MERP LEVEL I ENERGY AUDIT

prepared for

Vermont Department of Buildings & General Services
133 State Street, 5th Floor,
Montpelier, Vermont 05633-5801

Mr. Brian Sewell

And

The City or Town of Belvidere

Old Schoolhouse #2
5864 Route 109
Belvidere, Vermont 05442

PREPARED BY:
Bureau Veritas
6021 University Blvd. Suite 200
Ellicott City, Maryland 21043
800.733.0660
www.bvna.com

BV CONTACT:
Ivan Meneses, PE, CEM
Program Manager
800.733.0660 x 7296267
Ivan.Meneses@bureauveritas.com

BV PROJECT #:
161246.23R000-095.267

DATE OF REPORT:
April 29th, 2024

ON SITE DATE:
February 13, 2024

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Certification

Bureau Veritas has completed an ASHRAE Level I Energy Audit in accordance with the State of Vermont ACT 172 at Old Schoolhouse #2 located at 5864 Route 109 in Belvidere, Vermont. Bureau Veritas visited the site on February 13, 2024.

The assessment was performed at the Client's request using methods and procedures consistent with MERP Level I Energy Audit and using methods and procedures as outlined in Bureau Veritas's Proposal.

This report has been prepared for and is exclusively for the use and benefit of the Client identified on the cover page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and Bureau Veritas.

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Estimated installation costs are based on Bureau Veritas's experience on similar projects and industry standard cost estimating tools including *RS Means and Whitestone CostLab*. In developing the installed costs, Bureau Veritas also considered the area correction factors for labor rates for Belvidere, Vermont. Since actual installed costs may vary widely for particular installation based on labor & material rates at time of installation, Bureau Veritas does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. Bureau Veritas does not guarantee the costs savings estimated in this report. Bureau Veritas shall in no event be liable should the actual energy savings vary from the savings estimated herein.

Bureau Veritas certifies that Bureau Veritas has no undisclosed interest in the subject property and that Bureau Veritas's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies due to deferred maintenance and any noted component or system replacements.

Any questions regarding this report should be directed to Ivan Meneses, PE, CEM, at 800.733.0660, ext. 7296267.

Prepared by: Nick Thompson,
Project Manager

Reviewed by:

Ivan MENESES, PE, CEM
Sr. Energy Project Manager

1. Executive Summary

The purpose of this MERP Level I Energy Audit is to provide Vermont Department of Buildings & General Services and Old Schoolhouse #2 with energy efficiency opportunities at the facility and specific recommendations for Energy and water Conservation Measures (ECM's). Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Utility grants towards energy conservation, or as a basis for replacement of equipment or systems.

Building Type / Name	# Bldgs	# Stories	Year Built/ Renovated	Building Size	Estimated Occupancy
Old Schoolhouse #2	1	1	Circa 1850	1,250 SF	None

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

Summary of Existing Energy Performance	
Percentage Area Cooled	0%
Percentage Area Heated	0%

1.1. Energy Conservation Measures

Bureau Veritas has evaluated 58 Energy Conservation Measures (ECMs) for this property. The savings for each measure is calculated using standard engineering methods followed in the industry. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, Bureau Veritas has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

For this site we did not receive utility data due that the building is un-occupied and has no utilities. However, the client's intent is to fully occupy this building, therefore we will assume full occupancy.

Below is a general description of the recommended energy conservation measures:

HVAC SYSTEM: Bureau Veritas recommends installing a 2.5 Ton air cooled heat pump system. A heat pump will supply heating and cooling and will be appropriately sized for the space. Installing a programmable thermostat to better control the equipment's operating hours will yield additional energy savings and is also recommended.

SOLAR AND BATTERY STORAGE SYSTEMS: Bureau recommends installing a 13 kW Photovoltaic system with an annual capacity of 15,009 kW/Hour. The array should be installed on the roof. A 14 watt/hour battery storage system with an eight-hour energy storage capacity should also be installed. The battery storage system should be installed near the main electric panel. These recommendations are for planning purposes. Qualified electrical and structural engineers must be consulted to determine the electrical requirements and to evaluate the load-bearing capacity of the roof structure.

ELECTRICAL VEHICLE CHARGING STATIONS: Bureau Veritas does not recommend installing an EV charging station. There is not sufficient electrical capacity to add a 40-AMP breaker to accommodate an EV charging station. However, a qualified electrician must be consulted to determine to verify the electrical requirements.

WINDOWS AND WEATHER STRIPPING: Bureau Veritas recommends replacing all existing single-paned wood framed windows. While the building has some newer double-paned windows, replacing the remaining energy inefficient windows and installing door and window sweeps will reduce air leakage. Caulking the doors, windows and wall joints is also recommended.

ATTIC INSULATION: Bureau veritas recommended adding insulation to equal the EPA standard of R-49, as currently there is none.

WATER HEATER: Bureau Veritas recommends adding an electric heated water heater.

1.1.2. Other Considerations

- OTHER SOURCES OF ENERGY: Consider conducting a study for evaluation of alternative sources of renewable energy such as geothermal, wind and hydrogen.
- LED LIGHTING: Consider evaluating the feasibility of installing LED and lighting controls.
- WATER CONSERVATION: Consider installing water sense labeled water faucet models.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Evaluated Energy Conservation Measures: Financial Impact	
Total Projected Initial ECM Investment	$97,757
Estimated Annual Cost Savings Related to ECMs	$1,972
Estimated Annual Cost Savings- Electricity	$2,135
Estimated Annual Cost Savings- Propane	
Estimated Annual Cost Savings- Fuel Oil	
Net Effective ECM Payback	49 Yrs.
Estimated Annual Energy Savings	56%
Estimated Annual Utility Cost Savings *(excluding water)*	87%

Onsite Renewable Energy Generation Solar Photo Voltaic Analysis	
Estimated number of panels	19
Estimated kW Rating	8 kW
Potential Annual kWh Produced	9,127 kWh
% of Current Electricity Load	101%
Investment Cost	$27,132
Estimated Energy Cost Savings	$1,643
Payback without Incentives	17- Years
Payback with All Incentives	17- Years
Battery Size	8 KW/hr
Battery Cost	$10,685

Energy Conservation Measures Sorting:

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

$$Simple\ Payback = \frac{Initial\ Cost}{Annual\ Savings}$$

1.2. Assumptions

Bureau Veritas has made the following assumptions in calculation of the Energy Conservation Measures.

- Building operating hours are assumed to be (in the future) 40 hours per week.
- The facility occupancy is assumed to be 5 people.
- Annual Heating Equipment Operating Hours are derived from estimated consumption and equipment input rates to be 936hours/year.
- Annual Cooling Equipment Operating Hours are derived from estimated consumption and equipment input rates to be 416 hours/year.

