Comprehensive Building Assessment



Shutesbury Elementary School
23 West Pelham Road
Shutesbury, MA, 01072

CBA Report # 0001
9/10/2026 – Revision Date

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EXECUTIVE SUMMARY

National Grid and Shutesbury Elementary School acquired the services of The RISE Group, Inc. to conduct a Comprehensive Building Assessment (CBA) as offered by the Sponsors of Mass Save. This detailed study for Shutesbury Elementary School in Shutesbury, MA provides rough estimates of costs and savings for all identified energy conservation measures (ECMs) to help the building owner understand the scope of work needed to meet electrification and decarbonization goals.

This report focuses on a combination of electrification and energy efficiency improvements that reduce a building's annual greenhouse gas (GHG) emissions. The preliminary energy[1] and GHG savings presented here were evaluated by comparing the proposed energy consumption and GHG emissions to the existing levels, which are based on billing data.

Table 1 shows annual energy consumption data which was taken from utility bills and used to calculate the annual GHG emissions. These values will be used to develop a baseline for how this building currently performs with respect to target emission values.

Table 1: Existing Annual Energy Consumption and Carbon Emissions

Electric (kWh)	Oil (Gallons)	GHG Emissions (Metric Tons CO2e)	Building Area (ft^2)	EUI (kBtu/ft2)	CEI (MTCO2e/ ft^2/yr)
209,163	13,101	187	34,886	72.3	0.005351

[1] The energy savings presented within this CBA report may differ from the energy savings that the Sponsors of Mass Save consider for incentives in the energy efficiency programs, which must follow regulatory and evaluation standards.

Table 2 summarizes the energy efficiency ECMs, showing estimated annual electricity and fossil fuel savings, energy cost savings and emissions reductions, as well as estimated project costs. See table 3 for Electrification ECMS.

Table 2: Executive Summary of Proposed EE ECMs

#	Measure Description	Electric Savings (kWh)	Oil (Gallons)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated install cost	Simple Payback (Years)
ECM-1	Control Sequences: HWOAT Reset, DCV for AHU-2 and 3	377	419	2.8%	$1,201	$20,000	16.6
ECM-2	Boiler Circulation Pump and DHW Pump EC Motors	1,028	0	0.1%	$320	$4,800	15.0
ECM-3	ERVs for AHUs	-853	412	2.6%	$799	$100,000	-
ECM-4	Repair Timeclock for Exterior Lighting	1,183	0	0.1%	$368	$200	0.5
Total Savings and Costs		1,735	831	-	$2,687	$125,000	46.5
Percent Reductions		0.8%	6.3%	5.6%	-	-	-

Notes:

1. Energy cost savings are based on $2.585/gallon of fuel oil based on fuel oil delivery invoices provided by the customer.
2. Energy cost savings are based on $0.311/kWh which is a default utility rate provided by MassSave.
3. GHG Emissions reductions listed are based on total site consumption, which includes the electric meter and oil delivery data.

Table 3 summarizes the electrification ECMs, showing estimated annual electricity impacts and fossil fuel savings, energy cost savings and emissions reductions, as well as estimated project costs. Electrification measures should assume that EE ECMs affecting displaceable fossil fuel loads are implemented prior to electrification.

Table 3: Executive Summary of Proposed ELX ECMs

#	Measure Description	Cooling Electric impacts (kWh)	Heating Electric impacts (kWh)	Oil Savings (gallons)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated installed Cost	$/ Lifetime GHG reduction
ELX-1A	Air to Water Partial	-23,134	-110,400	8,353	45.5%	-$19,937	$712,400	$493
ELX-1B	Air to Water Full	-23,134	-171,178	12,194	66.5%	-$28,910	$2,626,000	$1,245
ELX-1C	Cascading Air to Water Full	-23,306	-183,359	12,194	70.8%	-$28,738	$2,818,400	$1,255
ELX-2A	Air to Air Partial	-23,134	-92,437	6,707	36.0%	-$18,606	$670,800	$588
ELX-2B	Air to Air Full	-23,134	-174,105	12,194	66.3%	-$29,821	$1,313,000	$624
ELX-3	GSHP	-19,805	-158,649	12,194	67.6%	-$23,979	$9,945,000	$3,154
ELX-4	HP DHW Heater	0	-774	74	0.4%	-$48	$15,500	$1,127

