The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Exeter Safety Complex
20 Court St., Exeter, NH 03833

Prepared for:

Town of Exeter, NH

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Clean Air Cool Planet

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

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Exeter and the Safety Complex (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.

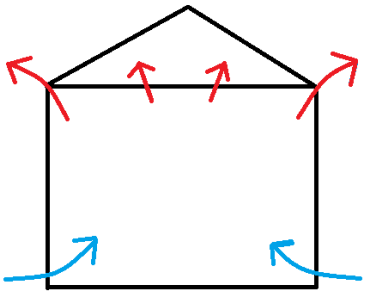
This DGA involves a quantification of energy consumption (electrical and heating fuel), a description of existing heating/cooling and distribution systems, thermal barrier inefficiencies, potential electric savings through lighting/appliances upgrades and behavior change, occupancy health and safety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

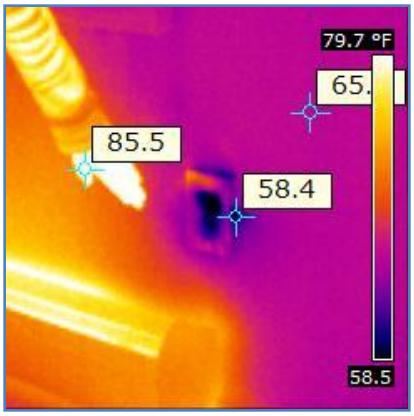
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



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.

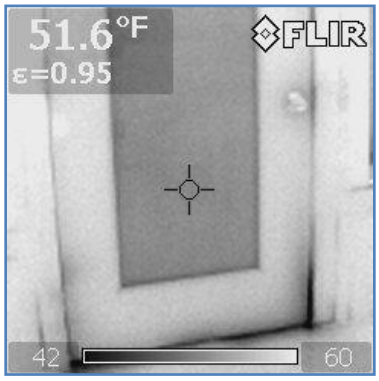
Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope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



<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.

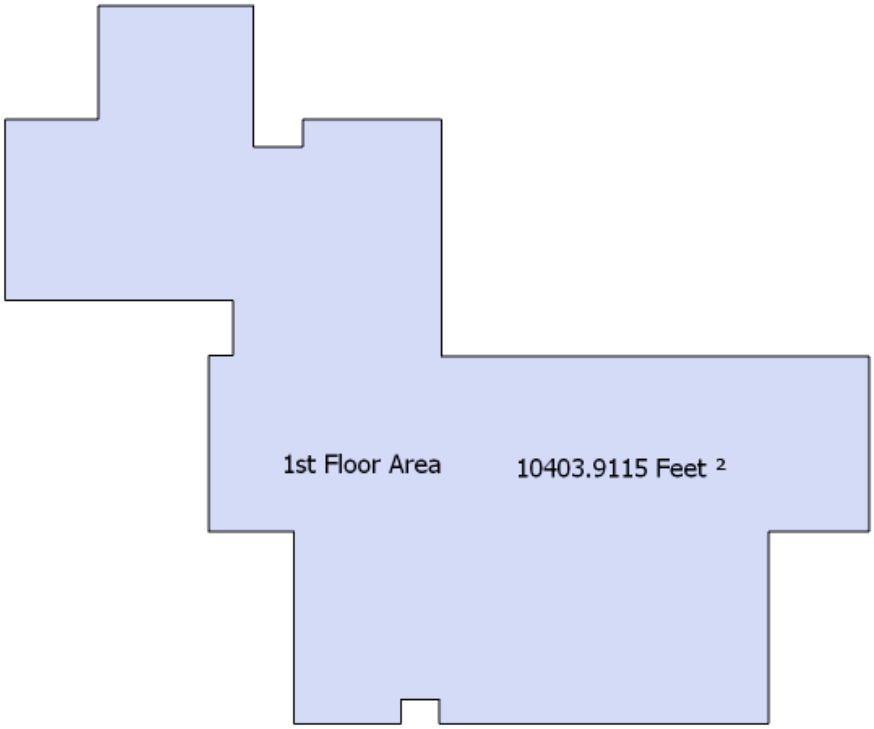
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable and to keep the water vapor from causing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

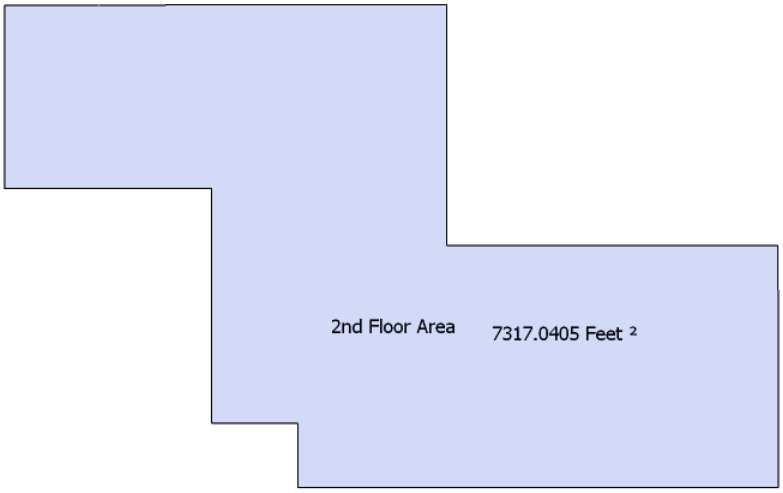
Just as BTUs conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and we use these to form a vapor barrier on the inside of the thermal boundary in an attempt to slow the amount of vapor diffusion. Small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

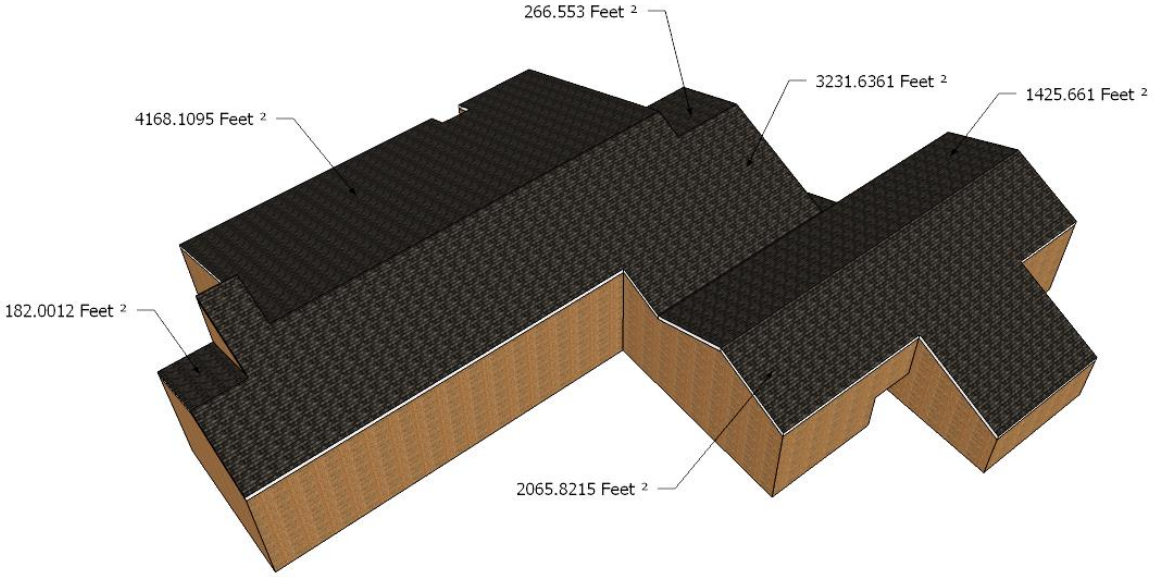
It is important to identify any current moisture problems and address them appropriately. This is always done by first finding and controlling the source of the moisture. Sometimes it can be quite difficult to see moisture damage, as it may be buried inside of wall cavities. It is also important to know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

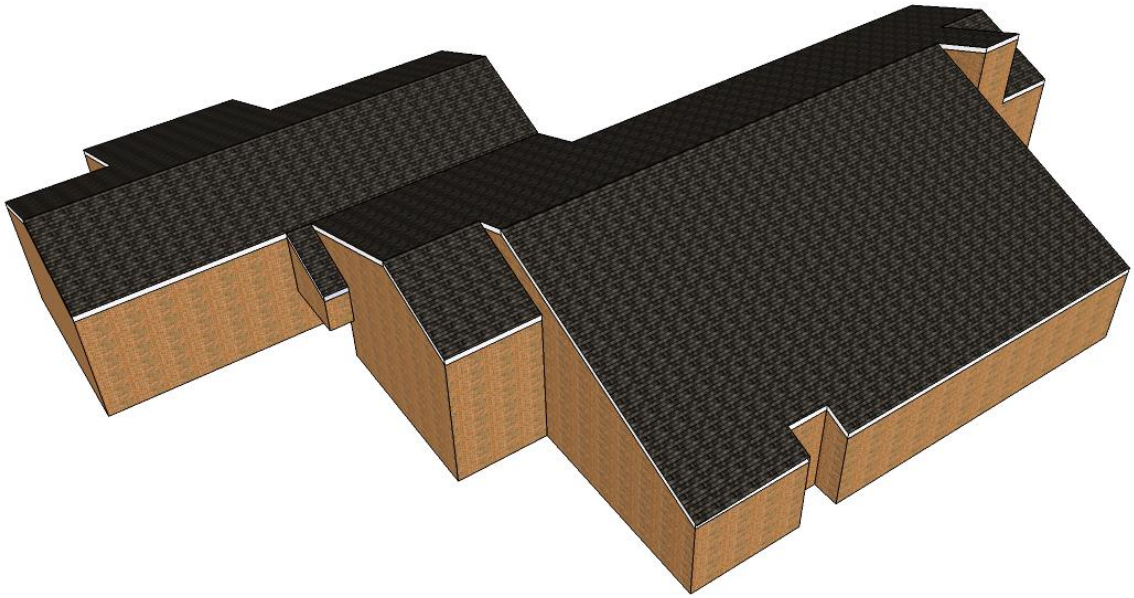
Building Description:

The Exeter Safety Complex was built in 1975. This building houses the Exeter Police Department and the Fire Department. Most of the office space is located on the 2nd floor as well as conference rooms, break rooms, and living quarters. Most of the 1st floor space consists of garage areas, mechanical rooms, holding cells, and emergency dispatch offices.


