Town of Gilmanton Old Town Hall

1800 NH 140, Gilmanton Iron Works

Level II Energy Audit

August 23, 2021

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Executive Summary

Many buildings in New Hampshire, and throughout the country, use more energy than they need to be safe and comfortable. When energy costs are low, building owners focus on other priorities. However, as energy costs become more of a burden to budgets, building owners seek solutions to reduce costs and improve the comfort of their buildings. The first important step in this process is an energy audit, which recommends cost-effective and appropriate improvements called Energy Efficiency Measures (EEMs). These EEMs are recommended to reduce energy use, but may also have other benefits including improved comfort, indoor air quality, and resiliency. The Resilient Buildings Group (RBG) team assessed the Town of Gilmanton Old Town Hall building in Gilmanton, New Hampshire and has determined there are opportunities to increase the building's energy efficiency.

This Level II Energy Audit Report intends to document energy efficiency opportunities for the Old Town Hall. It provides a thorough understanding of the building's current energy performance, the opportunities for improvement, and the costs associated with the implementation of each EEM. The report is also a tool to guide investment decisions that maximize energy reductions and minimize the building's operating costs, as well as improve overall occupant comfort.

RBG analyzed and benchmarked the energy usage of the building and compared it to buildings of similar function and type. During the site visit, RBG examined the existing conditions of the building, its shell, and all pertinent systems. This allowed RBG to understand how energy is consumed on site, to discover energy waste, and to recommend appropriate energy-saving measures to implement.

RBG selected the recommended measures to help the Town of Gilmanton Old Town Hall maximize the benefits and minimize the cost of the potential project. If the EEMs are implemented in a different order, the energy savings and the cost savings will differ from this report. Some of the recommended EEMs should be made in conjunction with others to either maximize benefits or for health/safety reasons. If the recommended EEMs are implemented with rebates, grants, or low-interest loans as outlined, this project could generate a higher return on investment and net present value. If the project receives rebates, grants, or loans lower than 5% interest and/or energy prices increase faster than 5% per year, these returns could improve.

Existing Conditions at the Town of Gilmanton Old Town Hall

Site

- **Size:** Total is 5941 ft², but the conditioned area is estimated to be 3,041 ft²
- **Sewer:** Private
- **Water:** Private
- **Year built:** The building was originally constructed in 1840
- **Building Type:** Function hall

Shell

- **Number of Levels:** Two
- **Foundation and Insulation:** The foundation is stone and granite block with a dirt floor.
- **Exterior Wall Construction and Insulation:** The exterior walls are balloon framed with 2"x4" wood studs. The exterior wall bays appear to be partially insulated with cellulose insulation.
- **Roof Type and Insulation:** The roof is wood framed with asphalt shingles. The attic is not insulated.
- **Doors and Windows:**
  - **Windows:** The building's windows are single-pane, double hung windows with exterior storm windows serving the basement and first floor. The third floor and attic windows do not have exterior storm windows.
  - **Doors:** The doors are solid wood core.

Heating, Plumbing, Ventilation, and Air Conditioning

- **Heating Fuel:** Oil
- **Heat Generation Equipment:** The museum is heated by a 117 MBH oil-fired furnace. The function hall is heated by a new, high-efficiency, propane-fired furnace.
- **Heating Controls:** The heating zones for the building are controlled by digital thermostats.
- **Domestic Hot Water (DHW):** The DHW for the building is currently heated by a 40-gallon, electrically heated tank. There are plans to install on-demand heaters in the bathrooms and to remove the existing 40 gallon unit.
- **Air-Conditioning Equipment:** None.
- **Air-Conditioning Controls:** N/A.
- **Ventilation Equipment**: None.