List of Recommended Energy Conservation Measures For Old Schoolhouse

		Description of ECM	Projected Initial Investment	Estimated Annual Energy & Water Savings					Total Estimated Annual Cost Savings	Simple Payback
			(a)	Natural Gas	Propane	No.2 Oil	Electricity	Water		
			($)	(Therms)	(Gallons)	(Gallons)	(kWh)	(kGal)	($)	(Yrs.)
1	Title:	Replace HVAC Units With Electric /Heat Pump HVAC Units	$7,010	0	0	0	-2,080	0	-$562	-12.48
	Attribute:	Replace (1x) 2kW - 2 Ton RTU With (1x) 2.5 Tons - Heat Pump RTU System;								
2	Title:	Reduce HVAC Hours of Operation	$315	0	0	0	291	0	$52	6.03
	Attribute:	Self Learning Smart Thermostat - (1x) Sensors								
3	Title:	Control External Air Leakage In Commercial Buildings	$1,489	0	0	0	189	0	$36	41.75
	Attribute:	Perform air sealing of building through Installing 80x linear feet of door sweeps								
4	Title:	Improve Attic Insulation Levels	$2,950	0	0	0	1,605	0	$292	10.11
	Attribute:	Improve existing attic insulation from R-1 to R-49 by adding Batt Insulation								
5	Title:	Upgrade Insulation	$30,453	0	0	0	934	0	$168	181.11
	Attribute:	Improve existing Walls insulation from R-2 to R-20								
6	Title:	Replace Existing Water Heater With New Energy Efficient Units	$3,157	0	0	0	2,246	0	$404	7.81
	Attribute:	Replace 1x 5kW Electric water heaters with 40-Gal,4-kW 2EF Heat Pump water heater								
7	Title:	Replace External Windows	$12,500	0	0	0	865	0	$157	79.48
	Attribute:	Replace Wooden Frame -Single Glazing windows with new double pane windows rated at U-0.31								
8	Title:	Install Fixed Tilt Solar Photovoltaic System	$27,132	0	0	0	9,127	0	$1,643	16.51
	Attribute:	Install fixed tilt 7.65KW Solar Photovoltaic System consisting of 7.65kW Rooftop Fixed Array PV System;								
Totals for No/Low Cost Items			**$315**	**0**	**0**	**0**	**291**	**0**	**$52**	**6.03**
Total For Capital Cost			**$84,691**	**0**	**0**	**0**	**12,886**	**5**	**$2,138**	**39.60**
		Interactive Savings Discount @ 10%		0	0	0	-1,318	-1	-$219	
		Total Contingency Expenses @ 15%	$12,751							
Total for Improvements			**$97,757**	**0**	**0**	**0**	**11,859**	**5**	**$1,972**	**49.58**

2. Site Utilities

2.1. Utility Rates

The following utility rates were used for the purposes of savings analysis.

Average Utility Rates				
Electricity	Natural Gas	Wood	Propane / No.2 Oil	Water & Sewer
Average Rate	Average Rate	Average Rate	Average Rate	Blended Rate
$0.18 /kWh	n/a	n/a	n/a	n/a

2.2. Site Utility Analysis

	Utility Analysis					
UTILITY TYPE	UTILITY PROVIDER	METER QUANTITY	ENERGY / WATER USES	ANNUAL CONSUMPTION	EST / ACT	ANNUAL COST
Electric	None	Disabled	Includes lighting, appliances, plug loads	9000 kWh	EST	$1,620

2.3. On-site Utility Storage

Onsite Utility Storage
None currently

2.4. On-site Generation

Site Utilities	
Facility Electric Service Size	Zero AMPS
Onsite Transformer	Pole-mounted
Electric Meter Location	Exterior Wall Mount

2.5. On-site Electric Vehicle Charging

Onsite Electric Vehicle Charging	
Onsite EV Charging Potential	
Spare AMPS at Main Electrical Panel	No AMPS
Proposed Location of EV Charger	South end of the building
Recommended Charger Type	Type II
Proposed Quantity of Chargers	0 (40AMPs / Charger)
Potential Initial Investment	$4,500 / Charger

3. Introduction

The purpose of this Energy Audit is to provide Vermont Department of Buildings & General Services and Old Schoolhouse #2 with a baseline of energy usage, the relative energy efficiency of the facility, and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, as well as support performance contracting, justify a municipal bond-funded improvement program, or as a basis for replacement of equipment or systems.

The energy audit consisted of an onsite visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, Make-Up Air Units, DWH equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

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Energy and Water Using Equipment

- Bureau Veritas has surveyed the spaces to document utility-related equipment, including heating systems, cooling systems, air handling systems and lighting systems.

Building Envelope

- Bureau Veritas has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This review also includes an inspection of the condition of walls, windows, doors, roof areas, insulation and special use areas.

Recommendations for Energy Savings Opportunities

- Based on the information gathered during the on-site assessment, the utility rates, as well as recent consumption data and engineering analysis, Bureau Veritas has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

Energy Audit Process

- Interviewing staff and review plans and past upgrades
- Performing an energy audit for each use type. Performing a preliminary evaluation of the utility system
- Making preliminary recommendations for system energy improvements and measures
- Estimating initial cost

Reporting

The Bureau Veritas Energy Audit Report includes:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priorities, based on initial cost.

4. Facility Overview and Existing Conditions

4.1. Building Occupancy and Point of Contact

Facility Schedule	
Hours of Operations /Week	None
Operational Weeks/Year	None
Estimated Facility Occupancy	None

Facility Schedule	
Point of Contact Name	Victoria Hellwig
Point of Contact Title	Reginal Planer
Point of Contact – Contact Number	518.429.4523

4.2. Building Envelope

The building envelope consists of the exterior shell, made up of the walls, windows, roof, and floor. The envelope provides building integrity and separates the exterior from the interior conditioned space.

Building Foundation	
Item	Description
Foundation	Piers
Basement and Crawl Space	Crawl space, dirt floor
Basement Wall Insulation	None

Primary Roof			
Finish	Metal	Coatings	None
Type / Geometry	Gable	Roof Drains	Edge drainage to ground
Maintenance	None	Main Ventilation Source	Ridge vents
Insulation	None	Roof / Attic Insulation	R-0

Exterior Walls	
Type	Location
Primary Finish	Wood siding
Secondary Finish	None
Wall Insulation	None

Exterior Windows		
Location	Window Framing	Glazing
Exterior	Wood-framed, fixed	Single glaze
Hallways	Wood-framed, operable	Single glaze

Exterior Doors		
Building Doors		Quantity
Main Entrance Doors	Solid core wood	1

Door Comments:

The *Condition* field in the chart above refers to the condition of the perimeter weatherstripping and/or caulking around the doors and frames. *No caulking or sealant was observed, and several of the windows are damaged or missing. There are several slats of siding missing along the top edge just under the soffits.*

4.3. Building Heating, Ventilating, and Air-Conditioning (HVAC)

Overall System Description:

The only heating was provided by a wood burning radiant heater that is no longer viable.

HVAC Comments:

Installation of an HVAC system is recommended.

4.4. Building Lighting

Space Lighting:

Suspended pendant indirect and surface mounted socket light fixtures containing incandescent bulbs provide interior lighting in the buildings. The fixtures are currently not powered as there is no electrical service to the building. The suspended fixtures are located in the main classroom and the socket mounts are in the entry and back hallway.

Lighting Controls:

The facility doesn't have any automatic lighting controls on internal light fixtures.

Emergency Lighting:

There are no EXIT signs in the facility.

Exterior Lighting:

There are no exterior lighting fixtures.

4.5. Building Appliances & Laundry

The building doesn't have any working appliances.

4.6. Building Domestic Water

Plumbing Comments:

Currently the facility does not have any domestic water services or plumbing.

4.7. Recommended 5 year Phased Approach Table.

Recommended 5 Year Plan			
Description of ECM	Priority	**Net Projected Initial Investment**	**Projected Completion Term**
Replace HVAC Units With Electric /Heat Pump HVAC Units	Priority 2	$ 7,011	1-3 years
Reduce HVAC Hours of Operation	Priority 1	$ 315	< 12 months
Control External Air Leakage In Commercial Buildings	Priority 1	$ 1,489	< 12 months
Improve Attic Insulation Levels	Priority 1	$ 2,950	< 12 months
Upgrade Insulation	Priority 2	$ 30,453	1-3 years
Replace Existing Water Heater With New Energy	Priority 2	$ 3,157	1-3 years
Replace External Windows	Priority 2	$ 12,500	1-3 years
Install Fixed Tilt Solar Photovoltaic System	Priority 3	$ 27,132	1-3 years

