RESILIENT BUILDINGS
GROUP
Superior energy performance

Town of Gilmanton Public Safety Complex

297 NH 140, Gilmanton

Level II Energy Audit

August 23, 2021

Prepared by: *Resilient Buildings Group*, Inc.

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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 Public Safety Complex 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 safety building. 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 Public Safety Complex 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 Public Safety Complex

Site

- **Size:** 7106 ft²
- **Sewer:** Private
- **Water:** Private
- **Year built:** The building was originally constructed in 2010
- **Building Type:** Police station and fire station

Shell

- **Number of Levels:** One and one half.
- **Foundation and Insulation:** The foundation is poured concrete, slab-on-grade. The foundation footings are insulated with 2" of rigid insulation that provides a thermal resistance of R-12.
- **Exterior Wall Construction and Insulation:** The exterior walls are constructed of 2"x6" wood studs 16" on center with R-19 fiberglass batt insulation. The knee walls of the storage space and the garage are insulated with R11 fiberglass batt insulation.
- **Roof Type and Insulation:** The roof is a wood truss with asphalt shingles. The garage ceiling is insulated with R60 blown cellulose. The eave space ceiling above the offices is insulated with R50 blown cellulose. The ceiling above the storage space is insulated with R30 fiberglass batt insulation.
- **Doors and Windows:**
    - **Windows:** The building's windows are double-pane, casement windows with an estimated U-value of 0.28.
    - **Doors:** Most of the doors are insulated, metal doors.
    - **Garage overhead doors:** The overhead garage doors are insulated and in good condition.

Heating, Plumbing, Ventilation, and Air Conditioning

- **Heating Fuel:** Propane
- **Heat Generation Equipment:** The offices are heated by two propane fired, high efficiency furnaces. These furnaces are original to the building's construction and have a tested efficiency of 95%, which is ideal for a fossil fuel burning unit. The garage bays are heated by unit heaters with an estimated efficiency of 86%.
- **Heating Controls:** The heating zones for the building are controlled by digital thermostats.
- **Domestic Hot Water (DHW):** The DHW for the building is heated by a 50-gallon, propane-fired, sealed combustion, direct vent tank.
- **Air-Conditioning Equipment:** Two condensing units provide cooling for the offices. These units are both ten years old and both have a rated SEER of 16.

- **Air-Conditioning Controls:** The air conditioning is controlled by digital thermostats.
- **Ventilation Equipment**: The bathrooms are equipped with spot ventilation. The fire department garage is equipped with tail-pipe exhaust fans. The police department garage is equipped with an exhaust fan linked to the operation of the overhead door.

Electrical

- **Common Area Lighting Type:** The lighting in the police department is LED. The lights in the fire department garage are T5 fluorescent fixtures. The fire department offices are T8 fluorescent fixtures.
    - **Lighting Controls:** The interior lighting is controlled by toggle switches. The garage lights are on occupancy sensors. The exterior lights are controlled by a timer set for each season.

Notable Issues

- There is not a continuous air barrier on the ceiling of the storage areas.
- The condensate pan for one of the air handlers in the fire department storage area was full of water at the time of the audit. It appears the pump may not be operating as intended.
- The police department's garage exhaust fan was not operational at the time of RBG's site visit. RBG recommends fixing this as soon as possible.
- Condensate drains from the condensing propane furnaces and hot water heater did not have neutralizing filters during RBG's site visit. It is important to run condensate through a neutralizer because it is highly acidic. The high acidity levels can damage both the sewage system and the natural environment.

Blower Door Testing

Blower Door Information

An effective building envelope provides a barrier between the outside and inside air while retaining a high percentage of the energy used to condition the inside air (heating or cooling energy). This is achieved only when the envelope is well insulated and a continuous air barrier is implemented. The best way to properly investigate the current condition of a building envelope or shell is to perform a full blower-door test. The blower-door test quantifies the amount of uncontrolled outside air that enters the building through cracks, gaps, and poorly sealed penetrations, etc. Shell shortcomings, such as a lack of air sealing and lack of insulation, further compromise the temperature of the indoor air which the owner has paid to condition (heat or cool).