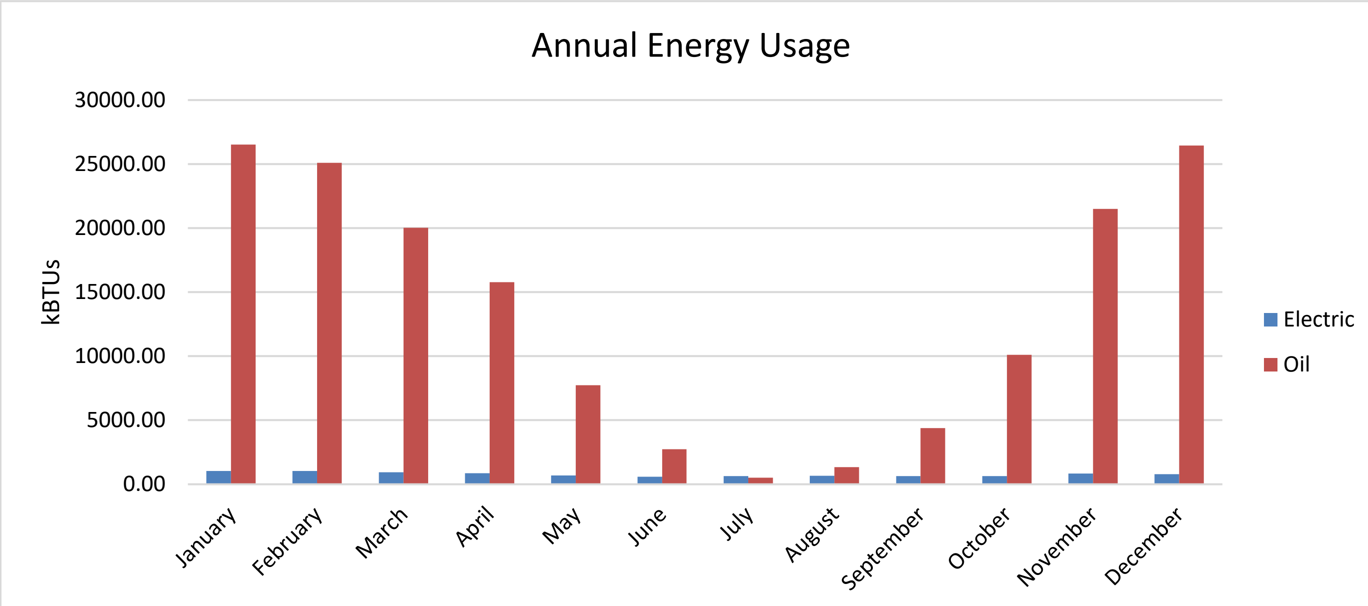
Electrical

- **Common Area Lighting Type:** The function hall lighting has been converted to LED. The museum lighting is T8 fluorescent fixtures.
  - **Lighting Controls:** The interior lighting is controlled by toggle switches.