1st Floor Area
10403.9115 Feet ²


2nd Floor Area
7317.0405 Feet ²

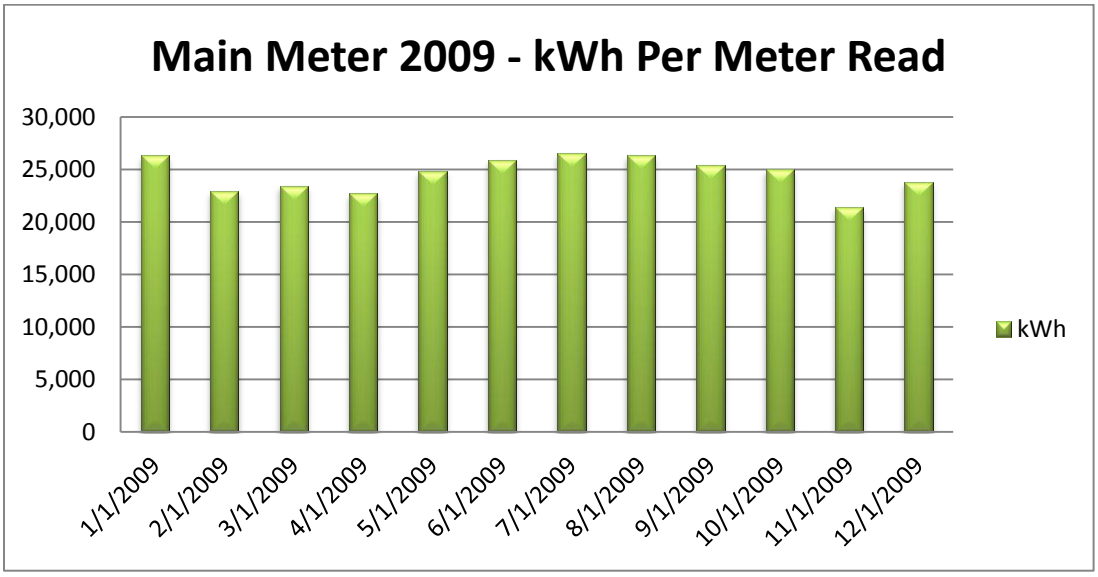

266.553 Feet ²
3231.6361 Feet ²
1425.661 Feet ²
4168.1095 Feet ²
182.0012 Feet ²
2065.8215 Feet ²



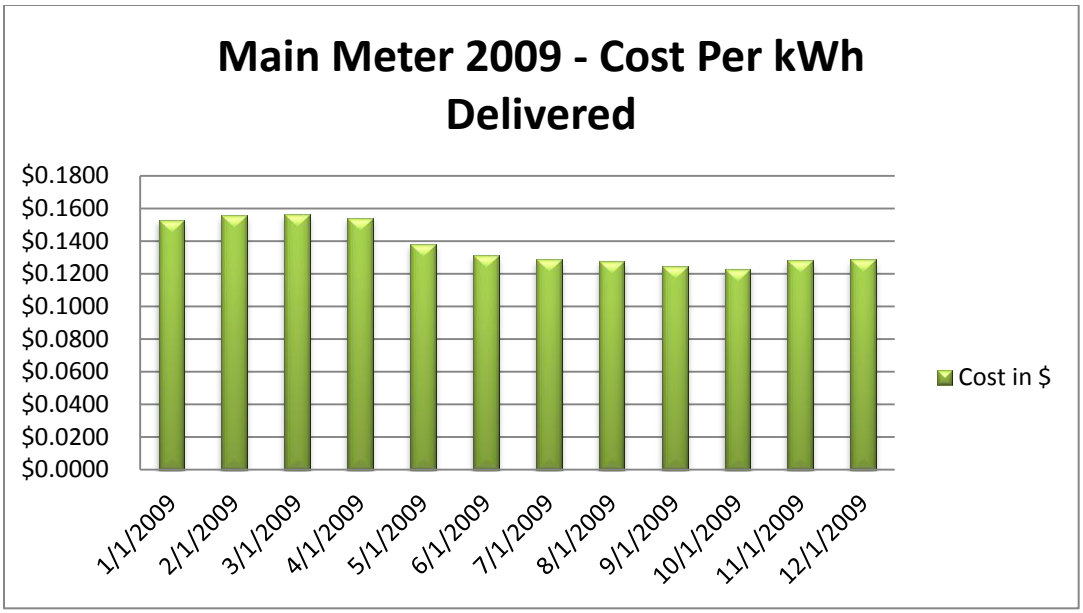
Energy Data Collection:
Analysis from provided utility bills for 2009 produced the following snapshot of electricity consumption. Monthly consumption is designated low to high, red being the lowest and green being the highest consumption months in the table below.

Electric Usage – 2009			
Date	**KWH**	**Total $/Mo**	**Cost Per kWh**
12/1/2009	23,760	$3,059.00	$0.1287
11/1/2009	21,360	$2,739.00	$0.1282
10/1/2009	25,020	$3,077.00	$0.1230
9/1/2009	25,440	$3,171.00	$0.1246
8/1/2009	26,340	$3,359.00	$0.1275
7/1/2009	26,520	$3,416.00	$0.1288
6/1/2009	25,860	$3,396.00	$0.1313
5/1/2009	24,840	$3,432.00	$0.1382
4/1/2009	22,680	$3,493.00	$0.1540
3/1/2009	23,400	$3,652.00	$0.1561
2/1/2009	22,920	$3,566.00	$0.1556
1/1/2009	26,340	$4,029.00	$0.1530

Total kWh This Year =	**294480**
Total Paid For Year=	**$40,389.00**
Ave Cost Per kWh =	**$0.1374**



Annual electricity consumption for the Exeter Safety Complex



Cost of delivered electricity for the Exeter Safety Complex

Heat Source 1 - 2 Nat. Gas Boilers			
Natural Gas			
Date	**Fuel Units**	**$**	**Cost Per Unit**
12/1/2009	1,745	$2,465.00	1.4126074
11/1/2009	789	$1,106.00	1.4017744
10/1/2009	512	$663.00	1.2949219
9/1/2009	135	$261.00	1.9333333
8/1/2009	3	$64.00	21.333333
7/1/2009	15	$76.00	5.0666667
6/1/2009	203	$257.00	1.2660099
5/1/2009	422	$506.00	1.1990521
4/1/2009	1,076	$1,567.00	1.4563197
3/1/2009	1,841	$2,743.00	1.4899511
2/1/2009	2,055	$3,369.00	1.6394161
1/1/2009	2,404	$3,931.00	1.6351913

Total Units Used =	**11200**
Total Paid For Year =	**$ 17,008.00**
Ave Cost Per Gal =	**$ 1.52**

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:

The amount of heat loss from a foundation and slab can be substantial, sometimes 20% or more of a building's heat load. As Figure 1 and 2 indicate, the concrete slab of this building is likely not insulated.

Figure 1

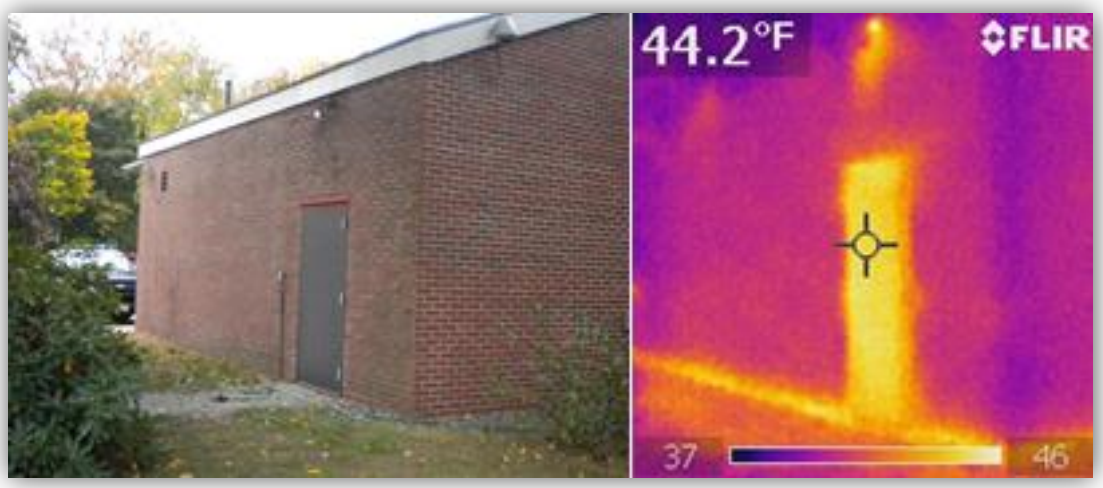


Figure 2

While there is little to be done about the thermal efficiency of the exterior walls, there are projects that could be implemented to reduce the amount of heat loss from the top and the bottom of the building. Figure 3 illustrates the process of slowing the heat loss from the slab. 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.

Because this building has large areas where pavement meets the exterior walls, a project like this would be challenging and more costly. Though insulating the slab would produce long term savings over the life of the building, which may be standing for 100 years or more, this project would fall fairly low on a prioritized list of energy improvement projects.

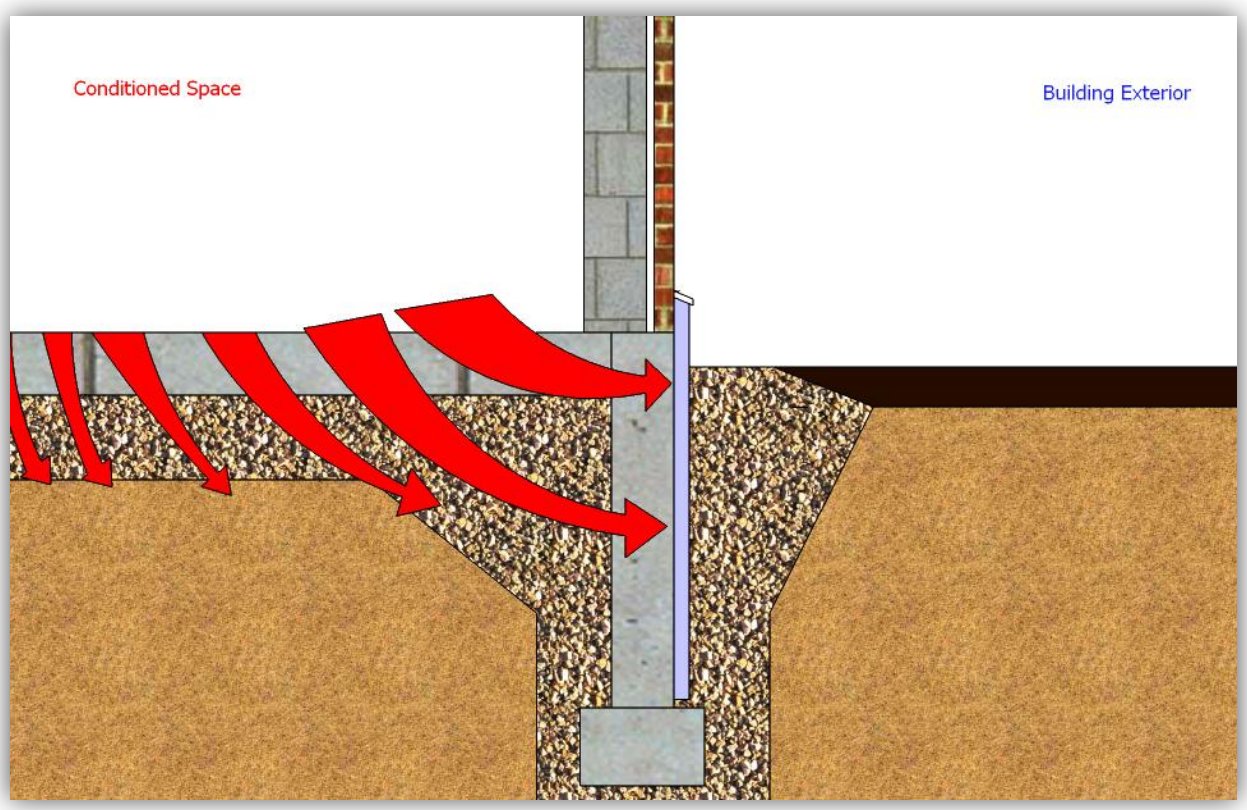


Figure 3

Exterior Walls:

As previously stated, there are few project options that would substantially increase the thermal efficiency of the exterior walls of this building. A common way of insulating masonry walls is to do so from the outside with an exterior insulation and finish system (EIFS). This would involve a continuation of the rigid slab insulation, described previously, that would extend to the tops of the walls. There are various options for finishing the walls, though a durable cement or stucco type finish is common. This would also be a costly project to undergo, and its importance would also be shadowed by higher priority energy improvement projects.

There are smaller projects that could be done to address specific weak points in the exterior walls. The flowing Figures help to reveal these target areas. Darker purple areas of the IR images indicate colder surfaces and therefore areas with less substantial heat loss. The light purple, orange, yellow, and white areas (in that order) indicate problem areas. Note the color (temperature) scale at the bottom of each IR image.

Figure 4

Figure 5

We would like to make mention of the glazing in Figure 6 in this section of the report, because it may be more of an exterior wall than a window. As the IR image indicates, this is a large source of heat loss during the colder months, and the negative heat gain during the warmer months is likely just as significant. This is a great architectural feature and allows a lot of daylight into the hallway and stairwell. The benefit of this daylight does come at a cost, however, both in heating and electrical costs. If this feature is to remain in place, it would be beneficial to eventually increase the efficiency of this glazing. The glass could be replaced with triple glazed thermal panes or even potential treatment options to the existing glass. Note the door as showing the greatest amount of heat loss.
Also note the vent to the left of the glazing and the amount of heat pouring out. Later in the report, we will discuss options for capturing some of this energy loss through the use of energy/heat recovery ventilation systems (ERV/HRV).