4.8. Recommended Energy Conservation Measures Scope of Work.

- **Replace Heating Units with Heat Pumps Cooling and Heating System**: The objective is to replace the current fosil fuel HVAC system by a heat pump system. Perform commercial load calculation in accordance with the current version of ANSI/ACCA Manual N (Commercial Load Calculation) or equivalent using interior design temperatures of 75 degrees for cooling and 70 degrees for heating .Perform commercial load calculation in accordance with the current version of ANSI/ACCA Manual N (Commercial Load Calculation) or equivalent using interior design temperatures of 75 degrees for cooling and 70 degrees for heating . Room by room load calculations will be performed when installing a new duct system or in retro-commissioning projects. Select commercial equipment in accordance with the current version of ANSI/ACCA Manual CS (Commercial Applications, Systems and Equipment) or equivalent. Select cooling equipment capable of meeting the sensible and latent load of the building that is not sized more than 115% of total load or next available size. Select heating equipment of the lowest capacity required to meet the design heating load and provide the air movement required by any air conditioning equipment installed. Select system that is ENERGY STAR® certified or equivalent. Select outdoor units that are corrosion-protected for marine climate zonesDemolish existing HVAC units. Procure and install new like-for-like high efficiency Heat Pump units (SEER 15). If on the roof, reuse existing curbs on the roof, provide curb adapter if necessary. Install new disconnect switch and conduit to the new units in accordance with NFPA 70. Locate unit to provide clearance on all sides and top according to manufacturer specifications and service access according to applicable code. Situate outdoor unit on a non-wicking equipment pad. Install exterior ductwork using rigid, corrosion-resistant metal insulated to a minimum of R-12. Test and balance all modified systems. Perform duct leak remediation as required per SMACNA standards. Install smoke detector if required by local State Code. Connect new HVAC equipment to new Thermostat. Commision equipment and controls. Install smoke detectors inside the supply duct plenum of systems that move more than 2,500 cubic feet per minute (CFM) in accordance with the applicable building code
- **Control External Air Leakage In Commercial Buildings**: The objective is to control external air leakage in commercial buidlings. Weatherstripping: Place weatherstripping around all openings. Where external vents are used – such as for a clothes dryer – select vent covers that are as airtight as possible. Apply weatherstripping snugly against both surfaces. The material should compress when the window or door is shut. Choose the appropriate door sweeps and thresholds for the bottom of the doors. Weatherstrip the entire door jamb. Apply one continuous strip along each side.Make sure the weatherstripping meets tightly at the corners. Use a thickness that causes the weatherstripping to press tightly between the door and the door jamb when the door closes without making it difficult to shut. Replace all caulking on windows. Caulking: Most caulk is designed to fill a joint that is no more than ½-inch deep and ½-inch wide, although products called elastomeric caulks can fill larger gaps. Joints that are the correct width, but too deep, such as the gap between a window frame and the rough opening, can be packed with backer rod or stuffed with fiberglass insulation first and the remaining space filled with caulk. For larger gaps, expanding foam is an effective sealant. Dispensed from canisters through a gun, foam will fill gaps up to a couple of inches wide. However, larger gaps may need to be covered with a scrap of solid wood or OSB first and then foam applied in the remaining gaps.Install mastic on electrical boxes, wired penetrations and unsused knockouts. Window and door frames should be sealed to the wall frames with caulk, foam or flexible tape depending on the size of the gap. Casement and awning windows are preferable from an air leakage standpoint because the sash presses against the gasket when closed. When possible locate attic hatches and crawl space access doors in places where they will not penetrate

the air barrier. For example, the attic hatch can often be located in a garage or gable end wall. Crawl space access can be placed in an outside wall below the level of the insulated floor.

- **Improve Attic Insulation Levels**: The objective is to ensure that the roof deck can be safely insulated. Verify that installation area is intact, able to support insulation weight, and air sealed. Verify that installation area is free of the following a. active water leaks, fuel leaks (i.e., gas, oil, propane), and pest intrusions b. energized or undammed knob and tube wiring, c. uncovered electrical junctions, d. improperly terminated devices (ventilation fans, dryers, plumbing stacks, condensate lines, combustion appliance flues/chimneys, etc.), e. unshielded high-temperature devices (non-IC rated recessed lights, chimneys, flues, vents, etc.) unless they are zero clearance devices and f. insulation escape openings. Select insulation materials that have a flame spread and smoke development index of 75/450 or less when tested in accordance with ASTM E84 or UL 723. Remove contaminants from all SPF application surfaces that will prevent full adhesion or cause degradation. Verify all SPF application surfaces are in accordance with manufacturer specifications for moisture content and temperature. Apply SPF to prescribed R-value in a continuous layer from exterior wall top-plate to peak of roof and over all surfaces exposed to ambient temperatures using a pass thickness maximum in accordance with manufacturer specifications. In colder climates (IECC Zones 5-8), install SPF to a thickness of at least a class II vapor retarder or have at least a class II vapor retarder coating or covering in direct contact with the underside of the SPF.
- **Install Fixed Tilt Solar Photovoltaic System:** The objective is to properly install a photovoltaic system. Verify current electrical panel and service line infrastructure is in good condition, compliant with codes, and of sufficient electrical capacity (Amps) to accommodate interconnection of solar power. Verify position of spare (unused) breaker or space to install new breaker in panel for solar power interconnection. If a roof installation is planned, verify that the roof will support the installation (e.g., dead load, wind load) and that the current roof covering is less than 5 years old. Verify that the type of roof is suitable for solar installation (e.g. not slate or wood shingle). The roof understructure shall be inspected and evaluated for support of PV system. Any reinforcements, such as blocking between rafters, shall be completed before load of PV system is applied. If a roof installation is planned, the roof shall be inspected, cleaned and any necessary repairs shall be made. Design the size of PV system to serve the prescribed load. Prepare electrical one line drawing. Prepare layout drawings showing location and connections of all equipment. Provide list (make, model) of all equipment.Design PV system layout to provide safe access around PV modules as required by codes and standards, and required clearances around balance-of-system components such as inverter and switchgear. Locate PV Modules to minimize shading factor and maximize solar gain, but not interfere with existing systems or appliance operation (e.g., chimneys, vents, exhaust terminations). Secure approval of design by utility and secure interconnection agreement to operate utility-connected PV system. Secure electrical permit to install and operate PV system from Authority Having Jurisdiction (AHJ) (e.g. County building Dept.).Installer shall meet the requirements of AHJ. Secure the mounting structures to the roof following manufacturer instructions. Install flashing to make all roof penetrations weather-tight and leak-proof using instructions and materials specified by manufacturer. Install inverters and disconnects in a safe and accessible location, inverter shall be located in the shade when specified by manufacturer's instructions. Install solar panels on the mounting structures according to the manufacturer's instructions. The installation shall comply with all applicable codes and standards adopted by Authority Having Jurisdiction, including but not limited to: National Electric Code (NEC), International Residential Code (IRC), IEEE 1547 Standard for

Interconnecting Distributed Resources with Electric Power Systems, UL 1703 Standard for Flat-Plate Photovoltaic Modules and Panels , Manufacturer's installation and operation manuals. nstall all electrical components according to the NEC and authority having jurisdiction. Fasten wires with wire ties and conduit as per design and installation instructions. The system shall be connected to the electrical grid at a location and in a method approved by the utility. Monitor the system energy delivery for a minimum of 12 months and compare results with predicted energy production. Provide documentation to the building owner, including: copy of the installation and operation manual, electrical diagrams and schematics, certificate of inspection and approval, system performance benchmark data. Perform electrical tests to verify proper operation and system performance. Tests include open circuit voltage, operating current, resistance of grounding system (should be <25 ohms), and resistance of electrical insulation (should be >1 Megohm). Measured voltage shall be compared to reference voltage corrected for temperature. Measured current shall be compared to reference current corrected for insolation (sunlight level). The PV modules and inverter shall be warranted by the manufacturer. Provide occupants/owners with user's manual, warranty information, installation instructions, and installer contact information. Whole system shall be warranted by the installer for a period of at least 1 year. The warranty shall cover defects in materials and workmanship.

