major changes made to this building in the near future. One of these changes may include converting the garage area of the building into office space. Though a project such as this would not change all recommendations given for this area of the building, it could change recommendations for heat distribution systems for example. When we review these recommendations with the City, we can discuss how these recommendations would be altered in relation to future building plans.

Foundation and Floors:

- Insulate the foundation of this building from the exterior as described earlier in this report. If this is done, it would be beneficial to put in place drainage pipes while the perimeter of the foundation is exposed to help channel rain and snow melt away from the building.

Exterior Walls:

- Continue the foundation insulation up the exterior walls to create an exterior insulation and finish system (EIFS).

Ceilings and Attic:

- As much as possible, air seal major air passage ways between floors of this building.

- Consult with a trusted spray foam insulation company about adding R-value to the underside of the roof systems. This is a type of project that would need to be carefully planned and implemented to maximize the benefits of such an investment, and to ensure that building durability is maintained.

Doors and Windows:

- It would take a very detailed heat load analysis to determine the cost vs. benefit of replacing the window and door units. What is certain is that it would reduce the cost to heat and cool the building over the long term and increase occupant comfort. This may be a lower priority item. In the interim, ensure that all doors and windows provide a good air seal when closed.

Mechanical:

- Ensure that all the hot water piping in the building is well-insulated, including all the piping in the boiler room.

- Clean the radiators at the beginning of every heating season.

- Install 7 day digital/programmable thermostats.

- Replace the existing potable hot water heater with a more efficient means of production. This could be an indirect hot water heater (only if the current boiler is replaced), a solar domestic hot water system, or an on demand system. More about these options can be discussed during the presentation of this report.

- Replace the existing boiler with only the highest efficiency, modulating/condensing natural gas-fired boiler. The size of a new boiler would be directly affected by other changes to the heating system. A careful analysis would ensure that the new boiler is appropriately sized.

- If the garage area of the building is to remain this type of space indefinitely, consult with an HVAC specialist or mechanical engineer on the energy saving benefits of heating this space with infrared tube heaters. If this space is to be converted to office space, there are many options for heating systems and heating/cooling distribution systems. These options can be discussed during the presentation of this report.

Electrical:

- Plug all electronic equipment that does not need to be powered 24 hours/day into power strips, and fully cut the power to as much equipment as possible when not in use. "Smart" power strips can be purchased that have a couple of outlets that will not fully cut the power to certain items, like computers perhaps. Also, some smart strips come with digital meters so that usage can be monitored.

- Consult with a lighting engineer to examine ways to maximize lighting efficiency. Look for ways to incorporate LED technology in high use fixtures and outdoor safety/security lighting that may need to be left on throughout each night.

- Replace the window AC units with either individual ductless split systems (install units with the highest SEER available), or, by adding an air handler with associated ductwork

and outdoor condenser. The pros and cons of each can be discussed during the presentation of this report.

- Install a photovoltaic solar system on site to supplement the costs of electricity. Options for funded such a project are given in the "Financial Considerations and Options" section of this report.

Health and Safety:

- Ensure that any air passage ways from the garage areas to the rest of the building are well sealed.

- Though we did not test for mold, there were no obvious signs of mold growth in this building. Any moisture issues that should occur need to be addressed right away, always beginning by eliminating the source of the moisture.

- Install and maintain CO sensors in the garage area that automatically control a main exhaust system.

- With the building well sealed, it will be necessary to ensure an adequate number of air changes per hour in the office spaces and living quarters. This should be done with either heat or energy recovery ventilation systems to minimize the impact on heating and cooling costs.

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

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- 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.

