The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Lee Public Library
7 Mast Road Lee, NH 03861

Prepared for:

Town of Lee, NH

Prepared by:

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In cooperation with:

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5/10/2010

The following report was generated as part of the 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 Lee 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 Lee.

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Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Lee and the Public Library (hereinafter "the building"). This report discusses the findings and subsequent recommendations for energy efficiency improvements at the building. Included within this report are details regarding the walk-through and exploration conducted in the facility and examples that illustrate recommended building alterations and improvements that can reduce energy costs 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 participating in several State level funding opportunities for municipal energy projects. These funds distributed under the aegis of the ARRA (American Recovery and Reinvestment Act) are targeted specifically to towns and cities.

Prior to the audit process beginning, each selected municipality must carry out the MEAP energy inventory process. The inventory process is required in order to receive an energy audit. This report relied on those initial findings to help determine the most appropriate building to conduct an energy audit for, with the intent of maximizing the potential energy savings.

The Audit

The first stage of any audit process is understanding the nature of the system and the objectives of the audit. The use of the building and the Town's goals and objectives are the foundation of a solid audit. In most cases, these objectives combine environmental and economic goals. In the case of public buildings and facilities, comfort and safety are also primary concerns that help guide our analysis and recommendations.

A decision grade audit involves an inventory of heating systems, quantification of energy usage (electrical and heating fuel), and the process of coordinating this information with the goals and objectives of the Town into a decision tool. Under MEAP we look to provide recommendations that will, if carried out, help the Town achieve at least a 30% reduction in energy consumption. The level of detail provided herein is meant to create the basis upon which investment grade audits and decisions can be made. The decision grade audit is meant to filter options and expectations so that the Town can understand the fundamental building system, how changes to the system can result in economic and environmental benefits and how those changes can interact with other policy and philosophical objectives.

The following information will describe the characteristics witnessed during the building inspection and those areas of the building where improvements may be made. The objective of these recommendations is to create a series of options the Town can further explore.

Energy Data Collection:

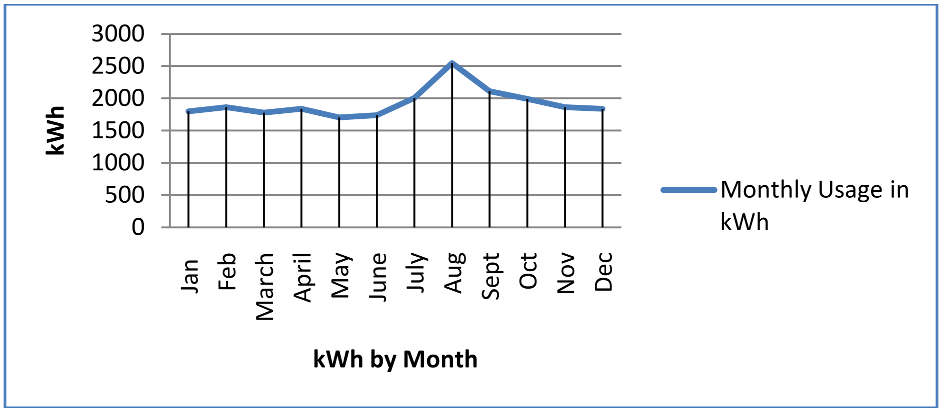
Name of Building	Heating Fuel Type(s)	Area (Sq. Ft.)	Energy Use: Electricity (million Btu)	Energy Use: Heating Fuel (million Btu)	Total Building Energy Use (million Btu)	Site Energy Intensity[1] (kBtu/sq ft)	EPA Average Site kBtu/sq ft for building type	NH Average Site kBtu/sq ft for building type
Lee Library	Propane	5,727	79	210	289	51	104	80

* The above chart was extrapolated from the Lee Municipal Greenhouse Gas and Energy Use Baseline Report.
Energy use data generated by STOCC software; energy intensity data generated by Portfolio Manager Software.

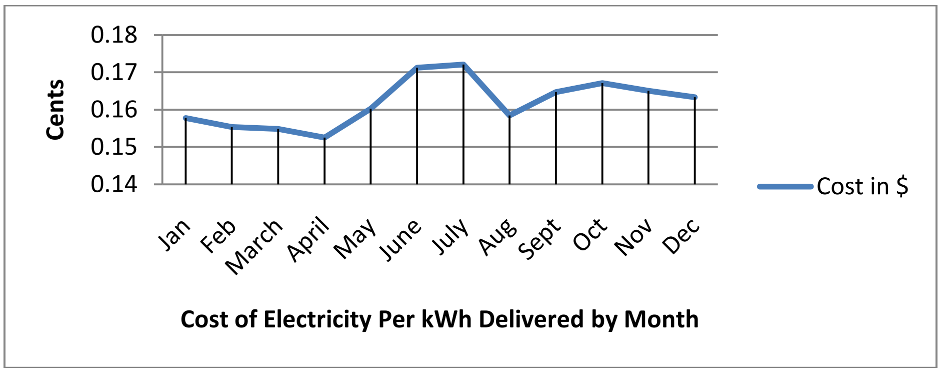
Meter: LEE PUBLIC LIBRARY ELECTRIC			
Building: Lee Town Library			
April 22, 2010 - 11:26:49 AM			
Fuel Type: Electricity, Grid Purchase (kWh (thousand Watt-hours)) **Space(s):** Entire Facility			
Start Date	**End Date**	**Energy Use**	**Cost - US Dollars**
12/1/2008	12/31/2008	1,836.00	$300.00
11/1/2008	11/30/2008	1,860.00	$307.00
10/1/2008	10/31/2008	1,992.00	$333.00
9/1/2008	9/30/2008	2,112.00	$348.00
8/1/2008	8/31/2008	2,544.00	$403.00
7/1/2008	7/31/2008	2,004.00	$345.00
6/1/2008	6/30/2008	1,740.00	$298.00
5/1/2008	5/31/2008	1,704.00	$273.00
4/1/2008	4/30/2008	1,836.00	$280.00
3/1/2008	3/31/2008	1,776.00	$275.00
2/1/2008	2/29/2008	1,860.00	$289.00
1/1/2008	1/31/2008	1,800.00	$284.00

*Note: The presented data was extrapolated from energy information entered into the EPA's Portfolio Manager.

