The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Springfield Town Offices
2750 Main St., Springfield, NH 03284

Prepared for:

Town of Springfield, NH

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

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Springfield and the Town Office building (hereinafter "the building"). This report discusses the findings and subsequent recommendations for energy efficiency and occupant health and safety improvements at the building. Included within this report are details regarding the inspection of the building, and examples that illustrate recommended building alterations and improvements that can reduce energy costs, occupancy health risks, and the building's natural resource footprint. In this report we will provide a set of options that can help achieve real energy savings and carbon dioxide reductions. These recommendations should be viewed as initial avenues to making capital investments, and participating in Federal and State level funding opportunities for municipal energy projects.

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

The Audit

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

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

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

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

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

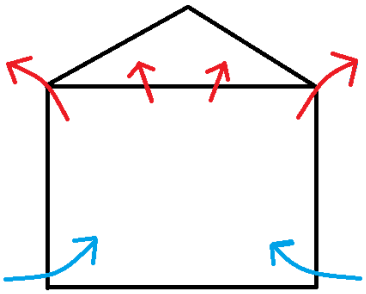
This DGA involves a quantification of energy consumption (electrical and heating fuel), a description of existing heating/cooling and distribution systems, thermal barrier inefficiencies, potential electric savings through lighting/appliances upgrades and behavior change, occupancy health and safety concerns, a prioritized list of recommended improvements, and a look at current 15 year projected energy expenses vs. a 30% annual energy usage reduction for the examined building.

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

Basics of Heat Loss:

Though we are typically used to measuring heat in temperature, it can be measured in a variety of other units. For the purpose of measuring how much heat is produced to condition a space, and how we measure the rate at which heat leaves a structure, we measure in British Thermal Units (BTUs). One BTU is roughly the same amount of heat produced from a kitchen match. Another good reference to have is that there are about 138,500 potential BTUs in 1 gallon of heating oil. During the winter months, we cannot keep BTUs from leaving our buildings. Hot always goes to cold, or, areas of high pressure are always trying to go to areas of low pressure. What we can do is try to slow the process. We do this by using an air barrier and insulation at the building envelope to create a thermal barrier.

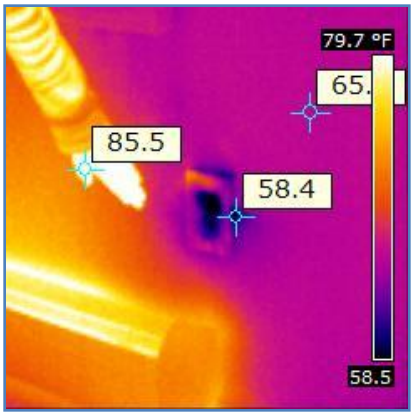
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of convective heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



The stack effect describes, on a macro level, the natural way in which air moves through a building. As warmed air leaves through the upper levels of a building, cold air infiltrates through the lower sections. In most cases, this pulls air from less than desirable areas of a building, such as basements, crawl spaces and mechanical rooms, which are often damp and unmaintained. These spaces can be the source of exhaust fumes from heating equipment, mold and mildew, as well as a number of other air contaminants, such as radon. Without an effective air barrier between the conditioned (heated and/or cooled) space and the attic, warm air will exit the building. For every 1 cubic foot of air that leaves a building, 1 cubic foot of air will infiltrate at a different location. Gaining control of the air movement through a building not only has a positive effect on efficiency, but also contributes to increased comfort and improved indoor air quality.

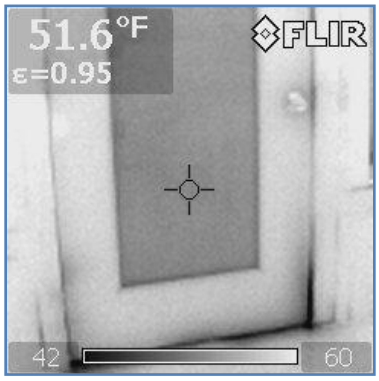
Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope where there is solid building material and no insulation, "thermal bridging" will occur. For example, a 2x6 inch wood stud in an exterior wall has an R-value, or insulative value, of about R-7, while the 5-½ inch fiberglass insulation in the wall cavity is rated at R-19. Solid material in the exterior wall of a typical structure built with 2-inch stock, 16 inches on center (O.C.), will usually make up 20-25% of the wall surface area. This, in combination with any doors and windows, means that a significant percentage of the building envelope has an R-value of less than 10. Even a wall with a high R-value cavity insulation, such as spray foam, is subject to these weak points in the thermal boundary. Employing methods to reduce or eliminate thermal bridging in our built

environment will dramatically reduce energy costs and emissions over the long term as we move towards a new generation of energy and environmental challenges.



Radiant heat loss describes how heat waves, or infrared radiation, pass through space from one surface to another. For example, the heat from a hot copper pipe will radiate towards cooler surfaces around it, like an exterior wall. The heat can then conduct through building materials to the exterior.

With regards to the building envelope, gaining control of convective heat loss is the main priority, and usually the easiest to address through air sealing. After this is done, increasing insulation levels, or R-value, of the building envelope is the next step to gain better control of conductive heat loss. In many cases, a significant amount of a structure's radiant heat loss will be addressed with added insulation, either to ceilings, floors, walls, ductwork or piping. Treating the whole building as a system, and addressing all the issues of heat loss, will produce optimum savings and comfort.



Basics of Moisture Control:

The issue of moisture control in buildings is very complex and essential to maintaining structural durability and occupant health. The mismanagement of moisture can lead to a multitude of negative effects. Some of these include mold growth, poor indoor air quality, and the early degradation of building materials and equipment. It can also contribute to potentially serious health issues for the people who live and work in our buildings.

The two basic forms of moisture in need of managing are bulk moisture (fluid) and water vapor. Two ways to manage bulk moisture are to keep rain and ground water from entering the building and to quickly fix any water leaks from sources within the building, such as leaking pipes.

Managing relative humidity and water vapor is a challenge. At some points of the year, occupants want more humidity in the air to maintain comfort and less at other times. For example, in the winter months we want more humidity indoors because it helps occupants experience greater comfort. In many situations, we increase the relative humidity mechanically with humidifiers. When indoor air is too dry during the winter, we feel colder, develop dry skin and our upper respiratory system can become dry causing discomfort.

Conversely, in the summer we want the air to be dry. Just as hot goes to cold, wet goes to dry. We cool ourselves by perspiring. As we produce this moisture on our skin, it evaporates into the air, drawing heat away from our bodies. The temperature of a room may not be very high, but if the relative humidity is high, we will feel hot because our perspiration is evaporating at a slower

rate. Much of the comfort we achieve from using an air conditioning system (AC) is by removing the moisture from the air, allowing our skin to dry more quickly.