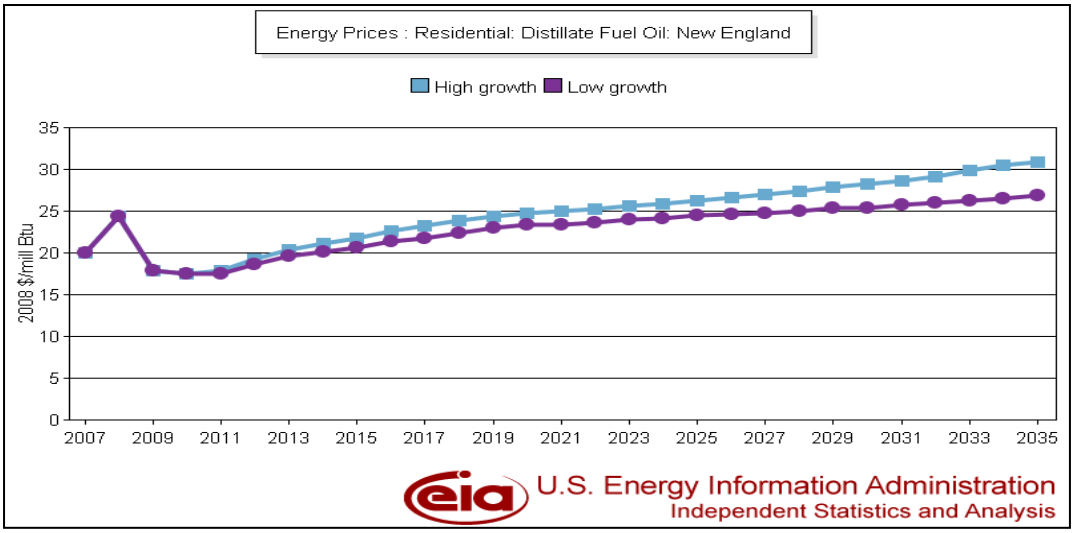
For more information on the history of energy prices and how energy cost projections are calculated, please visit: http://www.eia.doe.gov/analysis/

Price Summary

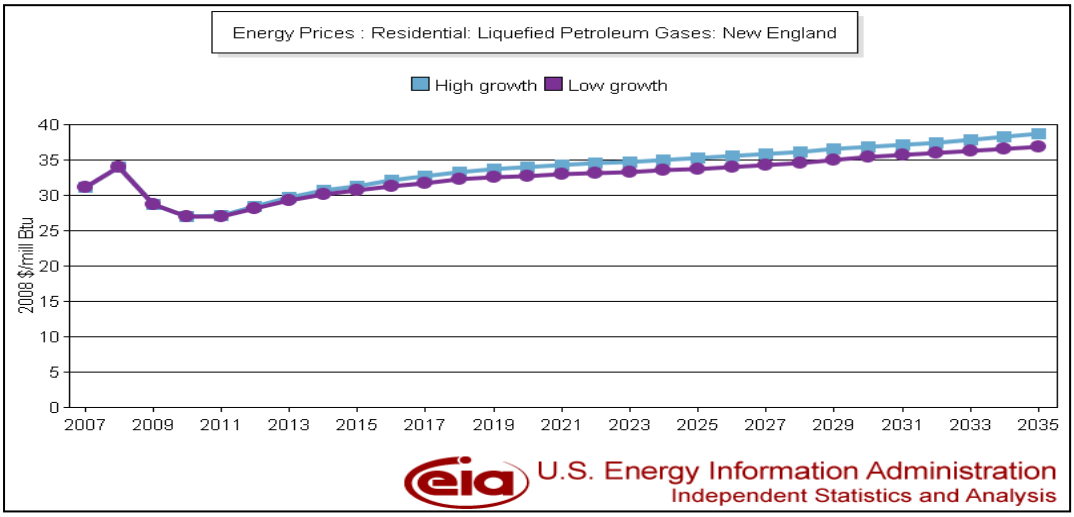
	Year				Percent Change		
	2009	2010	2011	2012	09-10	10-11	11-12
WTI Crude[a] ($/barrel)	61.65	79.40	93.26	97.50	28.8	17.5	4.5
Gasoline[b] ($/gal)	2.35	2.78	3.15	3.30	18.4	13.4	4.8
Diesel[c] ($/gal)	2.46	2.99	3.43	3.51	21.5	14.7	2.4
Heating Oil[d] ($/gal)	2.52	2.97	3.41	3.55	17.5	14.8	4.3
Natural Gas[d]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