- **Replace External Windows:** The objective is to replace the existing windows. Select sealants that: are compatible with their intended surfaces, allow for differential expansion and contraction between dissimilar materials. Meet the requirements of the applicable fire safety code (e.g., thermal or ignition barriers), and for use inside the pressure boundary select low volatile organic compound (VOC) sealants that meet independent testing and verification protocols. Select: pest-resistant materials that adequately support applied load and are permanent air barriers, materials that meet the requirements of the applicable fire safety code (e.g., thermal or ignition barriers), and low volatile organic compound (VOC) materials for use inside the pressure boundary that meet independent testing and verification protocols. Select windows that meet the SHGC, U-value, and air leakage requirements of the work order. Select windows that meet the egress and safety glass requirements of the location where they are installed. Remove existing window stops, sashes, parting strips, pulleys, and weights. Insulate and seal existing window weight pockets if they will remain after new installation. Replace any damaged or rotting framing. Remove any material from the sealing area that will prevent full adhesion of the selected sealant. Remove any material from the installation area that will prevent a level and firm installation. Seal the rough opening to the wall system's air and thermal boundary with non-expanding sealants. Install flashing to direct water away from the window opening in accordance with manufacturer's instructions. Install new window in accordance with manufacturer specifications in alignment with the wall system's air and thermal boundary. Install flashing per the manufacturer's specifications. Gaps between the new window and existing opening will be sealed with low-expanding foam or equivalent sealant. Final installation will be air and watertight.
- **Upgrade Insulation:** The objective is to ensure that the space can be safely insulated. Select insulation that has a flame spread and smoke development index of 25/450 or less and backing material that has a smoke development index of 450 or less when tested in accordance with ASTM E84 or UL 723. Remove any existing insulation or vapor barrier materials from the installation area that are installed improperly. Install batt insulation to prescribed R-value in every joist bay in full contact with the air barrier and all sides of the cavity without gaps, voids, compressions, or misalignments If batt contains a facing material install it in contact with the conditioned space. Install an airtight backing material in full contact with the existing cavity insulation. Secure backing material using mechanical fasteners that penetrate the sub framing a minimum of 1". Installation must have a minimum of a 30-year service life.

- **Replace Water Heater:** The objective is to select a water heater system that is eficient, durable and properly sized. Select a water heater that: has an Energy Factor (EF) of 0.93 or better fits in the installation space with required clearances and provides sufficient hot water for the home and occupants. Ensure that old equipment is permanently removed from service, in accordance with federal and local laws and regualtions. Install water heater in compliance with applicable code (e.g., NFPA 70, IRC, IBC, IMC) and manufacturer specifications. Provide a level working space not less than 30" in length and 30" in width in front of the control side of the appliance. Install appliance and plumbing to allow for inspection, maintenance, and replacement of the appliance and its components, without disturbing other installed equipment, controls, piping, and components, other than what requires repair/replacement. Ensure that anode rod is accessible for replacement. If appliance is installed in or above conditioned space or in a location where water damage could occur, install a drain pan according to local plumbing code. Drain pan to the exterior of the building. Install a separate water cut-off valve for both the hot and cold water lines. Set discharge temperature to not exceed 120 degrees or as prescribed by local code.
- **Replace Thermostat / Reduce Hours of Operation:** The objective is to replace thermostat by a 24 hour fully programable unit. Verify that sufficient number of thermostat wires is available to meet the needs of the replacement unit and the existing system. Select a double-setback programmable thermostat that allows for full functionality of the installed system (supplementary heat, emergency heat, fan only, ventilation control, etc.). Install thermostat where it accurately reflects the temperature and humidity of the zone which it controls (i.e., not exposed to extreme temperatures, radiant heat sources, warm/cold walls, or drafts). Connect supplementary heat to second-stage heating terminal in accordance with manufacturer specifications. Install and connect outdoor temperature sensor that is compatible with the thermostat in accordance with manufacturer specifications. Calculate and select an optimum thermal balance point for supplementary heat operation in accordance with ANSI/ACCA Manual S and manufacturer specifications. Program the thermostat to match the equipment and control board settings per manufacturer specifications. Set time delay for fan start in accordance with manufacturer specifications and as appropriate for the climate zone (e.g., no time delay for hot humid climates, longer time delay for cold climates). Program the thermostat setbacks to a schedule that accommodates the occupant and reduces overall run time.
- **Replace Exterior Doors:** The objective is to replace door by a continuous weather tight air and thermal boundary that mantains operability. Select sealants that are compatible with their intended surfaces, and allow for differential expansion and contraction between dissimilar materials. Select doors that meet the Solar Heat Gain Coeficient, U-value, and air leakage requirements of the work order. Select doors that meet the egress and safety glass requirements of the location where they are installed. Remove existing door frame and all components. Replace any damaged or rotting framing. Remove any material from the sealing area that will prevent full adhesion of the selected sealant. Seal the rough opening to the wall system's air and thermal boundary with non-expanding sealants. Install flashing to direct water away from the door opening in accordance with manufacturer's instructions. Install new door in accordance with manufacturer specifications in alignment with the wall system's air and thermal boundary. Install exterior flashing and weatherstripping per the manufacturer's specifications. Gaps between the new door frame and the rough opening will be sealed with low-expanding foam. Door rail (bottom) and threshold will be adjusted to ensure tight but operable fit. Final installation will be air and watertight.
- **Install a Vertical Wind Turbine System:** The objective is to install a Vertical Wind Turbine system that can provide sufficient energy to cover the new daily energy need of the building. Select a wind turbine that can achieve full rated capacity at low wind velocities (less than 10 meters per second). Vertical wind turbine systems are more efficient and can be installed in arrays in order to Vertical Wind Turbines can

be installed in an array and provide an average 30% better performance with an average production of 12-16 hours a day while offering a multiplication factor if installed vertically above 25'. Wind turbines also can provide a much higher plant factor of 65% compared to the 27% plant factor of a photovoltaic system.

5. Recommended Operations and Maintenance Plan

The quality of the maintenance and the operation of the facility's energy systems have a direct effect on its overall energy efficiency. Energy-efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property.

Building Envelope

- ✓ Ensure that the building envelope has proper caulking and weather stripping.
- ✓ Patch holes in the building envelope with foam insulation and fire rated caulk around combustion vents
- ✓ Inspect building vents semiannually for bird infestation
- ✓ Inspect windows monthly for damaged panes and failed thermal seals
- ✓ Repair and adjust automatic door closing mechanisms as needed.

Heating and Cooling

- ✗ Pilot lights on furnaces and boilers be turned off in summer
- ✗ All preventive maintenance should be performed on all furnaces and boilers, which would include cleaning of burners and heat exchanger tubes.
- ✗ Ensure that the combustion vents exhaust outside the conditioned space and the vent dampers are functional
- ✗ Ensure that the control valves are functioning properly before start of every season
- ✗ Ensure steam traps are functional before start of each heating season
- ✗ Ensure use of chemical treatment for boiler make up water
- ✗ Ensure boiler outside temperature re-set is set to 55F
- ✗ Ensure the duct work in unconditioned space is un-compromised and well insulated
- ✗ Duct cleaning is recommended every 10 years. This should include sealing of ducts using products similar to 'aero-seal'
- ✗ Ensure use of economizer mode is functional and used
- ✗
- ✗ Ensure air coils in the AHU and FCA's cleaned annually
- ✗ Return vents should remain un-obstructed and be located centrally
- ✗ Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
- ✗ Evaporator coils and condenser coils should be regularly cleaned to improve heat transfer
- ✗ Refrigerant pipes should be insulated with a minimum of ¾" thick Elastomeric Rubber Pipe Insulation
- ✗ Ensure refrigerant pressure is maintained in the condensers
- ✗ Change air filters on return vents seasonally. Use only filters with 'Minimum Efficiency Rating Value'(MERV) of 8

Central Domestic Hot Water Heater

- ✗ Never place gas fired water heaters adjacent to return vents so as to prevent flame roll outs
- ✗ Ensure the circulation system is on timer to reduce the losses through re-circulation
- ✗ Ensure all hot water pipes are insulated with fiberglass insulation at all times
- ✗ Tank-type water heaters flushed monthly

Lighting Improvements

- ✓ Utilize bi-level lighting controls in stairwells and hallways.

