The New Hampshire Municipal Energy Assistance Program

Decision Grade Audit Report

Albany Town Hall
1972-B Route 16 Albany, NH 03818

Prepared for:

Town of Albany, NH

Prepared by:

SDES Group
Sustainable Development & Energy Systems

2 Washington Street, Suite 206
Dover, NH 03820
www.sdesgroup.com

In cooperation with:

Jeffrey H. Taylor & Associates, Inc.
Clean Air Cool Planet
Sustainable Energy Resource Group — Efficiency Makes Sense
Vital Communities — engaged citizens ↔ vital communities
Carbon Solutions New England™

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5/23/2010

The following report is being 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 Albany 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 Albany.

For questions regarding this report, please contact:

Tobias Marquette
SDES Group, LLC
603.866.1514
2 Washington St., Ste. 206
Dover, NH 03820
www.sdesgroup.com

Introduction:

MEAP partners are pleased to provide this Decision-Grade Audit Report for the Town of Albany and the Town Hall (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 step of any audit process is to understand 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 observed during the walk-through and the areas of the building complex where improvements can be made. The objective of these recommendations is to create a series of options the Town can further explore.

Energy Data Collection:

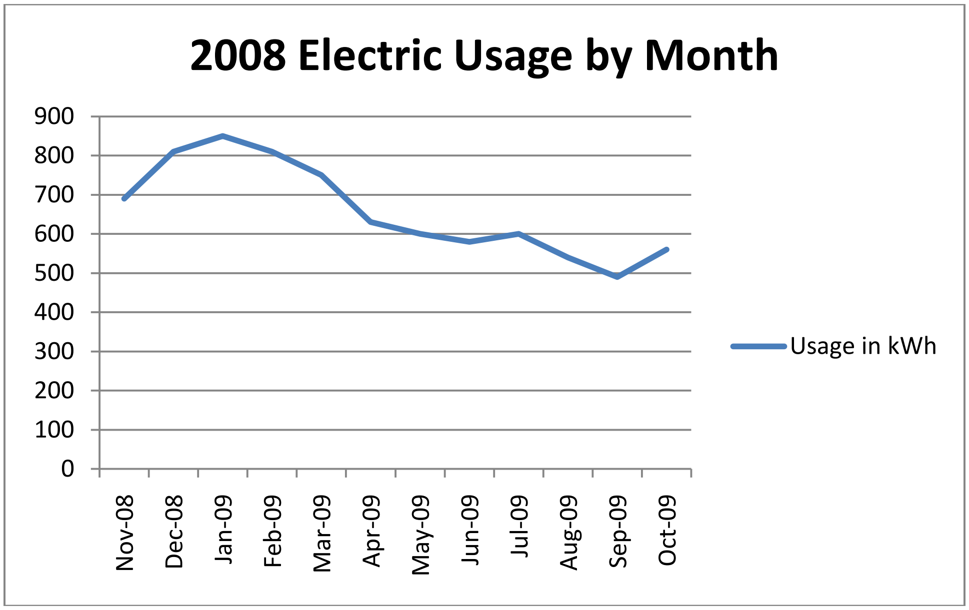
Name of Building	Fuel Type(s)	Area (Sq. Ft.)	Energy Use: Electricity (million Btu)	Energy Use: Heating Fuel (million Btu)	Total Building Energy Use (million Btu)	Site Energy Intensity[1] (kBtu/sq ft)	EPA Average Site kBtu/sq ft for building type	NH Average Site kBtu/sq ft for building type
Town Hall	Electricity, Heating Oil, Propane	4800	26.99	182.16	209.15	43.6	77	68.2

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

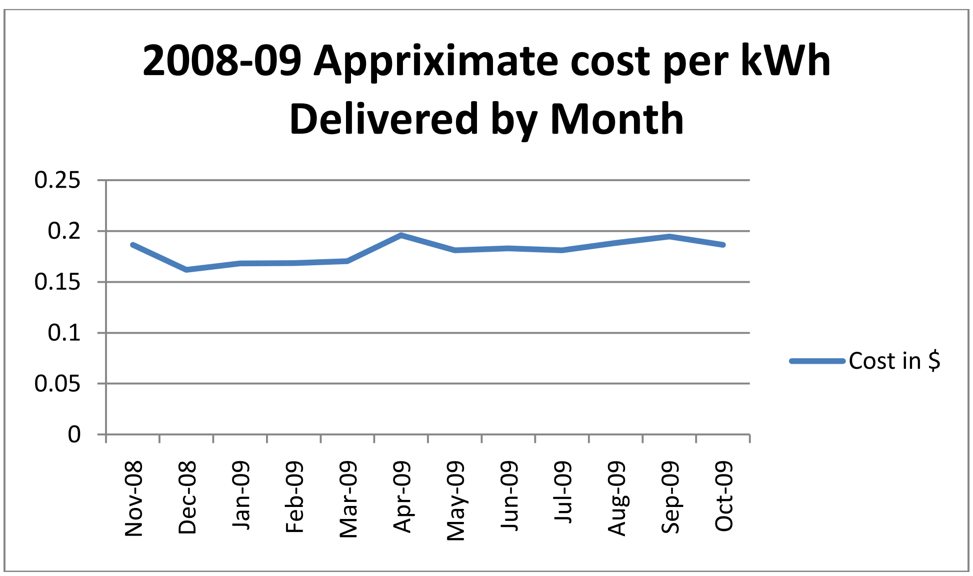
Meter: Town Offices			
Building: Albany Town Hall			
April 19, 2010 - 02:50:57 PM			
Fuel Type: Electricity, Grid Purchase (kWh (thousand Watt-hours)) **Space(s):** Entire Facility			
Start Date	**End Date**	**Energy Use**	**Cost - US Dollars**
10/1/2009	10/31/2009	560	$104.40
9/1/2009	9/30/2009	490	$95.33
8/1/2009	8/31/2009	540	$101.70
7/1/2009	7/31/2009	600	$108.60
6/1/2009	6/30/2009	580	$106.10
5/1/2009	5/31/2009	600	$108.60
4/1/2009	4/30/2009	630	$123.30
3/1/2009	3/31/2009	750	$127.80
2/1/2009	2/28/2009	810	$136.40
1/1/2009	1/31/2009	850	$142.90
12/1/2008	12/31/2008	810	$131.20
11/1/2008	11/30/2008	690	$128.60

*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

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

Total electric usage from Nov 2008 – Oct 2009: **7,910 kWh**

Total Cost of electric usage during this period: **$1,414.93**

Meter: Town Offices Propane			
Building: Albany Town Hall			
April 19, 2010 - 02:51:30 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
10/1/2009	10/31/2009	0	$0.00
9/1/2009	9/30/2009	156	$238.10
8/1/2009	8/31/2009	0	$0.00
7/1/2009	7/31/2009	0	$0.00
6/1/2009	6/30/2009	0	$0.00
5/1/2009	5/31/2009	0	$0.00
4/1/2009	4/30/2009	0	$0.00
3/1/2009	3/31/2009	0	$0.00
2/1/2009	2/28/2009	116.7	$164.40
1/1/2009	1/31/2009	0	$0.00
12/1/2008	12/31/2008	124.9	$183.90
11/1/2008	11/30/2008	0	$0.00

Meter: Town Office Oil			
Building: Albany Town Hall			
April 19, 2010 - 02:50:27 PM			
Fuel Type: Fuel Oil (No. 2), No fuel generation method associated with fuel type (Gallons) **Space(s):** Entire Facility			
Start Date	End Date	Energy Use	Cost - US Dollars
10/1/2009	10/31/2009	52.6	$146.10
9/1/2009	9/30/2009	0	$0.00
8/1/2009	8/31/2009	0	$0.00
7/1/2009	7/31/2009	0	$0.00
6/1/2009	6/30/2009	0	$0.00
5/1/2009	5/31/2009	0	$0.00
4/1/2009	4/30/2009	0	$0.00
3/1/2009	3/31/2009	189.8	$455.90
2/1/2009	2/28/2009	239.4	$574.80
1/1/2009	1/31/2009	224.6	$551.50
12/1/2008	12/31/2008	344.3	$863.50
11/1/2008	11/30/2008	0	$0.00