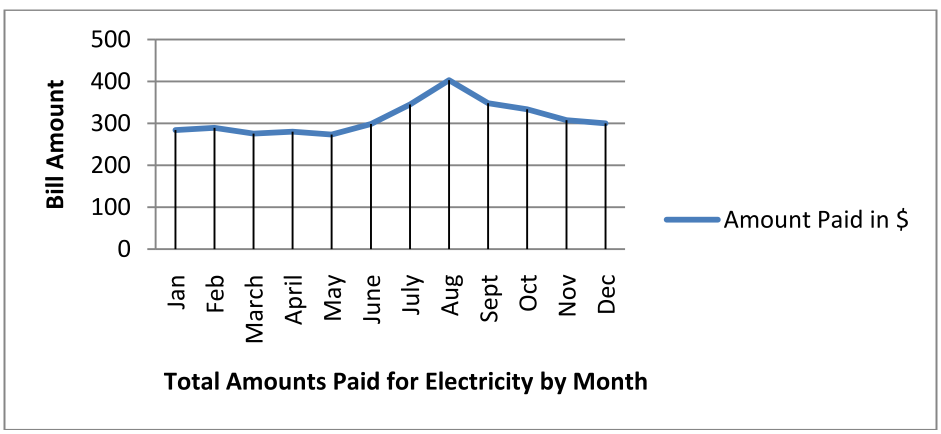
[1] Site energy intensity is the amount of energy expended per square foot *on site* to heat, cool, and electrify the area. This measure relates to how much is being used on site and fluctuates directly with how much lighting is being used, how thermostats are kept, etc.



Graph 1



Graph 2



Graph 3

*Graphs 1, 2 and 3 were generated based on data retrieved from the EPA Portfolio Manager account for Lee, NH.

Meter: LEE PUBLIC LIBRARY PROPANE			
Building: Lee Town Library			
April 22, 2010 - 03:39:47 PM			
Fuel Type: Propane, No fuel generation method associated with fuel type (Gallons) **Space(s):** Entire Facility			
Start Date	**End Date**	**Energy Use**	**Cost - US Dollars**
12/1/2008	12/31/2008	461	$825.20
11/1/2008	11/30/2008	461	$825.20
10/1/2008	10/31/2008	0	$0.00
9/1/2008	9/30/2008	0	$0.00
8/1/2008	8/31/2008	0	$0.00
7/1/2008	7/31/2008	0	$0.00
6/1/2008	6/30/2008	0	$0.00
5/1/2008	5/31/2008	0	$0.00
4/1/2008	4/30/2008	0	$0.00
3/1/2008	3/31/2008	461	$825.20
2/1/2008	2/29/2008	461	$825.20
1/1/2008	1/31/2008	461	$825.20

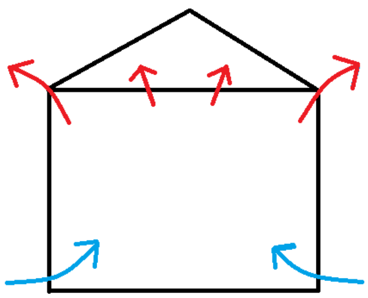
*Note: The presented data was extrapolated from energy information entered into the EPA's Portfolio Manager.

The Library is one of three heated Town buildings situated next to each other in the Town Center. All of the buildings are heated with Liquid Propane Gas (LP) appliances, and draw fuel from the same buried tank. Without individual meters on the three gas lines it is not possible to know how much gas each system is using. It would be possible to estimate this somewhat accurately, but would require performing a heat loss study for each of the three buildings. This being outside of the scope of this program, it was decided to divide the gas usage between the three buildings based on the percent of each building's square footage in regards to the total of the combined buildings. Using this method, it was estimated that the Library uses roughly 2,305 gallons of LP gas a year for heating.

Basics of Heat Loss:

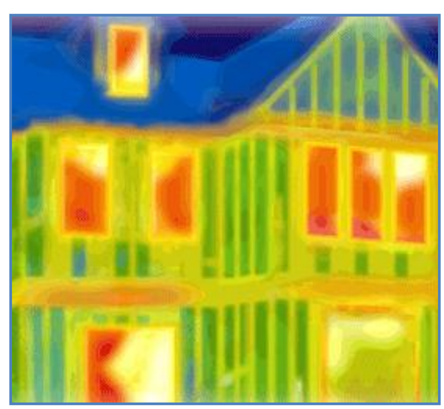
Though we are typically used to measuring heat in temperature, it can be measured in a variety of units. For the purpose of measuring how much heat is produced to condition a space, and how we measure the rate at which heat leaves a structure, we measure in British Thermal Units (BTU's). One BTU is about the same amount of heat produced from a kitchen match. Another good reference to have is that there are about 138,500 potential BTU's in 1 gallon of heating oil. During the winter months, we cannot keep BTU's 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. Typically, heated air leaves through the higher areas of a building, and cold air infiltrates through the lower areas. One of the forces causing this to happen is the "stack effect."

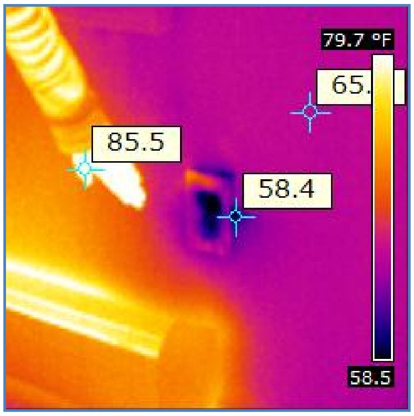


The stack effect describes, on a macro level, the natural way in which air moves through a building. As warmed air leaves through the upper levels of a building, cold air infiltrates through the lower sections. In most cases, this pulls air from less than desirable areas of a building, such as basements, 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 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 contributes to increased comfort and improved indoor air quality.

Conduction is the foremost way in which heat travels through a solid building material. At any point in the building envelope where there is a solid building material and no insulation, what is known as "**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 5.5 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 all of the 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 new and existing buildings will dramatically reduce energy costs and emissions over the

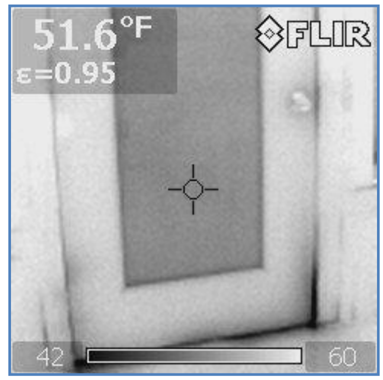


long term as we move towards a new generation of energy and environmental challenges.