Notes:

1. Energy cost savings are based on $2.585/gallon of fuel oil based on fuel oil delivery invoices provided by the customer.
2. Energy cost savings are based on $0.311/kWh which is a default utility rate provided by MassSave.
3. GHG Emissions reductions listed are based on total site consumption, which includes the electric meter and oil delivery data.

Local Ordinances

While there are no legally binding local ordinances regarding benchmarking or carbon emissions, the town takes decarbonization of the municipal assets seriously. As a participant in the Massachusetts Green Communities program, the Shutesbury Select Board created the Energy and Climate Action Committee to coordinate within the town to reduce GHG emissions and electrify municipal buildings. As of 2025, Shutesbury has been awarded over $365,000 in Green Communities grants and has become a Climate Leader Community.

Next Steps

ECM-1: Control Sequences - HWOAT Reset, DCV for AHU-2 and 3

The site should have an assessment performed by their preferred controls vendor to determine what kind of sensors and additional components may be needed to utilize the proposed control sequences. This controls vendor should be responsible for commissioning the equipment and ensuring it is integrated with the existing BMS. The controls vendor should also provide training for the facility's staff.

ECM-2: Boiler Circulation Pump and DHW Pump EC Motors

The site should contact a verified contractor to replace all existing boiler circulation pump motors and DHW motors with electronically commutated motors that can vary speed with demand.

ECM-3: ERVs for AHUs

The site should contact a verified HVAC design engineer and contractor to develop a plan to implement ERVs within the existing AHUs. This will need to include feasibility analysis on the existing AHUs in conjunction with a plan for re-routing the exhaust air flow back to the respective ERV.

ECM-4: Repair Timeclock for Exterior Lighting

A qualified electrician should be hired to repair and reconnect a time clock to effectively manage the exterior lighting.

ELX-1A/1B: A2WHP – Boiler Plant (Full & Partial Electrification)

Engage with HVAC design engineers to perform a detailed heating load analysis and evaluate existing terminal equipment compatibility with low-temperature heating water. The design should include equipment sizing, plant configuration, thermal storage requirements, electrical infrastructure impacts, and phasing considerations.

ELX-2A/2B: ASHPs (Full & Partial Electrification)

Work with a mechanical contractor to assess locations where ASHP units can be installed. The contractor should develop detailed scope of work that considers locations for refrigerant coils and outdoor condensing units. They will need to be involved with controls integration and associated electrical upgrades. Unit capacities and outdoor equipment locations should be confirmed during design. The facility should ensure that they keep in mind ways to limit refrigerant piping in and throughout the space to maintain compliance with health and safety practices.

ELX-3: Ground Source HP

Work with design engineers, contractors, and vendors to further develop the potential GSHP scope of work following the ground bore hole testing that has already been completed. A detailed technical assistance study should be conducted to closely identify the building's required heating load and estimated costs for implementation.

ELX-4: HP DHW

Work with a plumbing contractor to disconnect the existing oil-fired water heater and install a heat pump water heater (HPWH). Electrical work will be required. Additional storage for the tanks will be required so locations and the availability of space will need to be assessed.

INTRODUCTION & BACKGROUND

The objective of this study is to identify energy efficiency and decarbonization measures, and to perform a high-level evaluation of likely energy, emissions, and cost savings.

This report includes a summary of existing equipment and operations as well as our recommended ECMs. The RISE Group, Inc. conducted a site visit to collect nameplate and operational data from each building's major equipment and reviewed available drawings and utility data in order to document existing equipment, controls, and sequences of operation. This study provides associated high-level estimates of energy and cost savings and order of magnitude simple payback estimates.