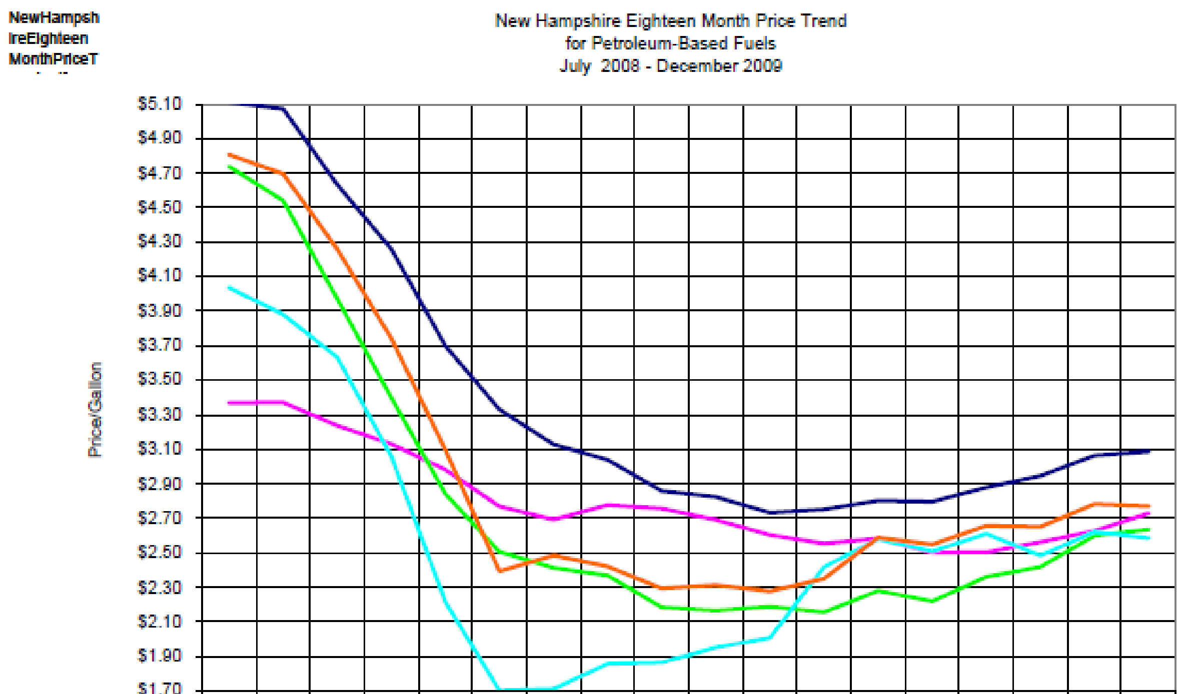
*Note: The presented data was extrapolated from energy information entered into the EPA's Portfolio Manager.

Propane:

- Total Propane delivered from Nov 2008 – Oct 2009: **397 Gallons**
- Total Cost of LP delivered during this period: **$586.4**
- Yearly average cost of LP per gallon delivered: **$1.468/gallon**

Heating Oil:

- Total gallons of oil delivered from Dec 2008 through Oct 2009**:** **1,050.7 gallons**
- Total cost of delivered during this period: **$2,591.80**
- Yearly average cost of fuel oil per gallon delivered: **$2.508/gallon**



	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

Prices surveyed all Mondays, October through March; and first Mondays, April -September. -
NH Office of Energy and Planning

*Retrieved from the NH Office of Energy and planning website.

The above chart displays the average cost per gallon of several fuels types in New Hampshire from mid July 2008 to December of 2009. We want to note the green line (heating oil) vs. the pink line (LP gas) and how the cost of LP tends to be more resistant to periods when the price of oil rises dramatically. We would also like to point out that the Town of Albany paid well below the NH average per gallon of LP gas in 2009.

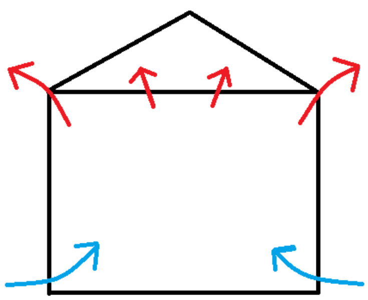
Heating equipment that burns natural or LP gas has the capability of burning the fuel more efficiently than heating oil boilers or furnaces. Though the combustion process is much more efficient and environmentally friendly, this does not always translate to savings. This is because there are more potential BTUs in a gallon of heating oil than there are in a gallon of LP gas and the price of LP gas tends to be too high for large dollars savings to result from such a fuel switch.

From an emissions standpoint, we would always recommend switching from heating oil to LP gas. In this particular situation, if the Town can secure such excellent LP gas prices going forward, it would also make good financial sense to replace the current oil fired furnace with a high efficiency (96%) LP fired condensing furnace.

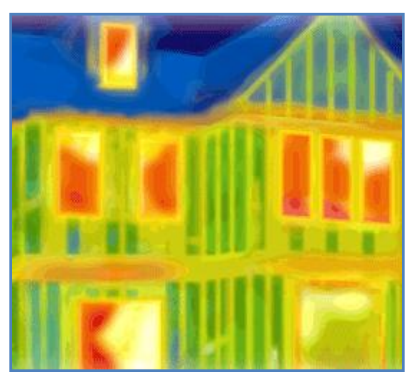
Basics of Heat Loss:

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

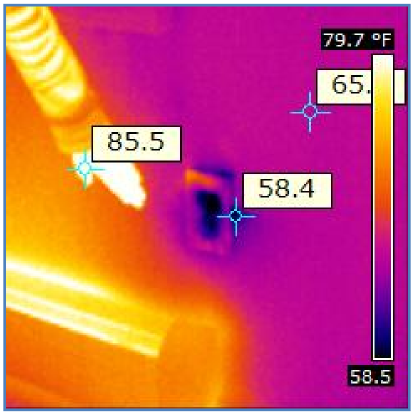
Heat moves through and leaves a building by three different means: *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. One of the forces causing this to happen is the "stack effect".



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

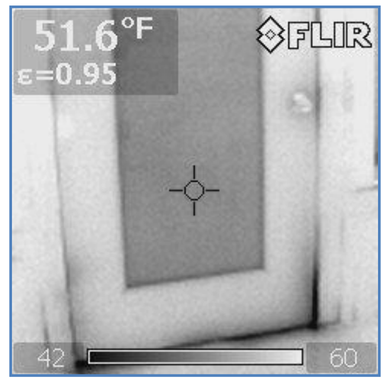


Conduction is the foremost way in which heat travels through a solid building material. R-value is one way to describe a given materials resistance to transfer heat. Materials with a high R-value, such as foams, cellulose, or fiberglass batts are used for insulation. At any location in the building envelope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



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

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



<u>Basics of Moisture Control:</u>

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

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

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

Conversely, in the summer we want the air to be dry. Just as hot goes to cold, wet goes to dry. We cool ourselves by perspiring. As we produce this moisture on our skin, it evaporates into the air, drawing heat away from our bodies. The temperature of a room may not be very high, but if the relative humidity is high, we will feel hot because our perspiration is evaporating at a slower rate. Much of the comfort we achieve from using an air conditioning system (AC) is by removing the moisture from the air, allowing our skin to dry more quickly.

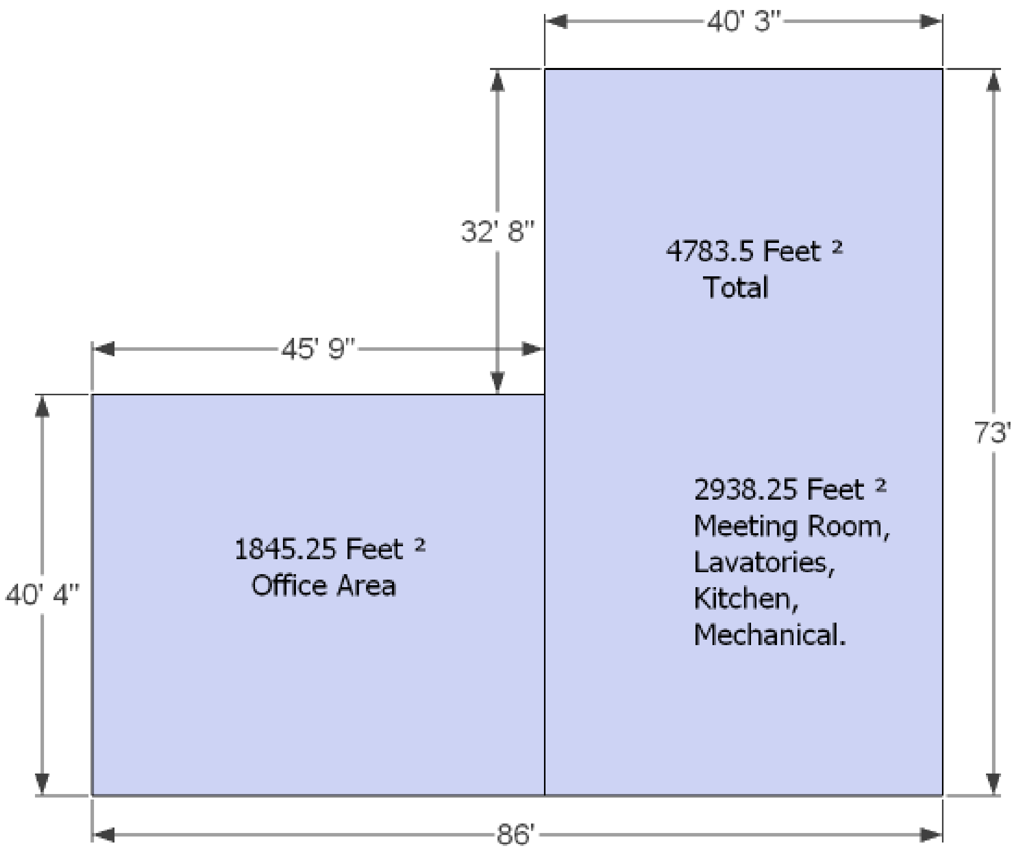
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable and to keep the water vapor from causing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

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

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

Building Description:

This is a one story building constructed in 1978. There is approximately 4,784 ft2 of conditioned space. There are two main section of this building. The largest section of this building is a large community meeting room which is kept at lower temperatures in the winter. The smaller wing of the building is office space where the Town conducts the majority of its business.



