Gilmanton Energy Audit Summary Page

Energy Usage Analysis

Building	Site EUI (kBTU/Ft^2/Year)	Source EUI (kBTU/Ft^2/Year)	CUI
GIW Fire Station	73.6	104.8	$2.31
Public Safety Complex	73.1	93.89	$1.64
Old Town Hall	56.6	62.3	$0.97
Waste Transfer Station	28.4	85.1	$1.41
Public Works	11.0	33.2	$0.55

The energy analysis shows that the GIW Fire Station and Public Safety buildings are the highest energy consumers per square foot. RBG recommends focusing efforts on improving these two buildings.

Potential Energy Efficiency Measures Identified

Weatherization Projects

Building	Measure	Estimated Cost	Annual Cost Savings	Payback (Years)
DPW Building	Air Sealing	$1,200	$295	4.1
Transfer Station	Air Sealing	$600	$145	4.2
GIW Fire Station	Air Sealing	$1,200	$972	9.8
Public Safety Building	Insulate Attic	$6,080	$578	10.5
Transfer Station	Insulate Walls	$1,400	$137	10.2
Transfer Station	Insulate Roof	$3,200	$274	11.7
Public Safety Building	Air Sealing	$4,500	$341	13.2
DPW Building	Simple Saver System	$8,600	$481	17.9
Old Town Hall	Insulate Attic Space	$2,800	$151	18.6
GIW Fire Station	Insulate Roof	$25,600	$982	18.8
Old Town Hall	Insulate Foundation	$7,790	$188	41.4
Old Town Hall	Air Sealing	$6,480	$148	43.7
Old Town Hall	Insulate Walls	$20,450	$307	66.5
Old Town Hall	Storm Windows	$11,000	$144	76.7

Lighting Projects

Building	Measure	Estimated Cost	Annual Cost Savings	Payback (Years)
DPW Building	LED Lights	$3,600	$822	4.4
Old Town Hall	LED Lights	$400	$86	4.7
Transfer Station	LED Lights	$3,640	$705	5.2
GIW Fire Station	LED Lights	$7,600	$1,378	5.5
Public Safety Building	LED Lights	$3,500	$626	5.6

Mechanical Projects

Building	Measure	Estimated Cost	Annual Cost Savings	Payback (Years)
Public Safety Building	Insulate Domestic Hot Water Lines	$350	$83	4.2
DPW Building	Electric Baseboard Heater	$800	$223	3.6
Transfer Station	Heat Pump System	$6,300	$801	7.9
GIW Fire Station	M2B - Heat Pump System	$13,000	$1,411	9.2
Old Town Hall	M3 – Heat Pump System (for museum)	$7,000	$259	27.0

Solar PV Projects

Building	Measure	Estimated Cost	Annual Cost Savings	Payback (Years)
GIW Fire Station	35 KW PV System	$87,502	$8,050	10.9
DPW Building	23 KW PV System	$57,000	$5,161	11.1
Public Safety Building	20 KW PV System	$50,000	$4,080	12.3
Waste Transfer	22 KW PV System	$55,000	$4,818	11.4

RESILIENT BUILDINGS GROUP
Superior energy performance

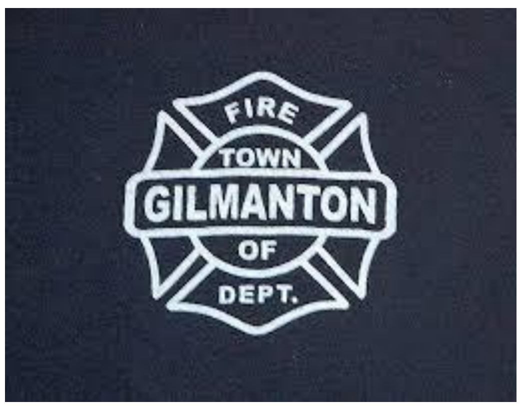
Town of Gilmanton Iron Works Fire Department

1824 NH 140, Gilmanton Iron Works

Level II Energy Audit

August 23, 2021

Prepared by: *Resilient Buildings Group*, Inc.



Town of Gilmanton Iron Works Fire Dept 1824 NH 140 Gilmanton Iron Works, NH 03837	**Resilient Buildings Group, Inc.** 6 Dixon Ave, Suite 200 Concord, NH 03301 (603) 226-1009

Contents

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 Iron Works Fire Dept. 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 fire department. 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 Iron Works Fire Dept. 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 Iron Works Fire Dept.

Site

- **Size:** 8,100 ft²
- **Sewer:** Private
- **Water:** Private
- **Year built:** The front bays of the building were originally constructed in 1972. The rear of the building was added in 1992.
- **Building Type:** Fire station and dormitory

Shell

- **Number of Levels:** Two
- **Foundation and Insulation:** The foundation is poured concrete, slab-on-grade.
- **Exterior Wall Construction and Insulation:** The exterior walls are constructed of metal studs with metal siding. The exterior walls of the garage bays are insulated with 1" polystyrene rigid insulation. The exterior walls of the rear addition (offices and dormitory) are insulated with 2" fiberglass batt, vinyl wrapped insulation with a thermal resistance of r-19.
- **Roof Type and Insulation:** The roof over both sections of the building is metal frame with corrugated metal panels. The roof is insulated with 6" fiberglass batt, vinyl wrapped 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. There is an aluminum-framed, glass door to the public entrance/vestibule
  - **Garage overhead doors:** The overhead garage doors are insulated and in good condition.

Figure 1. Exteror insulation of garage

Figure 2. Roof insulation above dormitory

Heating, Plumbing, Ventilation, and Air Conditioning

- **Heating Fuel:** Oil and propane
- **Heat Generation Equipment:** The building is heated by a 305 MBH oil-fired boiler. Baseboard distributes the heat in the first-floor offices and second-floor dormitory. The hydro-air duct system supplies heat to the garage bays.
- **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 40-gallon, propane-fired, atmospherically vented tank.
- **Air-Conditioning Equipment:** There are 7, portable, window air conditioning units in place.
- **Air-Conditioning Controls:** The air conditioning is controlled at each unit.
- **Ventilation Equipment**: The bathrooms are equipped with spot ventilation. The bathrooms do not appear to be vented to the exterior. The electric dryer is not vented to the exterior.

Electrical

- **Common Area Lighting Type:** The building's interior lighting primarily consists of T8, 2'x4' troffers.
    - **Lighting Controls:** The interior lighting is controlled by toggle switches. The exterior lights are controlled by a timer set for each season.

Notable Issues

- The window air conditioners appear to run at their maximum cooling capacity, whenever they are turned on.
- Protocol dictates the garage bays are maintained at 62 degrees throughout the winter.
- The bathroom exhaust fans are under performing and do not appear to be vented to the exterior. The dryer is not vented to the exterior.
- RBG believes that it is important to maintain a strong air barrier between the garage and office/dormitory spaces. Even though the town is installing a new point source exhaust system, we still recommend all penetrations through the wall between the offices and garage bay be sealed and the doors between those spaces weather-stripped.

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.