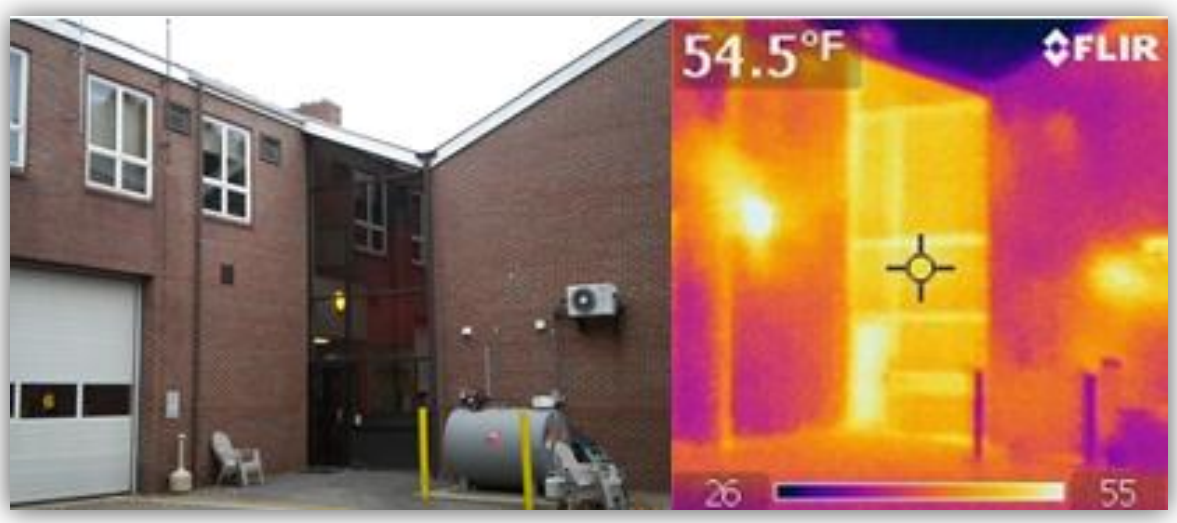


Figure 6

Figures 7 and 8 indicate weak points along the tops of these walls. The cold areas indicate conditioned air passing from this space into the attic. These, and any other air passageways, could be sealed to reduce this energy loss and keep any exhaust fumes from vehicles from passing into other occupied areas of the building.

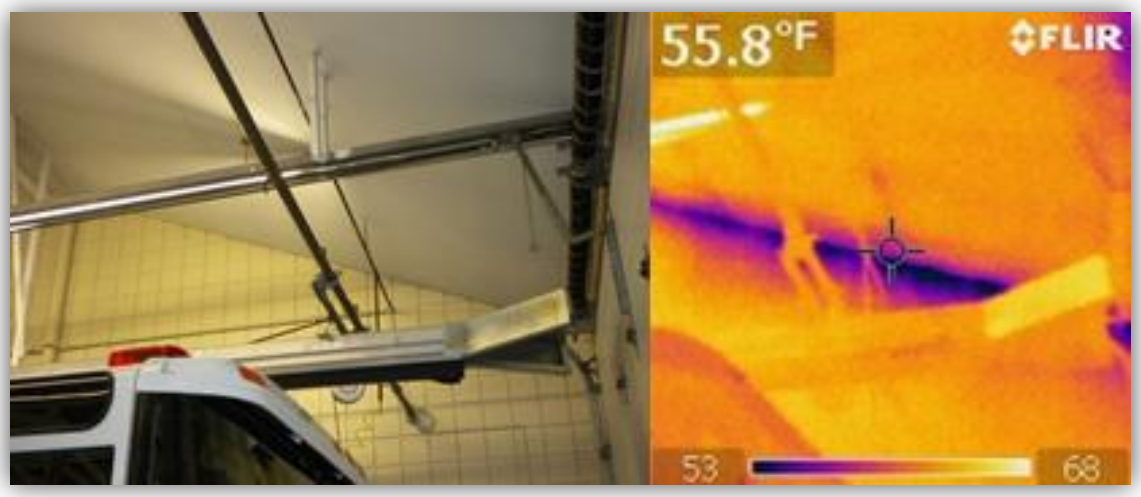


Figure 7

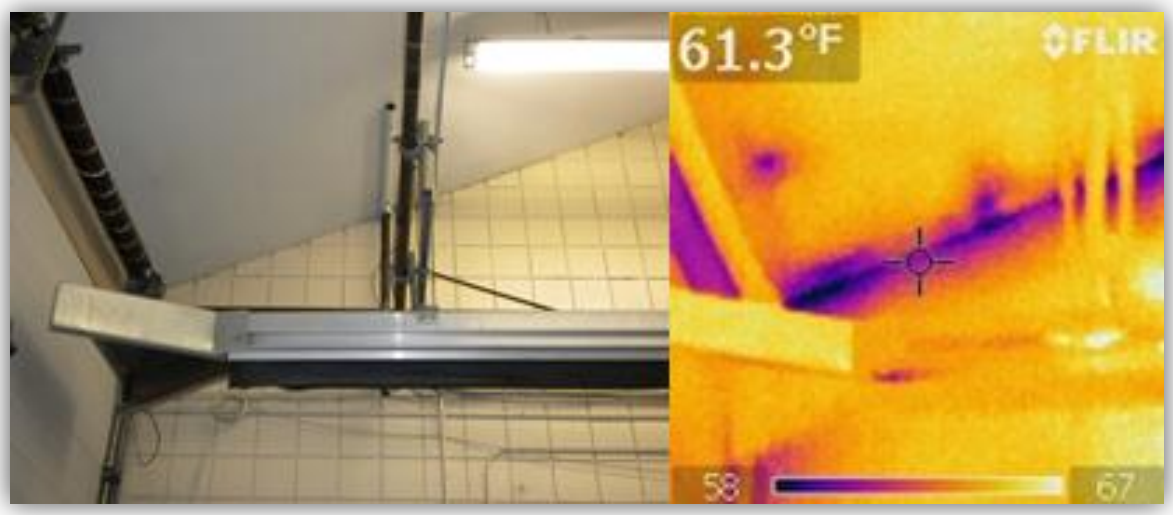


Figure 8

Ceilings and Attic:

With regards to the thermal envelope, the greatest opportunity for reducing the cost of heating the building will come from making air sealing and insulation improvements to the ductwork and attic area of the building. Note in Figures 9 and 10 the amount of heat coming from the roof of the building. In Figure 9, it is easy to see where the insulated sloping ceiling of the garage area ends and where the ventilated attic area begins.

Figure 9

On the back side of the building, the attic area begins at the top of the exterior walls with exception to the insulated sloping ceiling above the stairwell.

Figure 10

Figures 11 -13 show just a few of the many areas of the 2nd floor ceiling, taken from the attic, that are missing insulation and have air passageways from electrical and mechanical penetrations. Furthermore, much of the ceilings only have R-19 fiberglass batts. This is well below today's standards for R-value in ceilings, and represents a great opportunity for savings.

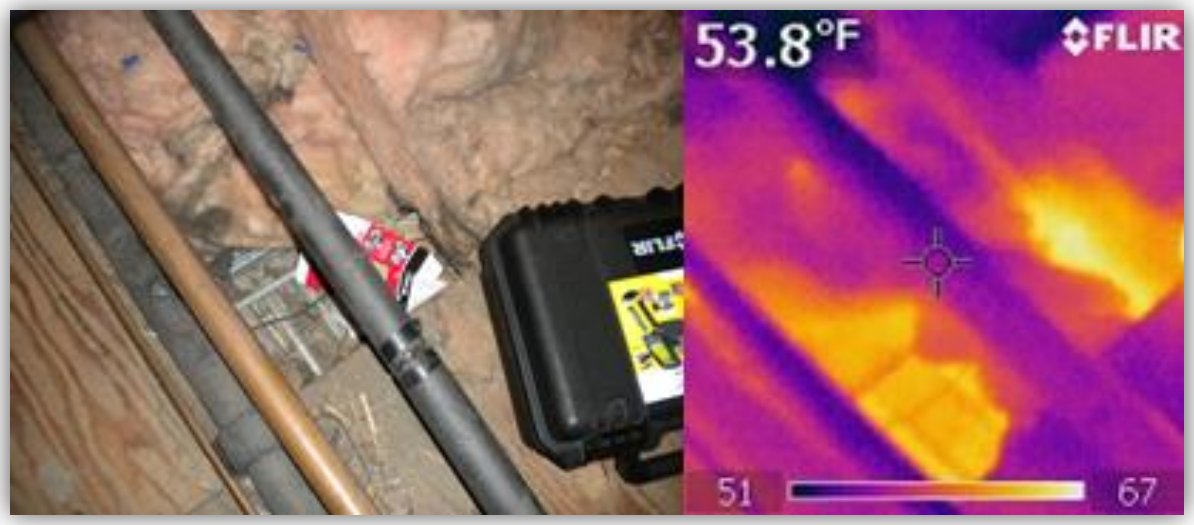


Figure 11

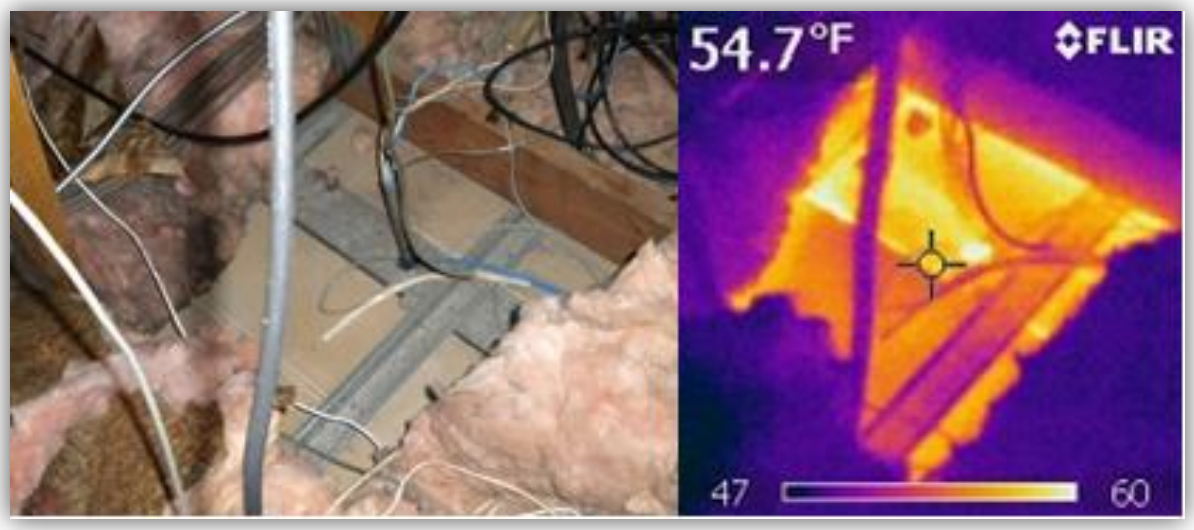


Figure 12

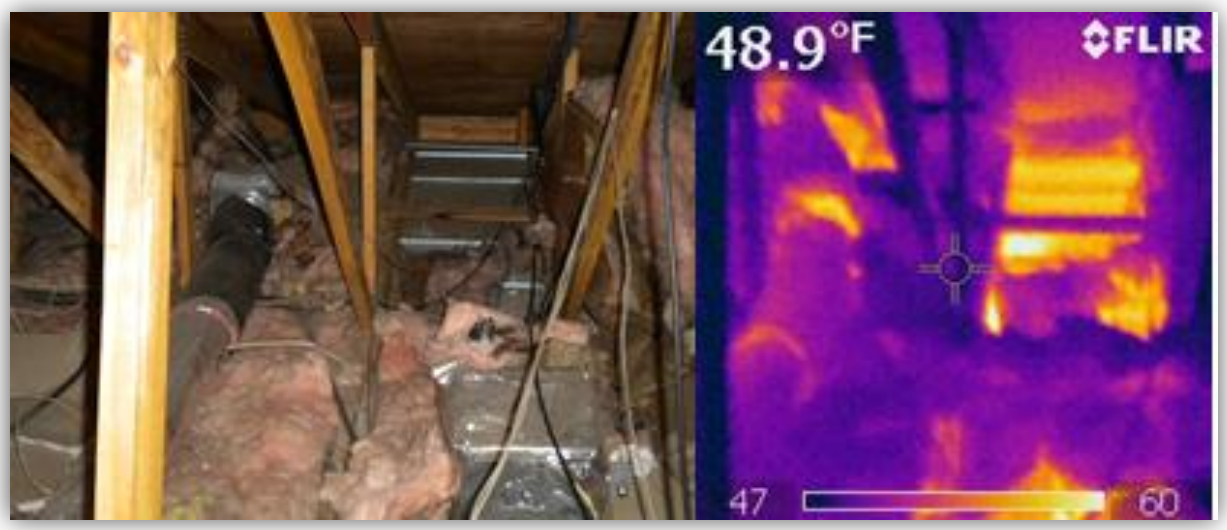


Figure 13

Figures 14 -16 show some of these same uninsulated areas from the conditioned spaces below. Note that from the attic these areas appear as hot (orange), while when seen from the conditioned space below they appear as cold (purple).