Foundation:

The building sits on an uninsulated concrete slab. The following photos and infrared (IR) images in Figures 1, 2 and 3 illustrate how heat is lost through the edges of the slab. The images taken from the interior of the building will show cold areas as dark shades. These are the areas of the greatest heat loss. Figures 1 shows, from the inside, how the heat produced from within the building conducts through the concrete and exits the slab, which is visible in Figure 3 from the exterior. Also, air infiltration is occurring behind the baseboard. The overall basic effect is both heat exiting via conduction and cold air infiltrating. Ensuring a good air seal at the base of the wall would be quite beneficial and, relatively speaking, easy to implement.

Insulating the slab would require digging a 4-foot deep trench alongside the building and apply 2 inches of foam board with an exterior finish. This is an effective way in which to slow the heat loss from around the perimeter of the slab, though somewhat controversial. In some cases where this insulation method has been used, pests such as ants have found their way into the foam board and made nests. Given this, it is very important to create a strong barrier between the foam and any potential infestation. A thick cement scratch coat with a lime based plaster applied the entire depth of the foam could be an ideal solution to this potential problem. Insulating the slab from the exterior would produce greater comfort and savings over the long term, but would require more of an initial investment. We would suggest this only after many of the other recommendations within this report are carried out.

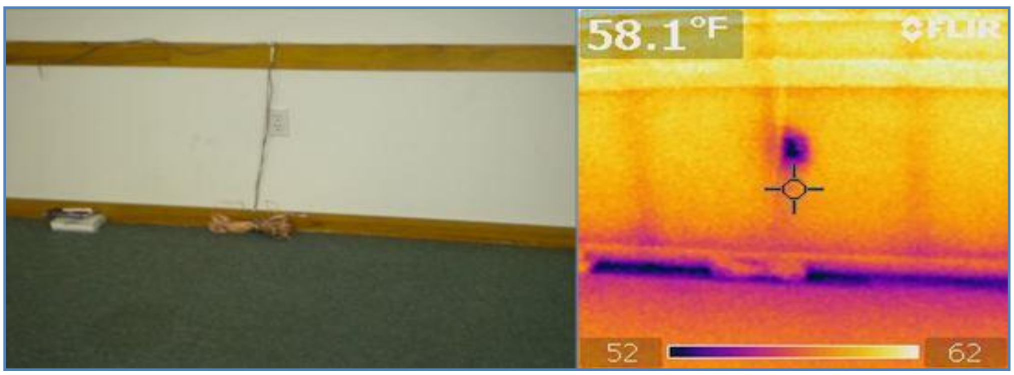


Figure 1

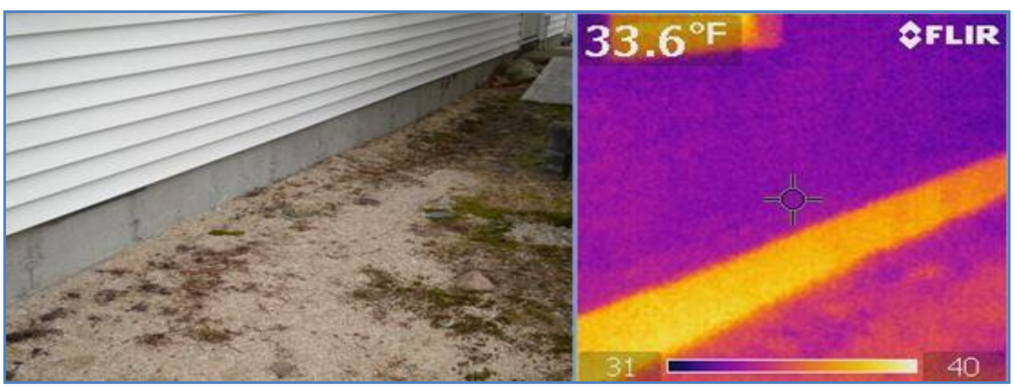


Figure 2

<u>Recommendations:</u>

- Air seal around the perimeter of the building. Temporarily removing the baseboard and applying caulking, spray foam or a type of construction adhesive between the drywall and the concrete slab can accomplish this. It would be very important to use a product that would be able to be exposed to moisture from the concrete and still maintaining adhesion.
- Insulate around the exterior perimeter of the concrete slab. This should only be done after the other, higher priority recommendations have been carried out.

Exterior Walls:

The exterior walls of this building are constructed with 2x6 inch studs, 16 inches on center. There is vinyl siding and a drywall interior finish. The wall cavities have been insulated with R-19 fiberglass batts.

The quality of the insulation could be described as standard. In Figure 3 we see a large dark area to the left of the door. This suggests that this wall cavity has no insulation, and may be indicative of the overall quality and care of this insulation job.

There are two small vertical sections of wall towards the ceiling on either side of the community room before the scissors trusses begin, visible in Figures 4 and 5 we would in this case consider them to be ceiling area and would recommend that air sealing and insulation work be done at the same time as the rest of the ceiling.

Figures 3, 4, and 5 illustrate the extensive amount of thermal bridging occurring in these walls. There is very little to be done to address the thermal bridging without going through a major renovation. Though taking measures to super insulate the exterior walls would be beneficial in regards to the long-term use of this building, there are many higher priority inefficiencies to be addressed first.

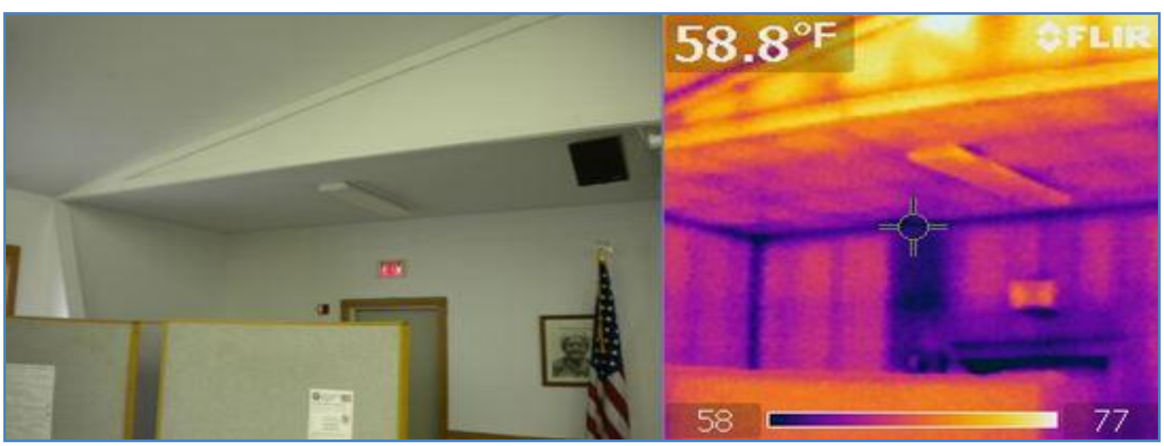


Figure 3

Figure 4

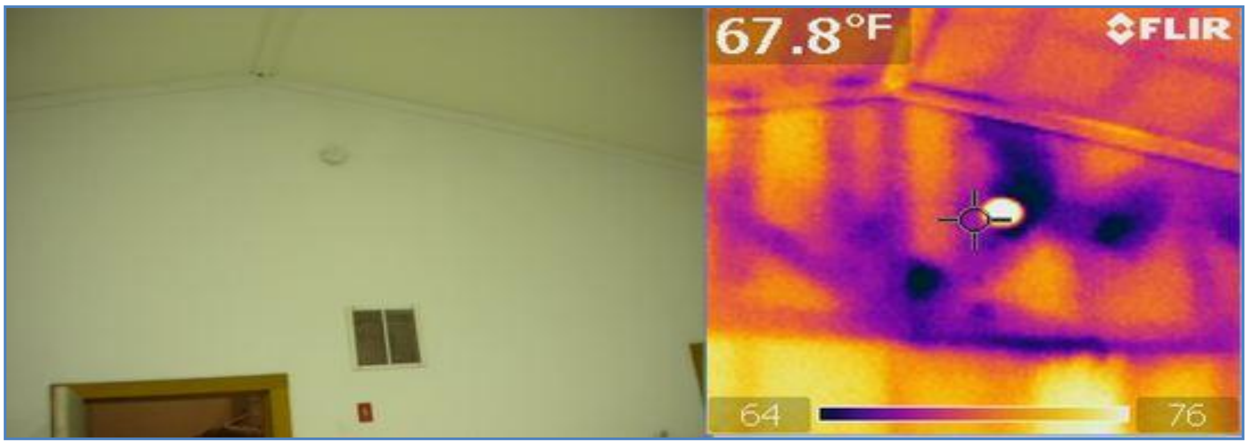


Figure 5

Recommendations:

- Air seal any areas of infiltration from the exterior wall system. This would include, but not be limited to, electrical outlets, light switches and window/door trim.
- Super-insulate the exterior walls of the building. This should be done after all of the more easily implemented energy efficiency measures have been carried out. When ready to do this, the Town should consult with a building performance specialist to examine all the options and find the best fit for this building. The plan should incorporate continuous R-value, eliminating the extensive thermal bridging.