Radiant heat loss describes how heat waves, or infrared radiation, pass through space from one surface to another within its view. For example, the heat from a hot cooper 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 large 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 are mold growth, poor indoor air quality, early materials and equipment degradation, and large negative health impacts on 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 important ways to manage bulk moisture are to keep rain and ground water from entering our buildings, and to quickly fix any water leaks from sources within our buildings 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 in 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 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.

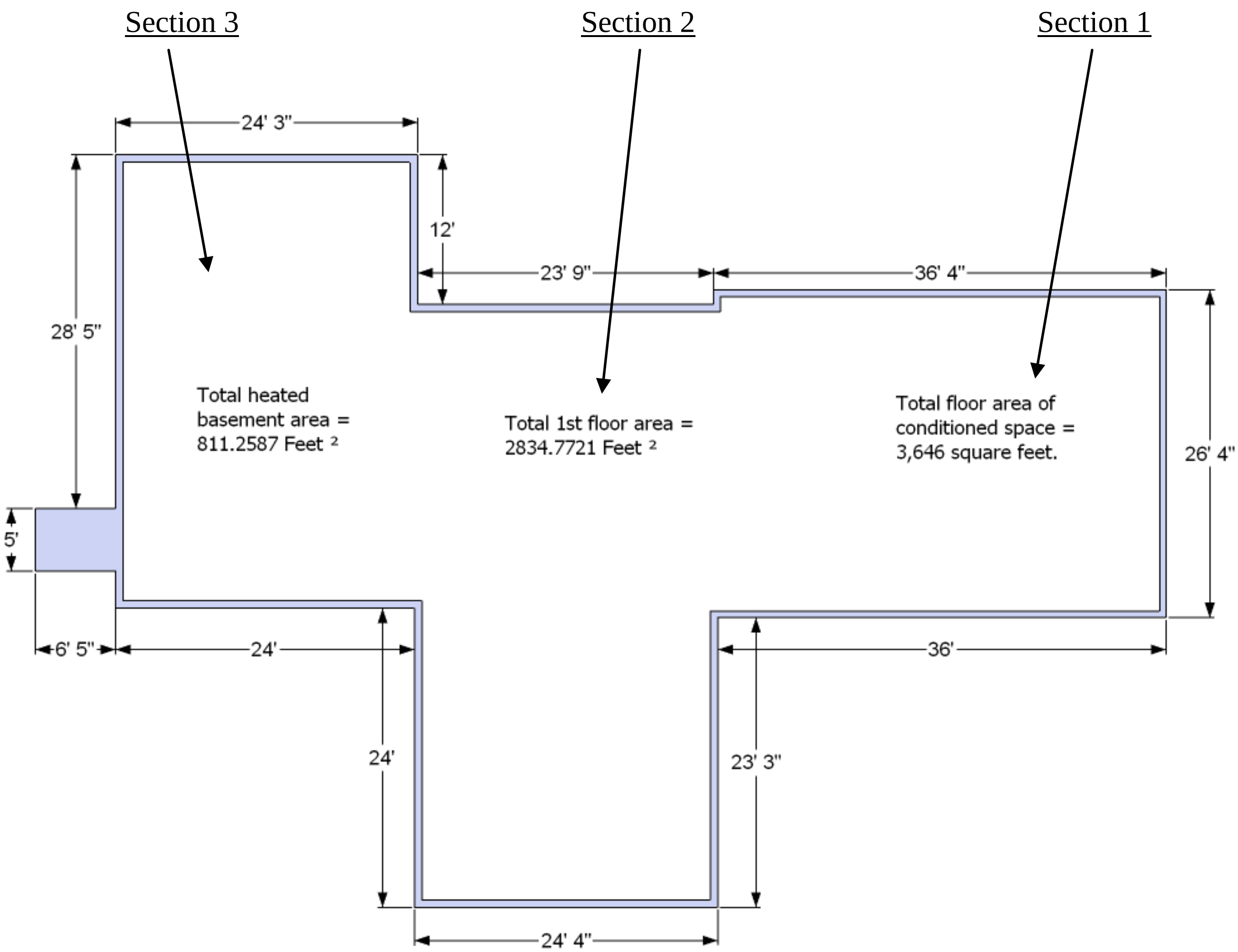
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable, and to keep the water vapor from causing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

Just as BTU's conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and so we use these to try and 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 try and identify any current moisture problems, and address them properly. 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, sometimes negatively, in which moisture affects the building.

<u>Building Description:</u>

There are three sections of this building. According to the Lee Portfolio Manager account the original section of this building was built in 1940. There have been two additions built on the rear side. This building is one story, with the rear addition basement serving as a children's room. See below for building measurements. We have broken this building into three sections for this report with Section 1 being the front of the building.



Floors, Crawl Spaces, and Basements:

There are three sections of the library, all built at different times. The original section (Section 1) has a full basement with uninsulated concrete walls. There is no insulation under the first floor. Figure 1 shows the wall of this foundation from inside the basement. Note the supply duct running along this cold wall. Figure 2 shows the same wall from the exterior. The scale at the bottom of each infrared (IR) image shows that the colder surfaces appear as blue, and the warmer surfaces are red or even white. Notice how the foundation in Figure 2 appears to be losing more heat than the uninsulated wall above.

There is a large amount of air infiltration into this space. Figure 3 shows a large gap above the bulkhead door which allows cold air into the basement. The cobwebs visible in Figure 4 move wildly due to the amount of air coming in from around this basement window. This cold air is not only serving to cool down the ductwork located in this basement, but is also greatly contributing to the stack effect.