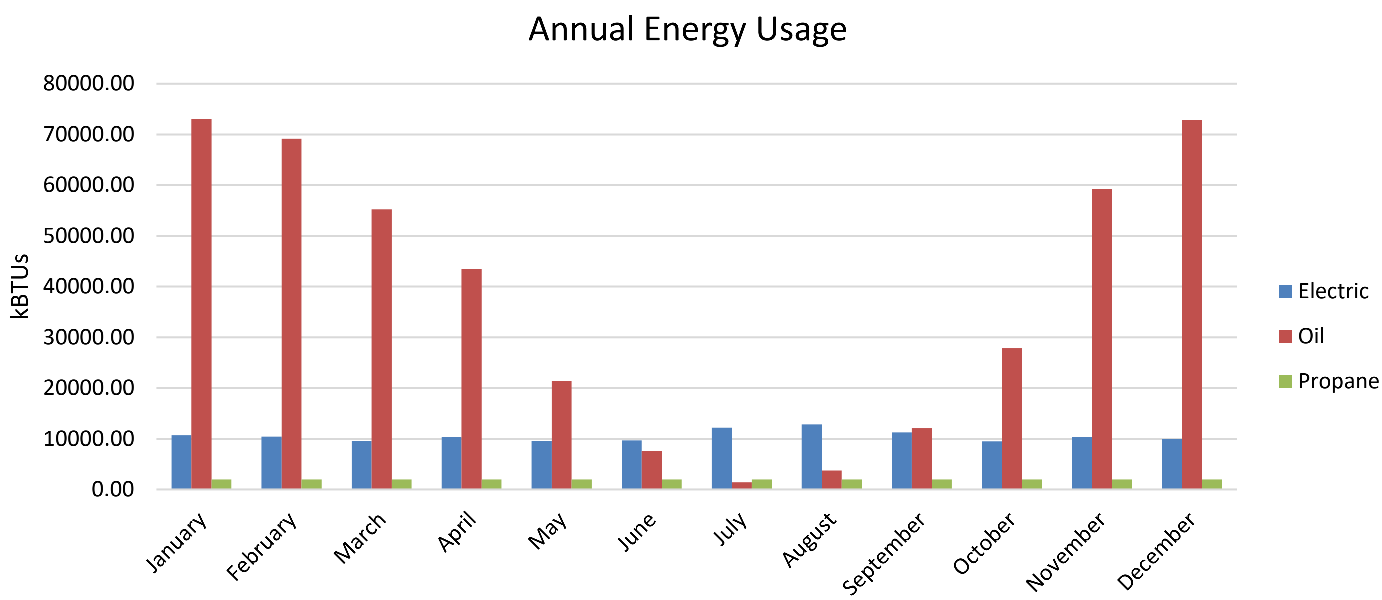
Blower Door Testing

Volume Ft^3	CFM @ -20 pascals	ACH_{50}
108,000 ft^3	12,029 CFM	6.7

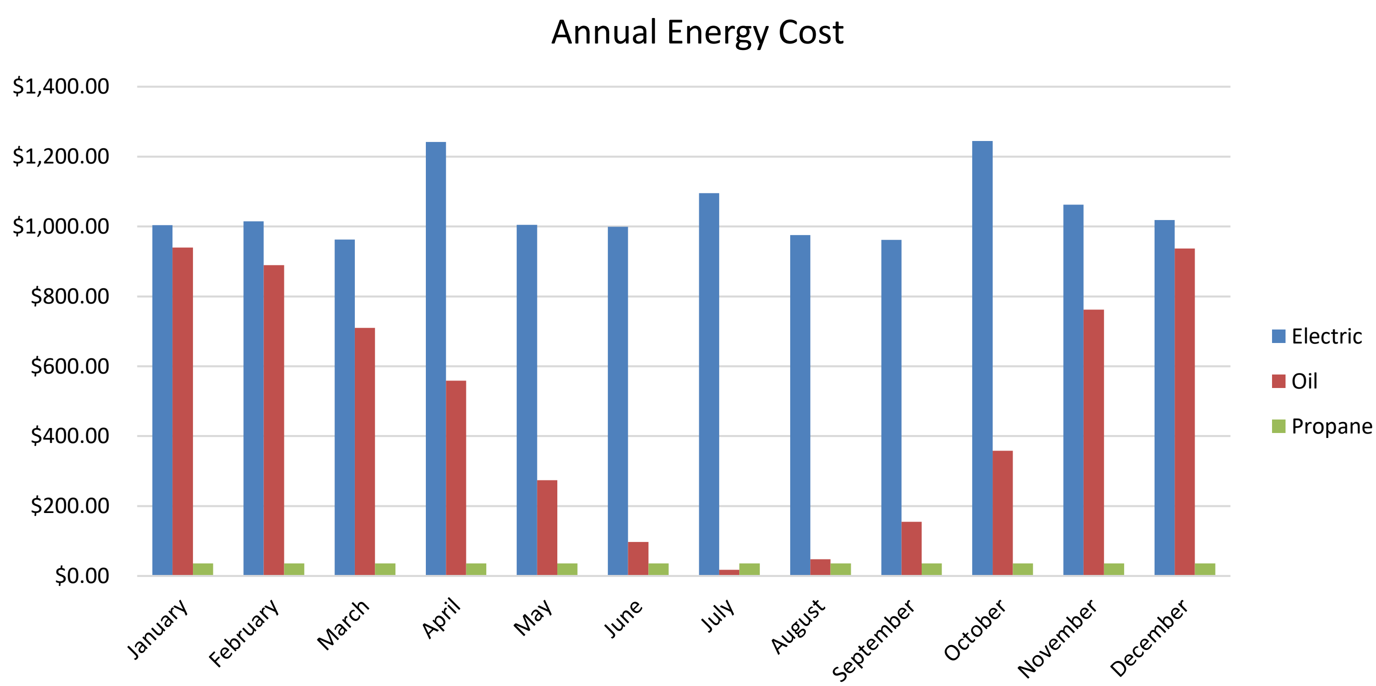
Goal:	3.0

RBG conducted a Blower Door Test on the Iron Works Fire Department. The findings of the blower door test suggest that there is ample room to air seal the building and reduce the amount of air infiltration through the envelope. The main source of air leakage through the space is cause by the lack of an air barrier in the attic space.

Energy Usage and Cost Analysis



Using past utility bills for the garage, we calculated an average yearly consumption of 3,222 gallons of heating oil, 258 gallons of propane for domestic hot water and 37,015 kWh of electricity, which translates to a total of 596,878 kBTUs of energy consumed per year on average.*



The building's average energy costs are $5,747 for oil, $430 for propane and $12,585 for electricity, which equates to a combined average of $18,762 per year. *

*Based off 2 years of electric, oil and 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, oil, and propane use and cost data with the stated conditioned floor area of 8,100 ft^2.

Current EUI/CUI Data:	
Site EUI:	73.6 kBTU/ ft^2/Year
Source EUI:	104.8 kBTU/ ft^2/Year
CUI:	$ 2.31 / 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
Fire Station		**124.9**	**63.5**	CBECS – Fire Station/Police Station

The national average Source EUI for a typical fire station is 124.9 kBtu/ft^2/Yr and the average Site EUI is 63.5 kBtu/ft^2/Yr. The Town of Gilmanton Iron Works Fire Dept.'s Source EUI is less and its Site EUI is higher than the national average. What stands out the most in these metrics is the CUI. RBG considers any CUI above $1 as high. At $2.31, the fire station has an astronomically high operating cost. We are confident that investments made to improve the building's efficiency will dramatically lower its annual operating costs.

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.** The penetrations through the roof above the dormitory and the between the dormitory attic storage space and the roof system of the front bays should be sealed. We recommend continued weather-stripping maintenance to all exterior doors and windows, along with other shell penetrations to prevent infiltration. This should be recognized as an annual maintenance task, as continual maintenance of weather stripping is needed on high-use doors.

- **B2: Spray foam attic and garage roof.** The storage attic roof and garage roof is insulated with R19 fiberglass batt insulation. RBG recommends installing 3" of closed cell spray foam on the underside of garage roof and apply intumescent paint. This will increase the total R-value to R-40.