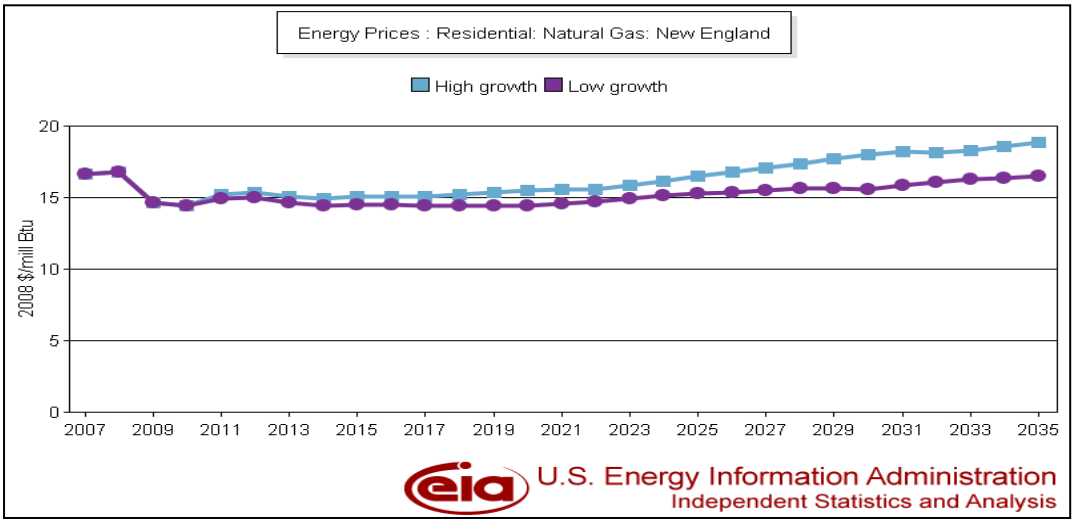
Table 1 – Retrieved from US EIA website



Graph 1 - Retrieved from US EIA website



Graph 2 - Retrieved from US EIA website



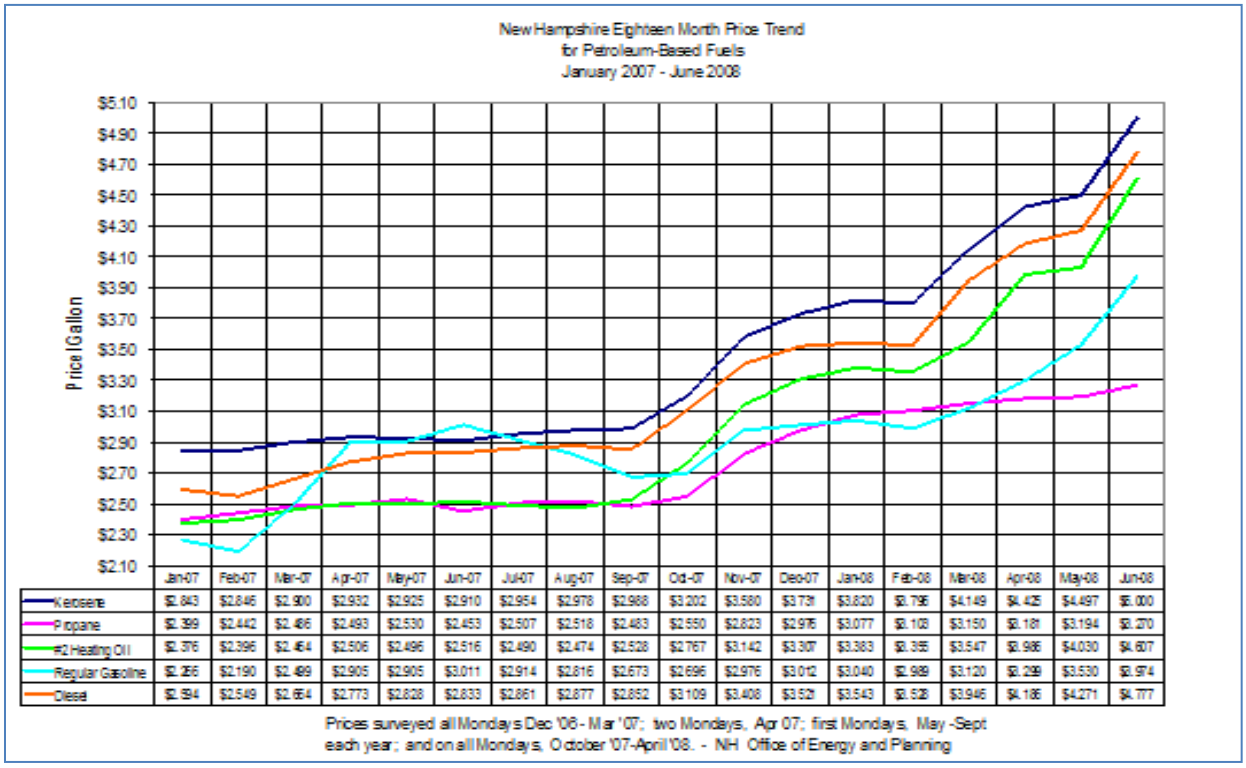
Graph 3 - Retrieved from US EIA website

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.