Ceilings and Attic:

The building has a truss roof system and is insulated with R-30 fiberglass insulation. Figure 6 shows weak points along the top of this wall. This is very common and is due in part to the lack of an air seal between the top plate of the stud wall and the proper vent. Fiberglass insulation does very little to stop air movement. Air moves particularly easily through the ends of a fiberglass batts, as is the case here. See Figures 7 and 8 for a visual explanation.

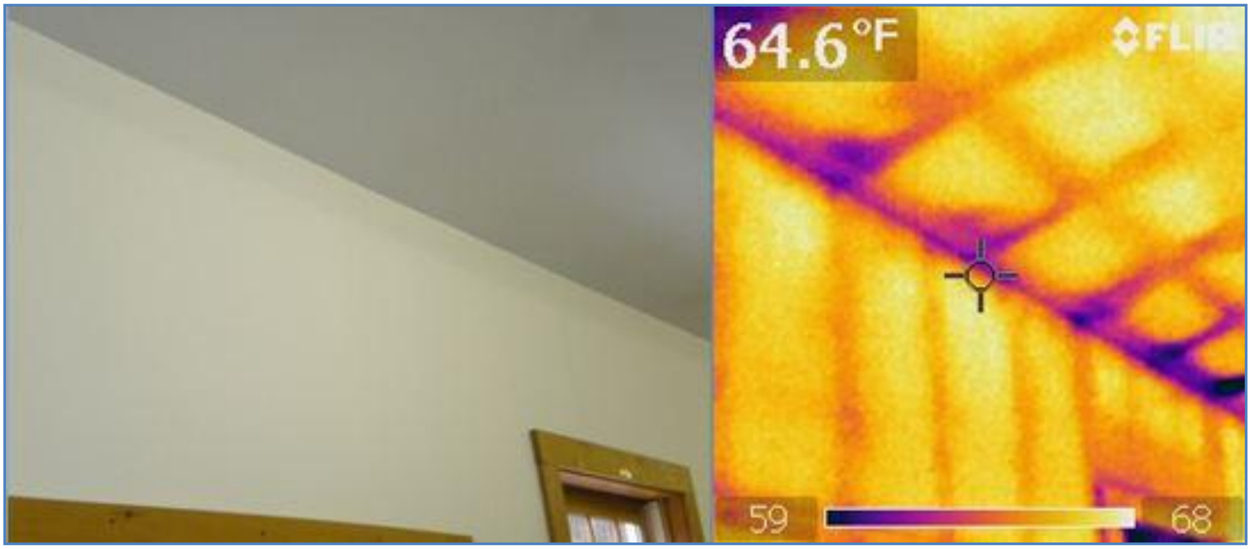


Figure 6

Typical scenario:

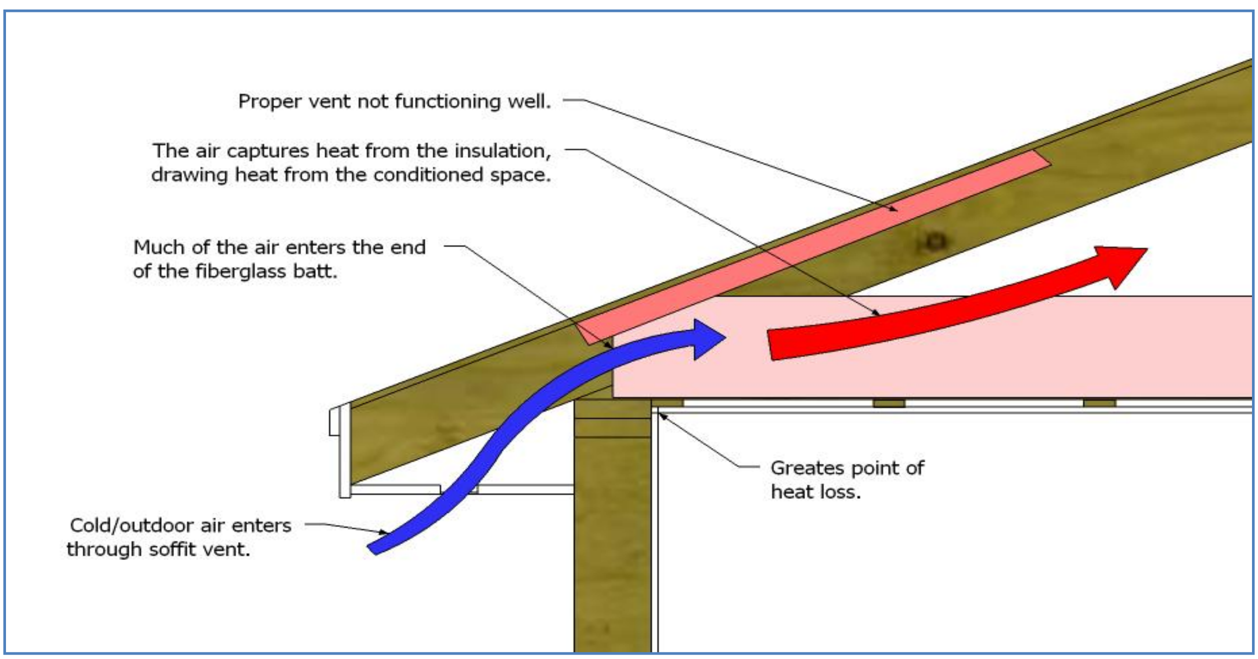


Figure 7

Improved scenario:

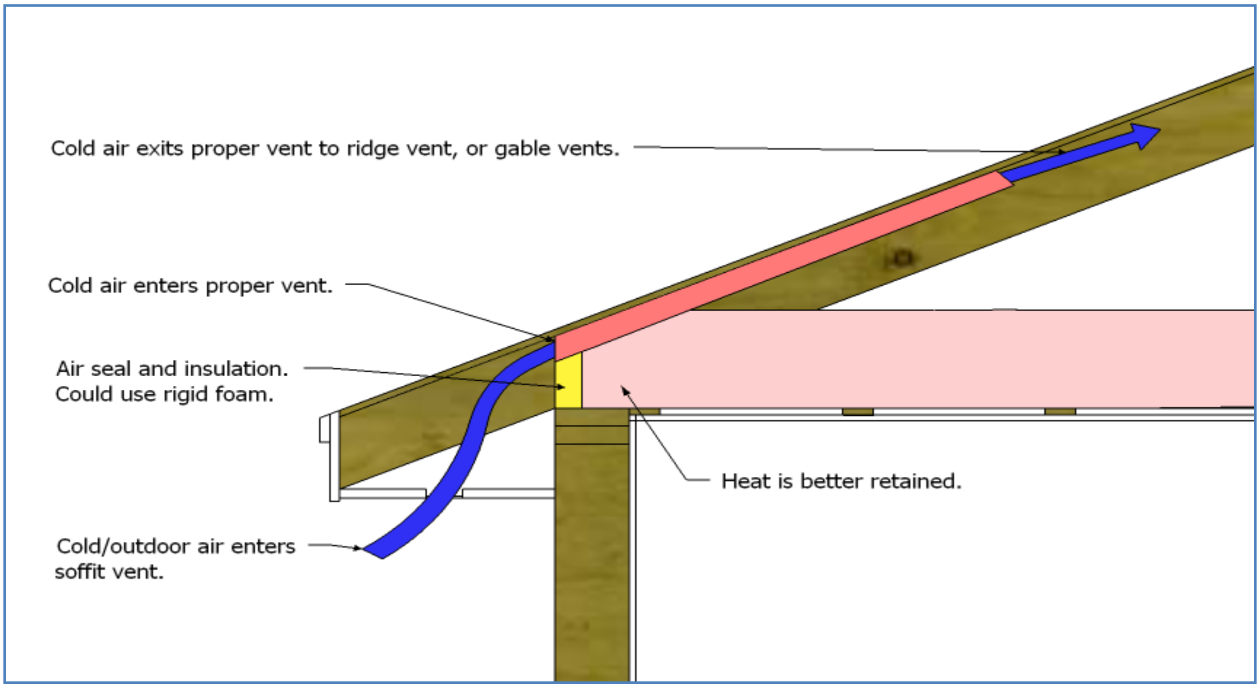


Figure 8

Anywhere in the insulation where there are gaps between the fiberglass batt and a structural member, a weak point will be created, drastically reducing the effective R-value of the wall or ceiling cavity. Figure 9 depicts just one of the numerous weak points. This is why it is critical to use extreme care when insulating with fiberglass insulation and also one of the reasons why those in the high performance construction industry do not prefer the use of fiberglass insulation.