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. The exhaust fans and dryer should be hard piped to the exterior through the roof or wall. These measures are important to maintain healthy indoor air quality by exhausting warm, moist air to the exterior. High humidity can potentially lead to mold growth and respiratory irritants.

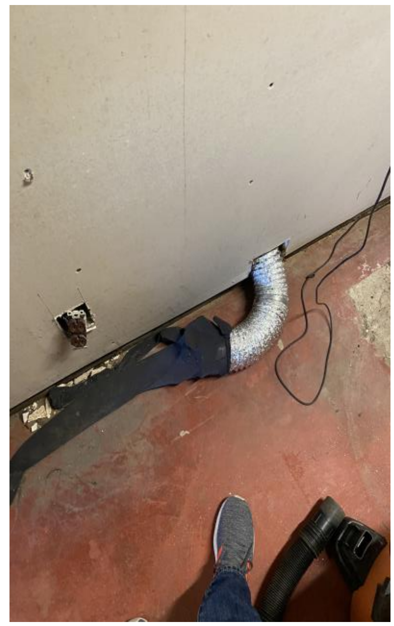


Figure 3. Dryer not vented to exterior

- **M2: Air Source Heat Pump System.**
    - **Option A: Cooling Only Heat Pumps.** The presence of multiple window air conditioners presents an opportunity to replace them with high-efficiency heat pumps. Ductless heat pumps will improve the air-tightness of the building envelope, while significantly reducing the amount of energy needed to cool the building.
    - **Option B: Heating and Cooling Heat Pump System.** Leave the existing hydro-air system in place as a backup and install a ductless heat pump system to heat and cool the office, gym, and dormitory spaces. This option would effectively electrify the rear of the building, which can be an economically sound decision if the electricity is sourced from a renewable system.

Furthermore, RBG recommends that the garage space continue to be heated with the fossil fuel based hydro air system or an infrared radiators rather than a heat pump system. This is because it is too leaky by nature for a heat pump system to effectively heat it.

- **M3: New Propane Boiler.** If the town prefers to keep a fossil fuel-based heating system than the fuel source oil to propane because it burns more efficiently than oil. If so, at the end of the existing boiler's service life, replace it with a new condensing propane unit. Be sure that the new unit has a minimum AFUE rating of at least 96.

  If the boiler is replaced to a high-efficiency unit, remove the propane fired domestic hot water heater and replace it with an indirect fired storage tank. This is a cost-effective way to improve the efficiency of the domestic hot water heater.

- **M4: Infrared Heaters in Garage.** When the existing boiler reaches the end of its service life and the Town wishes to electrify the building, install electric infrared heaters in the garage space. These are more efficient than air based systems in garages because they heat up surfaces rather than air. This ensures that the heat stays within the space even when the garage doors are opened.

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 Refrigerators.** The refrigerator in the break room appears to be 24 years old. The refrigerator in the dormitory kitchen appears to be 26 years old. Replacing both refrigerators with new Energy Star appliances would result in significant energy savings.

- **E2: LED Lighting.** RBG recommends replacing the T8 fluorescent fixtures with LED fixtures. We recommend LED fixtures because they will have a longer lifetime, as opposed to swapping out just the bulbs.

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.

Figure 4. Proposed PV array

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 35 kW PV array on the building's roof. This array is projected to generate 45,080 kWh/year assuming the installation of high-efficiency panels. The building consumes an average of 37,015 kWh per year, which means the proposed PV system would generate approximately 120% of the building's average annual electric usage.

  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		Oil		Propane		Total Energy per Year	
Baseline Energy Usage:	37,015	kWH	3,222	Gallons	258	Gallons	596,801	kBTU
Baseline Energy Cost:	$6,292	Cost	$5,747	Cost	$430	Cost	$12,469	Cost
Baseline Unit Cost:	$0.17	($/kWh)	$1.78	($/Gallon)	$1.67	($/Gallon)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Insulate Roof	$25,600	$982	61,795	18.8	1.8%	($9,862)
B2	Air Sealing	$1,200	$972	93,393	9.8	26.8%	$6,006

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M2A	Heat Pump System (Cooling Only)	$10,000	$900	18,073	11.1	13.0%	$14,976
M2B	Heat Pump System (Heating and Cooling)	$13,000	$1,411	212,699	9.2	15.2%	$26,006
M3	New Propane Boiler	$15,000	-$395	71,451	N/A	N/A	($25,034)
M4	Infrared Heaters in Garage	$7,200	-$236	45,254	N/A	N/A	($13,267)

EEM #	Electrical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lighting	$7,600	$1,378	27,651	5.5	23.0%	$30,247
E2	Replace Refrigerators	$1,300	$220	4,424	5.9	21.8%	$4,760

EEM #	Renewable System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
R1	35 KW PV System	$87,502	$8,050	151,554	10.9	13.2%	$135,723

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
RBG Recommended Project – (B1,B2, M2B, E1 & E2)	**$48,700**	**$3,805**	**$289,997**	**12.80**	**11.5%**	**$57,157**
RBG Recommended Project With Renewables	**$136,202**	**$11,855**	**$441,551**	**11.49**	**12.6%**	**$192,880**

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 Iron Works Fire Dept., 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 Iron Works Fire Dept. in obtaining rebates through the NHSaves program.

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Town of Gilmanton Old Town Hall

1800 NH 140, Gilmanton Iron Works

<u>Level II Energy Audit</u>

August 23, 2021

Prepared by: *Resilient Buildings Group*, Inc.

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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.

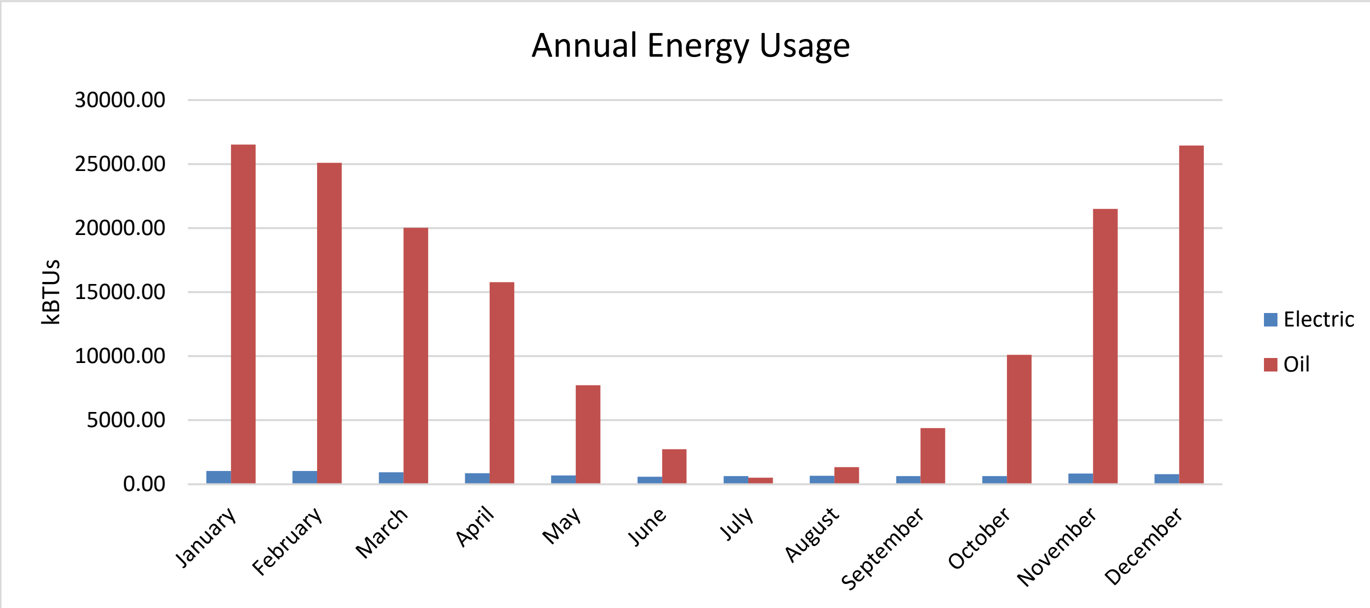
Electrical

- **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.