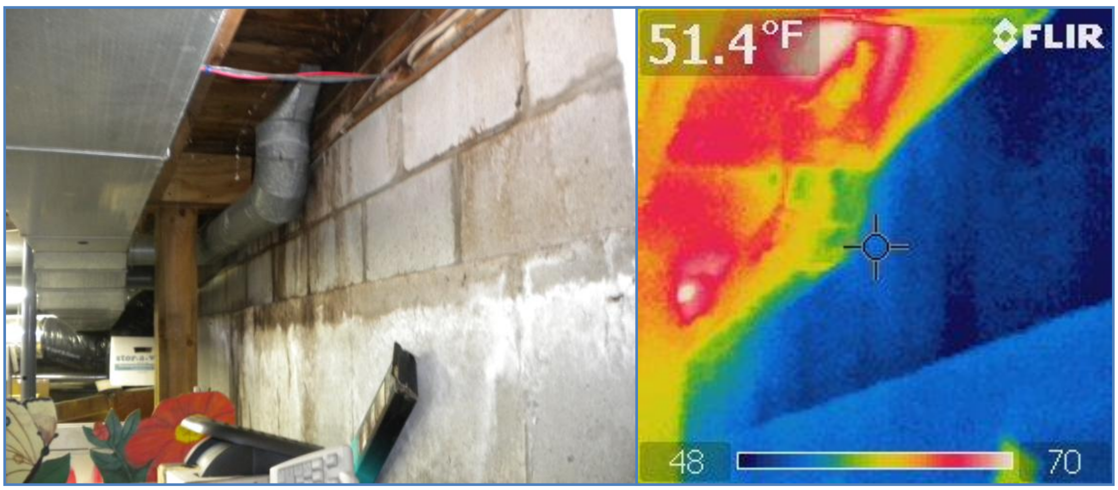


Figure 1

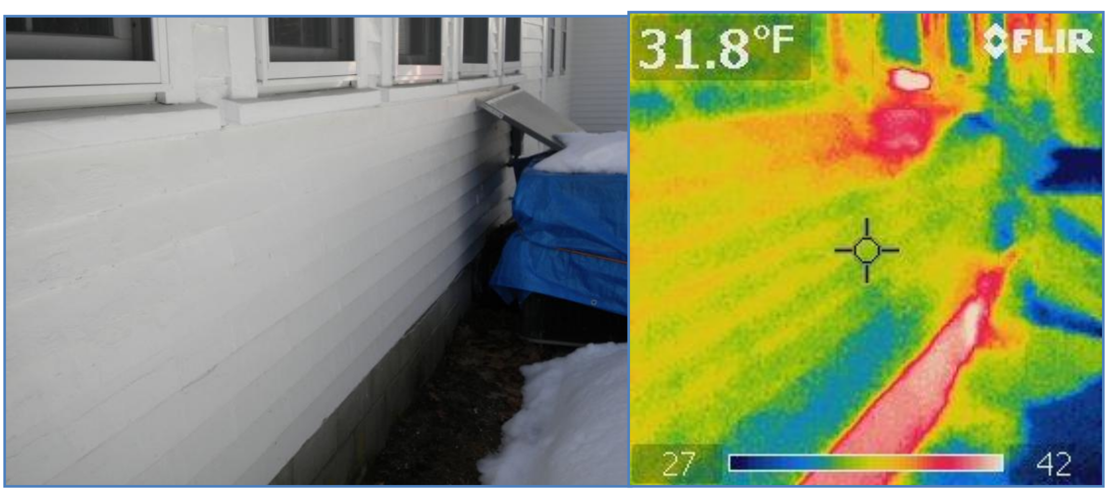


Figure 2

Figure 3

Figure 4

The middle section (Section 2) of the building sits over a crawl space. There are uninsulated concrete walls and a dirt floor at varying depths. Approximately half of the space has fiberglass insulation between the floor joists. There is no vapor barrier present. See Figures 5 and 6.

Figure 5

Figure 6

The rear section of the building (Section 3) has a full basement that is heated and used as a children's room. Neither the walls, nor the floors of this section are insulated. There is a large amount of heat-loss occurring through the concrete. So much in fact that the furnace used to heat this space is used in conjunction with two large electric space heaters in an attempt to keep the space up to temperature. Figure 7 shows how cold (blue) the walls in this basement are, while the images in Figure 8 show the same wall from the exterior and the amount of heat (red/white) that is leaving, even melting the snow next to it.

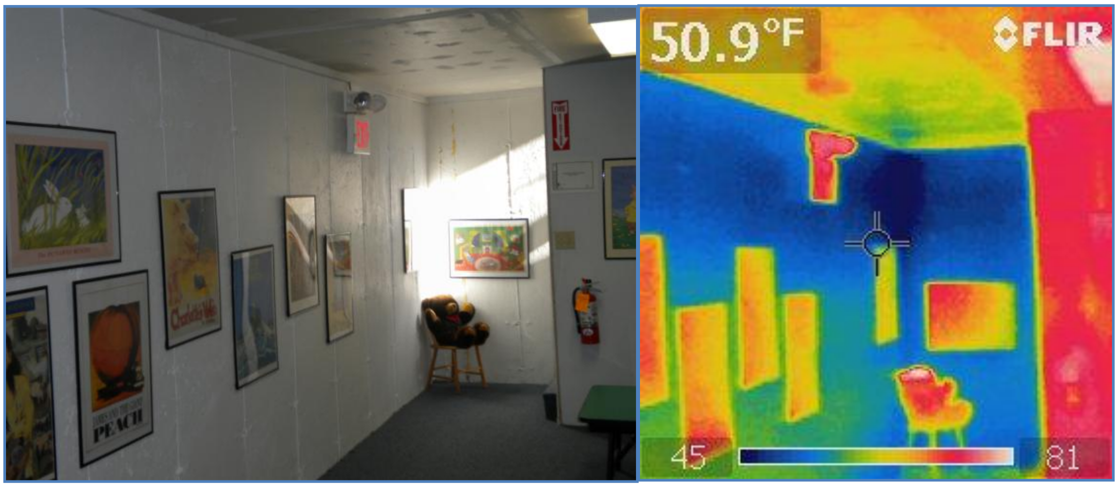


Figure 7

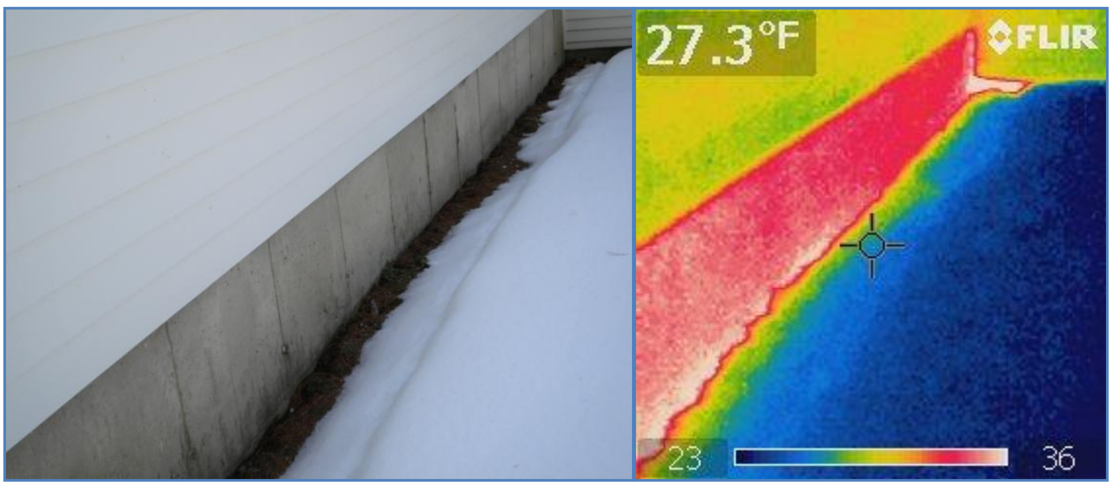


Figure 8

Recommendation:

- Insulate the floors and walls of the children's room. There are many ways to do this, with varying cost and effectiveness. Figure 10 shows one method with the greater idea of having continuous R-value and controlled moisture.