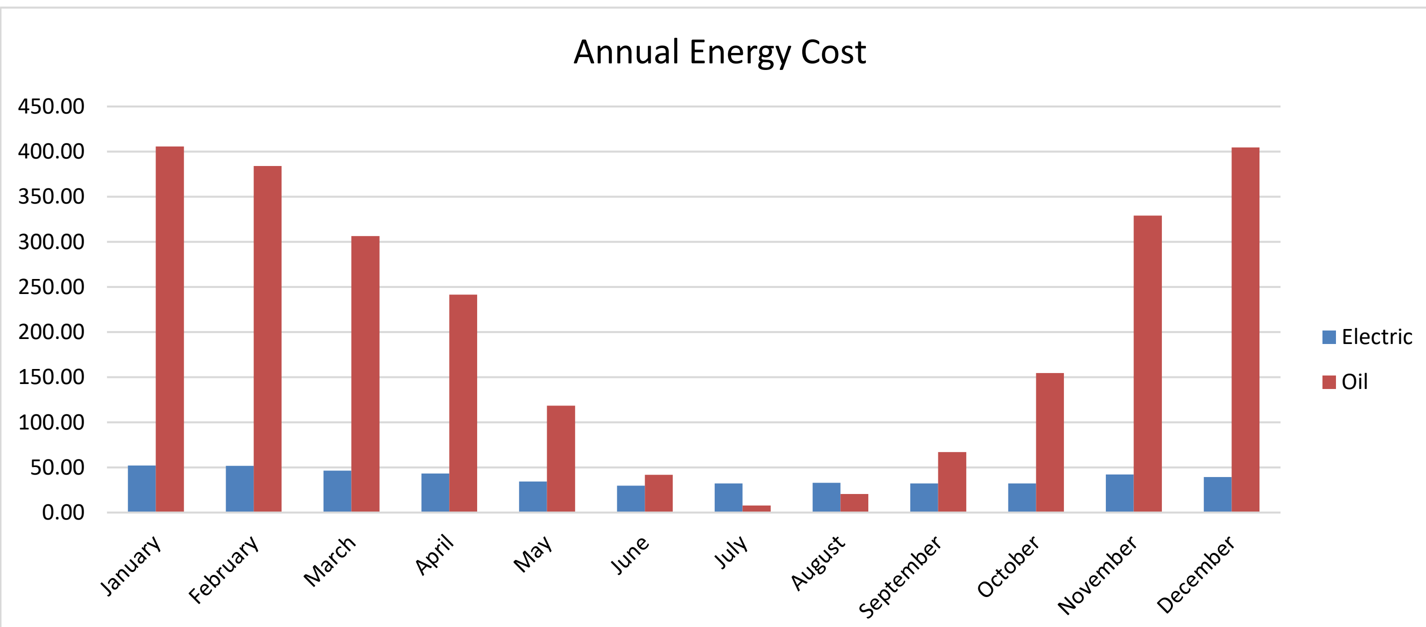
Notable Issues

- The second-floor, former Odd Fellows meeting hall is not currently used and is considered outside the thermal envelope.
- The windows are scheduled to be refurbished and new storm windows installed.
- The clapboard siding is scheduled to be scraped and painted.
- The hot water tank in the basement is scheduled to be discontinued and on-demand water heaters installed in the bathrooms.
- The dirt floor of the basement is scheduled to be covered with pea stone and covered with a vapor barrier.

Energy Usage and Cost Analysis



Using past utility bills for the town hall building, we calculated an average yearly consumption of 1,169 gallons of oil and 2,764 kWh of electricity, which translates to a total of 171,621 kBTU of energy consumed per year on average.*



The building's average energy costs are $2,481 for heating oil and $470 for electricity, which equates to a combined average of $2,951 per year. *

*Based off 2 years of electric bills and 2 years of oil bills. The analysis includes 1 building, with a conditioned area of footage of 3,041 ft². The data provided to RBG does not include the fuel switch to propane for one of the furnaces.

Preliminary Building Benchmarking

RBG analyzed the historical energy consumption of this building to calculate a Building Benchmarking rating. Building Benchmarking rates your building's performance on two metrics: Energy Use Intensity (EUI) and Cost Use Intensity (CUI).

EUI is the annual energy use in BTUs (British Thermal Units, usually displayed as kBTUs to signify thousands of BTUs) per square foot of conditioned space in the building (kBTU/SF/YR). CUI displays the annual energy cost per square foot in the building ($/SF/YR).

EUI is often split into two numbers, one providing the annual BTUs used at the site for all purposes (as used in the previous energy tables), and the other combining the site use figure with the additional BTUs required to generate and transmit electrical energy from its source. At RBG, we are chiefly interested in the source number because it provides the most accurate accounting for the total greenhouse gas emissions associated with a building's energy consumption. RBG accounted for both Site and Source kBTUs in the EUI numbers given below.

Our source EUI and CUI are calculated using the 2- year average of electric and oil use and cost data with the stated conditioned floor area of 3,041 ft^2.

Current EUI/CUI Data:	
Site EUI:	56.5 kBTU/ ft^2/Year
Source EUI:	62.63 kBTU/ ft^2/Year
CUI:	$ 0.97 / ft^2/Year

ENERGY STAR® PortfolioManager® Technical Reference

Primary Function	Further Breakdown (where needed)	Source EUI ($kBtu/ft^2$)	Site EUI ($kBtu/ft^2$)	Reference Data Source - Peer Group Comparison
Social/Meeting Hall		**109.6**	**56.1**	CBECS – Social/Meeting

The national average Source EUI for a typical social/meeting hall is 109.6 $kBtu/ft^2$/Yr and the average Site EUI is 56.1 $kBtu/ft^2$/Yr. Town of Gilmanton Old Town Hall's site EUI is higher, while it's source is significantly lower than the national average. This is the result of the building having a high heat demand and low plug load. RBG believes that investments made to lower the heating demand will be the most cost-effective.

Energy Efficiency Measures

Building Envelope

Infiltration and Insulation

A well-sealed and insulated building envelope is an essential element to create a high-performance building and can make a tremendous difference in comfort. Investment in measures to achieve such an envelope will reduce costs in building construction and operation. In a well-sealed and insulated building, heat systems can be smaller and therefore less expensive and less fuel intensive.

The *Energy Impact of Air Leakage in US Office Buildings* study prepared by the Building and Fire Research Laboratory in Maryland, analyzed nationwide infiltration levels. They found that infiltration - when outdoor air leaks into and out of buildings - is responsible for about 15% of the total annual heating load of the typical building. Heating loads rise from heat loss due to ventilation, conduction, and infiltration; all of which depend on Delta T (ΔT). Delta T is the difference between the indoor and outdoor temperatures. However, cooling loads are also heavily impacted by internal heat gains and solar gains, which do not always depend on ΔT between indoor and outdoor temperatures.