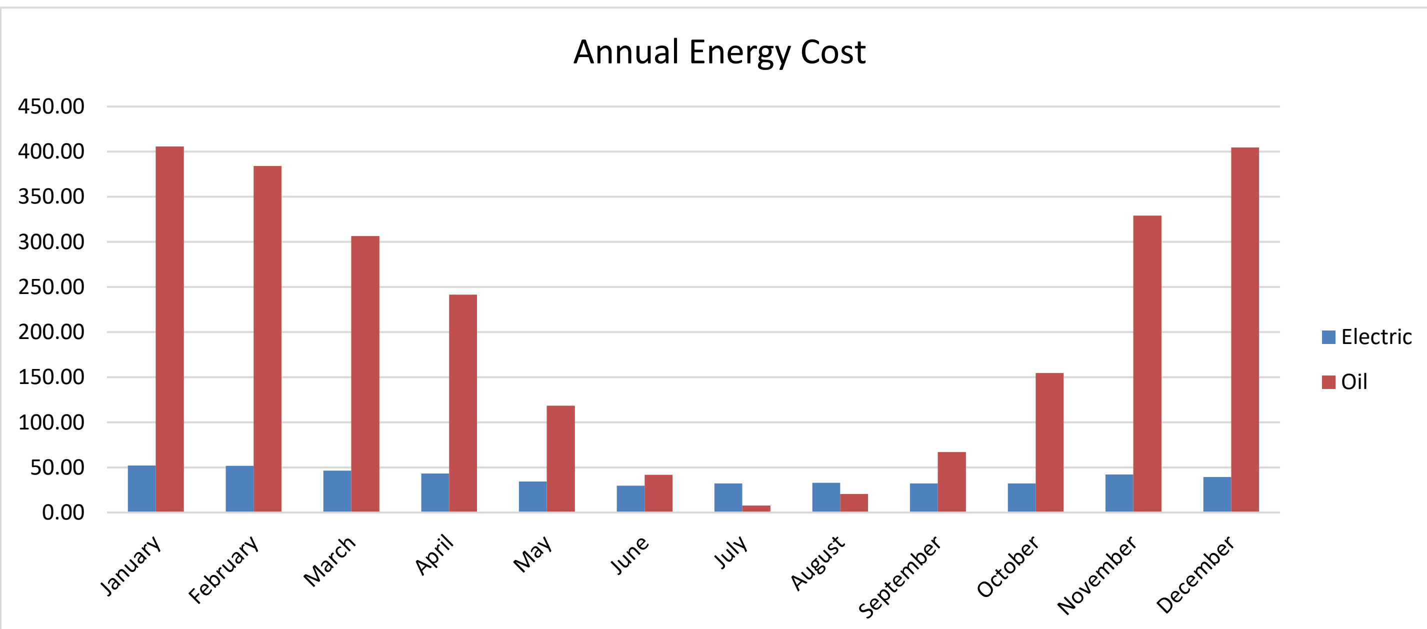
Notable Issues

- 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.

Figure 1. Uninsulated attic proper

- **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.

- **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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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.

Town of Gilmanton Public Safety Complex 1824 NH 140 Gilmanton Iron Works, NH 03837	**Resilient Buildings Group, Inc.** 6 Dixon Ave, Suite 200 Concord, NH 03301 (603) 226-1009

Contents

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).

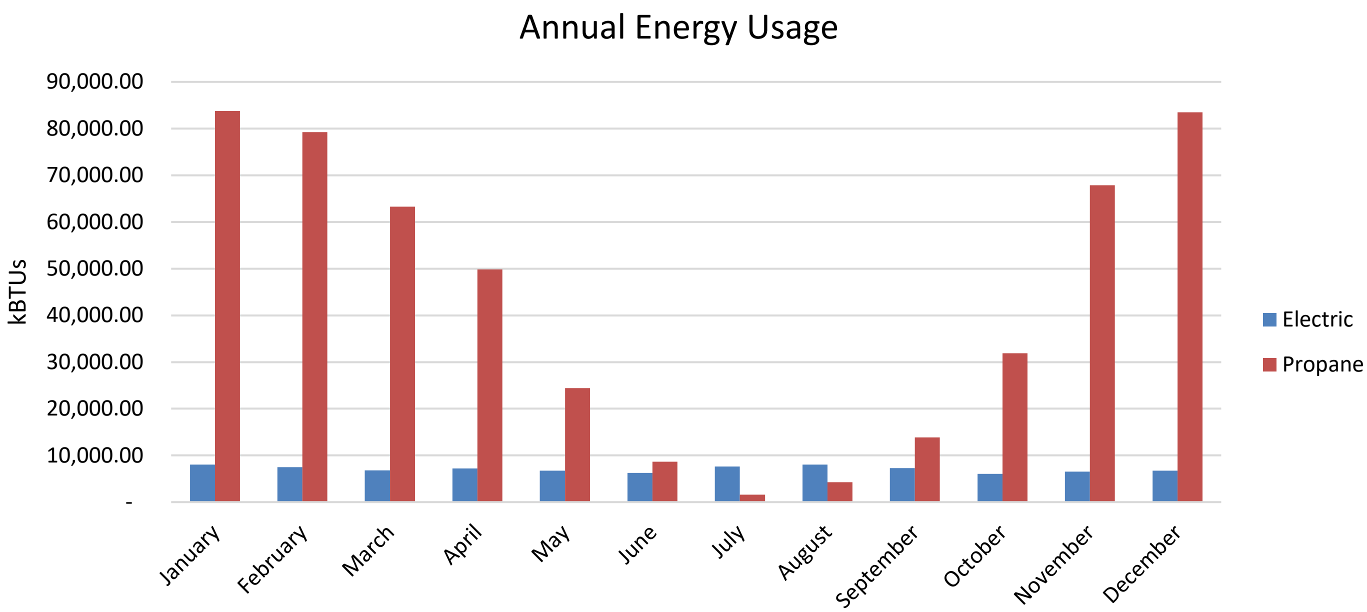
Blower door testing creates a measurable building pressure and airflow that allows us to evaluate a building’s air leakage. ACH50 is the number of Air Changes per Hour at -50 pascals (created by the fan). CFM50 is the cubic feet per minute of air being pulled into the building while it is depressurized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