- ✓ Use LED replacement lamps
- ✓ Clean lighting fixture reflective surfaces and translucent covers.
- ✓ Ensure that timers and/or photocells are operating correctly on exterior lighting
- ✓ Use occupancy sensors for offices and other rooms with infrequent occupancy

Existing Equipment and Replacements

- ✗ Ensure that refrigerator and freezer doors close and seal correctly
- ✗ Ensure kitchen and bathroom exhaust outside the building and the internal damper operates properly
- ✗ Ensure that bathroom vents exhaust out
- ✗ Office/ computer equipment either in the "sleep" or "off" mode when not used

Key

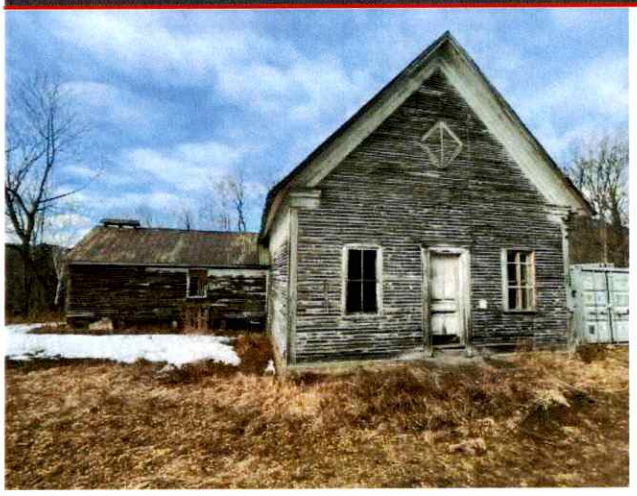
✗	Maintenance Measure is Not Applicable for the Given Facility
✓	Maintenance Measure is Applicable for the Given Facility

6. Appendices

APPENDIX A: Photographic Record
APPENDIX B: Site and Floor Plans
APPENDIX C: Mechanical Inventory
APPENDIX D: Energy Conservation Measures Calculations
APPENDIX E: Other Supporting Documents

Appendix A:
Photographic Record

Photographic Overview



1 - FRONT ELEVATION

2 - LEFT ELEVATION

3 - RIGHT ELEVATION

4 - REAR ELEVATION

5 - ROOF

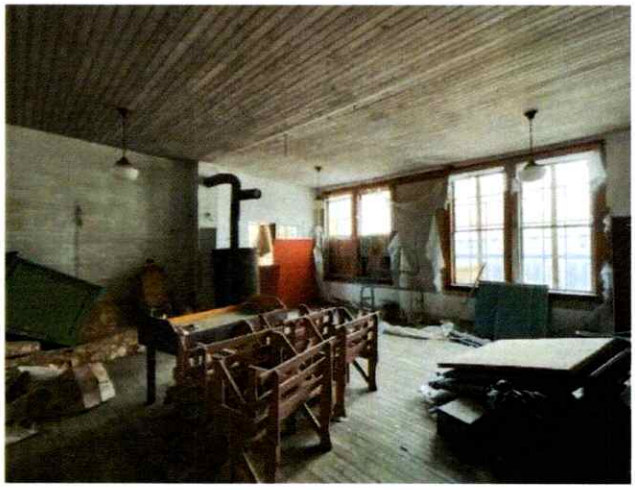
6 - ATTIC

Photographic Overview

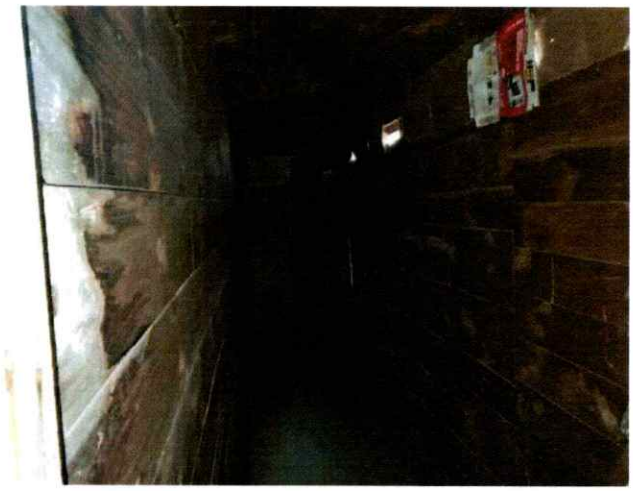
7 - ROOF

8 - CRAWL SPACE

9 - INTERIOR



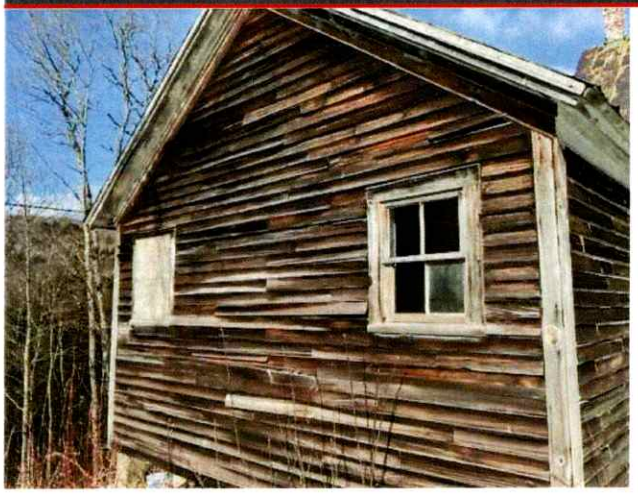
10 - INTERIOR



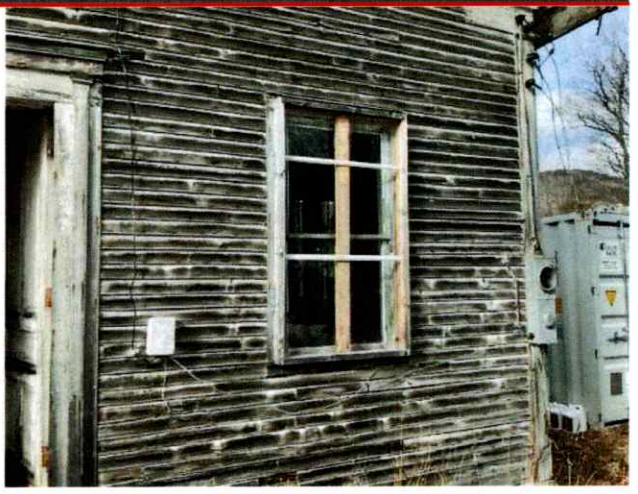
11 - INTERIOR

12 - WINDOW

Photographic Overview



13 - WINDOW



14 - WINDOW

15 - WINDOW

16 - EXTERIOR DOOR

17 - INTERIOR LIGHT FIXTURE

18 - RESTROOM

Appendix B:
Site and Floor Plans

Site Plan

Project Number	Project Name
161246.23R000-095.267	Old Schoolhouse #2 State of Vermont
Source	**On-Site Date**
Google	February 13, 2024

N

Appendix C:
Mechanical Equipment Inventory

Mechanical Equipment Inventory							
Equipment	Manufacturer	Model/ Type	Serial	Capacity	Age	Eff.	MLR
No mechannical equipment present							

Appendix D:
Energy Conservation Measures Calculations

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UIC	Replace HVAC Units With Electric /Heat Pump HVAC Units
EAH-15	Location:
Attributes:	Replace (1x) 2kW - 2 Ton RTU With (1x) 2.5 Tons - Heat Pump RTU System;