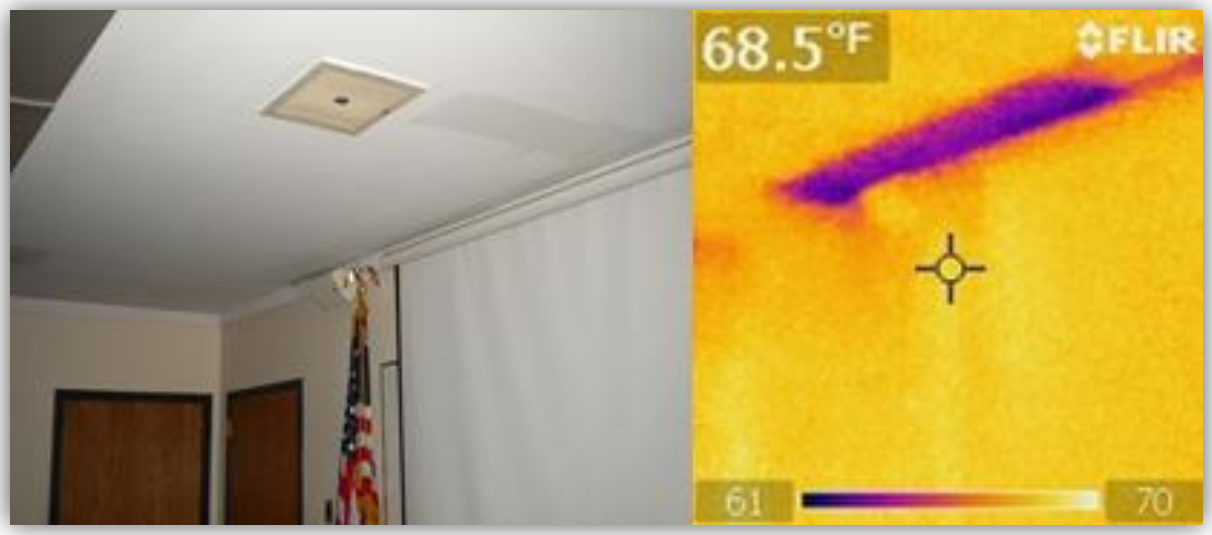


Figure 14

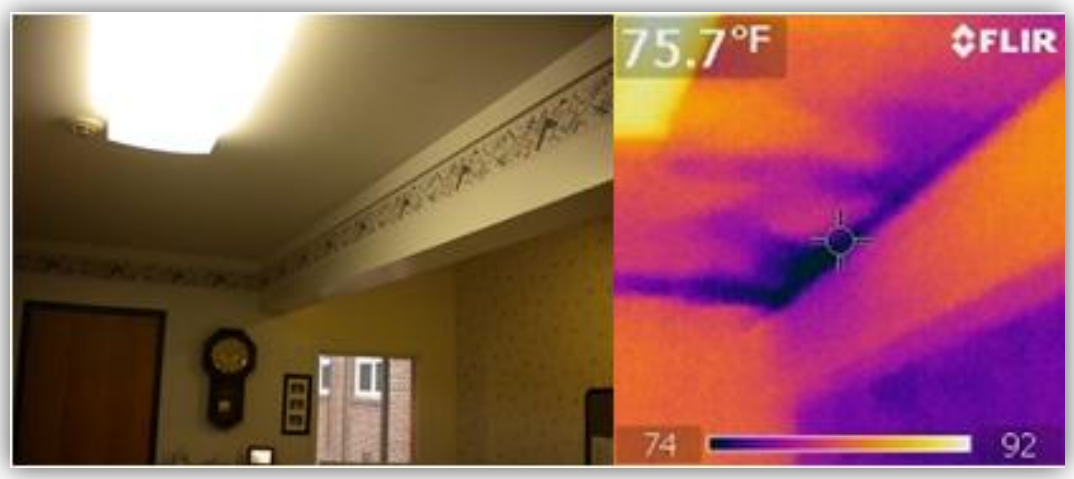


Figure 15

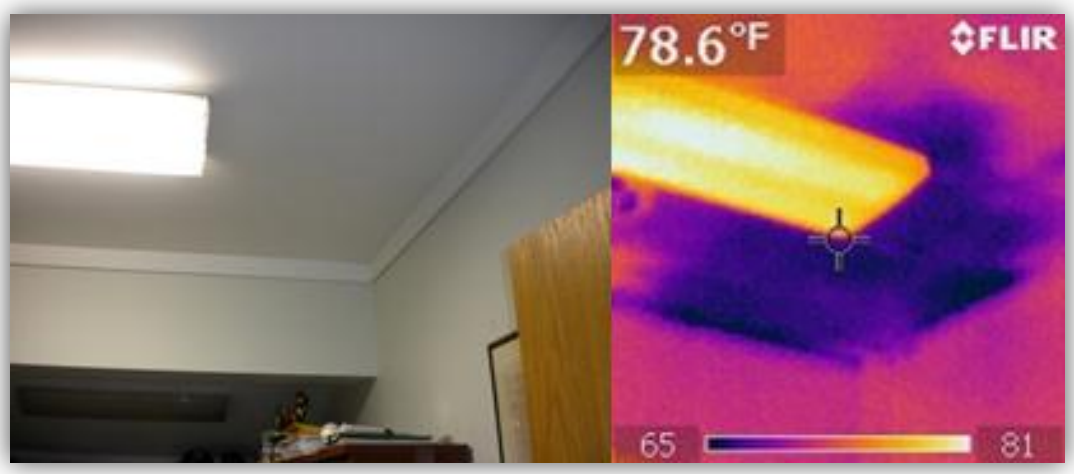


Figure 16

At first glance, it might seem as though the logical solution is to air seal the ceiling and add more insulation. However, much of the building's heating and cooling equipment and distribution systems are located in the ventilated attic, which, as described later in this report, are plagued with inefficiencies. It is always the best option in this circumstance, to bring the heating and cooling equipment into the building envelope. What this would entail would be to insulate the underside of the roof as well as any gable walls, creating an unventilated attic and "cold roof." Although some air sealing and insulation work would still need to be done to the ductwork in this space, bringing this area within the building's thermal envelope should substantially reduce the cost of heating the building. In addition, it will also have a positive impact on electricity cost from reduced cooling loads and the blower units in the air handlers needing to run less often in both the heating and cooling seasons. Moreover, making this improvement would also allow for an easier integration of heat or energy recovery ventilation systems, which if installed, would further reduce energy costs. This is a project that would need to be done well—by a trusted insulation company. More about this option can be discussed during the presentation of this report.

Doors and Windows:

Because of the limited options for improving the thermal efficiency of the exterior walls, the benefits of replacing doors and windows becomes more important than most none masonry buildings when trying to prioritize energy improvement projects.

Many of the window and door units in this building could be described as "metal brake": a very common type of window and door unit in this type of building—these units all have uninsulated frames. As Figure 17 makes apparent, the frames themselves conduct heat much faster than the glass portions. Not only are these windows and doors relatively inefficient, but they create discomfort for those who work next to them.

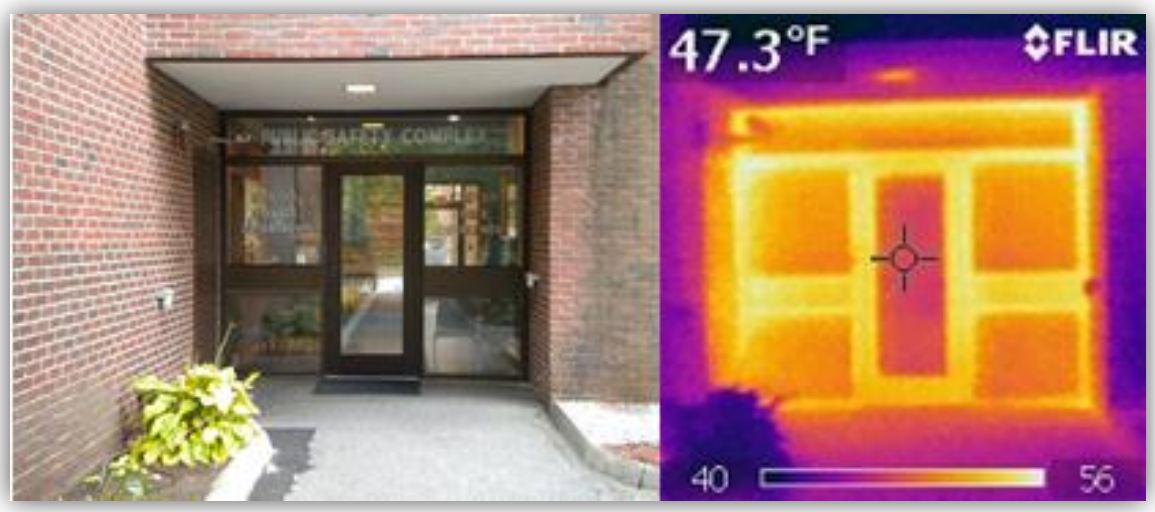


Figure 17

As this photo to the right indicates, the seal on many of these units has failed over time, further reducing their efficiency.

As little insulative value as these masonry walls may have to offer when compared to other types of wall systems, their inefficiency is shadowed by that of the uninsulated aluminum windows. Several employees of this building spoke of the discomfort caused by these windows. As it was described to them, hot is always trying to find cold. When one stands next to the windows, the cold sensation gives the impression that they may be leaky. To the contrary, these windows may be offering a good air seal. The cold feeling comes from heat radiating away from their bodies faster when next to the windows because of a greater temperature difference when compared to an exterior wall.