Building Envelope Recommendations:

- **B1: Air Sealing.** As noted above, the windows are scheduled to be rehabbed and storm windows installed to improve their performance and preserve their historic character. At the same time, the window assembly air tightness could be improved by removing the window weights and sealing those cavities with spray foam or dense pack cellulose. The floor of the former Odd Fellows Hall (first floor ceiling) is currently part of the primary air barrier, therefore the door at the bottom of the stairs to the second floor should be replaced with an insulated and weather-stripped door and the unused registers in the floor should be blocked and sealed. The foundation walls should be repointed and cracks sealed.

- **B2: Insulate Attic.** The attic is currently uninsulated and presents an excellent opportunity to install new insulation and reduce heat loss through this space. The floor of the former Odd Fellows Hall below the attic (pictured at right) is the current thermal boundary in order to reduce the heated volume. Should the Odd Fellows Hall return to useable, function space RBG recommends insulating the true attic to at least R60.

Figure 1. Uninsulated attic proper

- **B3: Insulate Walls.** There is evidence of cellulose insulation in the crawlspace, which suggests an attempt was made to insulate the walls, however some walls appear completely empty. Since the clapboards are scheduled to be scraped, repaired, and painted, now would be a good opportunity to remove a row of clapboards above and below windows on both floors and install dense pack cellulose in the wall cavities. This will improve the thermal resistance of the walls as well as provide an air sealing benefit.

Figure 2. Uninsulated wall cavity

- **B4: Foundation walls.** The foundation walls and rim and band joist throughout the original basement are not insulated. After the foundation walls are repointed and cracks sealed, the rim and band joist should be insulated with high-density, rockwool batt insulation. The basement floor is scheduled to be treated with crushed stone and a robust ground, vapor barrier. RBG recommends installing a dimple mat barrier from the sill plate to the basement floor. The ground, vapor barrier should be installed and secured on top of the dimple matt to create a continuous barrier down the wall and across the floor. After the dimple matt and vapor barrier are joined, RBG recommends installing 3" of closed cell spray foam the full height of the foundation walls, covering the seam between the vapor barrier and dimple matt. This assembly would be removable if necessary, without compromising the historic nature of the foundation walls.

Figure 3. Dimple mat (https://crawlspace-diy.com/)

- **B5: Crawlspace.** The floor of the museum is above a crawlspace and is insulated with fiberglass batt insulation that is falling. RBG recommends removing a section of flooring to access the crawlspace to remove the fiberglass batt insulation and install netting and dense pack fiberglass.

- **B6: Storm Windows.** Install new storm windows to serve the third-floor windows. This will air seal the building, as well as preserve the windows from further water damage. RBG also recommends installing a new double-glazed window in the bathroom to replace the existing jalousie window.

Mechanical System

Once the building envelope is improved, the next step is to address the necessary mechanical improvements. High-efficiency heating, cooling, and ventilating systems, especially when reduced to a size appropriate to the needs of the improved building, can make an immediate difference in expenditures for heating and electricity. Improved piping and ducting systems for distributing heated and cooled air, fresh air, and water throughout the building ensures energy is delivered to the end-use areas with less waste and less cost. Tighter buildings have less infiltration of unconditioned outside air and may need high-performance ventilation systems to provide fresh air to occupants. While this may be an addition to the mechanical systems of some buildings and may add a small amount of electrical use, modern-day ventilators recover up to 80% of the replaced air's heat, thus creating a thermal savings. The result is a more comfortable and productive building; something well worth the additional cost.

The mechanical systems in any building – heating, cooling, ventilating, and plumbing – are the biggest users of fuels and electricity. For the building owner to save energy and money, it is essential that the building's need for all those services be reduced as much as possible. That means making the building envelope as resistant to the loss of conditioned (heated or cooled) air and the gain of excess outside air as is economically feasible.

Mechanical Recommendations:

- **M1: Mechanical Ventilation.** RBG recommends replacing the bathroom exhaust fans and venting them to the exterior. RBG recommends occupancy sensors or time delay switches that are tied to the operation of the bathroom lights. The sensors and delay switches trigger the bathroom exhaust fans to run while the spaces are occupied and for a set period (typically 10-20 minutes) after the fan is turned off or the bathroom is unoccupied.

- **M2: Duct Work.** The seams of the remaining, un-insulated ductwork in the basement should be sealed then the ductwork should be insulated with R8 duct insulation.