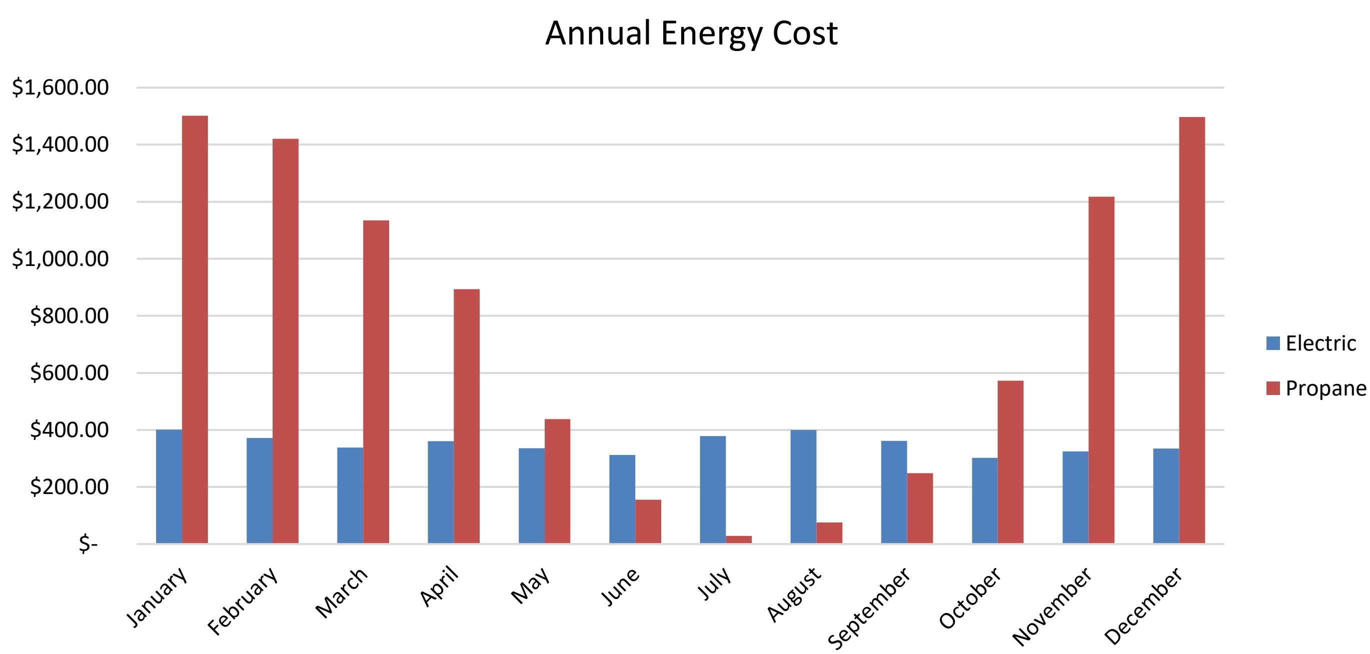
Goal:	3.0

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 inexpensive 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.

Resilient Buildings Group, Inc.

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Town of Gilmanton Department of Public Works

770 Stage Rd, Gilmanton

Level II Energy Audit

August 23, 2021

Prepared by: *Resilient Buildings Group*, Inc.

Town of Gilmanton Department of Public Works 270 Stage Rd Gilmanton, NH 03237	**Resilient Buildings Group, Inc.** 6 Dixon Ave, Suite 200 Concord, NH 03301 (603) 226-1009

Contents

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 Dept. of Public Works 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 garage. 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 Dept. of Public Works 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 Dept. of Public Works

Site

- **Size:** 3,620 ft²
- **Sewer:** Septic system
- **Water:** Private
- **Year built:** The building was originally constructed in 1996.
- **Building Type:** Garage

Shell

- **Number of Levels:** One
- **Foundation and Insulation:** The foundation is poured concrete, slab-on-grade.
- **Exterior Wall Construction and Insulation:** The exterior walls are constructed of 2”x6” metal studs. The walls are insulated with R-19 fiberglass insulation.
- **Roof Type and Insulation:** The roof is metal frame with a metal roof. The roof is insulated with R-19 fiberglass batts.
- **Doors and Windows:**
  - **Windows:** The office windows are double-pane, casement windows with an estimated U-value of 0.28.
  - **Doors:** The door to the office is an insulated metal door with glass window.
  - **Overhead doors:** The overhead doors are uninsulated steel units.

Heating, Plumbing, Ventilation, and Air Conditioning

- **Heating Fuel:** Waste oil
- **Heat Generation Equipment:** The garage is heated by a 235,000 Btuh oil-fired furnace.
- **Heating Controls:** The waste oil furnace is controlled by mercury, bi-metal thermostat.
- **Domestic Hot Water (DHW):** The DHW for the building is heated by a 40 gallon, electric storage tank.
- **Air-Conditioning Equipment:** None.
- **Air-Conditioning Controls:** N/A.
- **Ventilation Equipment**: The bathroom is equipped with an exhaust fan that is vented to the exterior.

Electrical

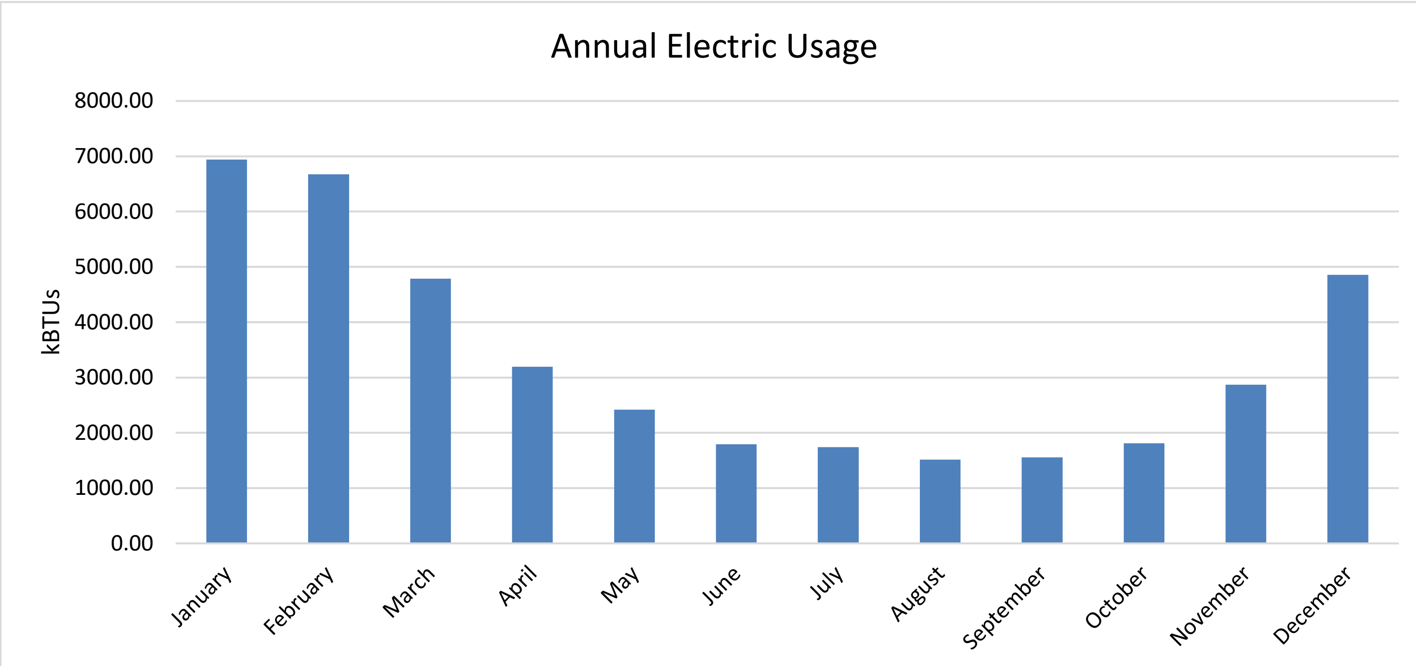
- **Common Area Lighting Type:** The building’s interior lighting is T8 fluorescent tube fixtures.
  - **Lighting Controls:** The interior lighting is controlled by toggle switches.