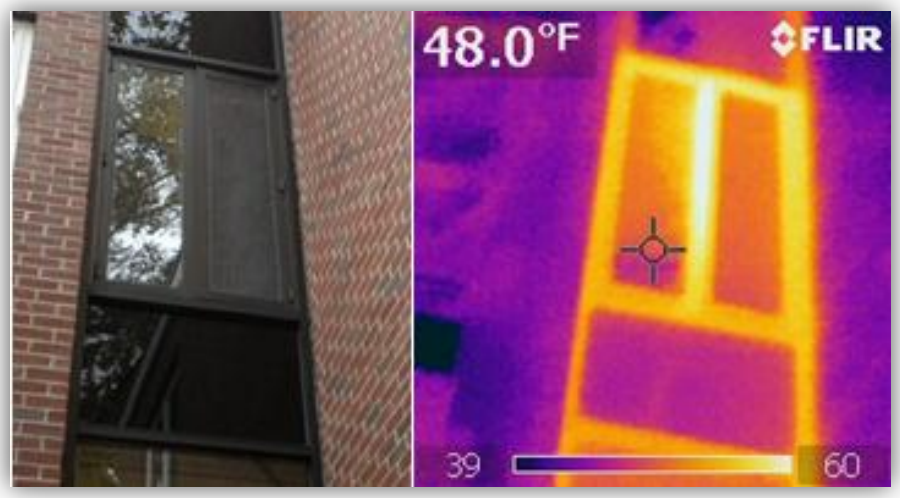


Figure 18

Figure 19 shows a clear side by side difference between the heat conductivity of metal aluminum framed windows and wood framed windows. Insulated fiberglass windows are an even greater improvement to the solid wood frames.

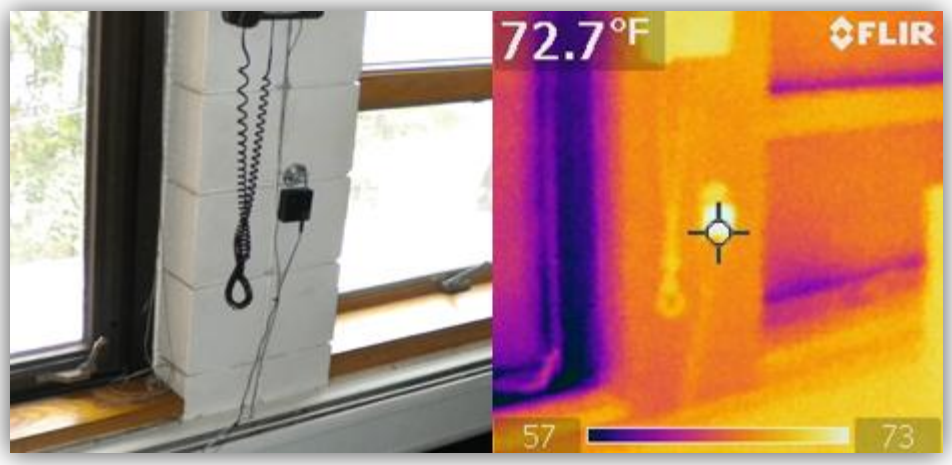


Figure 19

Metal doors, like those seen in Figure 20, present an energy saving opportunity as well. Not only in the core insulation of these doors, but by the amount of air infiltration from around the edges.

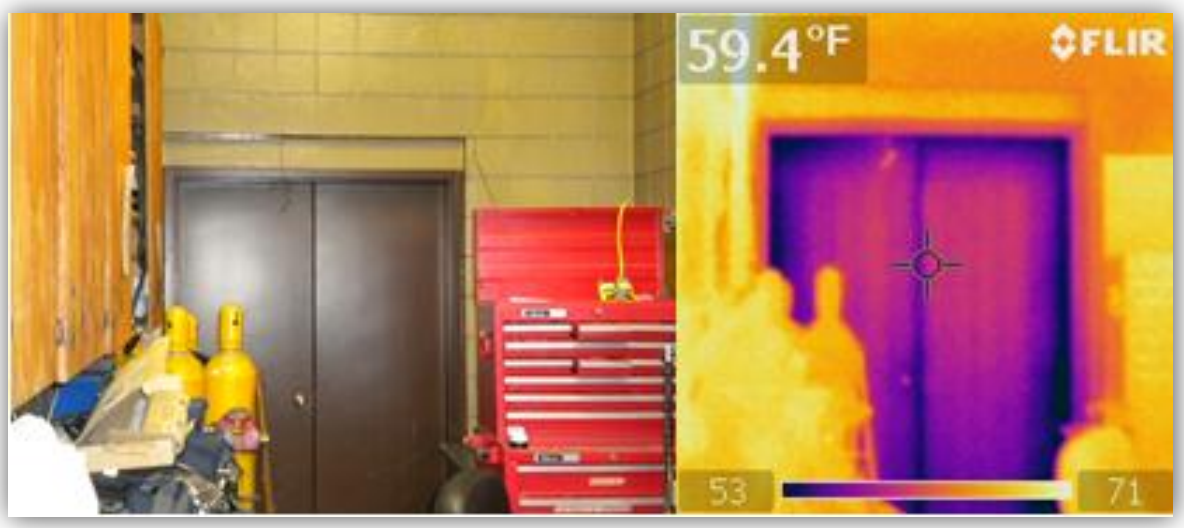


Figure 20

Note in Figure 21 the amount of heat radiating from the door and side glazing to the bottom left compared to the window units of the 2nd floor. Also seen here is the heat loss from the opened bedroom window. Balancing heat distribution and offering greater control of individual spaces not only creates greater comfort but also saves on heating and cooling costs.

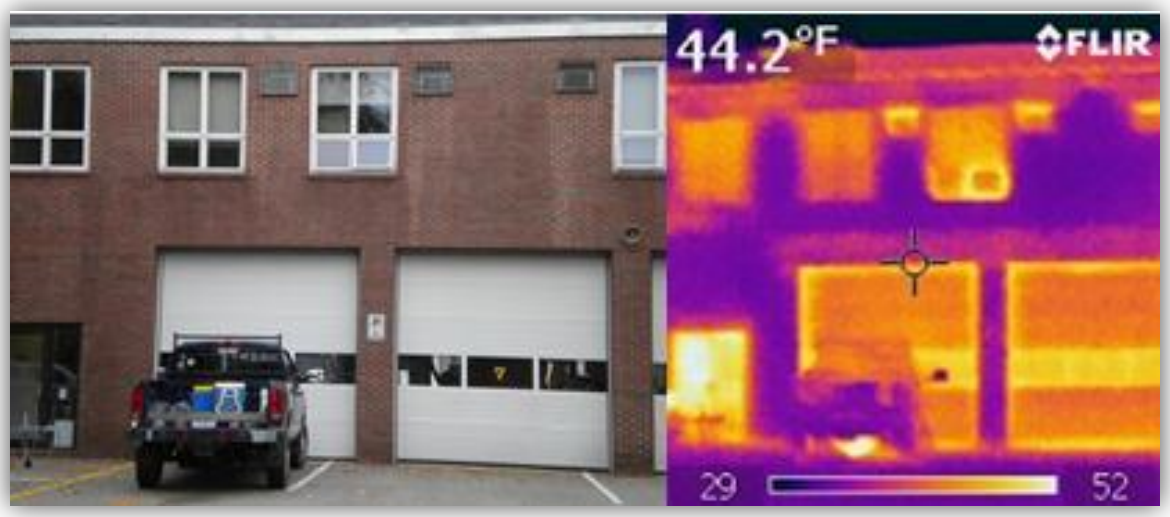


Figure 21

Seen here in Figure 23, also noted in some of the previous photo/IR pairs, is a greater amount of heat coming from some of the garage doors than others. These doors appeared to be the same make and model; therefore, we suspect that this greater amount of heat loss may be due to heat radiating from vehicles that were more recently used now parked just inside the doors. This same type of heat source can be seen in the glowing engine block beneath the pickup truck in Figure 21.

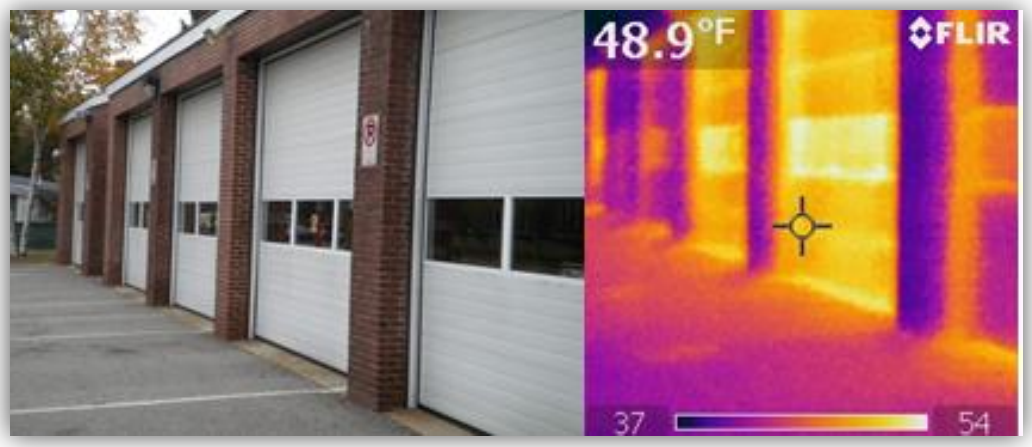


Figure 22

Figure 23 is a photo/IR image that was not captured at this building, but helps to illustrate the effectiveness of a well-placed radiant barrier. A radiant barrier can be made from any metalized/reflective surface. Though radiant barriers do not stop the movement of heat, they do reflect much of the heat radiating towards their surface back in the opposite direction. This principal is clear in the mirror image of the radiator that this piece of sheet metal creates when viewed with an IR camera.

Though replacing the garage doors of this building is not recommended at this time, it would be beneficial and inexpensive to line the interior of the doors with foil-faced bubble wrap insulation. With such a flexible material, it may even be possible to overlap the panel sections (the weakest points of the doors) without disrupting their operability. Also, ensure that these doors are well-sealed around the edges when closed. Weather stripping around any door will wear over time and needs replacement periodically.

Figure 23

Mechanical:

This building is heated with 2 Natural Gas fired boilers. These boilers were installed in 1999, have rated heat output of 880,000 BTU's each, and are rated at 88% combustion efficiency. It was brought to our attention that these boilers have come at a great cost with regards to service and maintenance. The same company that made these boilers (which are American made) now offers a well-respected, low maintenance line of fully modulating/condensing boilers that could replace these units. The efficiency gain alone would not be substantial enough to warrant their replacement (88% to 95%). Much of the reason for this is the fact that the fuel source is natural gas and therefore fairly inexpensive. What may be the deciding factor to justify replacing these boilers is the cumulative yearly cost to maintain them, coupled with the added operational efficiency. More about this cost:benefit potential can be discussed during the presentation of this report.

Another potential savings opportunity with regards to the production of heat is the concept of integrating a small cogeneration system into the existing system. Cogeneration systems (combined heat and power, or CHP) function by burning a single fuel source but provide both heat and electricity for a building. More about these systems can also be discussed during the presentation of this report.

Seen in this photo to the left is a type of boiler control known as an "outdoor temperature reset." An outdoor reset, functions by monitoring the outdoor temperatures and automatically adjusts the temperature set points of a boiler. For example, on the coldest days of a NH winter, the temperature of the water sent to baseboard radiators will most often not need to be greater than 180°F. If the outdoor temperature is only 50°F, the boiler may only have to send 160°F water to the baseboard. Many types, including this model, 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. The installation of this was a very wise decision as they will typically reduce fuel usage by 10%-20% or more on a yearly basis.

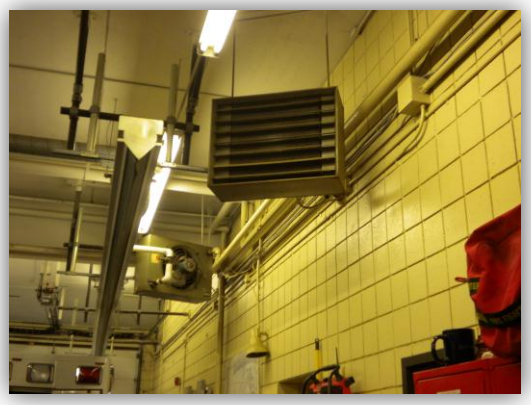
Much of the heat delivered to the building is done so through a series of air handling units like the one seen in the photo to the right. Most of these units are located in ventilated attic space, though there is one located in the conditioned sally port. These units also have a cooling coil serviced by outdoor condensing units, allowing them the provide most of the building's cooling needs.