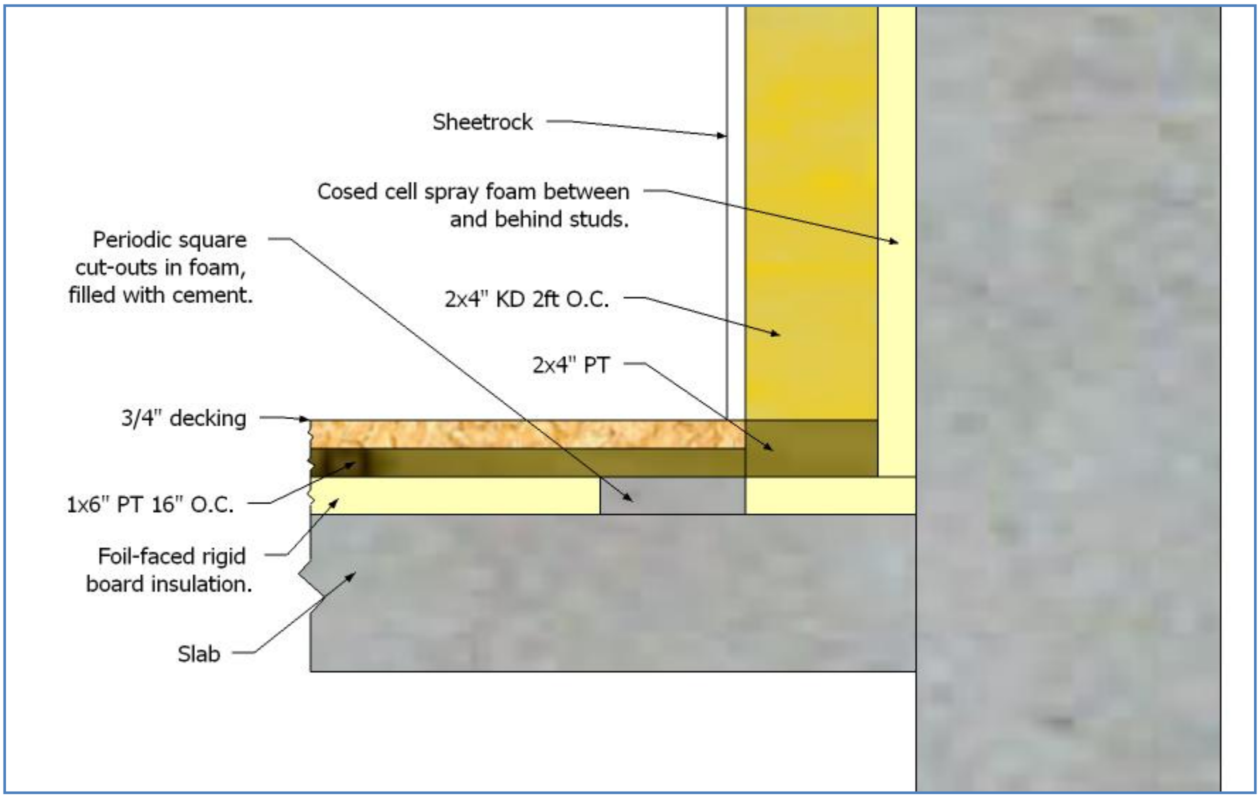


Figure 9

- Insulate the floor and walls of the Section 1 basement. We recommend this, and not insulating the underside of the first floor, because we feel it would be beneficial to try and maintain temperature and ideal humidity levels in this space due to the amount of mechanical equipment and storage in this space. Doing this would also allow for different uses of this space in the future if it were ever to be intentionally conditioned.
- Insulate the underside of the Section 2 floor. This should be done with closed cell spray foam, making sure that the foam comes down over the band joist and slightly overlaps the foundation wall.
- Replace the bulkhead door with an insulated unit. Make sure that the new door provides insulative value as well as a good air seal.
- Make rigid foam inserts for the basement windows in Section 1. Install the inserts during each heating season, and remove during the warmer months. It is necessary to keep humidity levels as low as possible in basements and crawl spaces during the summer months.

<u>Exterior Walls:</u>

The exterior walls of Section 1 were constructed with 2x4" studs. The IR images in Figures 11 and 12 suggest that these walls have no insulation. We were able to look into a few different wall cavities to confirm this.

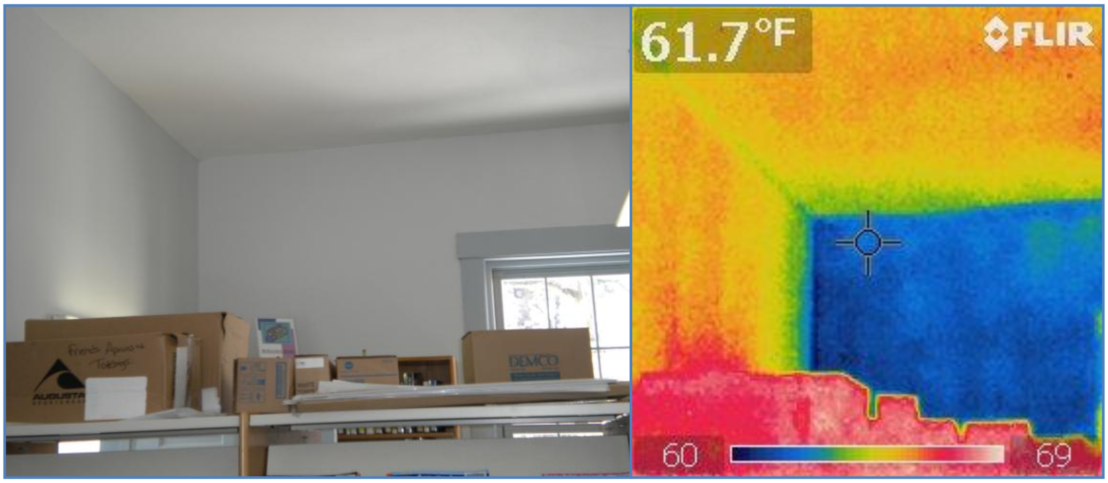


Figure 10

Figure 12 illustrates just how quickly heat from this supply air register is lost through the uninsulated wall.