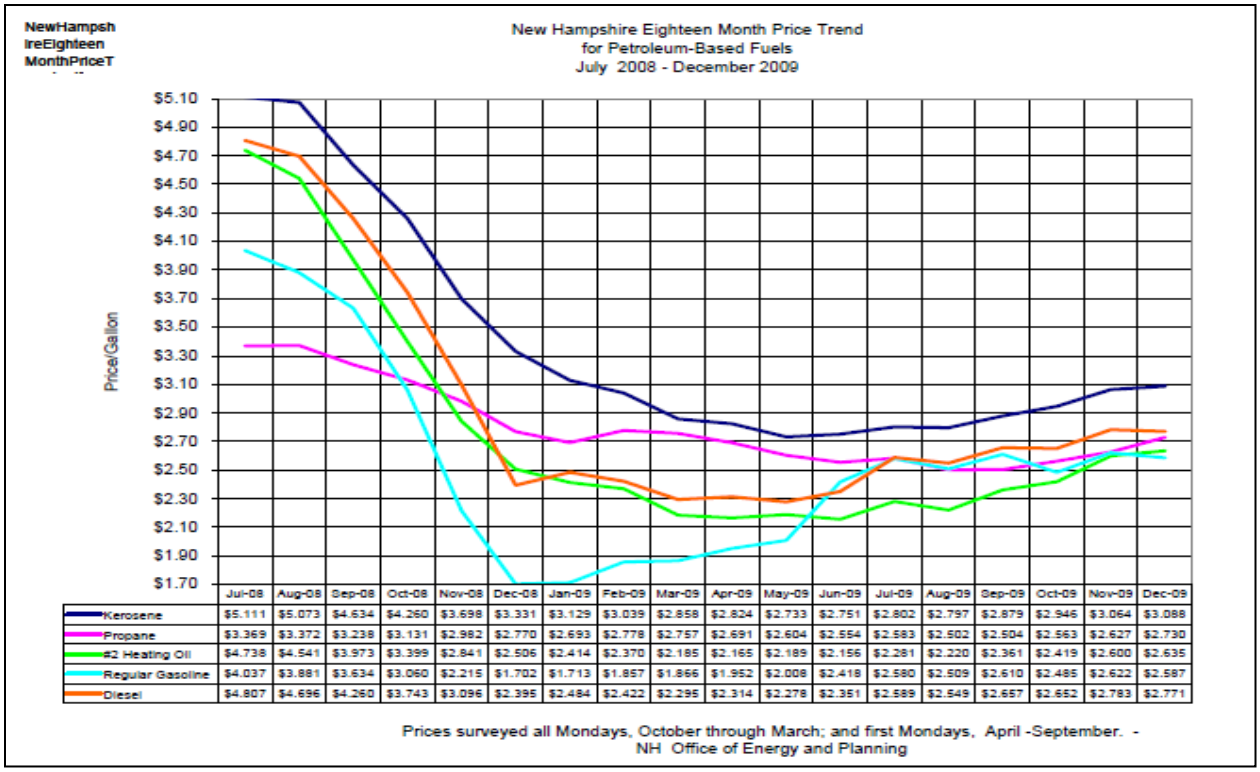
Projects such as air-sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler and a PV system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