The one of the greatest inefficiency associated with the forced-air component of the heating and cooling system is associated with duct losses, and the fact that the duct systems are located in an unconditioned attic space.

Aside from some sections of flexible ducts, all of the ductwork that we inspected was found not to be sealed, and much of it could be considered under insulated. The lack of proper air sealing is problematic for a couple of reasons: first, the return ductwork is under negative pressure, which means that air from the attic is being drawn into the ducts, cooling the air in the winter and heating the air in the summer before it arrives back at the air handlers. The result of this is greater gas and electric usage; second, the return ducts are pulling in dust and fiberglass insulation particles into the ductwork. This potentially unhealthy air is then redistributed to the occupied areas of the building.

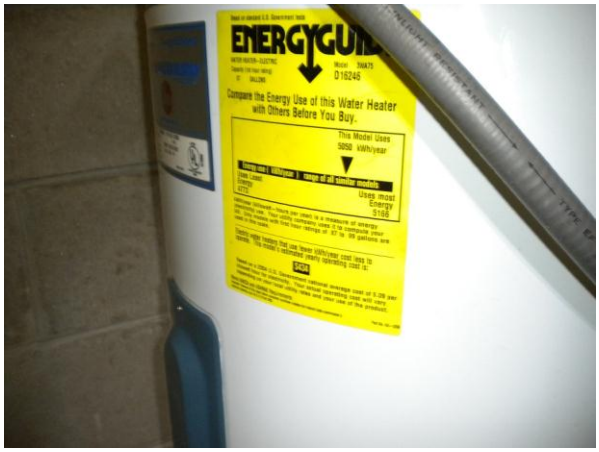
More obvious is the fact that the supply end of the ductwork is under positive pressure and is therefore pushing out heated or cooled air from the connections and seams of the ductwork into the attic before it reaches its intended destination. Regardless of whether or not the roof of the building is insulated, all of the duct work should be properly air sealed and insulated.

There are individual air conditioning units in the bedrooms of the fire department wing. A recent discussion with Town staff indicated that there are plans to replace these units with either individual ductless split systems or by adding an air handler to the attic space serviced by an outdoor condensing unit. Though there are pros and cons to each type, replacing these inefficient window AC units with either should provide lower operational costs, as well as mend the thermally weak point in the exterior walls when these units are removed and the holes insulated. Figures 4, 10, and 21 all indicate the amount of heat loss currently coming from these units and the gaps around them. More about the pros and cons of each replacement option can be discussed during the presentation of this report.



The fan coils seen in this photo heat the air of the garage areas, which in the winter months is lost very easily every time the garage doors are opened. A more efficient type of system for these spaces could be gas-fired infrared tube heaters. Infrared tube heaters work by heating objects in the space, like 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 will be difficult, as the necessary heat load analysis would rely heavily on a fairly accurate number of times per hour the garage doors are opened and closed throughout the heating season, as well as how long the doors are open. Another large factor would be the amount of air that is expelled via the exhaust systems in this space as well as the drying tower for the hoses. Another potential benefit of doing this would be the reduction of the heat load on the two main boilers. This would allow for smaller boilers, which could reduce boiler replacement costs. Another benefit would be the reduced heat loss from the hot water piping that could be eliminated. The the circulation pumps may be able to be reduced in size and possibly run less often, saving on electric costs. As this list of potential benefits grows, it is clear to see how complicated this study will 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.

The potable water for this building is produce by two sources, each handling this energy load at different times of the year. Below and to the left is an indirect hot water heater, which is provided heat from the main boilers. This is the source of hot water during the heating months, and, if properly controlled by the Tekmar boiler control, is an important means of reducing standby losses from the two boilers. Below and to the right is a large electric hot water heater that is used during the non-heating season to keep the large, relatively inefficient boilers from firing. This was a good decision and has likely been saving on this cost since it was implemented. There are several options for further reducing the cost of heating potable water by replacing the current methods. As an example, if the boilers were replaced with high efficiency, modulating/condensing boilers, the electric hot water heater could be eliminated. One of the two boilers could control the temperature of the indirect hot water heater and could be capable of down-sizing its BTU output (modulate) to a fraction of its capable BTU output, which should prove to be less expensive to produce hot water year round. Another option could be to install a solar domestic hot water system. There are many options, which can be discussed further during the presentation of this report.



Electrical:

The electric usage for this type of building is usually one the highest for any municipality. Much of this is due to the amount of electronics needed for this type of operation, and the fact that much of this equipment, and lighting, is needed 24 hours a day, 7 days a week. Because of the amount of electronics, there is likely substantial opportunity to save on electrical cost by fully powering down equipment that is not needed 24 hours a day. 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. If, for example, an employee is only normally in their office for 12 out of 24 hours, using power strips and fully cutting the power to as much electronic equipment as possible will reduce this unintended electric usage. Figures 24 and 25 are an example of such equipment that is turned off and is still drawing electricity. To put this low to no cost energy saving measure into perspective, if the electrical consumption in this building was reduced even by just 5% yearly, this could equal nearly $35,000 saved over the next 15 years. To further put this into perspective, this $35,000 dollars saved over 15 years could finance an 8.5 kilowatt solar PV system that could save an additional $35,000 over the next 15 years.

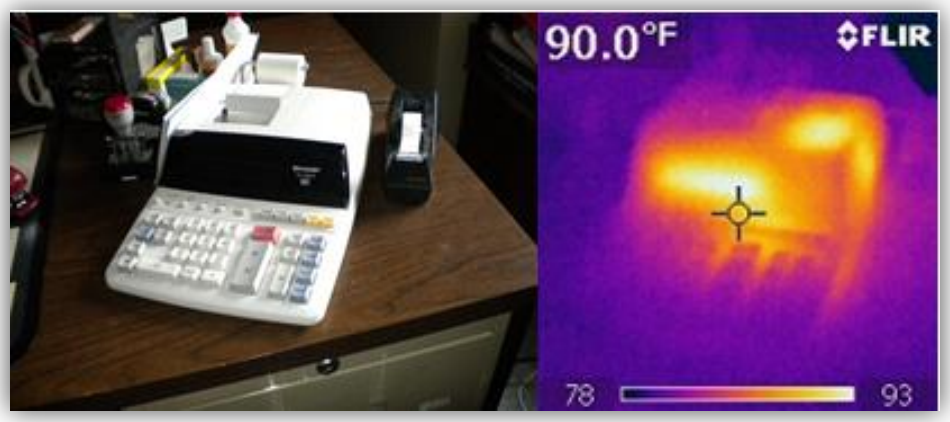


Figure 24

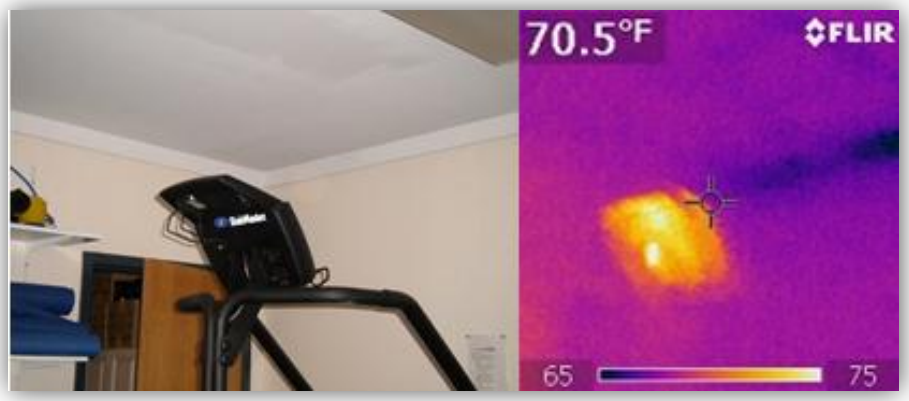


Figure 25

It is also important to remember that there are two forms of heat that AC systems work to expel, internal and external heat gains. 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. Cutting the power to equipment while it is not in use will eliminate the types of heat gains seen in Figures 24 and 25, further adding to the benefits of this behavior change.

External heat gains are produced from factors like hot/humid air infiltrating the building, the heat from the building shell conducting towards the interior (opposite of winter), or even strong sunlight radiating in through the windows. Making improvements to the building shell will not only reduce the heating bill but the cost of cooling as well. Replacing older inefficient cooling equipment, like the outdoor condenser seen in this photo, is one way to mechanically reduce this cost. Some newer high efficiency outdoor condensers can contain two compressors to add a staged effect, and have seasonal energy efficiency ratings (SEER) of 20 or more.

We recommend consulting with a lighting engineer to examine the various ways to reduce lighting costs for this building. Though a substantial initial investment, making use of solid state (LED) lighting options for fixtures that are used the greatest number of hours a day will not only dramatically reduce the electricity cost of lighting, but LED units also last much longer than any other types of light, reducing replacement, disposal, and maintenance costs, which can be substantial over time.

Installing a photovoltaic solar system on site to supplement the costs of electricity is always recommended. 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 add to the cost of heating and cooling because adjacent zones fight against each. Unbalanced heating also encourages the use of items like small electric space heaters, used to create greater comfort but are expensive to run. This is an issue on the second floor of the police department wing—Note the temperature of one office zone in the photo to the right, 79°F. An HVAC company or mechanical engineering firm should be hired to examine such issues and develop a plan for fixing them.

The ceiling register in this photo has dark areas around it suggesting that the quality of the air distributed to this space is poor. The air handlers in the attic do draw outdoor air via ductwork connected to the return plenums; however, this is a fairly inefficient means of supplying fresh air with regards to energy use and may be inadequate.

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 26. 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.

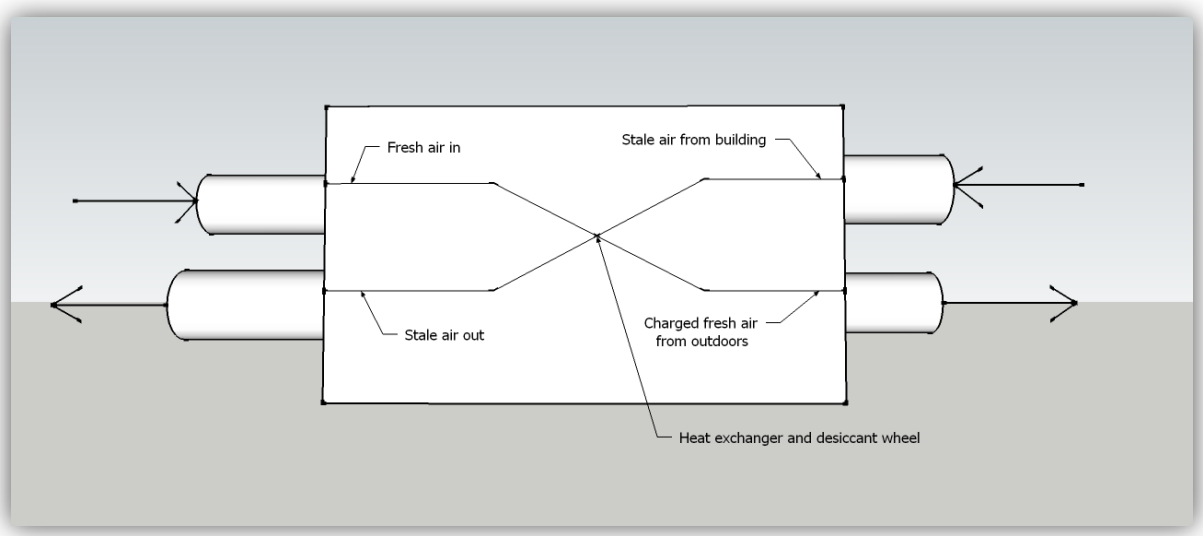


Figure 26

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.

Foundation:

- The foundation of this building could be insulated, but a stated earlier in this report, there are higher priority energy efficiency measures (EEM's). If, however, a study does prove it beneficial to change the heat source in the garage areas to infrared tube heaters, insulating the slab around these areas would become more important.