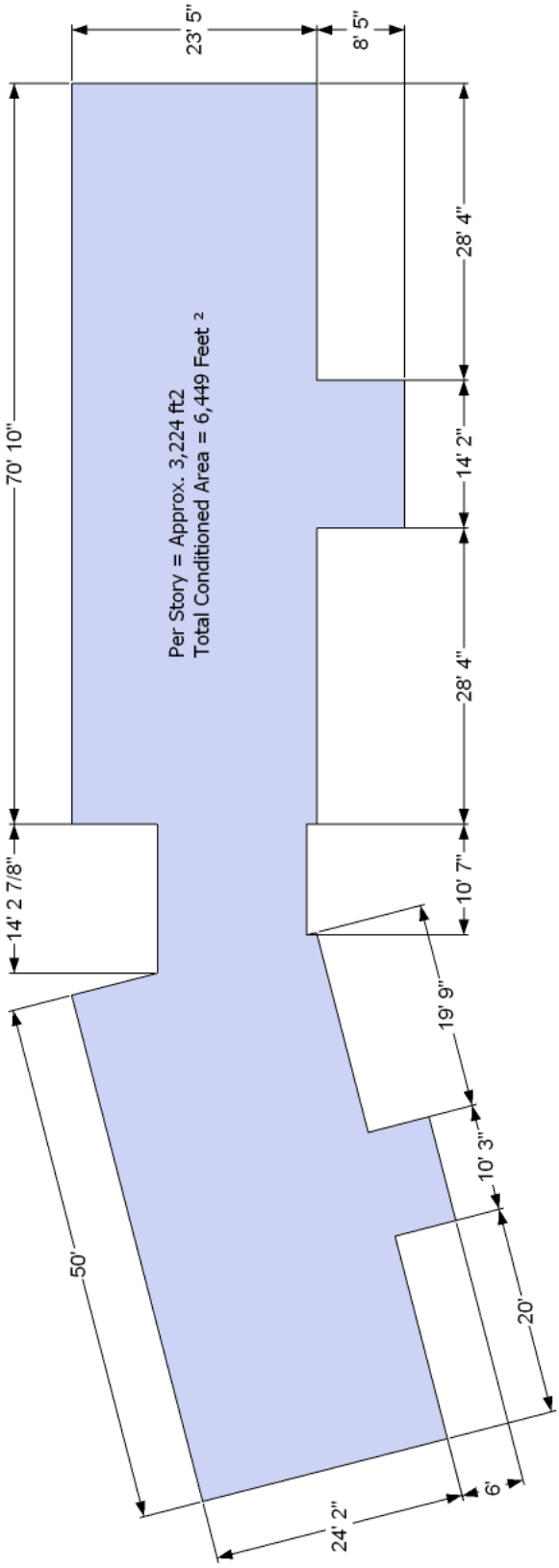
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable and to keep the water vapor from causing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

Just as BTUs conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and we use these to form a vapor barrier on the inside of the thermal boundary in an attempt to slow the amount of vapor diffusion. Small amounts of vapor traveling through a properly constructed building envelope will diffuse all the way to the exterior, and not cause any damage. If a large amount of vapor is allowed to enter a wall cavity, the molecules will condense on the nearest cold surface. When this happens, moisture can build up on the inside of the exterior wall sheathing or on other surfaces. This will cause a number of problems including long-term damage to insulation and structural components, as well as the promotion of mold growth.

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

Building Description:

There are two main portions of this wooden structure. The original building, Springfield Memorial, was constructed in 1948. On the 2nd floor (ground level at the front of the building), are the Town Offices to one side, and the Kindergarten class room to the other. Found on the 1st floor is the Selectmen meeting room, Police Department, boiler room, and building maintemance.
The two story Libbie A. Cass Library was added to this building in 1993, and is connected to the orginal structure by a smaller wedged shape portion of the addition that houses an elevator, lavatory, and small kitchenette for staff.

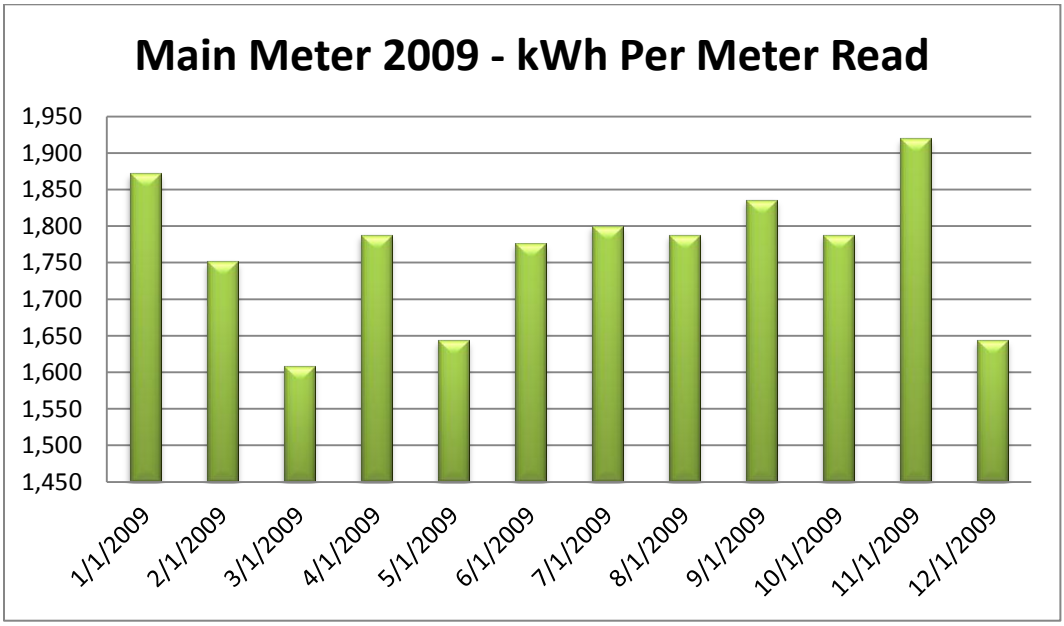

23' 5"
8' 5"
70' 10"
28' 4"
14' 2"
28' 4"
10' 7"
14' 2 7/8"
Per Story = Approx. 3,224 ft2
Total Conditioned Area = 6,449 Feet 2
19' 9"
10' 3"
50'
20'
6'
24' 2"

Energy Data Collection:

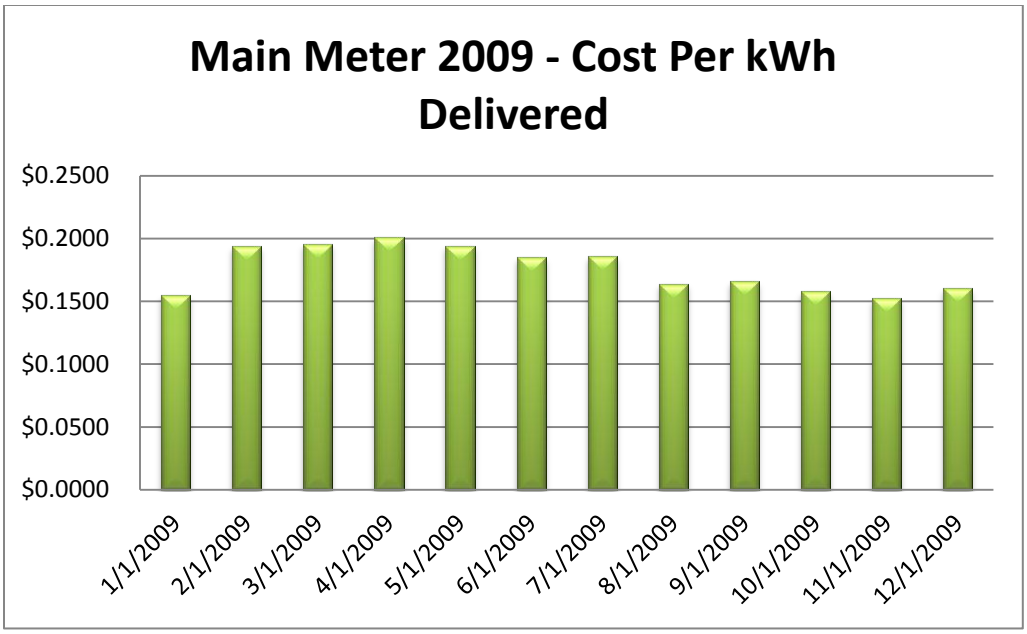
Analysis from provided utility bills for 2009 produces the following snapshot in electricity consumption. Monthly consumption is designated low to high, red being the lowest and green being the highest consumption months in the table below.