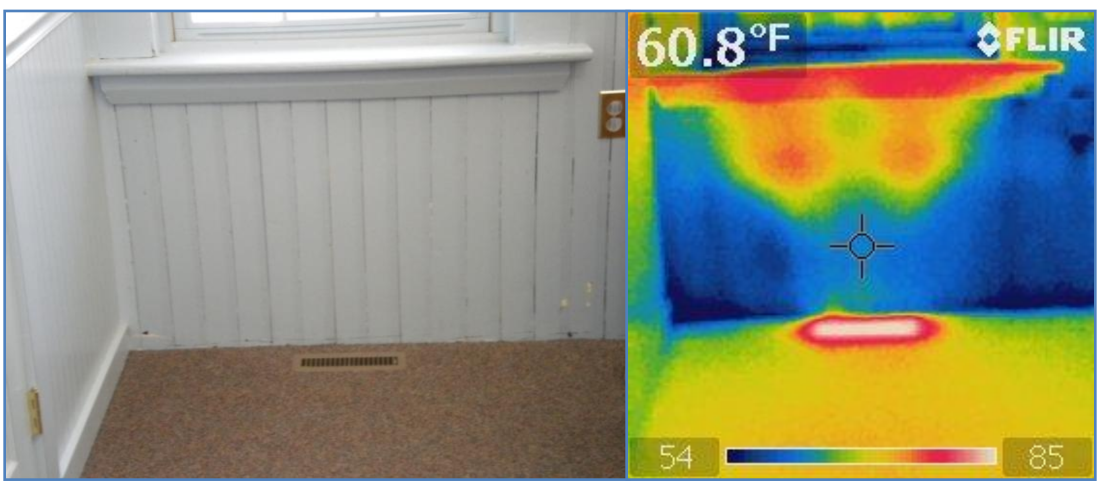


Figure 11

The exterior walls of the two additions were constructed with 2x6" studs, and are insulated with R-19 fiberglass batts. The images in Figure 13 show the warmer areas (yellow/red) which are the wall cavities where there is fiberglass insulation. We also see the cooler areas (blue/green) where there is no insulation. The vertical lines visible in this image are wall studs. We also see a dark blue area where the three surfaces meet in the upper corner. These tend to be particularly weak points in a wall structure of this type, as the corners and top plates of a stud wall are practically solid wood.

The blue portion of this image extends into the ceiling. The edges of this type of ceiling are also generally weak areas. This is because there are soffit vents that allow ambient air to pass from the soffit into the attic space where it is then vented to the outdoors taking excess heat and moisture with it. Fiberglass does very little to block air flow, even when the air pressure may be against the face of the fiberglass batt. When the batt is on its side, as with this case, the air can move easily into the end of the batt and pull the heat away from the interior surface producing the effect seen in the image below.

It is possible to reach the edge of this ceiling from the attic to make improvements to the ceiling insulation. Improving the insulation level of the walls would be much more difficult, costly, and would only be recommended if the building were to undergo a major renovation with the goal of super-insulating the entire building.

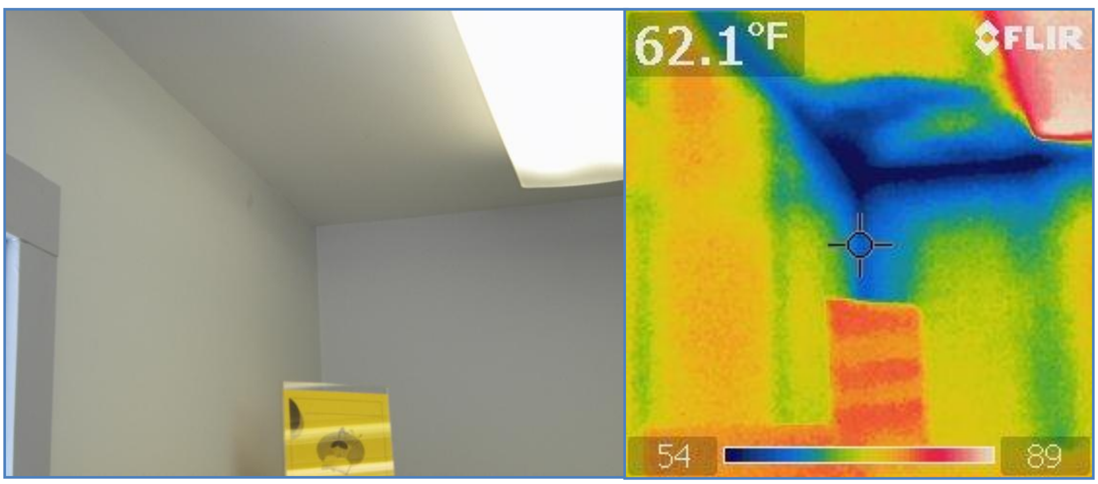


Figure 12

Recommendations:

- Have all the exterior walls of Section 1 filled with cellulose insulation. This would also be a good time to temporarily remove the window trim to seal and insulate around window frames, studs, sills, and headers.
- If at any point the building will undergo a major renovation, consult with a building performance analyst who specializes in super-insulated structures. A super-insulated building can require 75% less heating fuel than standard construction.

Ceilings:

The ceilings above the original section of building have several inches of vermiculite insulation with fiberglass batts placed on top. Combined cavity insulation is equal to around R-30.
The ceilings above the two additions are both insulated with R-30 fiberglass insulation. Though the insulation levels in the ceilings of this building are not of great concern, there is still room for improvement.

Recommendation:

- Air seal any electrical/mechanical penetrations from the main floor into the attic space. There are many light fixtures, and likely the same number of holes in the ceiling.
- Improve the insulation around the perimeter of the attic space, while making sure that the proper vents are not blocked.
- If many of the other recommendations on this report are addressed first, increase the R-value in the attic to R-60 with loose fill cellulose.