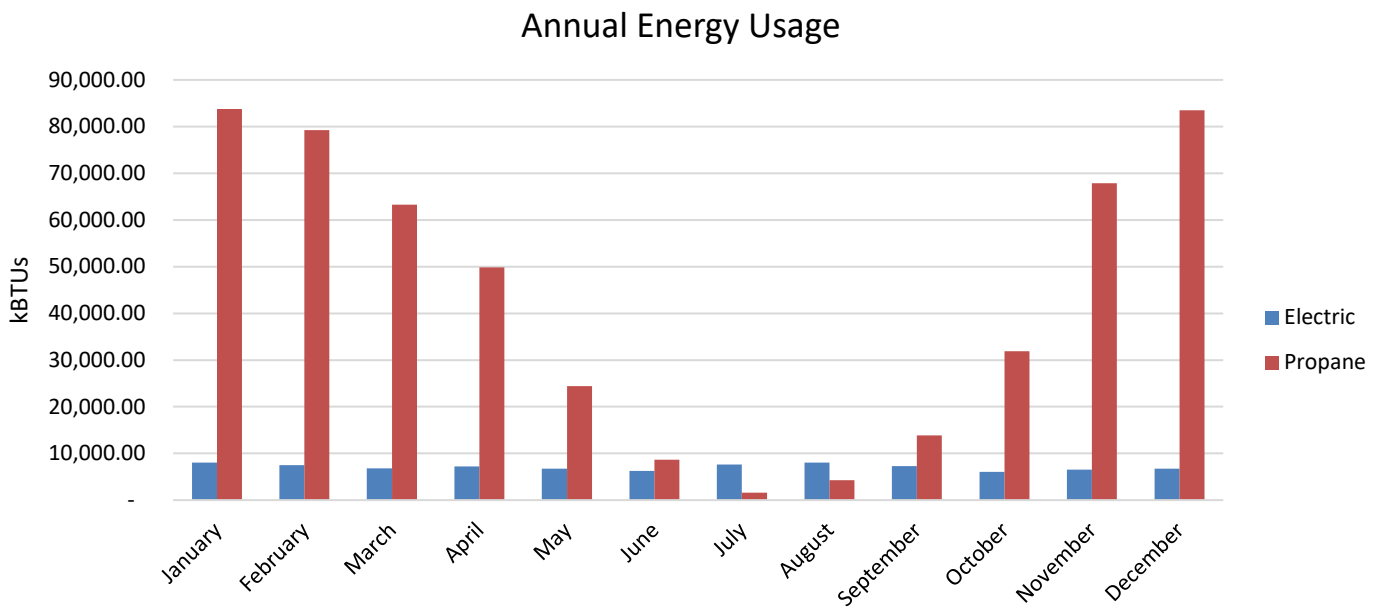
Blower door testing creates a measurable building pressure and airflow that allows us to evaluate a building's air leakage. ACH50 is the number of Air Changes per Hour at -50 pascals (created by the fan). CFM50 is the cubic feet per minute of air being pulled into the building while it is depressurized to 50 pascals. These values allow for comparison of the leakiness of different sized buildings.