Electric -Main Meter			
PSNH			
Date	**KWH**	**Total $/mo**	**Cost Per kWh**
12/1/2009	1,644	$264.00	$0.1606
11/1/2009	1,920	$292.00	$0.1521
10/1/2009	1,788	$282.00	$0.1577
9/1/2009	1,836	$305.00	$0.1661
8/1/2009	1,788	$293.00	$0.1639
7/1/2009	1,800	$335.00	$0.1861
6/1/2009	1,776	$329.00	$0.1852
5/1/2009	1,644	$319.00	$0.1940
4/1/2009	1,788	$359.00	$0.2008
3/1/2009	1,608	$315.00	$0.1959
2/1/2009	1,752	$339.00	$0.1935
1/1/2009	1,872	$290.00	$0.1549

Average $/kWh: $0.1759
Total kWh: 21,216
Total Cost in 2009: $3,722.00



Annual electricity consumption for Springfield Town Offices



Cost of delivered electricity for Springfield Town Offices

Heat Source 1 – 2 Oil Boilers			
No. 2 Oil			
Date	**Fuel Units**	**$**	**Cost Per Unit**
12/1/2009	226	$482.00	$2.133
11/1/2009	238	$590.00	$2.479
10/1/2009	203	$476.00	$2.345
5/1/2009	227	$429.00	$1.890
4/1/2009	267	$1,104.00	$4.135
3/1/2009	263	$1,088.00	$4.137
2/1/2009	426	$1,761.00	$4.134
1/1/2009	389	$1,607.00	$4.131

Total gallons delivered in 2009: 2239
Total annual payment: $7,537
Average cost per gallon: $3.37

Blower Door Test Results:

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

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

Foundations, Floors and Basements:

While the foundation walls of the addition do have some insulation, there are many areas of the original building that do not. This picture was taken from outside the selectmen's meeting room. From the bottom of window to the top of the wall is wood frame and likely contains R-11 fiber in the cavities—everything below the window is concrete. Consequently, this wall's R-value is about R-1—possibly even worse because there are baseboard radiators against the wall.

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

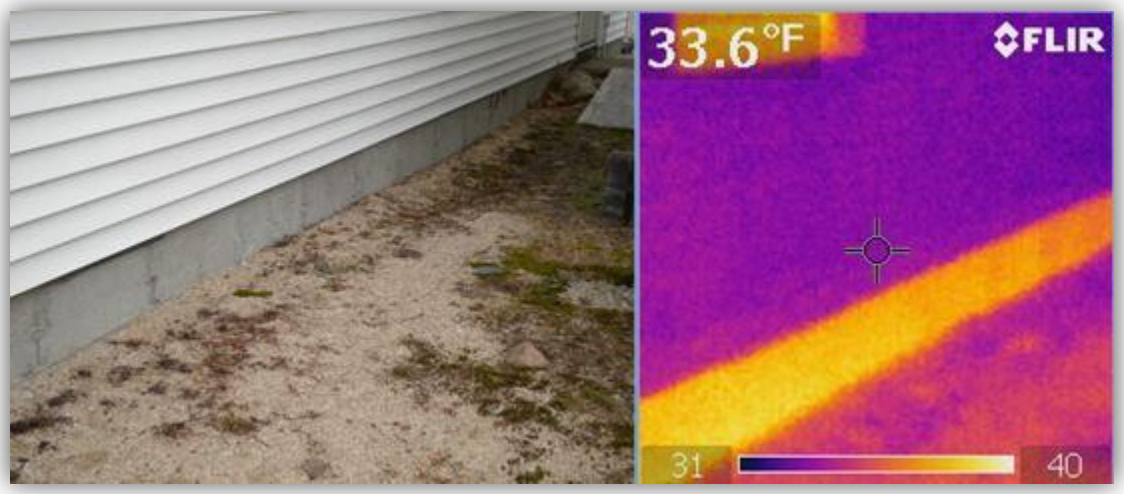


Figure 1

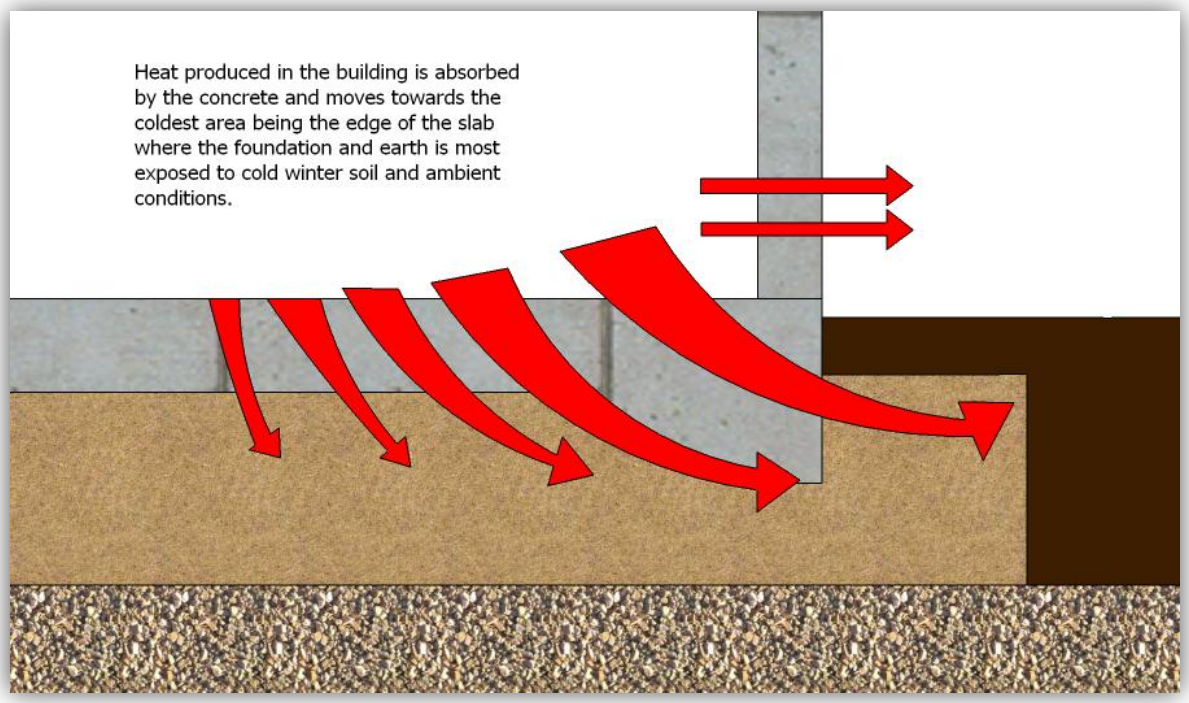


Figure 2

Figure three helps to illustrate how heat loss will still occur from the slab of a foundation and provides one method on how to slow this heat loss.

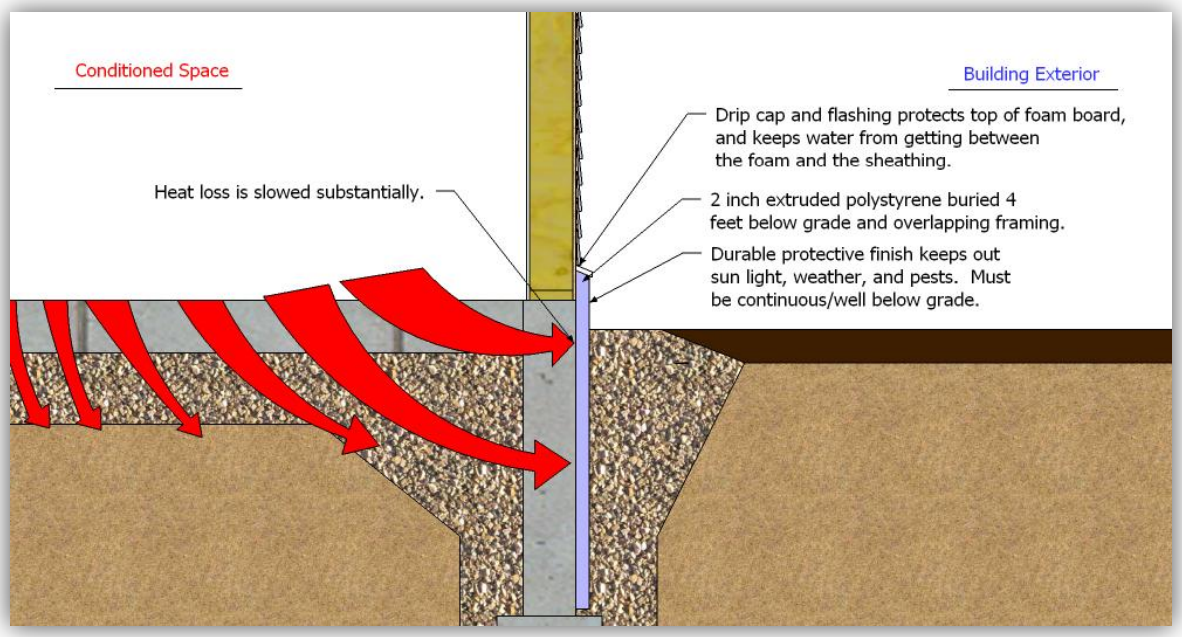
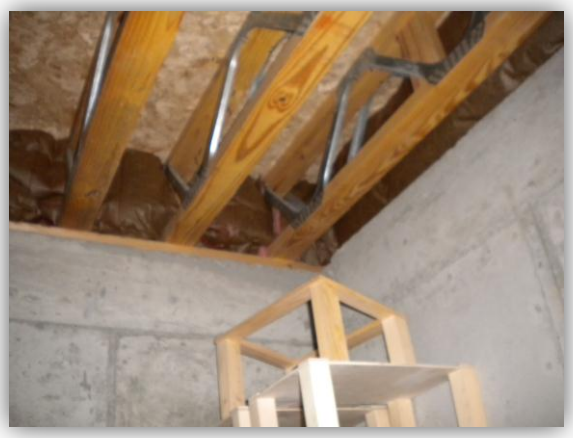