	Specify Location		Specify Location		Specify Location		Specify Location	
Heating System								
Number of Heating Systems to be replaced	1	Qty		Qty		Qty		Qty
Heating Fuel:	Electric		Natural Gas		Natural Gas		Natural Gas	
Heating System Capacity (Each)	2	kW		MBH		MBH		MBH
De-rated AFUE rating For **Eac**h Heating System	1.00	COP		%		%		%
Estimated Annual Operating Hours:	936	Hrs		Hrs		Hrs		Hrs
Estimated Annual Energy Use from All Heating Systems	549	kWh	0	Therms	0	Therms	0	Therms
Cooling								
Unit has Cooling?	Yes		Yes		Yes		Yes	
Refrigerant in Cooling System								
Cooling Capacity for Each Unit	24,000	Btuh		Btuh		Btuh		Btuh
EER of the Existing Cooling System:	12.00	EER		EER		EER		EER
Estimated Annual Operating Hours:	416	Hrs		Hrs		Hrs		Hrs
Energy Consumption From All Existing Air conditioner:	832	kWh	0	kWh	0	kWh	0	kWh
Proposed System								
Proposed System:	2.5 Tons - Heat Pump RTU							
Proposed Cooling System Capacity	30,000	Btuh	0	Btuh	0	Btuh	0	Btuh
EER of Proposed Air-Conditioning System:	12.00	EER	0.00	EER	0.00	EER	0.00	EER
Total Energy Consumption For Proposed RTU - Cooling:	1,040	kWh	0	kWh	0	kWh	0	kWh
Proposed Heating System Input:	2.59	kW	0.00	kW	0.00	kW	0.00	kW
COP of Proposed RTU Heating System:	3.40	COP	0.00	COP	0.00	COP	0.00	COP
Total Energy Consumption For Proposed RTU Heat:	2,421	kWh	0	kWh	0	kWh	0	kWh
Estimated Annual Energy Consumption From All Systems:	3,461	kWh	0	kWh	0	kWh	0	kWh
Savings Analysis								
Annual Energy Savings From Heating Systems:	-6,387	kBtuh	0	kBtuh	0	kBtuh	0	kBtuh
Annual kWh savings for all Air conditioner:	-208	kWh	0	kWh	0	kWh	0	kWh
Material Cost For All RTU(s):	$5,525		$0		$0		$0	
Labor Cost for All RTU(s):	$1,485		$0		$0		$0	
Installed Cost for all RTU(s):	$7,010		$0		$0		$0	
Total Investment	$7,010		$0		$0		$0	
Estimated Annual Energy Cost Savings:	-$562		$0		$0		$0	
Estimated Annual Energy Savings:	-7,097	kBtuh	0	kBtuh	0	kBtuh	0	kBtuh
	Natural Gas		Propane		No.2 Oil		Electric	
Total Utility Savings	0	Therms	0	Gal	0	Gal	-2,080	kWh

Total Initial Investment: $7,010 — **Total Annual Utility Cost Savings:** -$562

Simple Payback: -12.48 Yrs

Type of Recommendation: **Capital Cost ECM Recommendation**

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UIC	Reduce HVAC Hours of Operation
EAC3	Location: Throughout BLDG Air Handlers
Attributes:	Self Learning Smart Thermostat - (1x) Sensors

No. of Sensors Affected : 1 Qty.

Select Type of Recommendation: Self Learning Smart Thermostat (Select)
(Selection Based on Type of Property)

Heating Load Calculation

Select Type of Heating Fuel: Electric (Select)

Estimated Current Annual Energy Consumption For Winter Heating: 549 kWh

	Weekdays	Weekends
Day Time Set Back Hours	8.00	
Night Time Set Back Hours	16.00	24.00
Hours Without Set Back	0.00	0.00

Typical Indoor Temp	72.00	°F
Temp Set Point With Set Back During Day Time	70.00	°F
Temp Set Point With Set Back During Night Time	65.00	°F
Average Heating Set Point	66.19	°F
Savings Per Degree Set Back For Heating Season *(Industry Standard, 2004)*	3%	
Estimated Annual Heating Energy Consumption	1,872	kBtu
Estimated New Annual Heating Energy Consumption	1,546	kBtu
Estimated Annual Heating Energy Savings	96	kWh

Cooling Load Calculation

Select Type of Cooling Fuel: Electric (Default)

Estimated Current Annual Energy Consumption For Summer Cooling: 832 kWh

	Weekdays	Weekends
Day Time Set Back Hours	8.00	24.00
Night Time Set Back Hours	16.00	
Hours Without Set Back	0.00	0.00

Typical Indoor Temp	72.00	°F
Temp Set Point With Set Back During Day Time	74.00	°F
Temp Set Point With Set Back During Night Time	78.00	°F
Average Cooling Set Point	75.90	°F
Savings Per Degree Set Back For Cooling Season *(Industry Standard, 2004)*	6%	
Estimated Annual Cooling Energy Consumption	2,839	kBtu
Estimated New Annual Cooling Energy Consumption	2,174	kbtu
Estimated Annual Cooling Energy Savings	195	kWh

Cost Analysis

Average Annual Cost of Heating Fuel:	$0.18	$/kWh	Estimated Investment Per Sensor: *(Includes Material, Labor & Installation Costs)*	$207 $$
Average Annual Cost of Electricity:	$0.18	$/kWh	Total Estimated Cost For All Sensors:	$315 $$
Estimated Annual Heating Cost Savings:	$17	$$	Total Estimated Cost Savings From All Sensors:	$52
Estimated Annual Cooling Cost Savings:	$35	$$	Estimated Simple Pay Back Period	6.03 Yrs
Type of Recommendation	No/Low Cost ECM Recommendation			

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ECM DESCRIPTION:

Turning off energy-consuming systems when they are not needed is the most basic energy conservation technique. When a building is occupied intermittently, energy savings can be realized by minimizing the time the heating or cooling system is operated when the building is closed. Building control algorithms should be implemented to delay startup until the last moment and to shut down as early as possible.

Because of the thermal inertia of both the building structure and its heating and cooling equipment, preheat or precool time is almost always required to raise or lower the space temperature to the desired level before the occupants return. This start-up time depends on the outdoor environment, the thermal response of the building, and the thermal performance of the space conditioning equipment. Similarly, the thermal inertia of the building maintains the indoor temperature at a comfortable level for a short period of time after the equipment is shut off. It allows the system to be turned off before the end of an occupied period. An optimum start/stop control accounts for these factors.

SUMMARY

Initial Investment:	$315	Simple Payback Period:	6.03 Yrs
Annual Energy Cost Saving:	$52		

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UIC	Control External Air Leakage In Commercial Buildings
EAE4A	Location:
Attributes:	Perform air sealing of building through Installing 80x linear feet of door sweeps

ENTER EXISTING CONDITION

Insert Existing Estimated Air Change Rate/Hr (ACH 1): *(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)*	0.75	Cubic Feet/Min (CFM 1):	125
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	Cubic Feet/Min (CFM 2):	58
Estimated Space Volume Under Consideration	10,000 Cu.Ft		

WINTER			SUMMER		
Select Type of Heating Fuel	Electric (Select)		Is The Building Cooled?	Yes	
Estimated Annual Heating Plant Efficiency	1.00	COP	Estimated Annual Cooling Plant Efficiency	12.00	EER
Annual Heating Degree Days(HDD):	7,897		Annual Cooling Degree Days(CDD):	443	
Estimated Total Annual Input Heating Energy Savings	125	kWh	Estimated Total Annual Input Cooling Energy Savings	64	kWh
Cost/Unit of Heating Fuel:	$0.18	$/kWh	Cost/Unit For Electricity	$0.18	$$
Estimated Annual Heating Cost Savings	$22	$$	Estimated Annual Cooling Cost Savings	$11	$$

Cost Analysis

Install Flush Mounted, Vinyl Door Sweeps ?	Yes	Total Length of Door Sweeps to Be Installed: *(3.5' Standard Width Door)*	80 LF
Install Window Air Conditioner Covers For Winter:	No	Number of Air Conditioner Covers To Be Installed: *(Covers would meet HUD Chapter-12 Energ Conservation Compliance Section 329C)*	
Estimated Annual O&M Savings	$2	Estimated Length of Joints To Be Re-Caulked: *(Includes Demolition and Re-Caulking)*	LF
Total Estimated Annual Cost Savings	$36	Total Cost For Controlling Air Leakage	$1,489
Simple Pay Back Period	41.75 Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation

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ECM DESCRIPTION:

One of the most commonly used methods for reducing air leakage through building structures is caulking and weather stripping.
Particularly effective measures include caulking cracks around windows and door frames and weather stripping around windows and doors. Weather-stripping and caulking of doors and windows, helps in thermally isolating of the building with the outside atmosphere. This prevents the infiltration of external un-conditioned air along with moisture and humidity into the conditioned space at the same time, prevents the conditioned air from escaping out. A precisely thermally isolated building directly affects the cooling and heating load on the facilities HVAC system as it has to put in less effort in maintaining the desired temperature inside the facility. As per ASHRAE a well insulated and ventilated building should have an air change rate not more than 0.35 per hour.