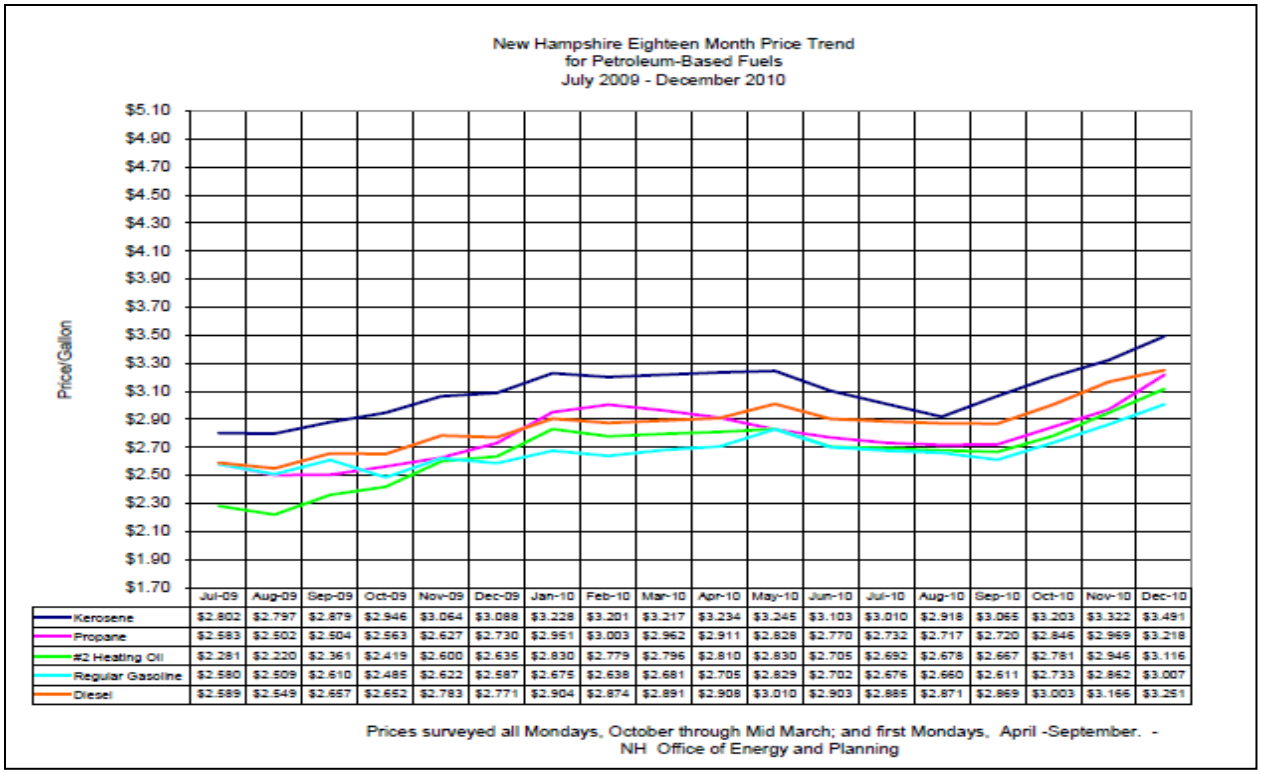
	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
Kerosene	$2.843	$2.846	$2.900	$2.932	$2.925	$2.910	$2.954	$2.978	$2.988	$3.202	$3.580	$3.731	$3.820	$3.796	$4.149	$4.425	$4.497	$5.000
Propane	$2.399	$2.442	$2.466	$2.493	$2.530	$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 3 - 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 City 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 4 – 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 and cost, with a 2% cost increase per year.