Figure 3

The photo to the right was taken from a closet in the basement of the library. This foam board behind the framed wall is better than no insulation at all, but it would have been twice as effective had whole sheets of this foam been fastened to the inside of the stud wall before sheetrock was applied. There is little that may be done to improve this without tearing the walls apart and staring over again or injecting closed-cell foam into the space. Either option would be expensive and would take some time to recoup the cost in energy savings.

These two photos below show the old and the new band joist. To the left is the original building's band joist, which for the most part has been insulated with pieces of polyisocyanurate. This was a great idea to help stop air infiltration through the basement while adding R-value, but it was not done in the preferred method, which is to cut the piece ¼ to ½ inch too small on all sides then fill the gaps with spray foam.; consequently, the caulking is beginning to crack, which will continue to increase—even now air is able to pass through in some areas. Also, the rest of the tall concrete wall and the heating pipes (visible in this image) are uninsulated.

The photo to the left shows the top of the addition foundation wall, which has been insulated with fiberglass. This picture is from the same closet as the photo above. This is doing little to nothing to impede air flow, and relative to the square feet of uninsulated surfaces around it, is contributing little to the weighted R-value of this area. Note that the underside of the front entry floor is not insulated. What we have here is an undefined building envelope—either the walls of the foundation need to be insulated (preferred solution) or the underside of the floor.



Exterior Walls:

The photo to the left shows that the exterior walls of the original building are insulated with R-11 fiberglass in the 2x4 inch stud walls. Also of note is this large chase way that ushers heat from the core of the building to the attic space. The picture to the right shows that 5/8 inch of extruded polystyrene foam board was fastened to the exterior walls of the original building before they were resided with the vinyl siding. This thin layer of foam is certainly helping reduce heat loss, but a preferred thickness would have been at least 2 inches. In order to ensure that this foam is performing as well as it can, make sure that the bottoms and tops of the foam are sealed. If cool air can get between this foam and the exterior sheathing, its effectiveness will greatly be reduced.

The right image was taken from the same place as the above left image, which is the access way into the attic. More about this area will be discussed in the next section; however, we wanted to point out that a wall which is an interior wall that abuts an unconditioned attic space (as in this case) should be considered an exterior wall and thus insulated appropriately. This particular section of wall is the top part of the Kindergarten class room. Much insulation work needs to be done in this unoccupied space.

This photo shows the walls in the closet where the attic access is located. Not only should the attic opening panels be insulated and sealed but the walls of this closet as well. Also noted are the mice and/or bat droppings. This will be discussed later in the report.

Ceilings and Attic:

There is much that can be done to the ceilings of both the new and old buildings to improve energy efficiency. There are fiberglass tiles in the suspended ceiling above the town offices. These may help to keep some of the heat in the office space, but this ceiling cannot be considered an air barrier so its effectiveness is limited. The original ceiling tiles are still in place, which not only allow for air passage but also do not serve as a vapor barrier. Above these tiles is un-faced R-38 fiberglass insulation. The combination of flies, ladybugs, and rodent droppings indicate that this space is not well air sealed.

These images were taken from above the Kindergarten class room. The old ceiling tiles have been removed, and the ceiling is insulated with R-19 faced fiberglass batts, with another layer of R-19 un-faced batts on top. Considering that fiberglass insulation does little to impede air flow, the photo to the right gives a clear picture of the lack of efficiency here. This photo was taken from the attic and looks down at the ceiling tiles in the class room.

This photo was taken from the space between the class room and the offices. This space is a major source of the buildings' heat loss. All of the fiberglass should be removed, and a spray foam insulation company should be hired to completely line this entire space with at least a minimum of 2 inches of closed-cell spray foam insulation.

These photos were taken in the 2nd floor of the library. The photo to the left is what was first seen when one of the tiles was removed. Day light was visible from the start. The image to the left gives a clearer picture of how the fiberglass batts end right at the inside corner of the framed wall's top plate. Even if they did extend further out, the fact that there is no air or vapor barriers in the main field of this ceiling shows great opportunity for an energy improvement project.

If the main field of this ceiling had a vapor/air barrier put in place, the edges of the ceiling should still be addressed. Figure 4 shows how the edges of most ceilings are constructed and illustrates one reason why the top corners of a room tend to be a large weak point in the thermal envelope.

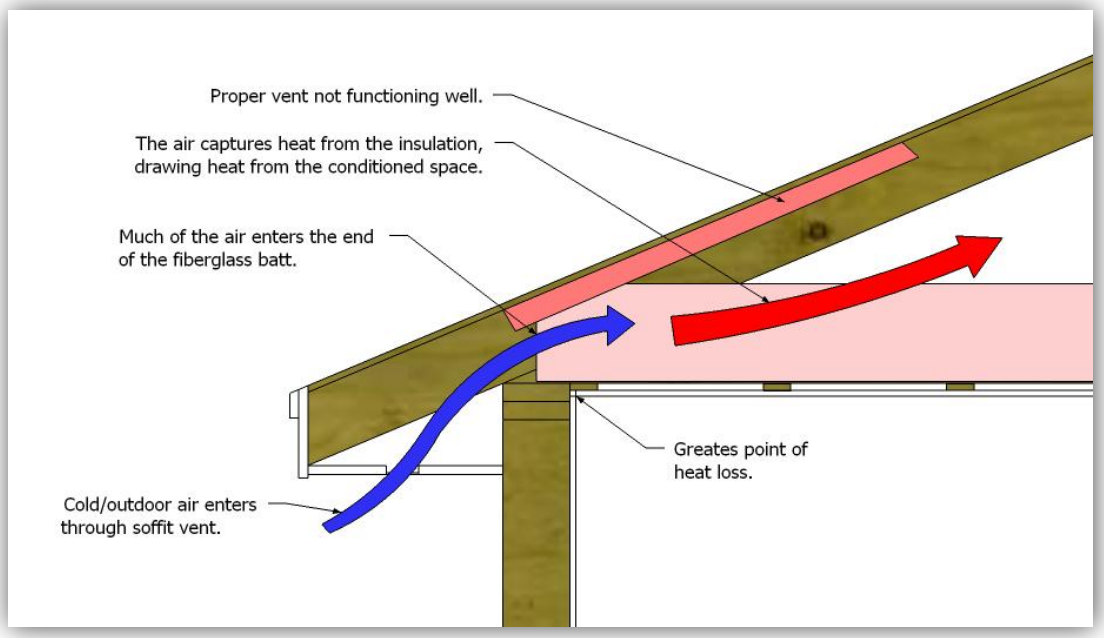


Figure 4

Figure 5 illustrates how this can be improved. To take this a step further, the rigid foam and proper vent would be located further toward the building exterior, and the foam would run down the exterior wall 4-5 inches (still within the soffit area) and cover the 2 top plates of the stud wall.