Exterior Walls:

- Eventually, and exterior insulation and finish system (EIFS) for this building should be considered.

Ceilings and Attic:

- It is recommended to bring all of the heating and cooling equipment located in the attic to within the thermal envelope. More about the various ways of achieving this can be discussed during the presentation of this report.

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:

- The following is a list of measures to reduce the energy cost associated with heating and cooling the building. These recommendations would require the consultation of a mechanical engineering firm to examine the cost:benefit of each.
    1. Air seal and insulate all of the ductwork (this should be done with or without analyzing the financial benefit of doing so).
    2. Replace the hot water loop and fan coils in the garage areas with natural gas-fired infrared tube heaters. If major changes are going to take place with regards to the volume of hot water circulated throughout the building, a close examination of more efficient piping schematics and pump sizes could prove to show savings opportunities associated with the electric use of the distribution system.
    3. Replace the two existing boilers with only the highest efficiency, modulating/condensing natural gas-fired boilers. The size of new boilers will be directly affected by other changes to the heating system. A careful analysis will ensure that they are not grossly over-sized.
    4. Replace the current method of supplying fresh air to the building, with the integration of individual ERV units into the return side of each air handler.
    5. If the main boilers are replaced, remove the electric hot water heater from the system, and only use the indirect hot water heater. Make sure that the indirect hot water heater is fully integrated into the reset control system in order to take full advantage of this technology. Some more sophisticated modulating/condensing boilers may already have these types of controls built-in to the boiler.
    6. Replace the window AC units in the 2nd floor bedrooms with either individual ductless split systems (install units with the highest SEER available), or, by adding an air handler to the attic space with associated ductwork and outdoor condenser.
    7. Replace any outdoor condensers with a SEER rating of 13 or less with the highest SEER rated condensers available. These should be SEER 20 of greater, and preferably would be two-stage units.
    8. Resolve any imbalances with regards to the various heating and cooling zones.

- Other alternative energy options, like solar hot water and CHP, 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.
- 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. Potential locations for installing such a system will be limited. More about this can be discussed during the presentation 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.
- Air sealing the return ductwork will increase indoor air quality.

- 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
- 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/

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.

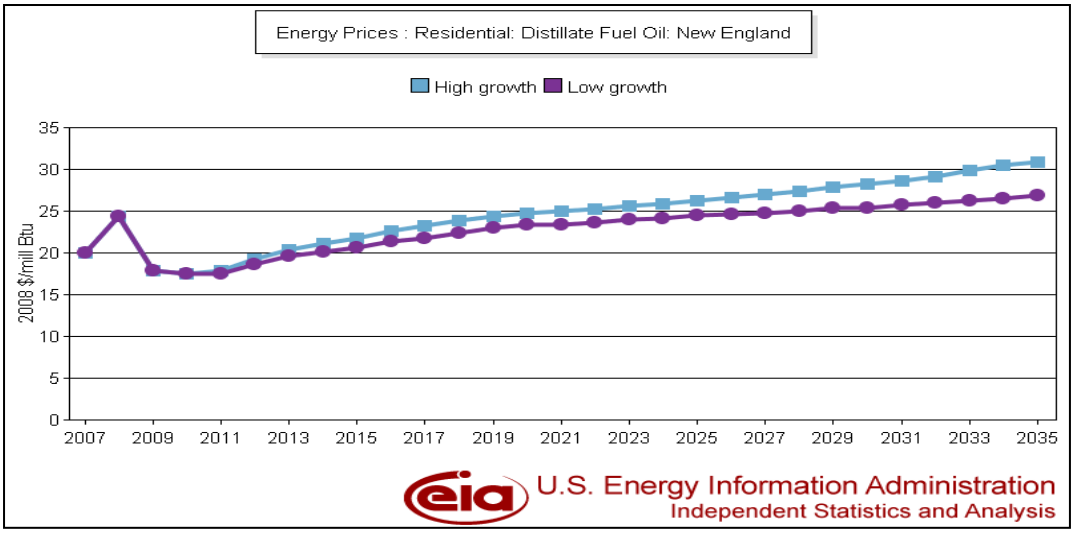
For more information on the history of energy prices and how energy cost projections are calculated, please visit: http://www.eia.doe.gov/analysis/

Price Summary

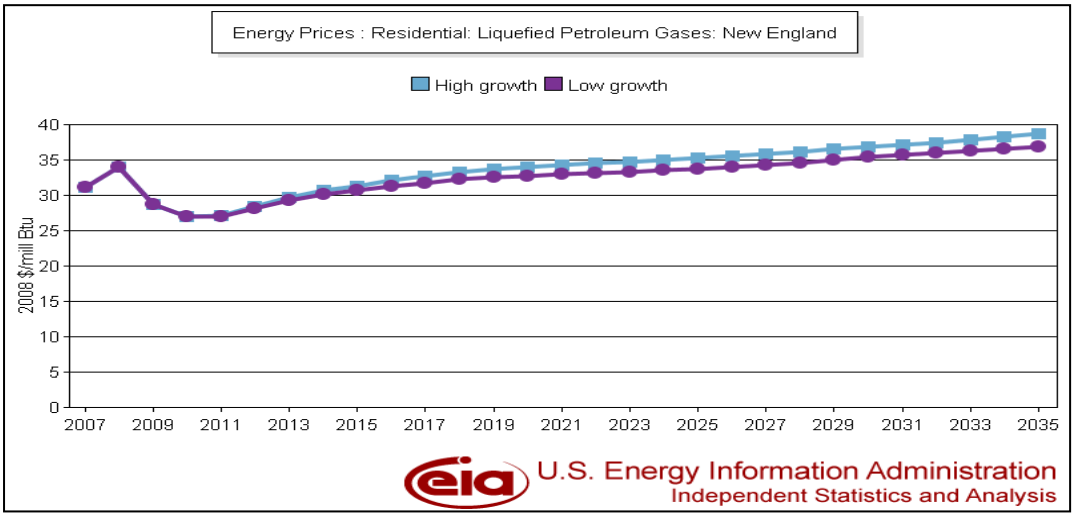
	Year				Percent Change		
	2009	2010	2011	2012	09-10	10-11	11-12
WTI Crude[a] ($/barrel)	61.65	79.40	93.26	97.50	28.8	17.5	4.5
Gasoline[b] ($/gal)	2.35	2.78	3.15	3.30	18.4	13.4	4.8
Diesel[c] ($/gal)	2.46	2.99	3.43	3.51	21.5	14.7	2.4
Heating Oil[d] ($/gal)	2.52	2.97	3.41	3.55	17.5	14.8	4.3
Natural Gas[d]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

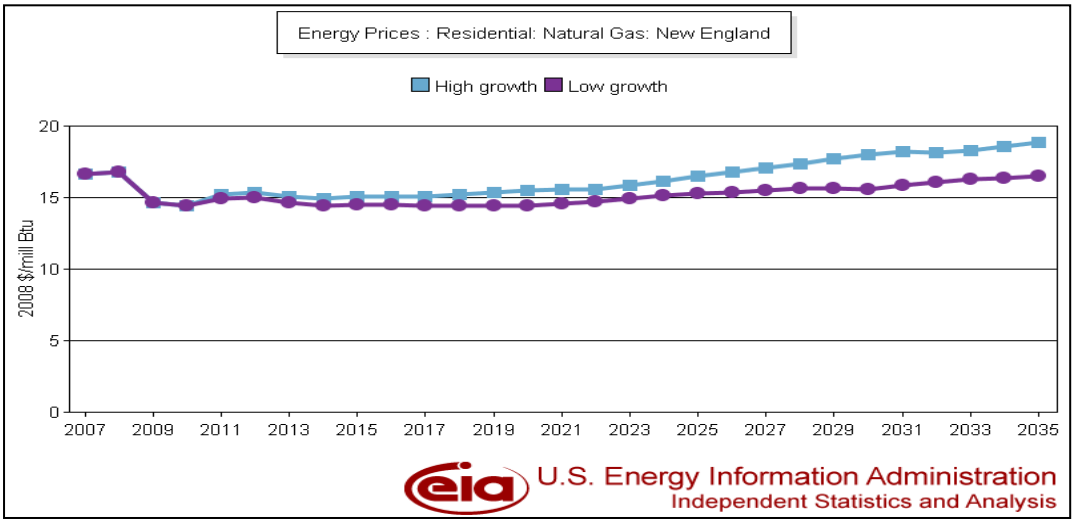
Table 1 – Retrieved from US EIA website



Graph 1 - Retrieved from US EIA website



Graph 2 - Retrieved from US EIA website



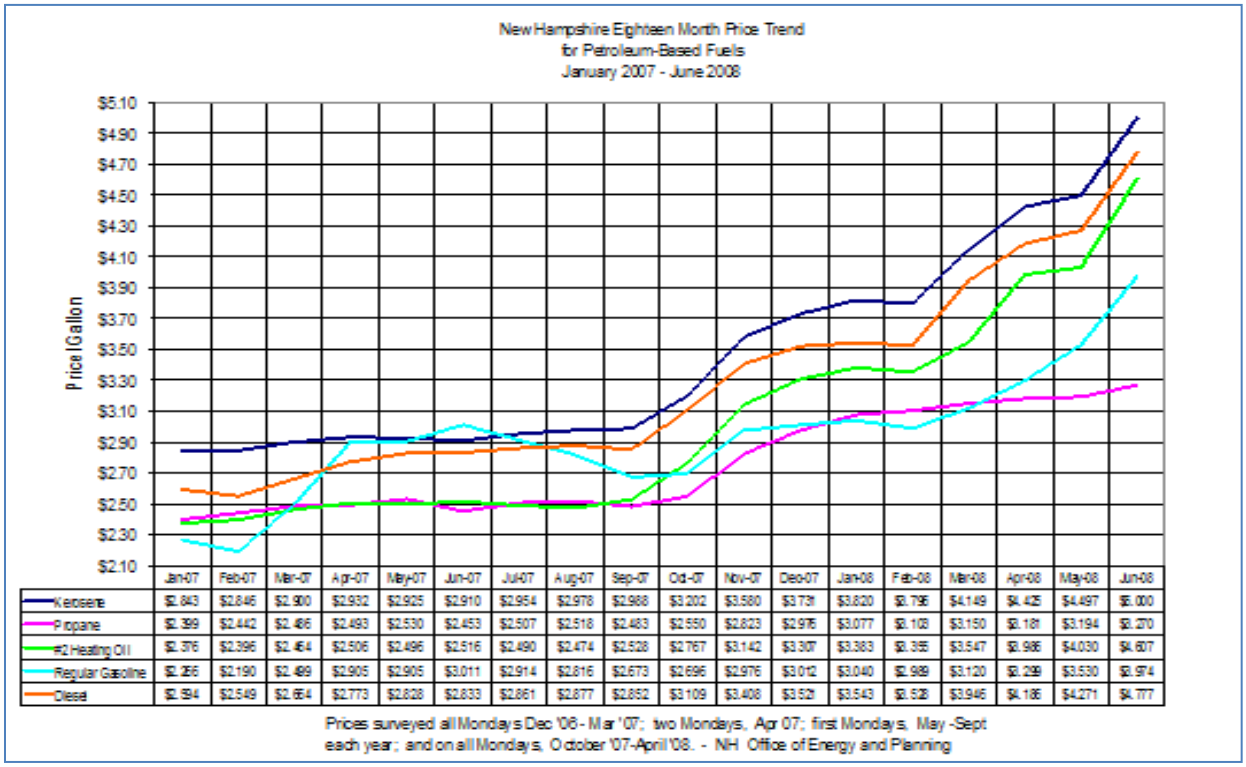
Graph 3 - Retrieved from US EIA website

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.