In order to ensure proper thermal isolation of the property, BV recommends ensuring that the weather-stripping and caulking of all external doors and windows remains intact. Its also recommended that door sweeps be installed under all the doors opening into conditioned space. Any visible cracks between the window frame and wall should be plugged by caulking.

In case of building with window airconditioners, BV recommends use of interior/exterior window airconditioner covers so as to prevent cold air drafts into the conditioned space during the winter so as to save on heating costs.

SUMMARY:

Initial Investment:	$1,489	Simple Pay Back Perio	41.75 Yrs
Annual Energy Cost Savings:	$36		

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UIC	Improve Attic Insulation Levels
EAE3	Location:
Attributes:	Improve existing attic insulation from R-1 to R-49 by adding Batt Insulation

ENTER EXISTING CONDITION

ASHRAE Climatic Zone	Zone-6		ASHRAE 90.1 Attic- Insulation Requirement:	R-49	
Enter Total Surface Area Under Consideration:	1,250	Sq.Ft	Existing Net Effective R-Value: (Sq.Ft deg F/btu)	1	
Proposed Type of Insulation To Be Added:	Batt Insulation	(Select)	Proposed Insulation Recommendation:	Full Upgrade	(Select)
Recommended Level of Insulation To Be Added:	R-49		Proposed Net Effective R-Value: (Sq.Ft deg F/btu) *(Post Retrofit-Final Net Insulation)*	49	

ENTER CLIMATIC & SYSTEM DATA

Annual Cooling Degree Days (CDD):	443		Estimated Annual Cooling Plant Efficiency (EER):	12.00	EER
Annual Heating Degree Days (HDD):	7,897		Estimated Annual Heating Plant Efficiency: COP	1.00	COP

WINTER			SUMMER		
Select Type of Heating Fuel	Electric	(Select)	Is the Property Cooled ?	Yes	(Select)
Annual Conduction Losses From Existing Insulation	236,922	kBtu	Annual Conduction Losses From Existing Insulation	13,299	Kbtu
Annual Conduction Losses From Proposed Insulation	4,835	kBtu	Annual Conduction Losses From Proposed Insulation	271	kBtu
Savings In Conduction Losses After Adding Insulation	232,087	kBtu	Savings In Conduction Losses After Adding Insulation	13,028	kBtu
Estimated Total Annual Input Heating Energy Savings	519	kWh	Estimated Total Annual Input Cooling Energy Savings	1,086	kWh
Cost of Heating Fuel/Unit:	$0.18	$/kWh	Cost of Electricity/Unit	$0.18	$$
Annual Heating Cost Savings	$93	$$	Annual Cooling Cost Savings	$195	$$

COST ANALYSIS

Estimated O&M Savings	$3	$$	Estimated Cost To Add Insulation on	$1,938	
Total Estimated Annual Cost Savings	$292	$$	Estimated Total Installation Cost	$2,950	$$
Simple Pay Back Period	10.11	Years	*Type of Recommendation*	Capital Cost ECM Recommendation	

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ECM DESCRIPTION:

The amount of heat conduction through ceiling and roof is proportional to its overall heat transfer coefficient (commonly called the U-factor) and the temperature difference between the conditioned space and its surrounding, modified by the effect of solar intensity and wind velocity on the exterior surfaces. One of the most effective ways to reduce heat transfer through ceilings and roofs is to retard heat conduction by adding insulation.

Where the existing roof is sound and directly accessible from an attic or ceiling void, polyurethane foam or mineral fiber may be sprayed on the underside, with rigid batt or other applicable insulation for the inside surface. Insulation, typically fiber-glass batt, may also be laid on the top of a ceiling, taking care not to cover up light fixtures.

Unimembers can degrade the performance of the insulation up to 20%, and resultant condensation can cause insulated structural the structure to deteriorate. Therefore, care should be taken to properly insulate the structural members. Often more energy can be conserved by insulating the ceiling rather than the roof unless the attic is being used for special storage, frequent access is required, or a moderate attic temperature is desired. However, if only the ceiling is insulated, any ducting or piping should be insulated to avoid excessive heat transfer or freezing. It is important to be sure that the attic is ventilated by providing one to two inches of ventilation area per square foot of attic.

Summary:

Initial Investment:	$2,950	Simple Payback Period:	10.11 Yrs
Annual Energy Cost Savings:	$292		

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UIC	Upgrade Insulation
EAE3B	Location:
Attributes:	Improve existing Walls insulation from R-2 to R-20

ENTER EXISTING CONDITION

Property Zone	Surface Under Consideration	Min. R-Value
Zone-6	Walls	R-20

Source: 2009 IECC For Residential Bldgs

"-" Not Specified

Enter Total Surface Area Under Consideration: 20,000 Sq.Ft

Existing Net Effective R-Value: (Sq.Ft deg F/btu) 2

Proposed Net Effective R-Value: (Sq.Ft deg F/btu) 20

ENTER CLIMATIC & SYSTEM DATA

Annual Cooling Degree Days (CDD): 443

Annual Heating Degree Days (HDD): 7,897

Estimated Annual Cooling Plant Efficiency (EER): 12.00 EER

Estimated Annual Heating Plant Efficiency: COP 1.00 COP

WINTER

Select Type of Heating Fuel: Electric (Select)

Annual Conduction Losses From Existing Insulation	1,895,376	kBtu
Annual Conduction Losses From Proposed Insulation	189,538	kBtu
Savings In Conduction Losses After Adding Insulation	1,705,838	kBtu
Estimated Total Annual Input Heating Energy Savings	692	kWh
Cost of Heating Fuel/Unit:	$0.18	$/kWh
Annual Heating Cost Savings	$125	$$

SUMMER

Is the Property Cooled ? Yes (Select)

Annual Conduction Losses From Existing Insulation	106,392	Kbtu
Annual Conduction Losses From Proposed Insulation	10,639	kBtu
Savings In Conduction Losses After Adding Insulation	95,753	kBtu
Estimated Total Annual Input Cooling Energy Savings	242	kWh
Cost of Electricity/Unit	$0.18	$/kWh
Annual Cooling Cost Savings	$44	$$

COST ANALYSIS

Estimated O&M Savings	$0.00	$$
Total Estimated Annual Cost Savings	$168	$$
Simple Pay Back Period	181.11	Years

Estimated Cost To Add Insulation/Sqft: $1.00

Estimated Total Installation Cost: $30,453 $$

Type of Recommendation: Capital Cost ECM Recommendation

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UIC	Replace Existing Water Heater With New Energy Efficient Units
EAD3	Location:
Attributes:	Replace 1x 5kW Electric water heaters with 40-Gal,4-kW 2EF Heat Pump water heater