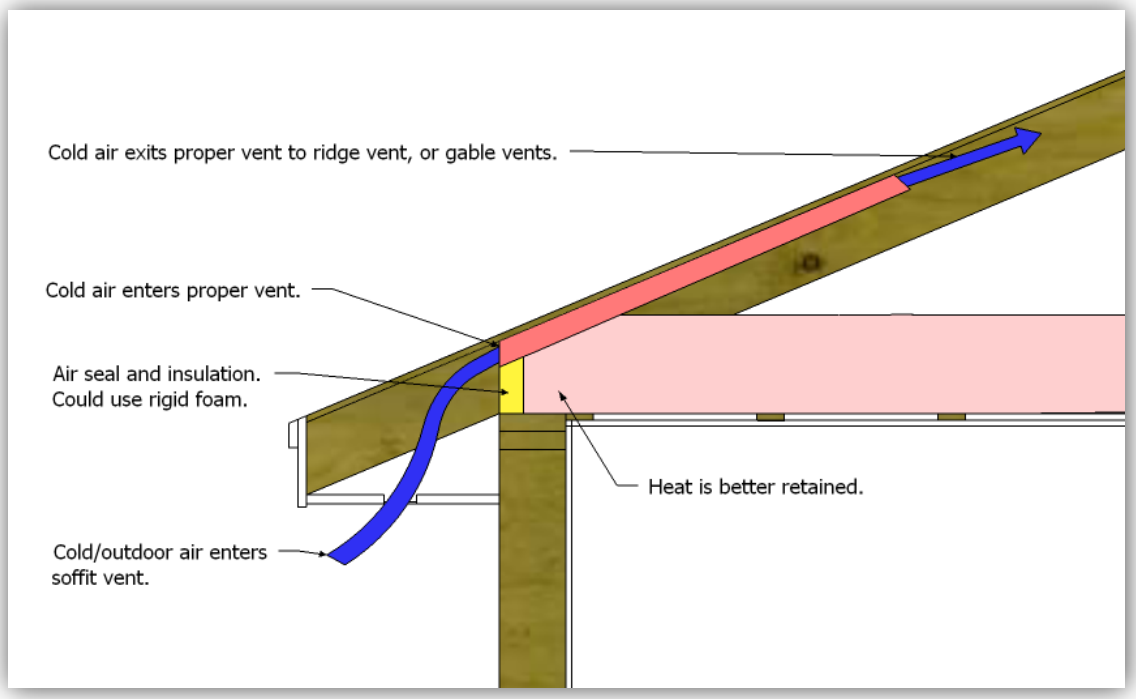


Figure 5

Doors and Windows:

The windows and doors of this building are not of great concern, and replacing them would not have a large impact on energy cost at this time. It is important to make sure that all doors and windows are well-sealed when closed. One improvement could be to check that the space between the jambs and the wall framing is air sealed and insulated. Often this is done with fiberglass, which is very ineffective. This would require temporarily removing the trim, removing any fiberglass, and filling with foam insulation. At a minimum, apply caulking to cracks in and around the trim, as seen in this photo.

This building has great southern exposure. This can be an asset in the winter with positive solar heat gain but greatly adds to the cost of air conditioning in the summer. Keeping shades closed at night in the winter will help reduce heating costs, while partially closing shades during hot summer days can reflect solar radiation to the building exterior, creating savings and greater comfort.

Mechanical:

The two boilers seen in this photo were installed in 1991 and are approaching the end of their useful life. Maintained with a combustion efficiency at 84%, these provide heat for the entire building. In addition, boiler 1 provides potable water year round.

The temperature set points on boiler 1 indicate that this unit is turned down during the no heating months. To better control the water temperature year round an Outdoor Temperature Reset could be installed along with an indirect hot water heater.

An outdoor reset, or modulating aquastat, functions by monitoring the outdoor temperatures and automatically adjusts the temperature set points of a boiler. For example, on the coldest days of a NH winter, the temperature of the water sent to baseboard radiators will most often not need to be greater than 180°F. If the outdoor temperature is only 50°F, the boiler may only have to send 160°F water to the baseboards. 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.

Any unsealed cracks or gaps, as those seen in the photo to the right, in the boiler room walls and ceilings should be sealed with fire-rated caulking.

The bottom of the chimney is decaying. The bottom of chimneys can fill with debris, which then acts like a sponge, taking a long time to dry out. Keep the bottom of this chimney cleaned out, and develop a way to keep bulk water away from it in the case of high water levels on the boiler room floor.

All of the pipes in the building should be well-insulated. This is a project that will not be very expensive relative to the amount of energy it will conserve.

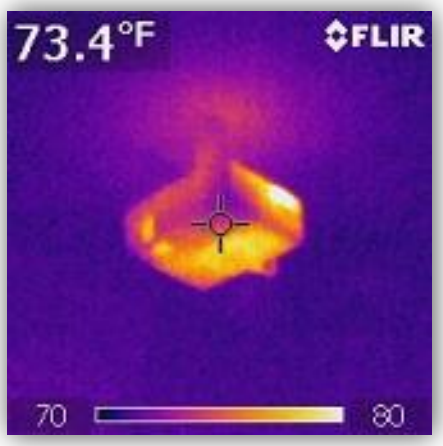
Another easy way to save on heating costs is to install digital/programmable thermostats and keep them set at an appropriate schedule for each zone.

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 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.

Modern electronic equipment often 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



There are several small air conditioning units in the office areas of this building. Turning these units off at night, keeping them at reasonable temperatures, keeping them clean, and replacing them with the highest efficiency units available when need be are the first measures for reducing this electric usage.

Some of the easiest ways to reduce electric costs do not involve initial investment—for example, making sure lights are out in spaces not being used. Also, if there are employees that arrive an hour before and after times of business, keep as many of the lights off as possible. Eliminating one hour of electric usage at either end of each day for an entire year can amount to substantial savings.

Health, Safety and Comfort:

There were signs of rodents and/or bats. Such unwanted animals can emit harmful gases from their droppings and are common in a building like this. It is important to address such issues immediately should they arise. The first line of defense is always to eliminate access points into the building.

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

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

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 6. 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.

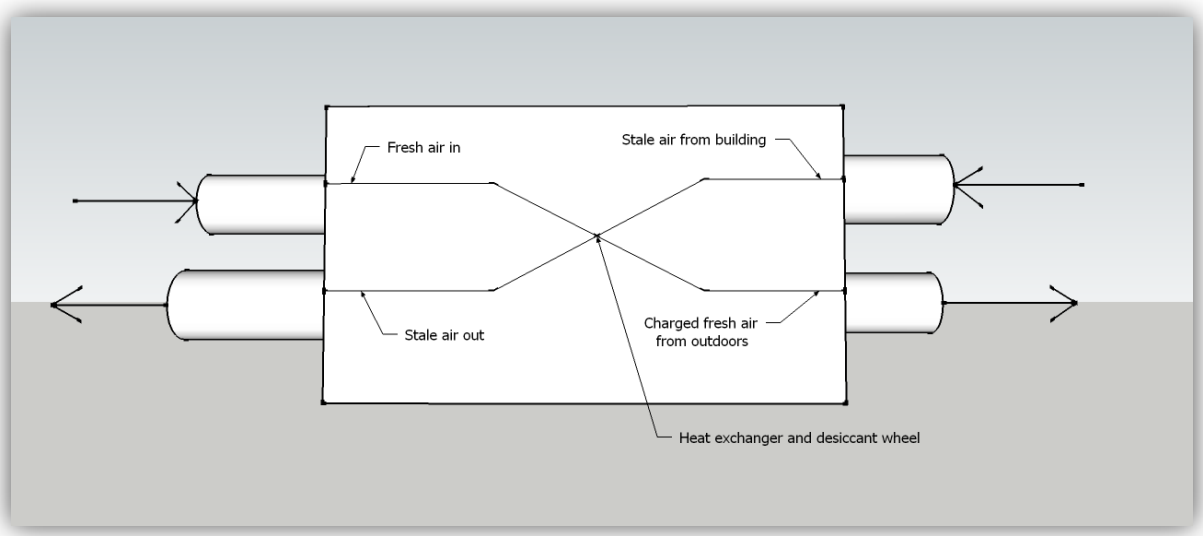


Figure 6

Recommendations:

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

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

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

Foundations and Slabs:

- Insulate the foundation of the original structure. Ensure that the band joist of the entire building is well sealed and insulated

Exterior Walls:

- Air seal between the exterior foam board and the wood structure.