- **Replace the Oil Furnace.** The existing oil fired furnace is nearing the end of its service lifetime. RBG proposes two options for replacing the unit. Additionally, at 117 MBHs, the furnace is significantly oversized for the space.
    - **Option A: Propane Furnace.** Replace the oil furnace serving the museum with a new propane unit that has a minimum efficiency of 96%. Although more expensive than oil per Btu, propane burns cleaner at a higher efficiency.

- **Option B: Air Source Heat Pump.** Replace the existing oil furnace with a ducted heat pump system. A ducted heat pump could meet the space's heating needs, while also providing the space with A/C and dehumidification.

Electrical System

Improving electrical systems includes analyzing the electrical demands, or the loads, in a building – lighting, appliances, computers, the electrical portion of the operation of mechanical equipment, etc. – and devising ways to reduce their requirements for energy and make them more efficient. Installation of all demand reduction techniques should be implemented first.

After envelope and mechanical improvements, installing high-performance, efficient electricity using devices, remains as a high priority in any building retrofit. The cheapest kilowatt hour is the one you do not need to buy.

Electrical Recommendations:

- **E1: Replace Refrigerator.** Remove the old refrigerator and install a new Energy Star Certified unit.
- **E2: LED Lighting.** Convert lighting in the museum to LED fixtures. These are the only lights in the building to receive enough hours to justify the investment.

Financial Modeling Results

The following table identifies each EEM's projected cost, **estimated** annual energy savings and costs savings, simple payback, internal rate of return, and net present value.

The building's energy use was modeled using the EQUEST energy modeling program to estimate energy use, which include breakdowns and energy savings from the recommended EEMs. Cost estimates were derived from several sources: RS Means construction estimating tools, actual contractor estimates, and RBG staff with field knowledge of installed work.

Energy Efficiency Measures

Assumptions :	Electric		Fuel Oil		Propane*		Total	
Baseline Energy Usage:	2,764	kWH	409	Gallons	1,154	Gallons	171,917	kBTU
Baseline Energy Cost:	$470	Cost	$867	Cost	$1,893	Cost	$3,230	Cost
Baseline Unit Cost:	$0.17	($/kWh)	$2.12	($/Gal)	$1.64	($/Gal)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Air Sealing	$6,480	$148	8,615	43.7	2.3%	($2,137)
B2	Insulate Attic Space	$2,800	$151	8,237	18.6	8.2%	$1,431
B3	Insulate Walls - Above Grade	$20,450	$307	17,200	66.5	0.0%	($11,113)
B4&B5	Insulate Foundation & Floor Joists	$7,790	$188	10,436	41.4	2.6%	($2,298)
B6	Install New Storm Windows & Replace Jalousie Window	$11,000	$144	8,052	76.6	-0.7%	($6,570)

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M2	Insulate / Air Seal Ductwork	$1,200	$53	3,281	22.6	6.7%	$302
M3A	Condensing Propane Furnace - Museum	$6,200	$241	18,455	25.7	5.7%	$665
M3B	Air Source Heat Pump - Museum	$7,000	$259	16,724	27.0	5.4%	$384

EEM #	Electric System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lighting	$400	$86	1,719	4.7	26.3%	$1,950

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
All Measures with M3A	**$56,320**	**$1,330**	**$76,175**	**42.33**	**2.5%**	**($17,435)**
All Measures with M3B	**$57,120**	**$1,348**	**$74,444**	**42.37**	**2.5%**	**($17,716)**

IRR and NPV assume a 5% inflation rate and a 5% Cost of Capital. Many of these EEMs could qualify for Utility Rebates & Tax Credits.

***Propane usage for the new furnace was calculated using an eQuest energy model.**

Next Steps

With the completion of this detailed Level II Energy Audit of the Town of Gilmanton Old Town Hall, the building managers should consider potential next steps to take advantage of the energy saving and comfort improving opportunities presented in this report. This Level II Report provides direction and guidance as you design and implement the renovation plans.

To achieve the projected energy savings, the managers must pay careful attention to the proper design and installation of the selected EEMs.

It should be noted that the estimated project costs shown in this report are limited to hard construction costs. The owners should be aware of project design fees and a contingency for unforeseen conditions are not included in the presented estimates but may be required to successfully complete the implementation of the EEMs.

The building examined in this report is an important physical asset and the energy use has significant economic and environmental implications. Proceeding to implement EEMs presents opportunities to reduce costs, improve comfort, and reduce environmental impacts. Please let RBG know if you have any questions about moving forward. RBG would also be able to assist the Town of Gilmanton Old Town Hall in obtaining rebates through the NHSaves program.

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