Volume Ft^3	CFM @ -50 pascals	ACH_{50}
80,640 ft^3	**4,518 CFM**	**3.36**

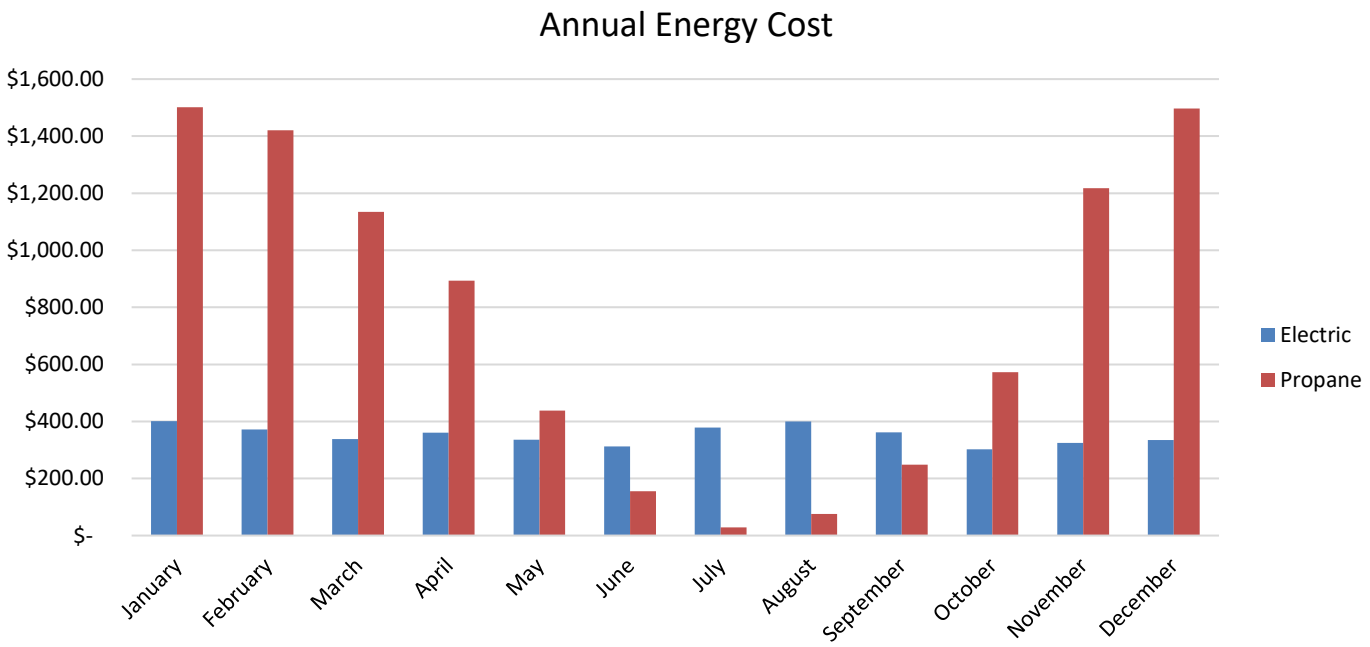
Goal:	**3.0**

RBG conducted the Blower Door Test on the Gilmanton Safety Complex. The findings of the blower door test suggest that the building is well air-sealed. However, there is still room to improve the air barrier, which will lower the building's carbon foot print and its operating expenses

Energy Usage and Cost Analysis



Using past utility bills for the garage, we calculated an average yearly consumption of 5,607 gallons of propane and 24,818 kWh of electricity, which translates to a total of 569,789 kBTU of energy consumed per year on average.*



The building's average energy costs are $9,182 for propane and $4,219 for electricity, which equates to a combined average of $13,401 per year. *

*Based off 2 years of electric bills and 2 years of propane bills.

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 2-year average of propane use and cost data with the stated conditioned floor area of 8,160 ft².

Current EUI/CUI Data:	
Site EUI:	73.13 kBTU/ ft²/Year
Source EUI:	93.89 kBTU/ ft²/Year
CUI:	$ 1.64 / ft²/Year

ENERGY STAR® PortfolioManager® Technical Reference

Primary Function	Further Breakdown (where needed)	Source EUI (kBtu/ft²)	Site EUI (kBtu/ft²)	Reference Data Source - Peer Group Comparison
Police Station		**124.9**	**63.5**	CBECS – Fire Station/Police Station

The national average Source EUI for a typical repair service building is 124.9 kBtu/ft²/Yr and the average Site EUI is 63.5 kBtu/ft²/Yr. Town of Gilmanton Public Safety Complex's Site EUI is below the national average, which shows that the building has a low plug load and high heat demand per square foot. This is largely the result of consistently low occupancy rates in the building.

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.** Blower door testing indicated substantial air leakage from the storage area. RBG recommends sheet rocking the ceiling of the storage areas. Weather-stripping should be installed on the doors from the office spaces to the garages, including the door to the storage space. RBG recommends air sealing duct, wiring, and plumbing penetrations through the ceiling plane. RBG recommends replacing the removable plywood panel to the storage eave space with a framed, insulated door.

- **B2: Insulate Attics.** The knee walls between the storage space and the eave spaces and the garage and the eave spaces are insulated with R11 fiberglass. RBG recommends installing 2” polyisocyanurate rigid insulation over the existing insulation. This will bring the total thermal resistance to R23 and will stop thermal bridging through the wall studs. The attic above the storage area should be insulated with an additional 10 inches of blown cellulose. This will bring the total thermal resistance to at least R60.

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: Replace Hot Water Heater.** If solar PV is not installed, when the existing propane fired hot water heater reaches its end of life, replace it with an on-demand propane fired unit. This will reduce the standby losses associated with the keeping and storing domestic hot water.

  If the Safety Complex installs solar PV behind its meter, consider replacing the domestic hot water's fuel source to electricity.

- **M2: Insulate Hot Water Lines.** Insulate the hot water lines with R-6 pipe wrap. This is a relatively in-expensive way for the safety complex to reduce its domestic hot water load.