Ceilings and Attic:

- Apply a polyethylene vapor barrier to all exposed fiberglass insulation above the library, Kindergarten, and office area. Make sure that all seams are well-sealed. This will also provide the necessary air barrier.
- Air seal and insulate all surfaces in the area of the attic access.

Doors and Windows:

- Make sure that the framing around the window and door units is well sealed. This may entail temporarily removing the trim and filling gaps and cracks with spray foam, then replacing the trim and seal with caulking.

Mechanical:

- Insulate all of the heating and domestic water pipes in the building.
- Replace thermostats with new digital/programmable units.
- Install a solar domestic hot water system, and turn off the boiler during none heating months.

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

Electrical:

- Replace any inefficient lighting systems with either CFL, T8, or LED technologies.
- Purchase smart strips, and be sure to cut power to any devices when not in use.
- Be sure to invest in the highest efficiency, Energy Star rated equipment when buying new items or replacing the old. Pay special attention to the highest energy users like air conditioning units and refrigerators.
- After efficiency matters have been addressed, install a photovoltaic solar system to provide onsite generation of electricity in order to supplement or eliminate what electric needs remain.

Health and Safety:

- Install HRV or ERV units to ensure an adequate number of air exchanges per hours for those working or doing business in this building.
- Address any pest or moisture issues that may arise, always by first eliminating the source or access of such unwanted problems.

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:

Springfield is served by both NH Electric Coop and PSNH. Both NH utilities provide technical and financial assistance for various types of efficiency measures that can be carried out at a municipal facility. Some programs offer the opportunity for municipalities to go forward with the installation of approved measures at no up front cost to the municipality. A town simply pays for the energy improvements with the savings from reduced energy usage until the project is paid off. Contact your utility provider to discover ways in which they can assist your municipality in reaching its energy efficiency goals.

For 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.

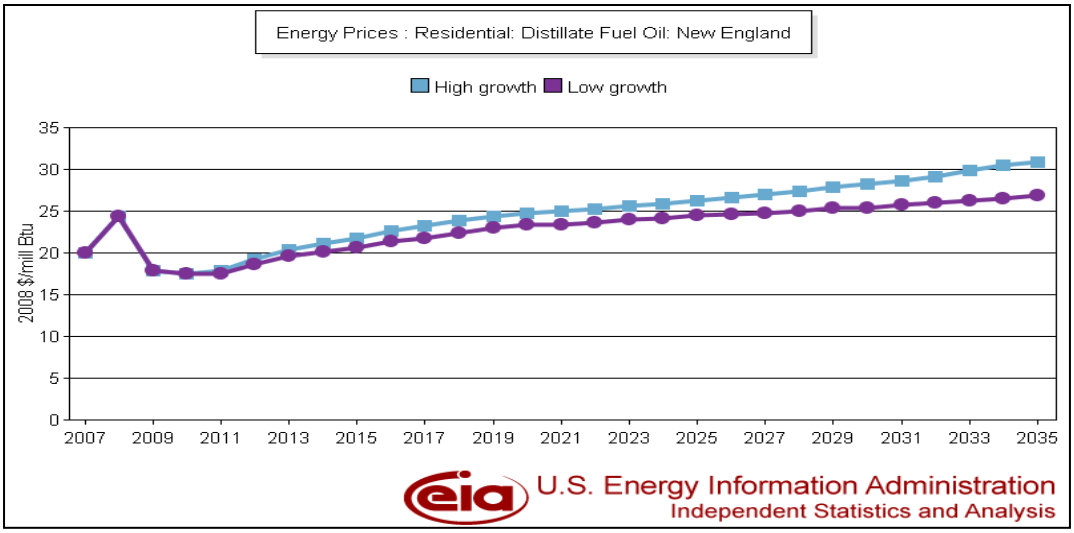
For more information on the history of energy prices and how energy cost projections are calculated, please visit: http://www.eia.doe.gov/analysis/

Price Summary

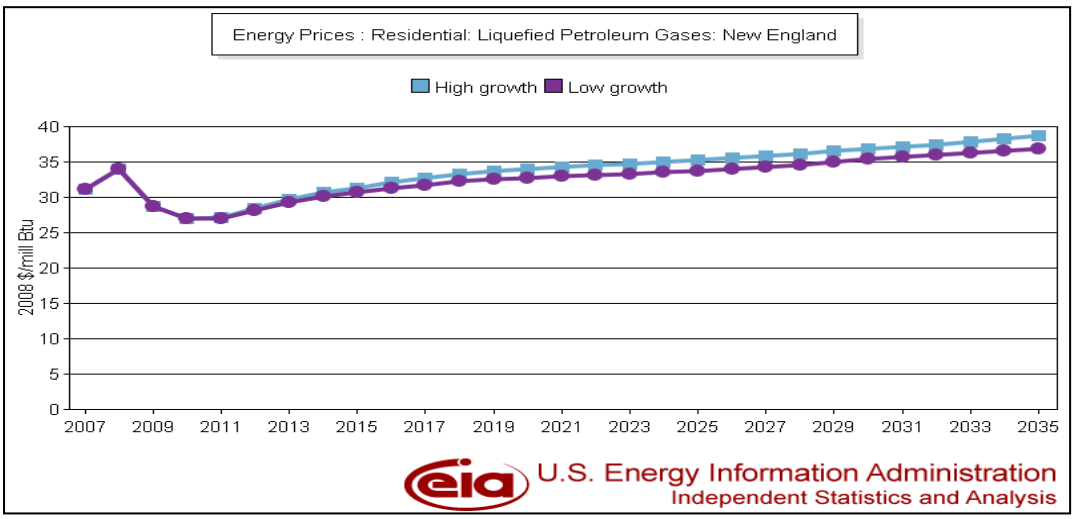
	Year				Percent Change		
	2009	2010	2011	2012	09-10	10-11	11-12
WTI Crude[a] ($/barrel)	61.65	79.40	93.26	97.50	28.8	17.5	4.5
Gasoline[b] ($/gal)	2.35	2.78	3.15	3.30	18.4	13.4	4.8
Diesel[c] ($/gal)	2.46	2.99	3.43	3.51	21.5	14.7	2.4
Heating Oil[d] ($/gal)	2.52	2.97	3.41	3.55	17.5	14.8	4.3
Natural Gas[d]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