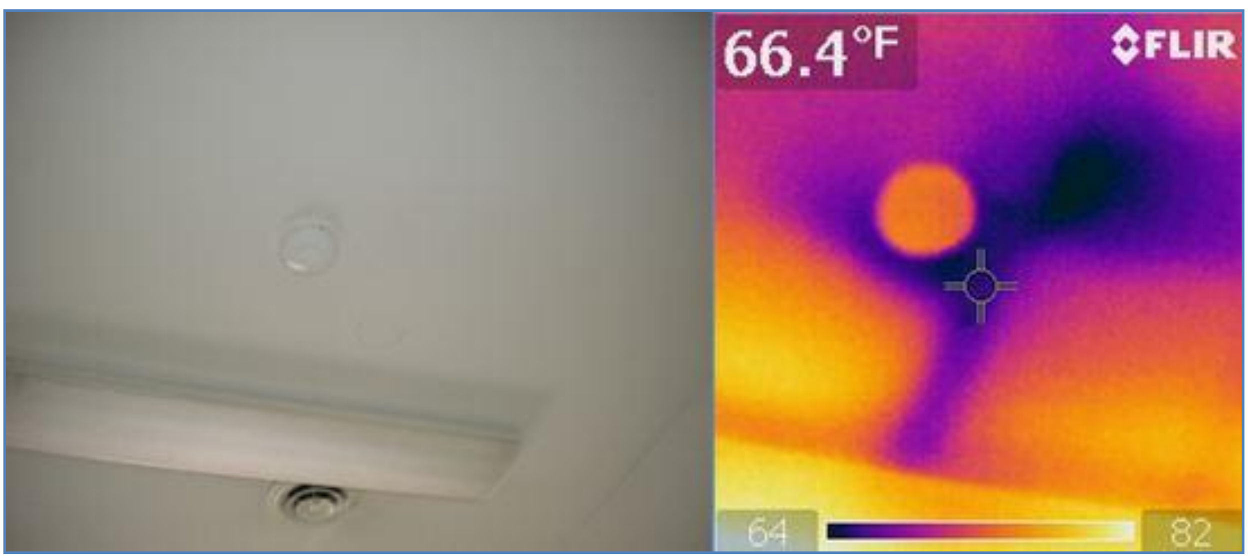


Figure 9

The first step towards improving the thermal boundary of the ceiling area is by air sealing any penetrations from the condition space into the attic. We found many avenues allowing this type of air movement, from the ductwork and attic access seen in Figure 10, to numerous wire and conduit penetrations as seen in Figure 11.

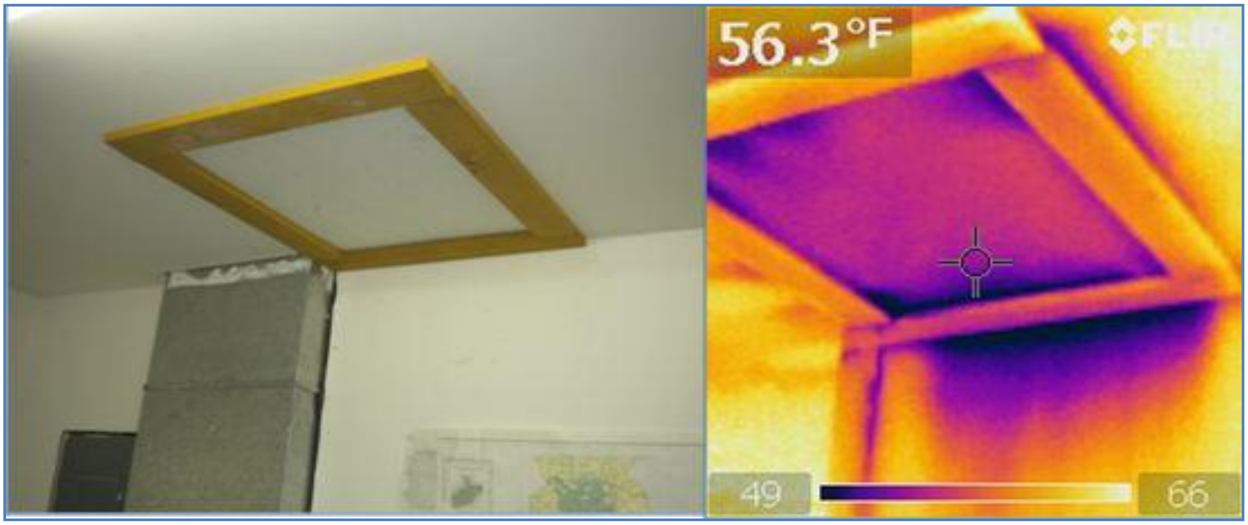


Figure 10

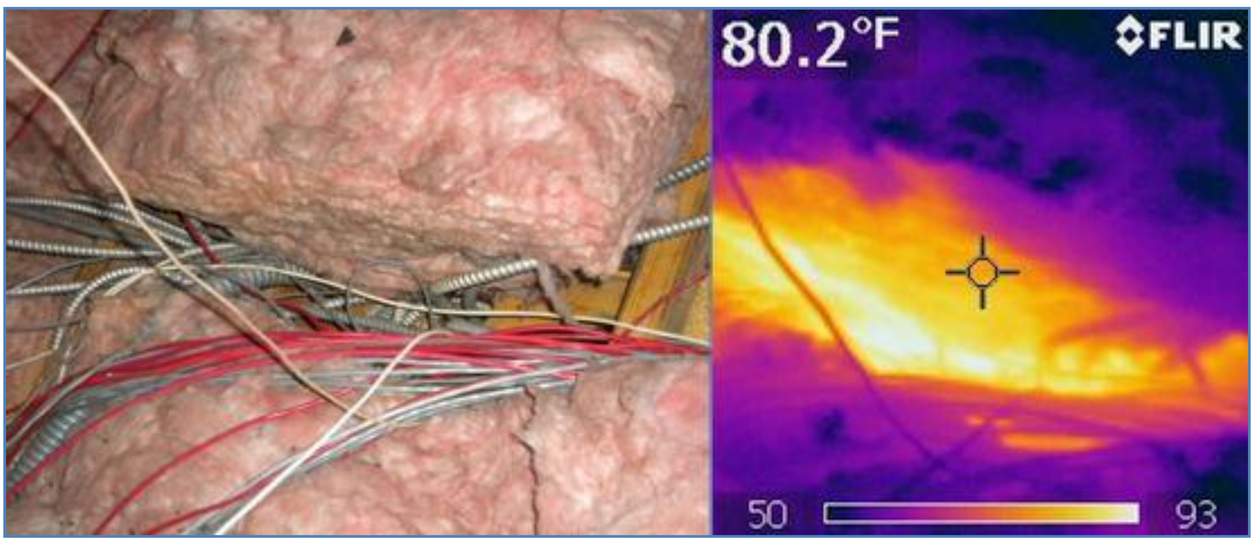


Figure 11

After all of the air sealing work has been completed, the next step is to increase the R-value of the ceilings. Covering the fiberglass batts with loose fill insulation will slow the heat loss process substantially. Not only will the many gaps be covered, but so too will most of the wooded ceiling components, which are currently providing a thermal bridge from the condition space to the attic.

Recommendations:

- Seal any passageways for air to pass between the conditioned space and the attic.
- Air seal and insulate between the top plate of the exterior walls and the proper vent.
- Add an additional section of proper vent to extend further towards the peak of the roof, thereby accommodating added loose fill insulation.
- Add 12 inches of loose fill cellulose to the entire ceiling area. Blow in additional amounts to the sides and top of all the ductwork (after all the duct work has been air sealed and insulated).

Doors and Windows:

There are four exterior doors. Three of the four are not performing very well. The front entrance may be performing the best, even though it is half glazed. Figure 12 shows the double door in the meeting room from the interior. Notice the dark areas around the door trim. This not only suggests poor insulation levels, but also indicates areas of air infiltration. When standing in the meeting room, daylight is clearly visible from around the edges of this door. Figure 13 shows the same door from the exterior. It is clear to see in the IR image how this door glows with heat loss. Though the replacement of this, or any of the other exterior doors, would not fall first on a prioritized list of recommendations, making sure that they provide a good air seal will produce immediate comfort and savings.