- **M3: Electrification.** If the town continues to pursue solar PV, shift the building's primary heat source from propane to an electric based system. RBG recommends switching the building's fuel source to electricity when the existing mechanical equipment has reached the end of its service life (roughly 10 more years). To do so, replace the furnaces with ducted heat pumps that have a minimum SEER of 21 and a minimum COP of 3.5. Additionally, replace the garage unit heaters with infrared units.

  The cost and savings of this measure includes replacing the hot water heater to an electric fired unit.

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:** RBG recommends replacing the T8 fluorescent fixtures with LED fixtures. RBG recommends LED fixtures because they will have a longer lifetime, as opposed to swapping out just the bulbs. Upgrading the lights to LED units will also reduce the energy required to light the Building by over 50%.

Figure 1: Example LED Fixture.

Renewable Energy

The use of renewable energy to meet buildings' thermal and electrical needs is expanding rapidly. Incentives are now in place at the federal, state, and even some local government levels. Any building upgrade project under consideration today should take advantage of the opportunities presented by renewable energy technologies including: stabilizing energy supply costs, reducing the environmental impact of the greenhouse gas emissions from buildings, and cost savings.

A key goal for RBG in building upgrade projects is to recommend and help implement measures that will dramatically reduce a building's reliance on fossil fuels. Renewable resources can help building owners achieve independence from fossil fuels.

- **R1: Photovoltaic Array.** Install a roof-mounted 20 kW PV array on the building's roof. This array is projected to generate 25,438 kWh/year assuming the installation of high-efficiency panels. The Public Safety Building consumes an average of 24,818 kWh per year, which means the proposed PV system would generate approximately 100% of the building's average annual electric usage.

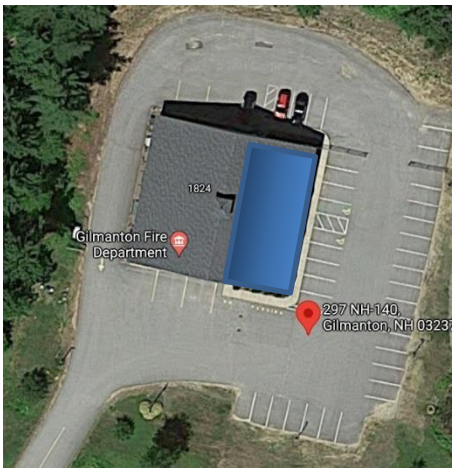


Figure 2. Proposed PV array

The cost and output of the PV Array is estimated using NREL's PVWatts calculator and project costs that RBG has been involved in. These numbers are strictly estimates.

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		Propane		Total Energy per Year	
Baseline Energy Usage:	24,818	kWH	5,607	Gallons	598,547	kBTU
Baseline Energy Cost:	$4,219	Cost	$9,182	Cost	$13,401	Cost
Baseline Unit Cost:	$0.17	($/kWh)	$1.64	($/Gallon)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Air Sealing	$4,500	$341	16,082	13.2	11.2%	$5,006
B2	Insulate Attic	$6,080	$578	30,816	10.5	13.6%	$9,929

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M1	Replace Hot Water Heater	$4,300	$42	2,348	102.5	-2.2%	($2,954)
M2	Insulate DHW Lines	$350	$83	4,672	4.2	28.8%	$1,938
M3	Electrification	$35,000	-$5,528	185,685	N/A	N/A	($183,742)

EEM #	Electrical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lights	$3,500	$626	12,563	5.6	22.7%	$13,699

EEM #	Renewable System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
R1	20 KW PV System	$50,000	$4,080	81,888	12.3	12.0%	$63,400

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
RBG Recommended Project (B1, B2, M2, & E1)	**$14,430**	**$1,629**	**64,132**	**8.86**	**15.7%**	**$30,572**
RBG Recommended Project With Renewables (B1, B2, M2, E1, & R1)	**$82,430**	**$8,506**	**202,159**	**9.69**	**14.6%**	**$152,939**
RBG Recommended Project With Electrification & Renewables (B1, B2, M2, M3, E1, & R1)	**$99,430**	**$181**	**331,705**	**549.30**	**-9.2%**	**($89,770)**

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.

Next Steps

With the completion of this detailed Level II Energy Audit of the Town of Gilmanton Public Safety Complex, 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 Public Safety Complex in obtaining rebates through the NHSaves program.

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