Doors and Windows:

All the windows in the building have a solid wood sash, and all are operable with exception the large center pane of the bay window in the rear of the building. Many of the windows are single pane, some having storms. The glazing of this building is equal to about 15% of the exterior walls. Replacing windows is not recommended at this time, as this would not fall very high on a list of energy priorities. It is important to make sure that all the windows are well sealed during winter months.

There are five exterior doors. Most are relatively efficient units and we do not recommend their replacement at this time. The front, solid wood, double door of the original building is quite leaky and in need of either replacement or substantial weather sealing.

Recommendation:

- Take steps to ensure that all of the doors and windows shut well, and provide a tight air seal.

If the recommended air-seal and insulation work is completed, it may be necessary to provide fresh air to the building. The most efficient way to provide fresh air in this case would be with an energy recovery ventilator (ERV). An ERV functions by removing a percentage of the stale air from the return plenum, then introduces 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 ERV. 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. In the winter months, 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 14.

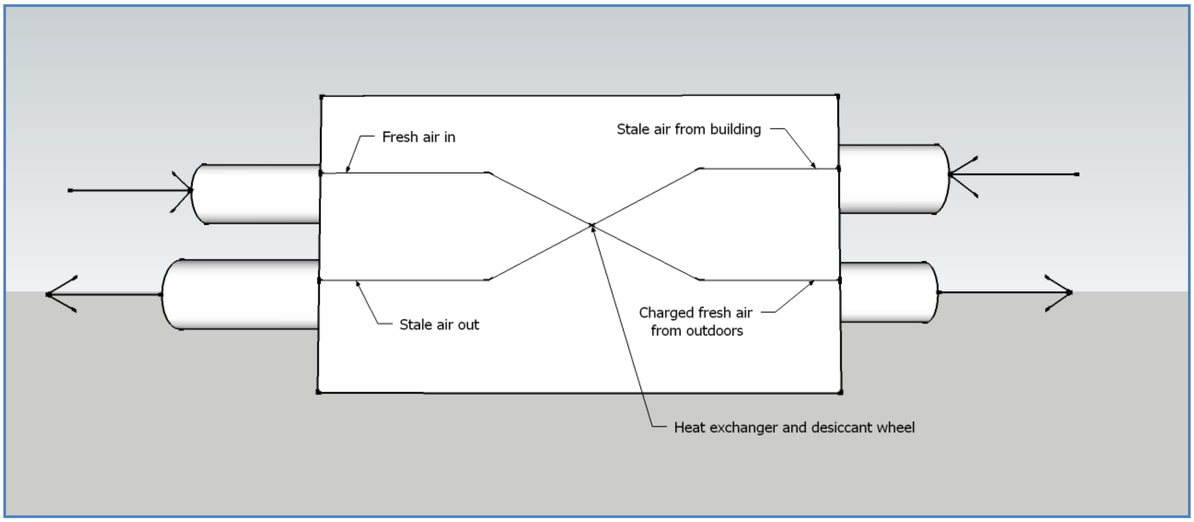


Figure 13

Envelope Efficiency:

The single largest area for improvement in building efficiency involves the building envelope. The best ways to increase an envelope's performance is to complete air sealing and insulation work. Although it could be a major undertaking to air seal and insulate the building, the resulting benefit would be equally significant.

From a building efficiency standpoint, 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 may only last 20 years, or 40 years before possibly needing to replace a PV array, but building envelope efficiency has a lasting positive impact long after equipment needs to be replaced. This is an important consideration when factoring in the true life cycle cost of the implemented solution.

Air sealing/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 new and efficient heating and cooling equipment provides the most savings.

Mechanical:

The building is heated by three sources. Section 1 and 2 are heated with a liquid propane gas (LP) fired furnace that has a combustion efficiency of about 80%. Section 3 has its own LP fired furnace located in the basement. This unit has a rated combustion efficiency of 80.1%. The third heat source comes from two electric space heaters located in the basement of Section 3. These are used in conjunction with a forced hot air system in order to achieve an acceptable comfort level. Both of the furnaces could be replaced with more efficient models that would have a rated combustion efficiency of 96%. Also, if the recommendations for insulating the children's room were carried out, there would likely no longer be a need to use the electric space heaters.

The only sections of ductwork in this building that are sealed or insulated are the lengths of flex duct attached to the main trunk in the crawl space of Section 2. The fact that all the ductwork runs through either uninsulated basements or crawl space contributes greatly to this inefficiency.

There is an AC unit on the exterior of the buildings that feeds cooled air through the furnace to the building. Not only is this unit very inefficient, but there are large round sections of flex duct running from the cooling unit into the basement. Though there are dampers keeping much of the heated air from running through this unit in the winter, there is still a considerable amount of heat loss from this flex duct, as is visible in Figures 15.

Providing AC to the building could be done a lot more efficiently by replacing this unit with an outdoor condenser unit to feed refrigerant to a coil in the duct work. This would also eliminate the heat loss during the winter months, seen in Figure 15, because the ductwork would be replaced with two small insulated copper pipes.

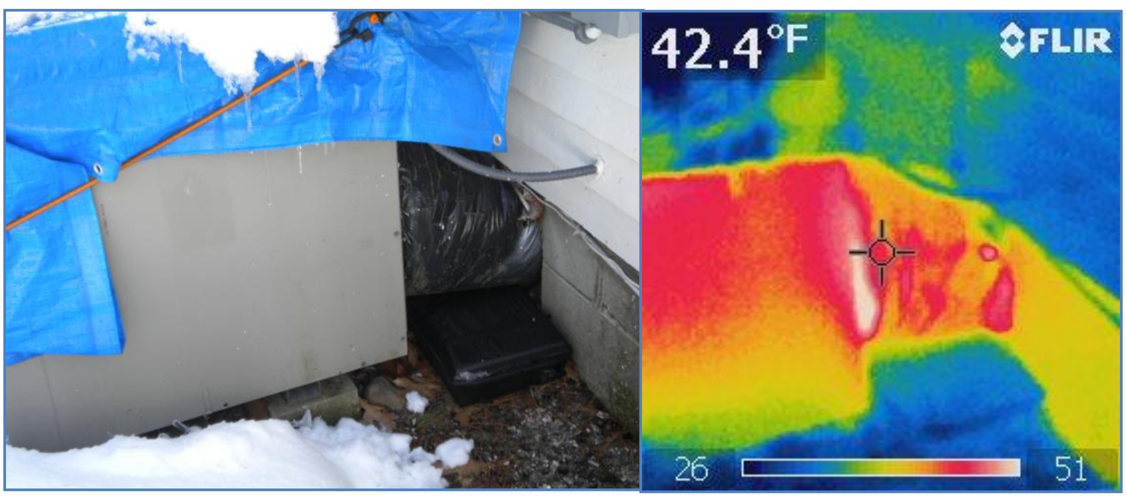


Figure 14

There is not a lot of domestic hot water (DHW) use in this building. There is only one lavatory and the hot water is supplied by the small electric hot water heater seen in Figure 16. Though there are more efficient ways of producing hot water, this is not a very high priority. This tank, and the pipes, should certainly be wrapped with more insulation.