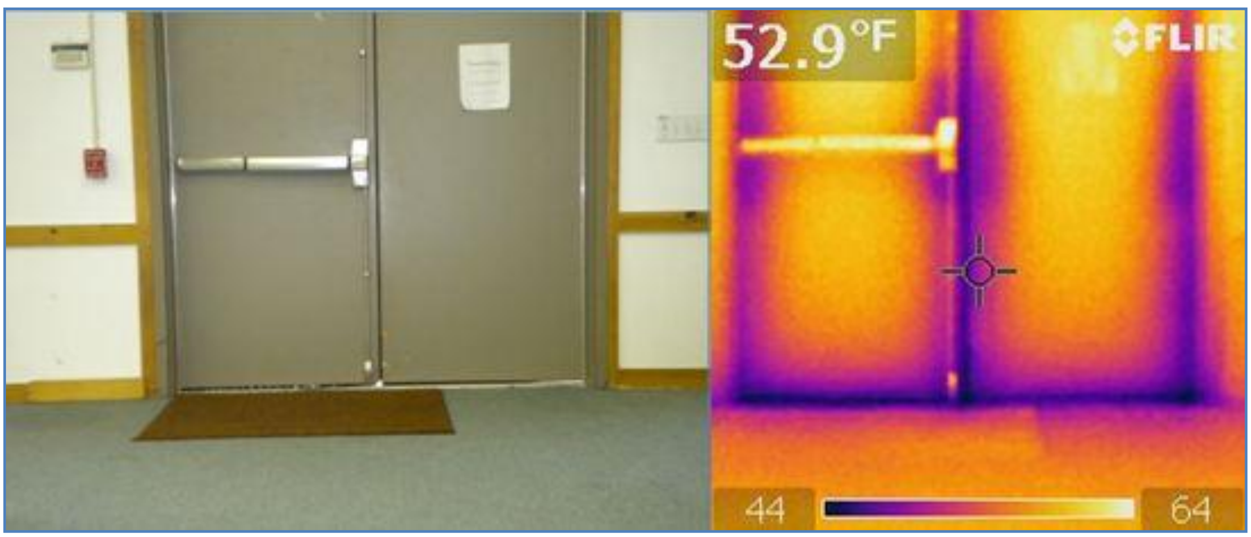


Figure 12

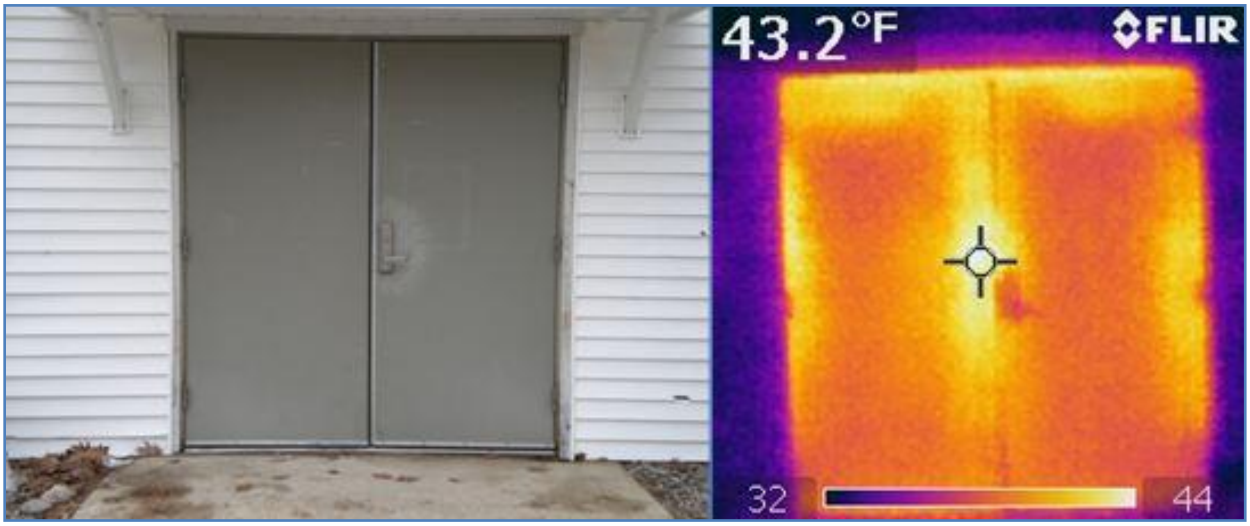


Figure 13

The window and door trim of this building is stained pine boards. Though none of the trim boards were removed for inspection, we feel it safe to guess that the spaces between the window jambs, sills, headers and jack studs have only been loosely filled with fiberglass insulation. Given that, even if the window sashes provided a perfect seal when closed, there would still be an amount of air infiltration from around the trim. There are many inefficient aspects visible in the IR image of Figure 14. What we would like to draw attention to are the dark areas to the right of the door trim. This is a great illustration of a poor air seal and inadequate insulation between the jack stud and the doorjamb.

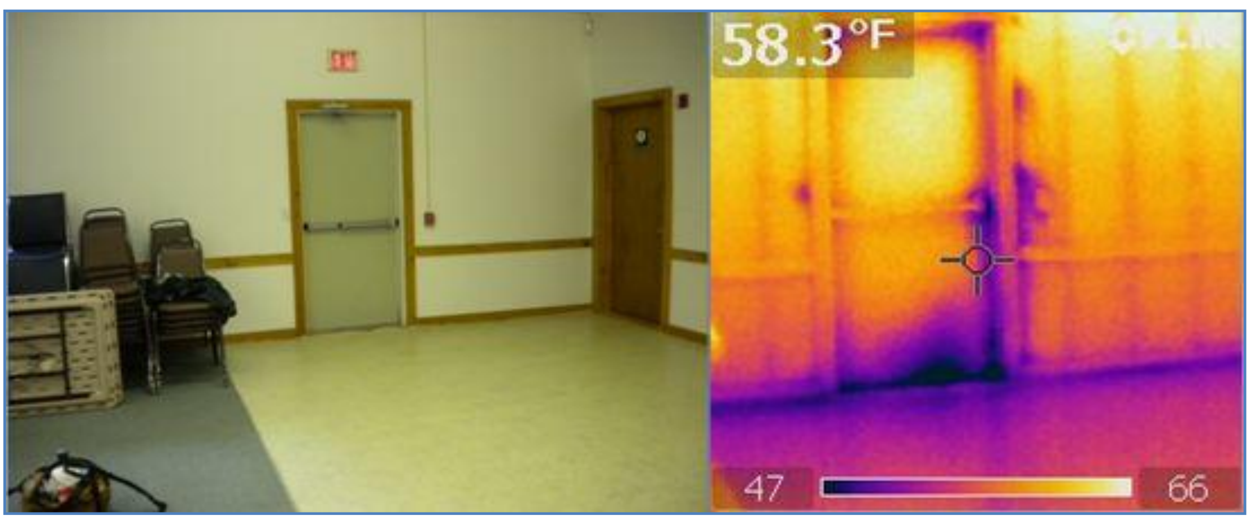


Figure 14

Figure 15

In Figure15 we see small gaps between the sill, jamb and face trim. This is typical of exposed wood trim, especially as wood can shrink over time. Again, the problem comes from the insulation used behind this trim. There are several ways to stop this airflow. Sealing the cracks with wood putty would be a pain stacking process and not produce the best results. Caulking the cracks and painting the trim would also stop airflow, but would not add insulative value and would cover the aesthetic quality of the exposed wood grain. Carefully removing the trim, pulling the fiberglass out, and filling in the gaps spray foam insulation could be fairly easy and would produce the best long-term results.

Figure 16 reveals air infiltration, not only from the window trim, but also from the window sash. The windows are solid wood and have double paned glass. As with the doors, replacing these windows with more efficient units would yield savings, but it would take much longer to recoup the initial investment when compared to higher priority recommendations. Employing various tactics to help these windows seal better is certainly recommended.

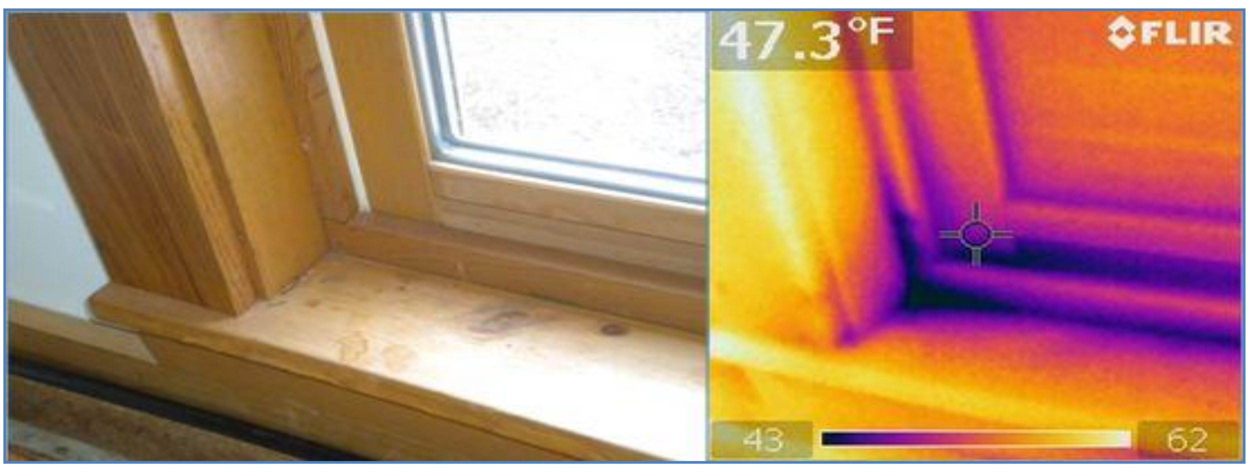


Figure 16

Recommendations:

- Weatherize all the doors and windows to ensure a good air seal when they are closed.
- Stop the air from infiltrating from around the window trim. The best method may be to temporarily remove the trim, remove the fiberglass insulation and fill the gaps with spray foam.

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.

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 and a photovoltaic (PV) array may last 40 years, 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.

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 ensure that a new and efficient heating plant provides the most savings.