Notable Issues

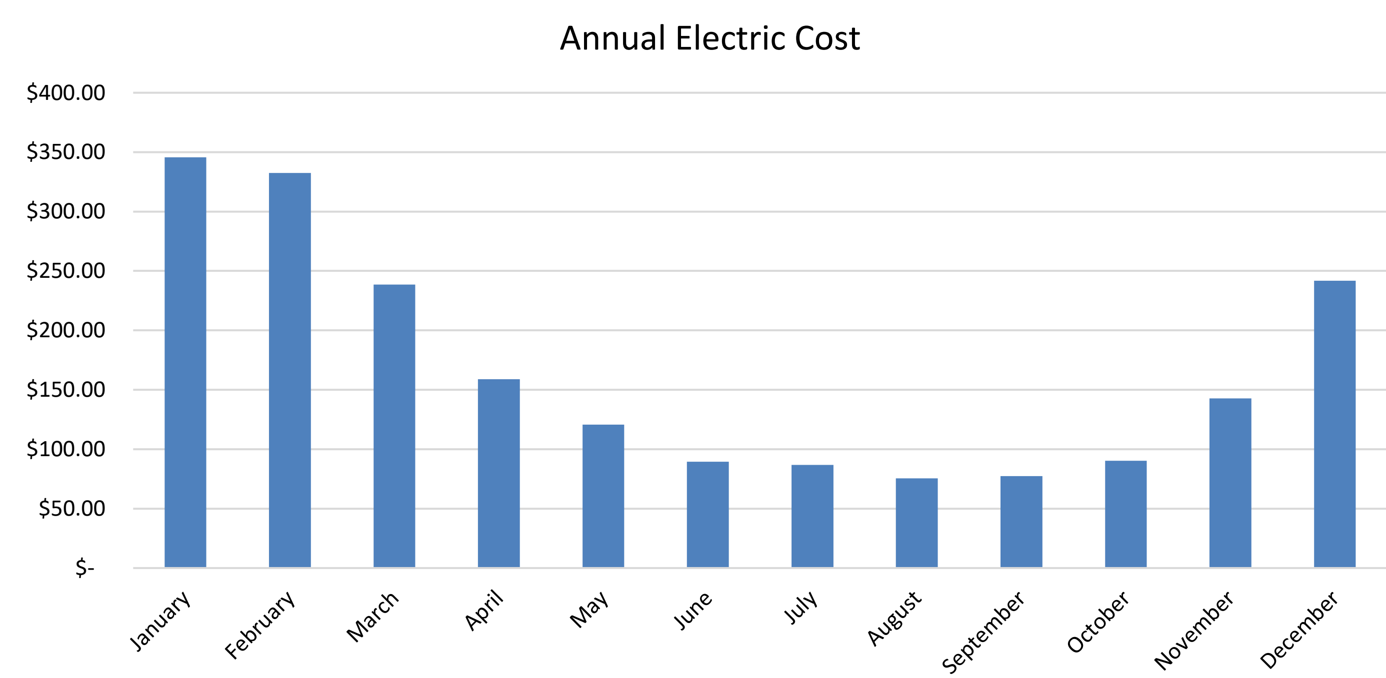
- The chimney serving the waste oil furnace appears to be filling up with creosote and should be cleaned.

- The lighting schedule is 40 -70 hours per week during the winter and 25 – 30 hours per week in the summer.

Energy Usage and Cost Analysis



Using past utility bills for the garage, we calculated an average yearly consumption of 11,768 kWh of electricity, which translates to a total of 40,154 kBTU of energy consumed per year on average. RBG was not able to calculate the fuel consumption because the garage is heated with waste oil as it becomes available.*



The building's average energy costs are $2,000 per year for electricity. The waste oil does not cost the town any money. *

*Based off 2 years of electric bills. The analysis includes 1 building, with a total square footage of 7,488 ft².

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 with the stated conditioned floor area of 3,620 ft^2.

Current EUI/CUI Data:	
Site EUI:	11.0 kBTU/ ft^2/Year
Source EUI:	33.2 kBTU/ ft^2/Year
CUI:	$ 0.55 / 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
Other	Other Public Services	89.3	40.1	CBECS - Other

The national average Source EUI for a typical public service building is 89.3 kBtu/ft^2/Yr and the average Site EUI is 40.1 kBtu/ft^2/Yr. Town of Gilmanton Dept. of Public Works' Source and Site EUIs is significantly lower because it does not include the heating oil consumption. However, we still believe the building's energy performance can be improved.

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.** The exterior door to the office should be weatherized. The weather-stripping around the overhead doors is deteriorated and should be replaced with heavy duty brush seals.

- **B2: Insulate Roof and Walls.** The existing insulation appears to be typical 6" vinyl backed fiberglass. RBG recommends increasing the insulation level to fill the space between the existing insulation and the perlins.

  Consider using a product like the Simple Saver warehouse insulation system. For price quotes, contact Thermal Design.

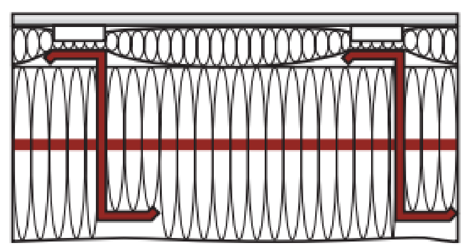


Figure 1: Example Insulation retrofit
(Thermal Design, Inc, 2018)

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: Electric Baseboard.** The office is heated with a portable electric space heater. We recommend installing baseboard electric heat tied to a programable thermostat. This will heat the space more evenly and accurately, as well as allow for setbacks during unoccupied hours.

- **M2: Infrared Heaters.** There is no economic reason to invest in a new heating system for the building if the waste oil burner works, and the town can secure free waste oil. However, if the town does source most of its electric consumption from solar PV, an electric based heating system should be considered for the building.

  If solar PV is installed, RBG recommends installing electric infrared heaters in the garage to heat the space. Infrared heaters are more efficient in garages than air systems because they heat surfaces, not air space. This means that garage doors can be opened and closed without losing excess heat.

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: LED Lights**. RBG recommends replacing the T8 lights with LED fixtures. When possible, the light fixtures should be operated by multiple switches to customize task lighting specific areas of the garage. This will further reduce the building's electric load.

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 23 kW PV array on the building's roof. This array is projected to generate 30,431kWh/year assuming the installation of high-efficiency panels. The garage building consumes an average of 11,768 kWh per year, which means the proposed PV system would generate approximately 258% of the building's existing average annual electric usage. This PV array would supply enough electricity to power the building if its fuel source was switched to electricity.

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 With Estimated Oil Usage and Cost*

Assumptions :	Electric		Oil		Total Energy per Year	
Baseline Energy Usage:	11,768	kWH	1,396	Gallons	233,723	kBTU
Baseline Energy Cost:	$2,001	Cost	$2,792	Cost	$4,792	Cost
Baseline Unit Cost:	$0.17	($/kWh)	$2.00	($/Gallon)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Air Sealing	$1,200	$295	15,558	4.1	29.6%	$6,896
B2	Simple Saver System	$8,600	$481	31,407	17.9	8.5%	$4,907

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M1	Electric Baseboard Heater	$800	$223	4,481	3.6	32.9%	$5,313
M2	Infrared Heaters	$6,000	-$2,931	-58,821	N/A	N/A	($85,461)

EEM #	Electric System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lights	$3,600	$822	16,503	4.4	27.8%	$18,945

EEM #	Renewable System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
R1	23 KW PV System	$57,500	$5,161	103,593	11.1	13.0%	$85,686

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
RBG Recommended Package (B1, B2, M1, E1)	**$14,200**	**$1,822**	**67,948**	**7.79**	**17.4%**	**$36,061**
RBG Package with Renewable System	**$71,700**	**$6,984**	**171,541**	**10.27**	**13.9%**	**$121,747**

***Usage based off an eQuest Energy Model and the cost is based off an assumption of $2/gallon of waste oil**

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.