Figure 15

Recommendations:

- Air seal and insulate all of the duct work. The ducts should be sealed with either mastic or metalized tape. Mastic is preferred. The ductwork in Section's 1 and 2 should be insulated with a minimum of R-8 (installed rating) foil-faced fiberglass duct insulation. The ductwork in the basement of Section 3 we would recommend insulating with a foil bubble wrap only.
- Replace both furnaces with more efficient units. Only purchase the most efficient equipment available.
- Replace the current AC system with a new outdoor condensing unit that provides cooling via split runs to a cooling coil in the ductwork, as opposed to the flex duct running through the building shell. Again, purchase the most efficient equipment available.

Electrical:

This building is primarily lit with 4 foot florescent tube fixtures. There are in total approximately 68 T12 4 foot florescent tubes. This is certainly a great opportunity for a lighting upgrade.

There are a variety of computers, printers, and other pieces of electronics. All should be on smart power strips and shut down at the end of each day and the power to these units disconnected. It is important to remember that most of the electronic equipment we use still draws electricity after we turn them off.

Recommendation:

- Consult with a lighting efficiency specialist to develop a plan for performing a lighting upgrade. Financing for this type of project may be available through the Town's electric provider. We have included contact information in the last section of this report for you inquiry.
- Put all electronics on smart power strips, making sure to completely cut the power to all equipment, where appropriate, when not in use.
- Install a photovoltaic system onsite. After the electrical consumption is better controlled through conservation and efficiency, onsite production of electricity is always a smart option.

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.

Life Cycle Costing –

The National Institute of Standards and Technology (NIST) Handbook 135, 1995 edition, defines Life Cycle Cost as "the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or a building system" over a period of time. Life Cycle Cost Analysis is an economic evaluation technique that determines the total cost of owning and operating a facility over period of time.

Since municipal buildings are funded in their initial year through bonds and/or capital outlays, they generally fall victim to an inordinate focus on the bottom line cost of construction instead of the lifetime cost to operate the building. This is a critical misstep in particular with energy concerns for municipal buildings because they are placed in service for a significant period and are subject to extended energy pricing. A more efficient building could save the costs of initial investments several times over during its lifespan.

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.

"Green" Building Cost Myths –

A perception that all energy-efficient construction costs more than conventional construction persists. We have been unable to find valid research that supports this conclusion - especially where choices made about efficiency are evaluated in a realistic context considering the life cycle cost to operate the facility. To the contrary, we have found several sources, from government facility agencies, that show not only that in most cases costs are in fact lower but that any increased cost is almost immediately realized through lower operating expenses.

A terrific resource to 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.

Utility Programs:

Many utilities provide rebates for various types of efficiency measures that can be carried out at a municipal facility. PSNH offers the Municipal Smart Start Program. This program offers 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.

For more information please contact Kathleen Lewis, (603) 436-7708 ext. 5628, or visit http://www.psnh.com/Business/Efficiency/Paysave.asp

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 a 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.

Summary of Recommendations:

- Take steps to ensure that all of the doors and windows shut well, and provide a tight air seal.
- Put all electronics on smart power strips, making sure to completely cut the power to all equipment, where appropriate, when not in use.
- Air seal and insulate all of the duct work. The ducts should be sealed with either mastic or metalized tape. Mastic is preferred. The ductwork in Section's 1 and 2 should be insulated with a minimum of R-8 (installed rating) foil-faced fiberglass duct insulation. The ductwork in the basement of Section 3 we would recommend insulating with a foil bubble wrap only.
- Insulate the floors and walls of the children's room.
- Insulate the underside of the Section 2 floor. This should be done with closed cell spray foam, making sure that the foam comes down over the band joist and slightly overlaps the foundation wall. Put down a vapor barrier on the dirt floor.
- Replace the bulkhead door with an insulated unit. Make sure that the new door provides insulative value as well as a good air seal.
- Make rigid foam inserts for the basement windows in Section 1. Install the inserts during each heating season, and remove during the warmer months.
- Insulate the floor and walls of the Section 1 basement.
- Air seal any electrical/mechanical penetrations from the main floor into the attic space.

- Improve the insulation around the perimeter of the attic space, while making sure that the proper vents are not blocked.
- Install an energy recovery ventilation system.
- Replace both furnaces with more efficient units. Only purchase the most efficient equipment available.
- Have all the exterior walls of Section 1 filled with cellulose insulation. This would also be a good time to temporarily remove the window trim to seal and insulate around window frames, studs, sills, and headers.
- Replace the current AC system with a new outdoor condensing unit that provides cooling via split runs to a cooling coil in the ductwork, as opposed to the flex duct running through the building shell. Again, purchase the most efficient equipment available.
- Consult with a lighting efficiency specialist to develop a plan for performing a lighting upgrade.
- Increase the R-value in the attic to R-60 with loose fill insulation, preferably loose fill cellulose.
- If at any point the building undergoes a major renovation, consult with a building performance analyst who specializes in super-insulated structures. A super-insulated building can require 75% less heating fuel than standard construction.
- Continually revisit the idea of incorporating alternative/renewable energy systems into the operation of this building, and other Town buildings. Such systems may include, but are not limited to, combined heat and power systems, photovoltaic solar panels, and biomass boilers.

Conclusion:

This report has identified many areas for improvement in this building. Implementing these recommendations will bring measurable results, helping this building adjust to current and future energy and environmental challenges.

It is very important that before any changes to the building are made that a building performance specialist is part of further developing any plan. We also recommended that this specialist be present at certain points for inspections of work. This will not only help insure the most energy savings are realized, but is necessary to protect the health of the building. For a list of certified companies and individuals, please visit www.repa-nh.org or www.nhsea.org. Should you have any questions regarding the recommendations provided in this report, please do not hesitate to contact us.