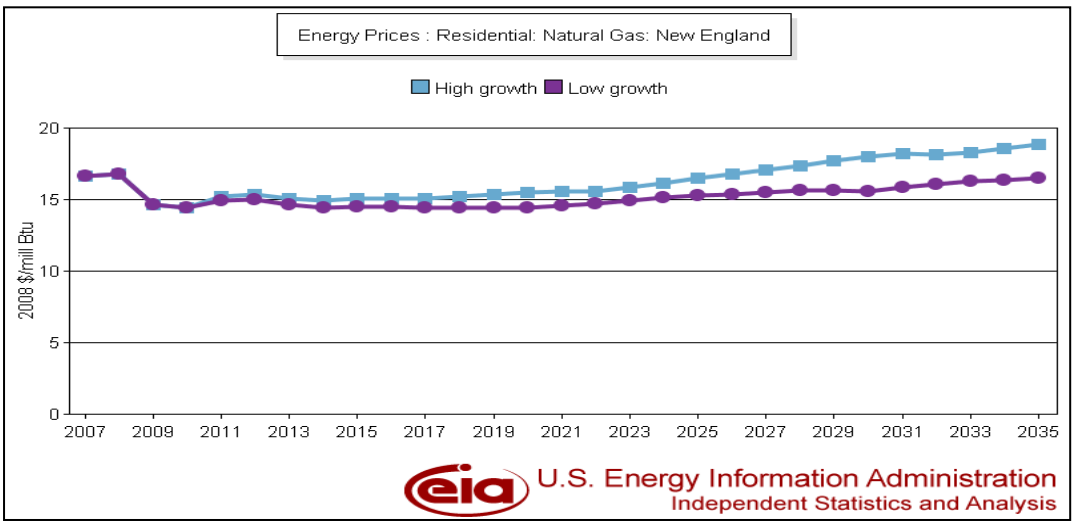
Table 1 – Retrieved from US EIA website



Graph 1 - Retrieved from US EIA website



Graph 2 - Retrieved from US EIA website



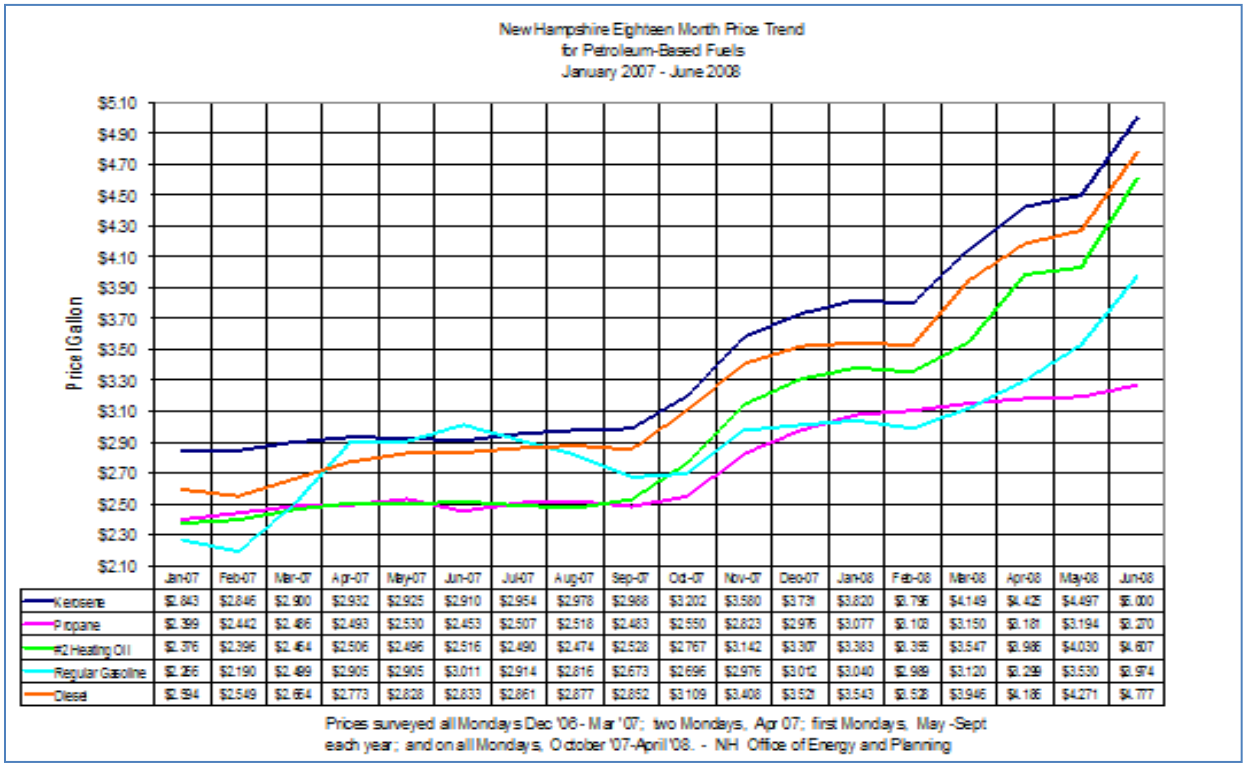
Graph 3 - Retrieved from US EIA website

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.

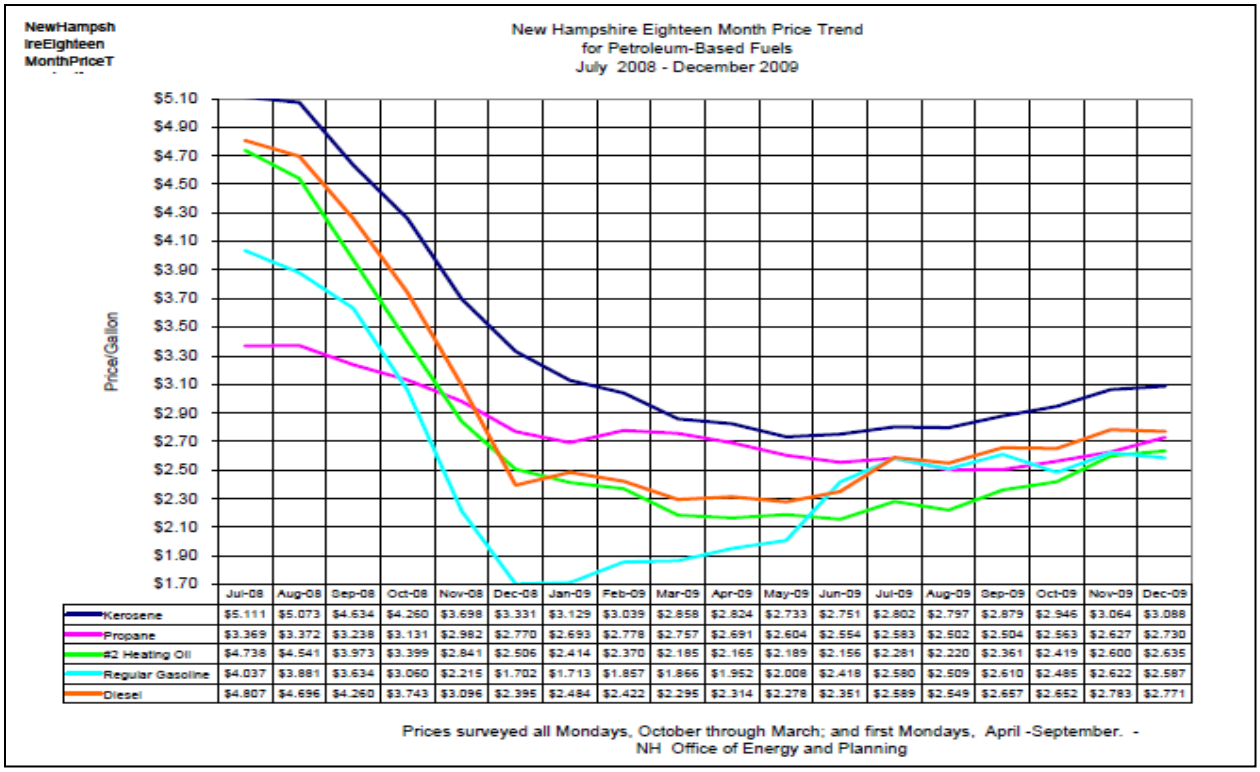
Projects such as air-sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler and a PV system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