If the recommended air seal and insulation work is completed, it may be necessary to provide fresh air to the building. A blower door test would determine how tight the building is as a result of the efficiency upgrades and help determine the size the ventilation equipment.
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 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 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 16.

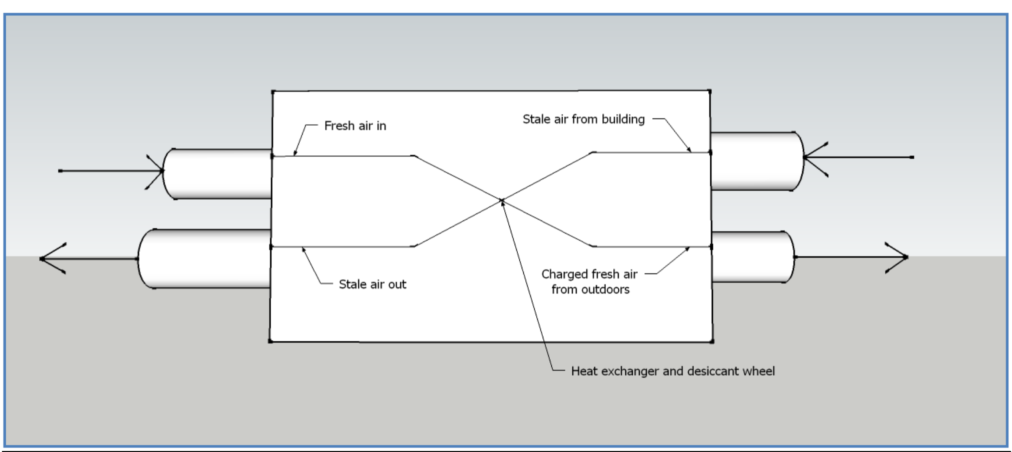


Figure 17

Mechanical:

Two different types of heating system, running on two different fuels, heat this building. The primary system is an oil-fired furnace seen in Figure 18. The second are two wall mounted propane fired space heaters, one in each of the main office spaces. See Figure 19.

Figure 18

The oil furnace has two zones, one providing heat to the community room, lavatories and kitchen. The other zone supplies hot air to the office spaces. Mechanical zone dampers work in conjunction with the two thermostats, controlling the flow of air to both zones. Zone 1 (community room) has a thermostat located outside of the mechanical room, while Zone 2 (offices) has a thermostat located in the main hall between the offices. The thermostat controlling Zone 1 is turned down substantially while the room is not in use. Though this may be a large amount of time during the heating season, it still takes quite a bit of energy to keep the space even at 55°F. The thermostat controlling Zone 2 is also kept at a lower temperature as this space is heated with the wall mounted space heaters. It is important to know that though zone dampers dramatically reduce the amount of air flowing through certain duct runs, they do not stop airflow completely. For example, during our site visit, there was a need for heat in the community room, but not for the office area, as the space heaters were adequately conditioning this space. Despite that, there was still some hot air coming from the ceiling registers in the offices. This would not be that large of an issue if the following were not true.


Figure 19


Figure 20

Almost all of the ductwork in this building is located outside of the thermal boundary in the attic space. None of the ductwork has been sealed, and a small percentage of the ductwork has any insulation. Insulation on unsealed ductwork has little positive effect. This is likely the single largest inefficiency of this building.

When entering the attic space, one of the first things we noticed is seen in Figure 20. Here we have two sections of duct that have not been sealed and are actually missing the slide that is supposed to hold them together.

Seen in Figures 21 and 22, are the supply and return trunks for Zone 2. Although the supply ducts are foil-faced bubble wrap insulated, the insulation is doing very little to stop the flow of heat because these duct have not been sealed. Because the air in the supply ducts is under positive pressures, much of this heated air that passes by the zone dampers is pushed out through all the seams of the ductwork before it reaches the office space.

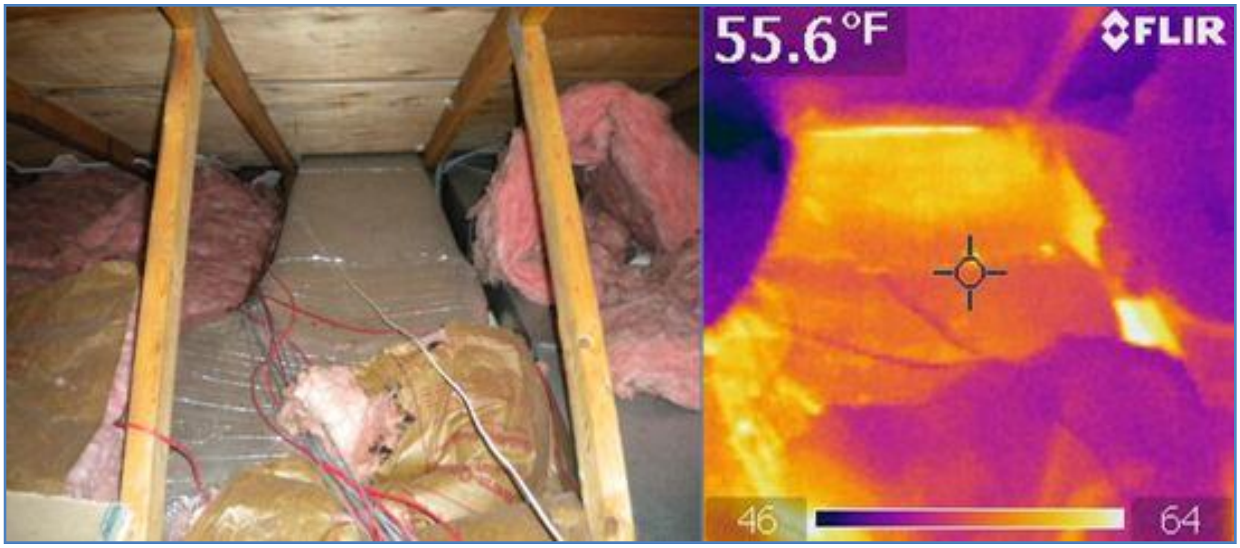


Figure 21

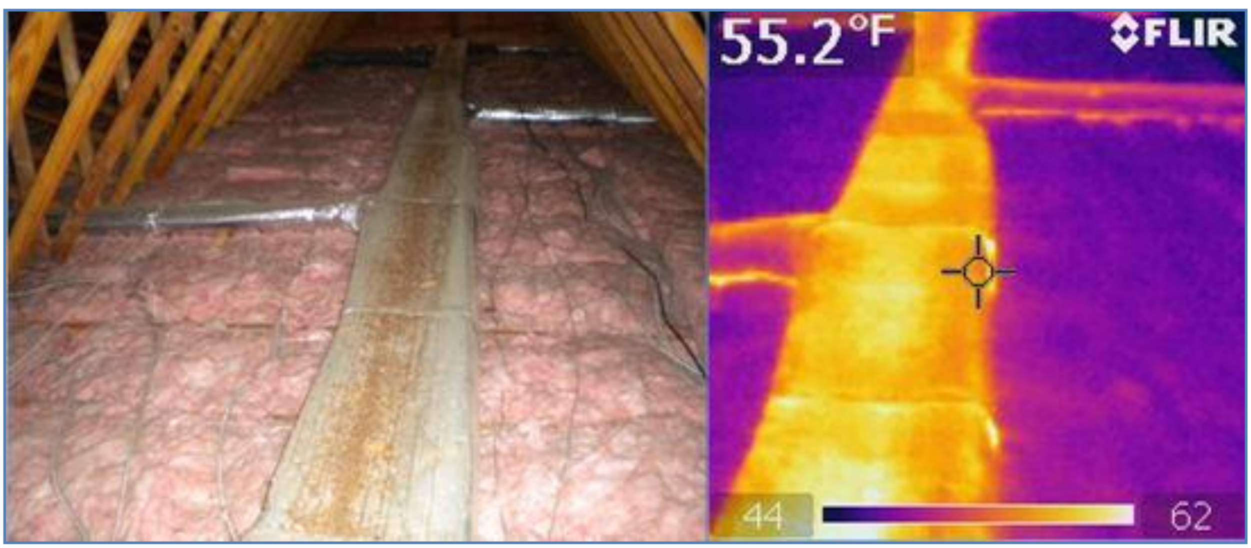


Figure 22

Figures 23 and 24 show views from the right and left sides of the Zone 1 supply air trunk. This ductwork is positioned in the well-vented attic space above the community room.