Energy Efficiency Measures with Free Waste Oil Heat*

Assumptions :	Electric		Oil		Total Energy per Year	
Baseline Energy Usage:	11,768	kWH	1,396	Gallons	233,723	kBTU
Baseline Energy Cost:	$2,001	Cost	$0	Cost	$2,001	Cost
Baseline Unit Cost:	$0.17	($/kWh)	$2.00	($/Gallon)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Air Sealing	$1,200	$100	15,558	12.0	12.2%	$1,579
B2	Simple Saver System	$8,600	$40	31,407	214.9	-5.5%	($7,102)

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M1	Electric Baseboard Heater	$800	$223	4,481	3.6	32.9%	$5,313
M2	Infrared Heaters	$6,000	-$2,931	-58,821	N/A	N/A	($85,461)

EEM #	Electric System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lights	$3,600	$822	16,503	4.4	27.8%	$18,945

EEM #	Renewable System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
R1	23 KW PV System	$57,500	$5,161	103,593	11.1	13.0%	$85,686

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
RBG Recommended Package (B1, B2, M1, E1)	**$14,200**	**$1,186**	**67,948**	**11.98**	**12.2%**	**$18,736**
RBG Package with Renewable System	**$71,700**	**$6,347**	**171,541**	**11.30**	**12.8%**	**$104,421**

*** Usage based off an eQuest Energy Model and the cost is based off an assumption of $0/gallon of waste oil**

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 Dept. of Public Works, 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 Dept. of Public Works in obtaining rebates through the NHSaves program.

Rebates, grants, and low-interest loans often affect the financial results of energy related improvements. As these opportunities often change, we have not included these advantages in our financial results. Efforts to define their availability should be made when the decision to implement the recommended energy measures is made.

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RESILIENT BUILDINGS
GROUP
Superior energy performance

Town of Gilmanton Transfer Station

284 Province Rd, Gilmanton

Level II Energy Audit

August 23, 2021

Prepared by: *Resilient Buildings Group*, Inc.

Town of Gilmanton Transfer Station	Resilient Buildings Group, Inc.
284 Province Rd Gilmanton, NH 03237	6 Dixon Ave, Suite 200 Concord, NH 03301 (603) 226-1009

Contents

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 Transfer Station 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 transfer station. 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 Transfer Station 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 Transfer Station

Site

- **Size:** 3,224 ft²
- **Sewer:** Septic system
- **Water:** Private
- **Year built:** The building was originally constructed in 2003.
- **Building Type:** Transfer Station

Shell

- **Number of Levels:** One
- **Foundation and Insulation:** The foundation is poured concrete, slab-on-grade.
- **Exterior Wall Construction and Insulation:** The exterior walls are constructed of 2"x4" wood studs. The walls appear to be insulated with R-11 fiberglass batt insulation.
- **Roof Type and Insulation:** The roof is wood frame trusses with a metal roof. The bailing room and storage room roof is not insulated. The office and bathroom ceiling is insulated with R-19 fiberglass batts (assumed 6").
- **Doors and Windows:**
  - **Windows:** The office windows are double-pane, casement windows with an estimated U-value of 0.28.
  - **Doors:** The doors to the office and storage room are metal insulated doors with glass windows.

Heating, Plumbing, Ventilation, and Air Conditioning

- **Heating Fuel:** Electricity
- **Heat Generation Equipment:** The bailing section has a waste oil furnace that is no longer utilized. The office section is heated by two electric space heaters.
- **Heating Controls:** Each space heater and the waste oil furnace are controlled by integral thermostats.
- **Domestic Hot Water (DHW):** The DHW for the building is heated by an on demand, electric storage tank.
- **Air-Conditioning Equipment:** The office is cooled by a window air conditioner.
- **Air-Conditioning Controls:** The air conditioning is controlled by controls on the window units.
- **Ventilation Equipment**: The bathroom does not appear to be equipped with an exhaust fan.

Electrical

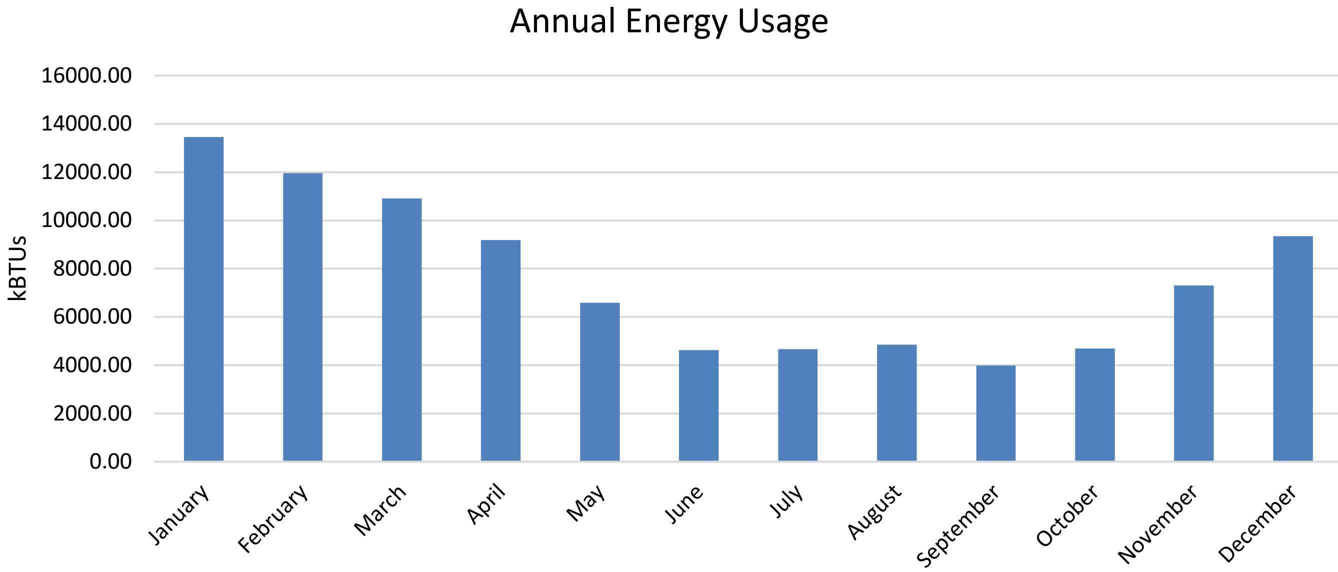
- **Common Area Lighting Type:** The building's interior lighting is T8 fluorescent tube fixtures. The exterior lights are a mix of LED and HID lights.
  - **Lighting Controls:** The interior lighting is controlled by toggle switches. The exterior lights are

controlled by a photocell.