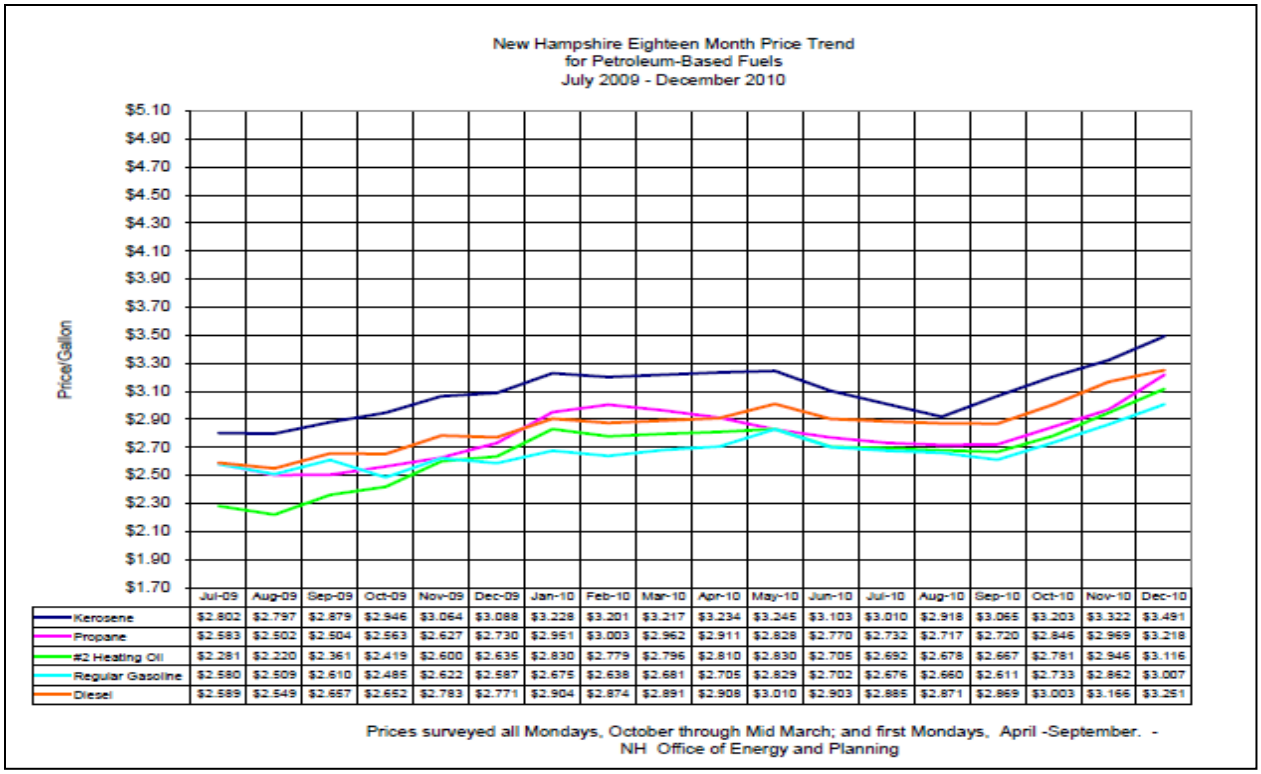
	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
Kerosene	$2.843	$2.846	$2.900	$2.932	$2.925	$2.910	$2.954	$2.978	$2.988	$3.202	$3.580	$3.731	$3.820	$3.796	$4.149	$4.425	$4.497	$5.000
Propane	$2.399	$2.442	$2.466	$2.493	$2.530	$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 7 - 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 table 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 8 – Retrieved from NH OEP website

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

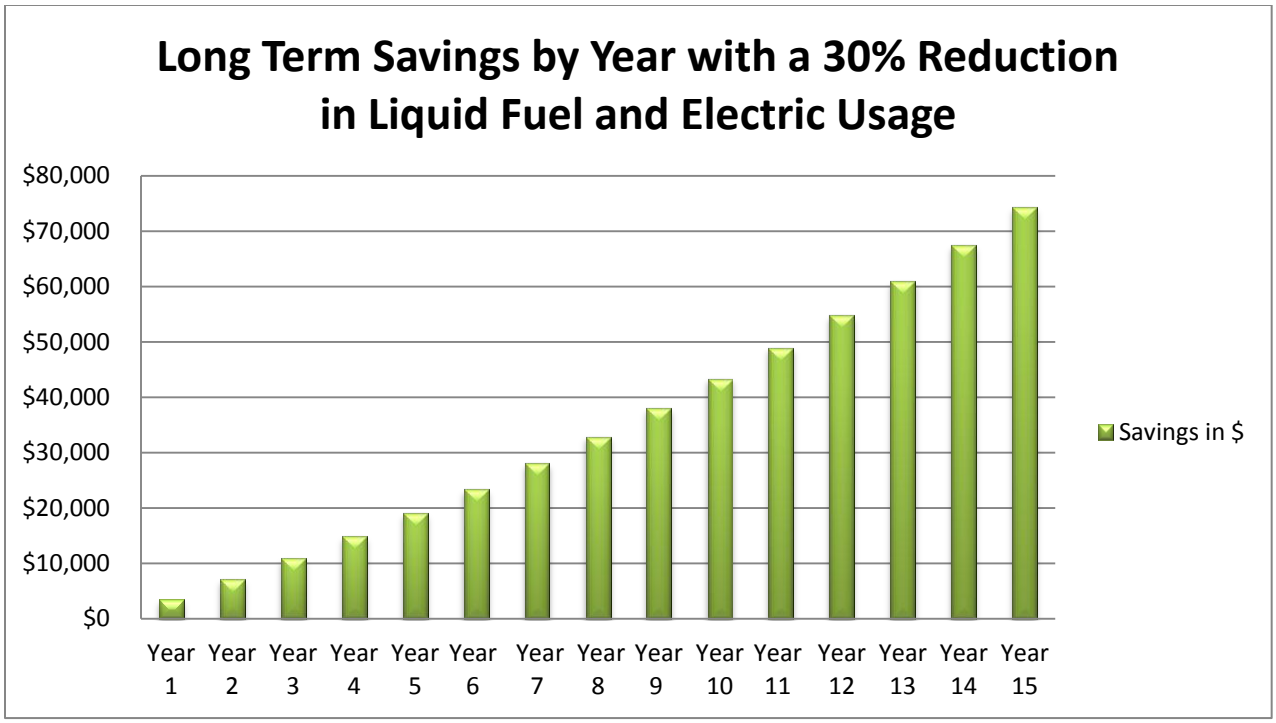
Current Fuel Usage				
Year	Energy Cost By Year	Yearly Increase	Total Accumulated Cost by Year	
		Escalation Rate	5.00%	
Year 1	$7,753.66	$387.68		$7,754
Year 2	$8,141	$407.07		$15,895
Year 3	$8,548	$427.42		$24,443
Year 4	$8,976	$448.79		$33,419
Year 5	$9,425	$471.23		$42,844
Year 6	$9,896	$494.79		$52,740
Year 7	$10,391	$519.53		$63,130
Year 8	$10,910	$545.51		$74,041
Year 9	$11,456	$572.78		$85,496
Year 10	$12,028	$601.42		$97,525
Year 11	$12,630	$631.49		$110,155
Year 12	$13,261	$663.07		$123,416
Year 13	$13,924	$696.22		$137,340
Year 14	$14,621	$731.03		$151,961
Year 15	$15,352	$767.59		$167,313

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

Electric Use - Current Usage				
Year	Energy Cost By Year	Yearly Increase	Total Accumulated Cost by Year	
		Escalation Rate	5.00%	
Year 1	$3,722.00	$186.10		$3,722
Year 2	$3,908	$195.41		$7,630
Year 3	$4,104	$205.18		$11,734
Year 4	$4,309	$215.43		$16,042
Year 5	$4,524	$226.21		$20,566
Year 6	$4,750	$237.52		$25,317
Year 7	$4,988	$249.39		$30,305
Year 8	$5,237	$261.86		$35,542
Year 9	$5,499	$274.95		$41,041
Year 10	$5,774	$288.70		$46,815
Year 11	$6,063	$303.14		$52,878
Year 12	$6,366	$318.29		$59,244
Year 13	$6,684	$334.21		$65,928
Year 14	$7,018	$350.92		$72,946
Year 15	$7,369	$368.47		$80,315

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	5.00%	
Year 1	$3,443	$172.13		$3,443
Year 2	$3,615	$180.74		$7,058
Year 3	$3,796	$189.78		$10,853
Year 4	$3,985	$199.27		$14,838
Year 5	$4,185	$209.23		$19,023
Year 6	$4,394	$219.69		$23,417
Year 7	$4,614	$230.68		$28,030
Year 8	$4,844	$242.21		$32,875
Year 9	$5,086	$254.32		$37,961
Year 10	$5,341	$267.04		$43,302
Year 11	$5,608	$280.39		$48,910
Year 12	$5,888	$294.41		$54,798
Year 13	$6,183	$309.13		$60,980
Year 14	$6,492	$324.59		$67,472
Year 15	$6,816	$340.82		$74,288



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