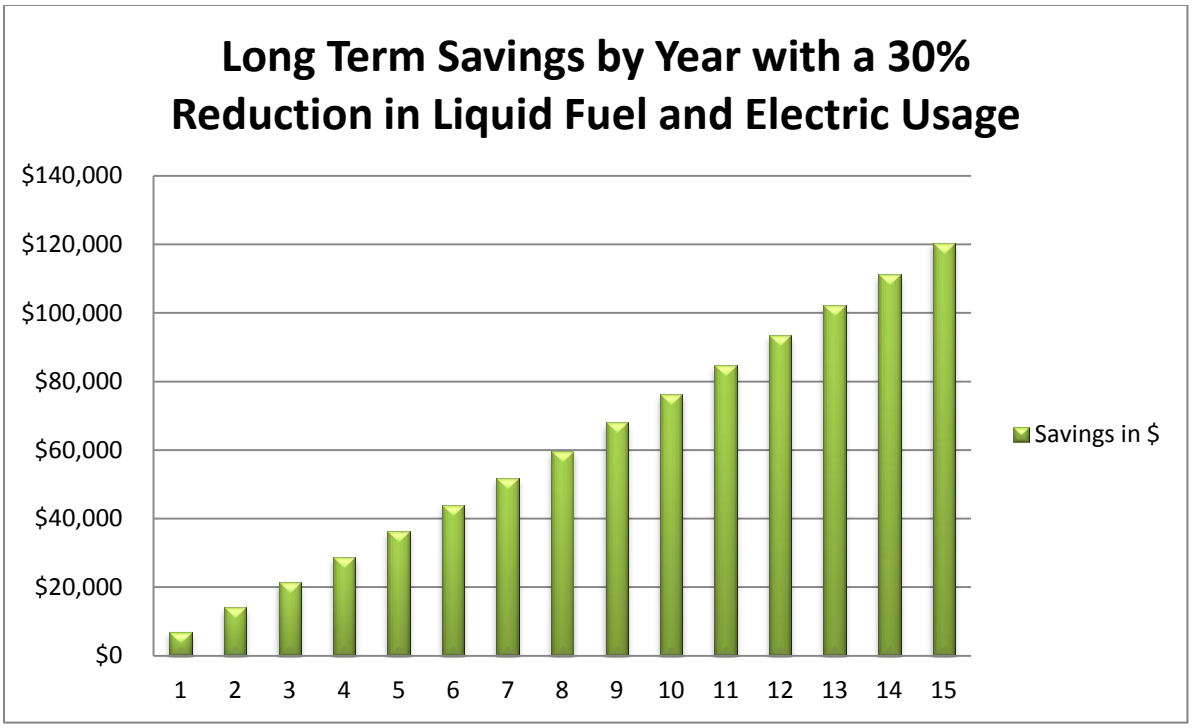
Current Fuel Usage				
Year	Energy Cost By Year	Yearly Increase	Total Accumulated Cost by Year	
		Escalation Rate	2.00%	
Year 1	$9,807.98	$196.16		$9,808
Year 2	$10,004	$200.08		$19,812
Year 3	$10,204	$204.08		$30,016
Year 4	$10,408	$208.17		$40,425
Year 5	$10,616	$212.33		$51,041
Year 6	$10,829	$216.58		$61,870
Year 7	$11,045	$220.91		$72,915
Year 8	$11,266	$225.33		$84,182
Year 9	$11,492	$229.83		$95,673
Year 10	$11,721	$234.43		$107,395
Year 11	$11,956	$239.12		$119,351
Year 12	$12,195	$243.90		$131,546
Year 13	$12,439	$248.78		$143,984
Year 14	$12,688	$253.75		$156,672
Year 15	$12,941	$258.83		**$169,613**

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	$13,406.41	$268.13		$13,406
Year 2	$13,675	$273.49		$27,081
Year 3	$13,948	$278.96		$41,029
Year 4	$14,227	$284.54		$55,256
Year 5	$14,512	$290.23		$69,767
Year 6	$14,802	$296.04		$84,569
Year 7	$15,098	$301.96		$99,667
Year 8	$15,400	$308.00		$115,067
Year 9	$15,708	$314.15		$130,775
Year 10	$16,022	$320.44		$146,796
Year 11	$16,342	$326.85		$163,139
Year 12	$16,669	$333.38		$179,808
Year 13	$17,003	$340.05		$196,811
Year 14	$17,343	$346.85		$214,153
Year 15	$17,689	$353.79		**$231,843**

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 - Heat and Electric				
Percent of Cost Reduction =			**30.00%**	
Year	**Avoided Cost By Year**	**Savings Gain By Year**	**Total Savings Over 15 Years**	
		Escalation Rate	**2.00%**	
Year 1	$6,964	$139.29		$6,964
Year 2	$7,104	$142.07		$14,068
Year 3	$7,246	$144.91		$21,314
Year 4	$7,391	$147.81		$28,704
Year 5	$7,538	$150.77		$36,243
Year 6	$7,689	$153.78		$43,932
Year 7	$7,843	$156.86		$51,775
Year 8	$8,000	$160.00		$59,775
Year 9	$8,160	$163.20		$67,934
Year 10	$8,323	$166.46		$76,257
Year 11	$8,489	$169.79		$84,747
Year 12	$8,659	$173.19		$93,406
Year 13	$8,832	$176.65		$102,238
Year 14	$9,009	$180.18		$111,248
Year 15	$9,189	$183.79		**$120,437**



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 City 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 City has several options available to increase the efficiency of the Central Fire Station. 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 City 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.