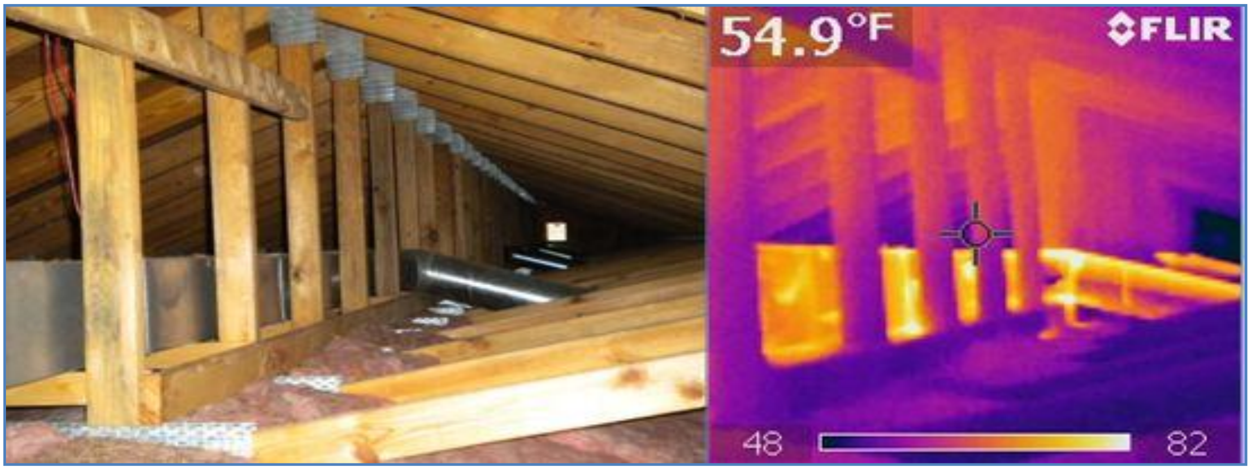


Figure 23

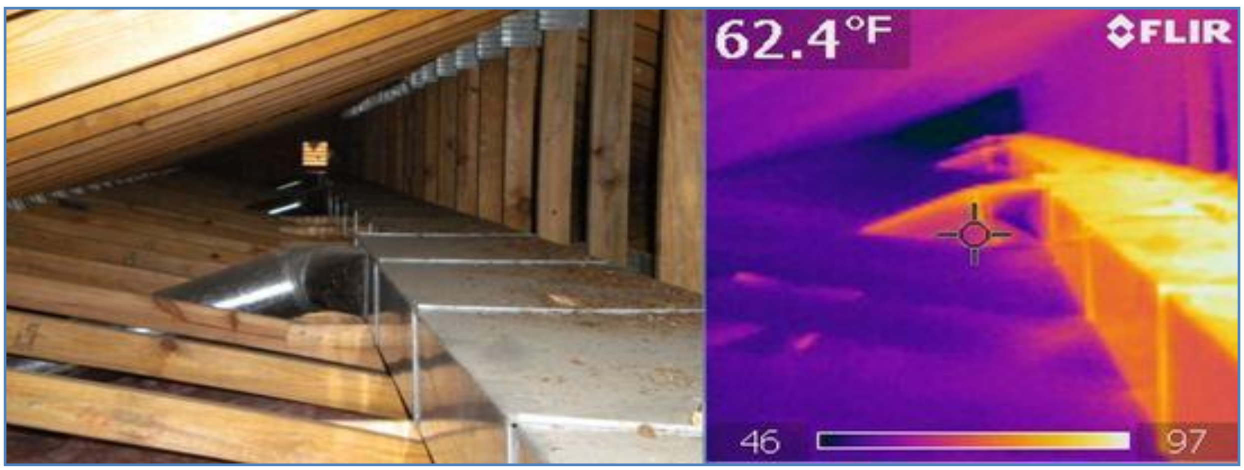


Figure 24

Unsealed, uninsulated ducts in a well-ventilated intermediate zone such as this effectively lose heat in three ways. First, the heated air in the supply ducts is under positive pressure and is forced out of the seams or separations in the ductwork. Second, return ducts are under negative pressure, sucking in cold air from the attic. This means that the normally room temperature air is being cooled before it is sent back through the heat exchanger. The third loss is that of radiant heat loss. As the heated air warms the very conductive metal duct, the heat radiates towards cold surfaces.

Air sealing and insulating all of the ductwork should be one of the first steps taken towards energy savings.

There is a propane-fired hot water heater visible in Figure 18. This unit is capable of producing a large amount of hot water and maintaining the temperature of this large tank may not be very practical given the relatively small amount of hot water use in this building. Also noted are the uninsulated hot water pipes. Though it is difficult to say how much could be saved from switching to a more efficient system, a propane-fired tankless hot water heater could yield significant savings.

There are two gas stoves side by side in the kitchen. See Figure 25. These stoves are older models and have 3 pilot lights per unit that burn propane year round. The amount of standby gas that they consume is unknown, but any amount of wasted gas provides room for improvement.

Figure 25

<u>Recommendations:</u>

- Remove any combustible materials from the mechanical room. This space should not be used as a storage closet.
- Add supply air to the mechanical room. Both the furnace and the water heater are open combustion appliances. This means that they need supply air from the room in which they are located for the combustion process to happen in a safe manner. Installing a vent on the exterior wall of the mechanical room and running ductwork from that vent to about 1 foot above the floor could accomplish this.
- Air seal and insulate all of the ductwork. The air sealing of the ducts should be done with mastic, making sure to not only seal where two section of ductwork meet, but also the horizontal seams that make up each section. The ducts should be insulated with a minimum of R-8 (installed) foil faced fiberglass duct insulation. All of these processes should be done with care and inspected by a third party Building Analyst Professional to ensure the best results. This is a project well worth doing, and therefore, well worth doing correctly.
- Have the zone dampers checked each time the heating system is service to ensure they are functioning properly. These units have moving parts and tend to need repair or replacement from time to time.
- Replace the two thermostats with 7-day programmable units to ensure maximum savings from reduced temperature settings.
- Replace the current hot water heater with a tankless LP fired system.
- Replace the two kitchen stoves with units that have an electric spark ignition system.

Electrical:

This is a typical office space with a standard number of computers, printers, copy machines, etc. The electric usage in this building is not very high and one of the easiest ways to save on electricity will be to cut power to electronics and equipment when they are not in use. Most of the equipment we noticed in the office will draw electricity even if they are turned off. Some computers may need to be accessed remotely, and therefore left on, but much of the equipment could be put on smart power strips and the electricity to this equipment disconnected during off hours.

Be aware of any items plugged into an outlet. The 2 microwaves in the kitchen may only be used once a day, but are constantly drawing a small amount of electricity. Even though they may only draw a small amount of electricity, any waste should be avoided. The combined savings from all unnecessary electrical draw is usually measurable.

This building is primarily lit with 4-foot T12 florescent tubes. This signifies opportunity for a lighting upgrade, as there are much more efficient lighting systems available. We would recommend contacting you utility provider to inquire about financing options. There is a possibility that a lighting upgrade could be performed at little or no upfront cost to the Town and the upgrade would be paid for with the resulting savings.

Recommendations:

- Put all electronics on power strips and cut the power to equipment when not in use.
- Contact the Town's utility provider to find out more about participating in the Smart Start program for a lighting upgrade.
- Whenever purchasing new electronics, always invest in the most energy efficient models available. Budgeting for a little more upfront cost will save more money over the long run.

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 they go down, budgets tend to go down. Changes result in 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 also that any increased cost is almost immediately realized through lower operating expenses. Additionally, 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 financing 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 the amount of 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 the 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:

- Remove any combustible materials from the mechanical room.
- Add supply air to the mechanical room.
- Put all electronics on power strips and cut the power to equipment when not in use.
- Whenever purchasing new electronics, always invest in the most energy efficient models available.
- Contact the Town's utility provider to find out more about participating in the Smart Start program for a lighting upgrade.
- Weatherize all the doors and windows to ensure a good air seal when they are closed.
- Air seal and insulate all of the ductwork.
- Have the zone dampers checked each time the heating system is service to ensure they are functioning properly.
- Replace the two thermostats with 7-day programmable units to ensure maximum savings from reduced temperature settings.
- Seal any passageways for air to pass between the conditioned space and the attic.
- Air seal and insulate between the top plate of the exterior walls and the proper vent. Add an additional section of proper vent to extend further towards the peak of the roof, thereby accommodating added loose fill insulation.
- Add 12 inches of loose fill cellulose to the entire ceiling area. Blow in additional amounts to the sides and top of all the ductwork (after all the duct work has been air sealed and insulated).
- Air seal any areas of infiltration from the exterior wall system. This would include, but not be limited to, electrical outlets, light switches, behind the baseboard, and window/door trim.
- Install a balanced mechanical ventilation system, preferably an ERV.
- Replace the current hot water heater with a tankless LP fired system
- Replace the two kitchen stoves with units that have an electric spark ignition system.
- Insulate around the exterior perimeter of the concrete slab.
- Super-insulate the exterior walls of the building. This should be done after all of the more easily implemented energy efficiency measures have been carried out. When ready to do this, the Town should consult with a building performance specialist to examine all the options and find the best fit for this building. The plan should incorporate continuous R-value, eliminating the extensive thermal bridging.
- Invest in alternative energy systems. Completing efficiency work first will reduce the amount of energy needed on site, thusly reducing the size and cost of alternative/renewable energy equipment.

Conclusion:

As a result of this audit, the Town has several options available to increase the efficiency of the Town Hall. We highly encourage the that the Town pursue these recommendations described in this report and to utilize the assistance provided under this program to help develop plans for implementation – including possible identification of contractors who will provide the services needed to carry out the recommendations. SDES Group will provide the Town an additional twenty-five hours of Community Energy Advocate service to assist with further efforts under the MEAP program in an effort to bring the recommendations outlined in the report to fruition.