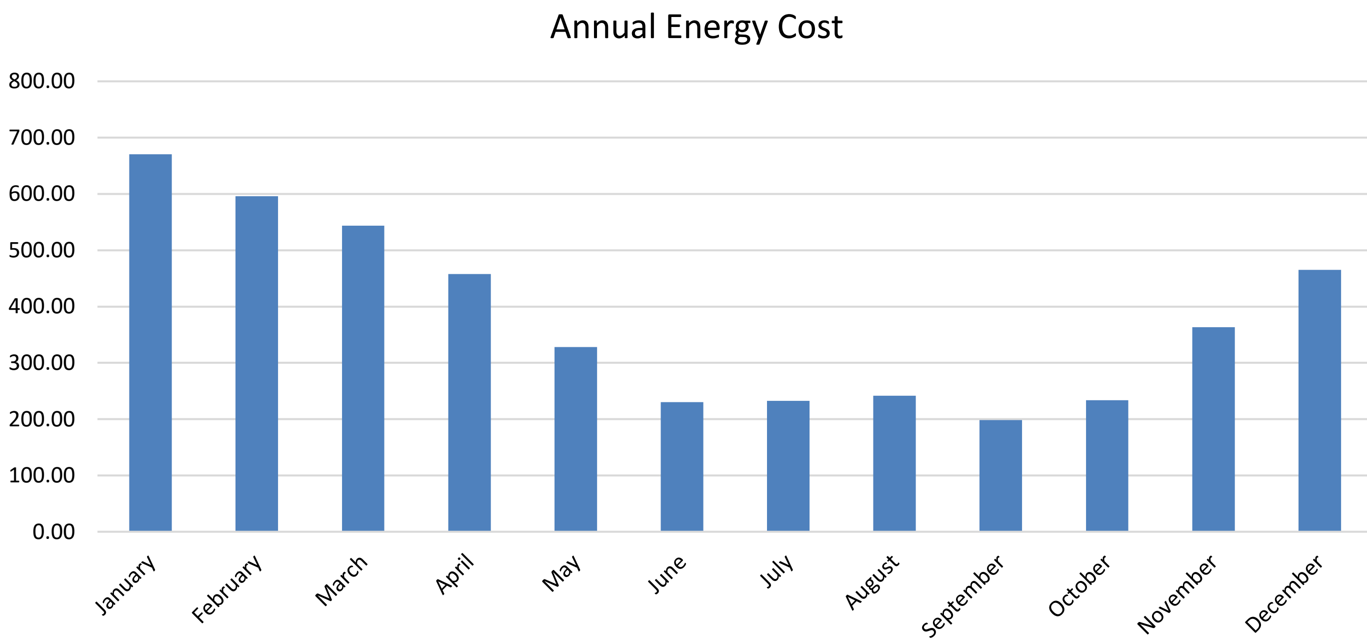
Notable Issues

- The compactor and baling equipment run off inverters.
- The location and equipment operation are well suited for incorporating solar PV electricity generation.
- The baling room is rarely heated. The area is only occupied when the baler is being used, which necessitates the overhead door being open.

Energy Usage and Cost Analysis



Using past utility bills for the garage, we calculated an average yearly consumption 26,826 kWh of electricity, which translates to a total of 91,532 kBTU of energy consumed per year on average.*



The building's average energy costs are $4,560 for electricity per year. It is important to note that the major driver for exceeding the electric baseline is the building's heat demand. Improving the office envelope's robustness will significantly lower the site's electric usage.

*Based off 2 years of electric usage.

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 with the stated conditioned floor area of 3,224 ft^2.

Current EUI/CUI Data:	
Site EUI:	28.3 kBTU/ ft^2/Year
Source EUI:	85.1 kBTU/ ft^2/Year
CUI:	$ 1.41 / 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
Other	Other Public Services	**89.3**	**40.1**	CBECS - Other

The national average Source EUI for a typical public service building is 89.3 kBtu/ft^2/Yr and the average Site EUI is 40.1 kBtu/ft^2/Yr. The waste Transfer Station's Source and Site EUIs are both lower than the national average.

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.** The envelope of the transfer station is limited to the office and bathroom. RBG recommends weather-stripping the doors from the office and bathroom to the baling room. The seams between the ceiling and exterior walls of the office and the bathroom should be sealed.
- **B2: Insulate Office Walls.** The heated envelope consists of the ceiling and walls of the office and bathroom. RBG recommends installing 2” polyisocyanurate rigid insulation on the bathroom walls adjacent to the baling room and the office walls adjacent to the storage/swap room. This measure will add R-14 of thermal resistance to the wall assembly.
- **B3: Insulate Office Attic.** RBG recommends installing 4” (two layers of 2” polyisocyanurate) rigid insulation over the plywood above the bathroom and office. This will effectively provide an additional R-27 of thermal resistance to the attic assembly, bringing its total thermal resistance up to R-45.

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 installing an exhaust fan in the bathroom that is vented to the exterior. This is not an energy saving measure, but it will improve the indoor air quality of the office and bathroom space.

- **M2: Heat Pump.** Install a small 9,000 btu per hour heat pump system to heat and cool the office space. Modern day heat pumps can modulate their cooling and heating outputs, making them ideal for small spaces like the office. If possible, reconfigure the bathroom entrance to enter from the offices. This will allow the heating and cooling energy from the heat pump to make it into the bathroom area. Without this reconfiguration, the bathroom will need to continue to be heated with electric resistance heaters.

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:

- **E2:** RBG recommends replacing the T8 lights with LED fixtures.

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. 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.

- **R1: Photovoltaic Array.**
    - Option A: Install a roof-mounted 22 kW PV array on the building's roof. This array is projected to generate 28,343 kWh/year assuming the installation of high-efficiency panels. The garage building consumes an average of 26,826 kWh per year, which means the proposed PV system would generate over 100% of the building's average annual electric usage.

Figure 1. Option 1 PV array

    - Option B: Utilize open, non-buildable space on landfill and install a ground-mounted 100 kW PV array. This array is projected to generate 127,189 kWh/year assuming the installation of high-efficiency panels. Installing PV arrays on landfills is common practice, but be sure to acquire the proper analyses and permits before installation.

Figure 2 Option 2 PV array

Financial Modeling Results

The following table identifies each EEM's projected cost, **<u>estimated</u>** 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.

Financial Modeling Results

Assumptions :	Electric		Total Energy per Year	
Baseline Energy Usage:	26,826	kWH	91,530	kBTU
Baseline Energy Cost:	$4,560	Cost	$4,560	Cost
Baseline Unit Cost:	$0.17	($/kWh)		

EEM #	Building Envelope Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
B1	Air Sealing	$600	$145	2,900	4.2	29.0%	$3,361
B2	Insulate Walls	$1,400	$137	2,746	10.2	13.9%	$2,389
B3	Insulate Roof	$3,200	$274	5,492	11.7	12.5%	$4,398

EEM #	Mechanical System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
M2	Heat Pump System	$6,300	$801	16,078	7.9	17.3%	$15,799

EEM #	Electric System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
E1	LED Lights	$3,640	$705	14,149	5.2	24.2%	$15,716

EEM #	Renewable System Upgrades	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
R1A	22 kW PV Array - Option A	$55,000	$4,818	96,706	11.4	12.7%	$78,730
R1B	100 kW PV Array - Option B	$250,000	$21,622	433,969	11.6	12.6%	$350,262

	Capital Investment	Annual Energy Cost Savings	Annual kBTU Savings	Simple Payback	IRR	NPV
RBG Recommended Package (B1 – B3, M2, & E1)	**$15,140**	**$2,061**	**$41,365**	**7.35**	**18.2%**	**$41,663**
RBG Recommended Project With R1A	**$70,140**	**$6,879**	**$138,072**	**10.20**	**14.0%**	**$120,392**

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 Transfer Station, 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 Transfer Station in obtaining rebates through the NHSaves program.

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