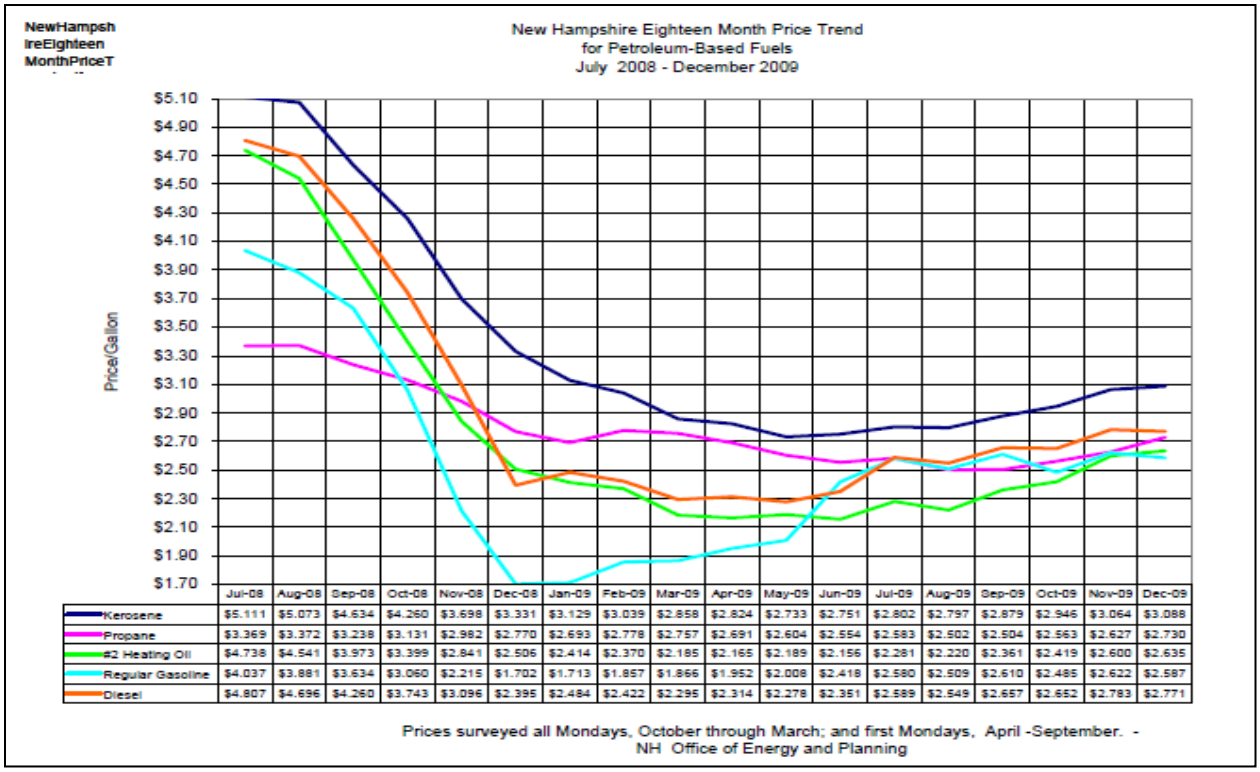
Projects such as air-sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler and a PV system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



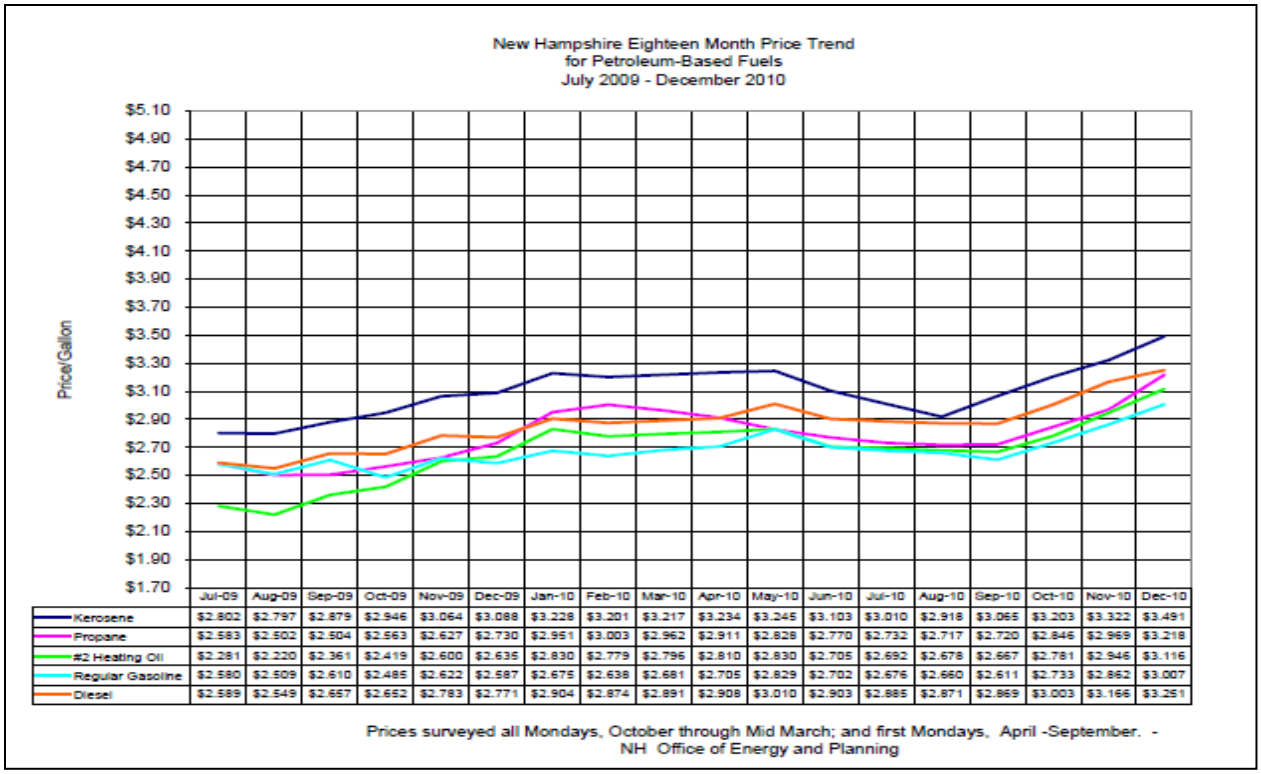
	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
Kerosene	$2.843	$2.846	$2.900	$2.932	$2.925	$2.910	$2.954	$2.978	$2.988	$3.202	$3.580	$3.731	$3.820	$3.796	$4.149	$4.425	$4.497	$5.000
Propane	$2.399	$2.442	$2.466	$2.493	$2.530	$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 27 - 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 28 – 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.

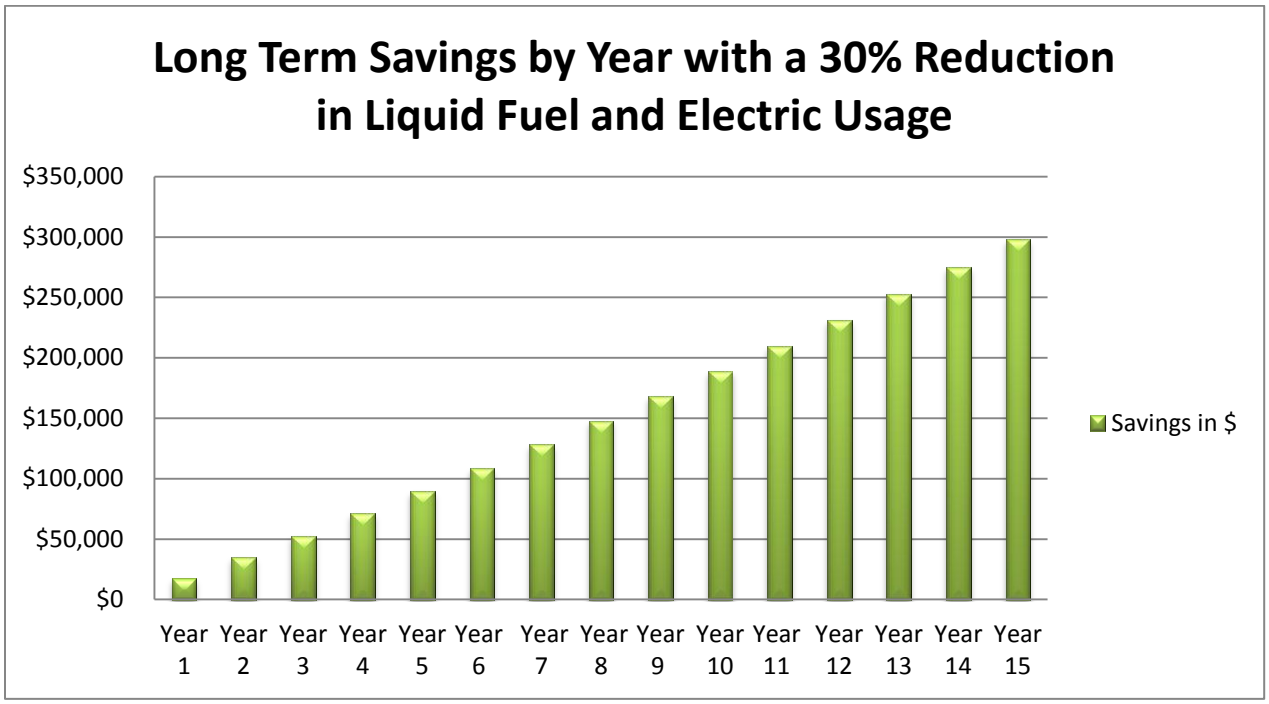
Current Fuel Usage				
Year	Energy Cost By Year	Yearly Increase	Total Accumulated Cost by Year	
		Escalation Rate	2.00%	
Year 1	$17,008.00	$340.16		$17,008
Year 2	$17,348	$346.96		$34,356
Year 3	$17,695	$353.90		$52,051
Year 4	$18,049	$360.98		$70,100
Year 5	$18,410	$368.20		$88,510
Year 6	$18,778	$375.56		$107,289
Year 7	$19,154	$383.08		$126,442
Year 8	$19,537	$390.74		$145,979
Year 9	$19,928	$398.55		$165,907
Year 10	$20,326	$406.52		$186,233
Year 11	$20,733	$414.65		$206,966
Year 12	$21,147	$422.95		$228,113
Year 13	$21,570	$431.41		$249,683
Year 14	$22,002	$440.03		$271,685
Year 15	$22,442	$448.83		**$294,126**

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	$40,389.00	$807.78		$40,389
Year 2	$41,197	$823.94		$81,586
Year 3	$42,021	$840.41		$123,606
Year 4	$42,861	$857.22		$166,468
Year 5	$43,718	$874.37		$210,186
Year 6	$44,593	$891.85		$254,779
Year 7	$45,485	$909.69		$300,263
Year 8	$46,394	$927.89		$346,658
Year 9	$47,322	$946.44		$393,980
Year 10	$48,269	$965.37		$442,248
Year 11	$49,234	$984.68		$491,482
Year 12	$50,219	$1,004.37		$541,701
Year 13	$51,223	$1,024.46		$592,924
Year 14	$52,247	$1,044.95		$645,171
Year 15	$53,292	$1,065.85		**$698,464**

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 Electricity				
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	$17,219	$ 344.38		$17,219
Year 2	$17,563	$ 351.27		$34,783
Year 3	$17,915	$ 358.30		$52,697
Year 4	$18,273	$ 365.46		$70,970
Year 5	$18,639	$ 372.77		$89,609
Year 6	$19,011	$ 380.23		$108,620
Year 7	$19,392	$ 387.83		$128,012
Year 8	$19,779	$ 395.59		$147,791
Year 9	$20,175	$ 403.50		$167,966
Year 10	$20,578	$ 411.57		$188,544
Year 11	$20,990	$ 419.80		$209,534
Year 12	$21,410	$ 428.20		$230,944
Year 13	$21,838	$ 436.76		$252,782
Year 14	$22,275	$ 445.49		$275,057
Year 15	$22,720	$ 454.40		**$297,777**



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 Safety Complex. 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.