Step 1	Existing Water Heater Details	Specify Location Here	Specify Location Here	Specify Location Here	Specify Location Here
	Number of Water Heaters Being Replaced:	1			
	Select Existing Hot Water Heater Fuel	Electric	Electric	Natural Gas	Natural Gas
	Insert Energy Factor of Existing Water Heater	1.00 EF	EF	EF	EF
	Input Existing Water Heater Input Rating	5.00 kW	kW	kBtus	4.50 kBtus
	Select One Method For Calculation	Annual Heating Hours	Annual Heating Hours	Annual DWH Load	Annual DWH Load
	Insert Average Annual Hours of Operation	450 hrs	hrs	Therms	Therms
	Annual Water Heater Energy Consumption/Heater	2,250 kWh	0 kWh	#DIV/0! hrs	0 hrs
	Total Estimated Annual Energy Consumption For all Heaters	2,250 kWh	0 kWh	0 Therms	0 Therms
	Total Estimated Annual Operating Energy Costs For all Heaters	$405 $	$0 $	$0 $	$0 $
Step 2	**Proposed New Water Heater**				
	Proposed Quantity of Water Heaters:	1			
	Proposed Hot Water Heater Fuel	Heat Pump			
	Capacity of the Proposed New Water Heater	40-Gal,4-kW			
	Energy Factor of Proposed Water Heater	2.00 EF	0.00 EF	0.00 EF	0.00 EF
	Proposed Water Heater Input Rating	4.00 kW	0.00 kW	0.00 kW	0.00 kW
	Annual kBtuh Consumption For All The Proposed Water Heaters	14 kBtuh	0 kBtuh	0 kBtuh	0 kBtuh
	Estimated Annual Water Heater Fuel Consumption (All Heaters)	4 kWh	0	0	0
	Estimated Total Annual Energy Costs	$1	$0	$0	$0
Step 3	**Energy & Cost Saving Calculation**				
	Estimated Material Cost of New Water Heater	$1,380	$0	$0	$0
	Estimated Labor Cost of New Water Heater	$1,777	$0	$0	$0
	Total Estimated Installation Cost	$3,157	$0	$0	$0
	Total Estimated Annual Cost Savings	$404	$0		$0
	Total Annual Cost Savings:	$404	Total Initial Investment::	$3,157	
	Simple Pay Back Period	7.81			
	Type of Recommendation	Capital Cost ECM Recommendation			

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UIC	Replace External Windows
EAE2	Location: Exterior Windows
Attributes:	Replace Wooden Frame -Single Glazing windows with new double pane windows rated at U-0.31

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	288	sq.ft
Approximate number of windows:	8	
Total existing window area:	288	Sq.Ft
Select The Existing Window Type	Wooden Frame -Single Glazing	(Select)
Existing U-value of window: (1/R)	0.9	Btu/ ft².°F-h
ASHRAE Climatic Zone	Zone-6	
New U-value with Double pane Low E window: (1/R)	0.31	Btu/ ft².°F-h

AHRAE 90.1 Recommended Value

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1):	1.00	
(Existing Air Changes Per Hour, 1.5 is very leaky and 0.35 ideal)		
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.35	
Estimated Space Volume Under Consideration	10,000.00	Cu. Ft
Is the Property Cooled ?	No	(Select)

WINTER

Select Type of Heating Fuel	Electric	(Select)
Net heating plant & distribution system efficiency:	1.00	COP
Annual Heating Hours:	7,897	HDD
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	0.00	kWh
Estimated Total Annual Input Heating Energy Savings Achieved By Controlling Air Leakage Through Windows	865	kWh
Estimated Total Input Heating Fuel Savings From Replacing Windows	865	kWh

SUMMER

Select Type of Cooling Fuel:	Electric	(Default)
Cooling Plant Efficiency **(EER)**:	10.00	EER
Annual Cooling Hours:	443	CDD
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	181	kWh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controlling Air Leakage Through Windows	0	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	0	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel:	$0.18	$/kWh	Annual Heating Cost Savings:	$155.72	$$
Insert Cost of Cooling Fuel:	$0.18	$/kWh	Annual Cooling Cost Savings:	$0.00	$$
Total Annual Cost Savings	$157		Total Annual Cost Savings From Heating & Cooling:	$156	$$
Cost of window upgrade:	$12,500		Estimated Annual O&M Savings	$2	$
Simple payback:	79.48	Yrs	*Type of Recommendation*	Capital Cost ECM Recommendation	

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ECM DESCRIPTION:

Windows play a major role in the energy use and comfort of an interior space. In the winter, heat in a room is lost when cold outside air infiltrates around the edges of windows. Heat also can be lost by conduction directly through the pane, even if the window fits tightly. Windows with insulated panes, such as those filled with Argon address this issue, while proper caulking and sealant address the infiltration issue. The cold drafts and the chilly windowpane make the room uncomfortable. Windows also can help to heat a room by letting the sun's rays enter. While this solar radiation is beneficial in the winter, it can be a major source of discomfort in hot, summer climates. Energy Star rated windows with Low-E glazing are designed to keep the solar heat gain minimized during the summer months. Choosing a replacement window that fits properly has the desired U-value, and proper glazing characteristics is critical to energy conservation through window upgrades.

Summary:

Initial Investment:	$12,500	Simple Payback	79.48 Yrs
Annual Energy Cost Savings:	$157		

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UIC	**Install Fixed Tilt Solar Photovoltaic System**
EAR1	**Location:**
Attributes:	Install fixed tilt 7.65KW Solar Photovoltaic System consisting of 7.65kW Rooftop Fixed Array PV System;

Select State: Vermont **Electric Rate:** $0.18 $/KWH Annual Electric Consumption: 9,000 KWh

Roof No.	Description	Location of the Array	DC System Size Per Roof	Estimated Battery Size	PV System Sizing For All Roofs	Estimated Number of 400 Watt PV Panels	Total Estimated Annual Electricity Generated/ Roof	Total Estimated Electricity Generated (All Roofs)	Total Cost Savings	Installation Cost	Simple Pay Back Period without Incentives	One Time Potential Utility or State Incentives	One Time Potential Federal Incentives	Annual Potential Incentives and Rebates		Simple Pay Back Period with All Incentives
			kW	KW-H	kW		kWh	kWh			Yrs		Federal Tax Credit	Federal REPI Incentive	Solar Renewable Certificates (SRECs): ($/MWH)	Years
													26%	$0.00	Varies by State	
1	Rooftop Fixed Array	Main Bldg	8	8	8	19	9,127	9,127	$1,643	$27,132	16.5	$0	$0	$0	$0	16.5
2					0	0		0	$0	$0		$0	$0	$0	$0	
3					0	0		0	$0	$0		$0	$0	$0	$0	
4					0	0		0	$0	$0		$0	$0	$0	$0	
5					0	0		0	$0	$0		$0	$0	$0	$0	
6					0	0		0	$0	$0		$0	$0	$0	$0	
7					0	0		0	$0	$0		$0	$0	$0	$0	
8					0	0		0	$0	$0		$0	$0	$0	$0	
9					0	0		0	$0	$0		$0	$0	$0	$0	
10					0	0		0	$0	$0		$0	$0	$0	$0	
		0			8	19	9,127.4	9,127	$1,643	$27,132	16.51	$0	$0	$0	$0	16.51

Solar Rooftop Photovoltaic Analysis		
Total Number of Roofs	0	
Estimated Number of Panels	19	
Estimated KW Rating	8	kW
Potential Annual KWh Produced	9,127	kWh
% of Current Electricity Load	101.4%	

Financial Analysis		
Investment Cost	$27,132	
Estimated Energy Cost Savings	$1,643	
Potential Rebates	$0	
Potential Annual Incentives	$0	
Payback without Incentives	16.5	years
Incentive Payback but without SRECS	16.5	years
Payback with All Incentives	16.5	years

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Appendix E:
Other Supporting Documents

Glossary of Terms and Acronyms - Energy Audits

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates typically are based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period – The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy-efficiency recommendations be based on a calculated SIR, with larger SIRs receiving a higher priority. A project typically is recommended only if the SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost – The sum of the present values of (a) Investment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity – The sum of the total site energy use in thousands of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousands of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity – This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions – Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions , the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).