FACILITY DESCRIPTION

Shutesbury Elementary School is 34,886 ft^2 and was originally constructed in 1994. It is located at 23 West Pelham Rd in Shutesbury, MA and is arranged around a small central courtyard. The main school space is a single floor and consists of classrooms, administration offices, a cafeteria/gymnasium/auditorium, library/media center, and typical common spaces of an elementary school.

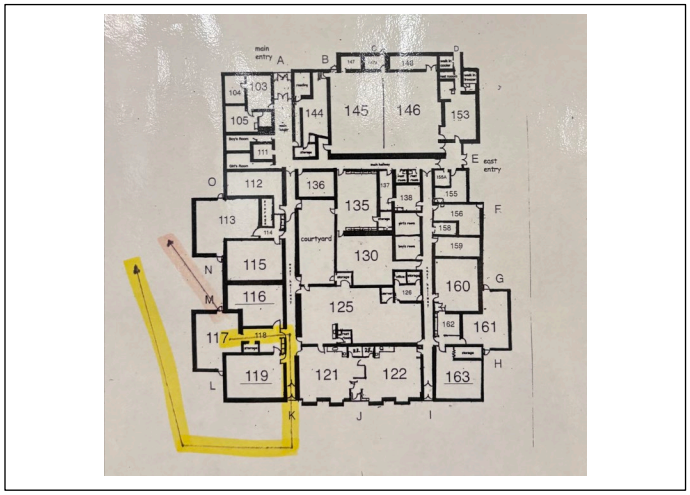


Figure 1: Building Layout

The building is wood framed and is constructed such that it is typical for school buildings of the time. The school accommodates around 127 students from preschool through sixth grade and has about 25 staff members. Since the initial construction, the school has not had any significant renovations or structural changes although there have been upgrades through the years such as new roofing, new windows, new doors, and other envelope improvements.

The entire facility is heated, which is achieved through forced air duct heating from the AHUs, hydronic unit ventilators (UVs), and hydronic baseboard radiators. There is no permanent cooling in the school other than in the library/computer room and the IT closet. Some rooms, such as the offices, have window A/C units installed during the warmer months.

The most pressing concern for the school is the oil tank, which is located in an underground vault under the turnaround, on the opposite side of the building from the boiler room. The oil from the

tank is pumped to a day tank in the boiler room, where it is then used by the heating and DHW systems. Last year, there was an oil leak from the tank into the vault, which was then pumped out by the sump pump. The problem is currently under control and everything is in compliance with the state, though a new $20-25k oil leak alarm will be required to keep using the current tank. Due to its unreliability, this oil tank will need to be removed, which will cost approximately $25-50k. A new above ground tank could be added near the boiler room for an additional $25-50k; however, this would be postponing the decarbonization of the school which does not align with the previously mentioned decarbonization goals.

The town is very committed to decarbonization and are looking into all possibilities, including ground source heat pumps in which they had a preliminary study completed by Brightcore in May 2026.

Hours of Operation & Occupancy

The typical school day is from 8:15 AM-2:55 PM, except Wednesday, which is from 8:15 AM-1:00 PM, excluding standard holidays and other typical closures. Custodians begin turning on systems and getting the school ready for occupants at 7:00AM. The custodians and staff usually stay in the building until 5:00PM. There are afternoon activities that take place on a regular basis. The activities run from 2:55 PM-4:40 PM on a typical day and from 2:55 PM-3:00 PM on Wednesdays. The school is closed during the summer months.

Building Envelope

Shutesbury Elementary School was built in 1994 and is consistent with the construction codes and requirements of that era. Although detailed information regarding the construction materials and insulation types were not able to be identified visually on site, the building assessment document provides further insight.

The facility is constructed on a concrete slab. The exterior walls throughout the facility are comprised of wooden clapboard over CMU. The estimated R-value based on the year of construction is approximately R-12.5.

The school replaced the flat white TPO roof in 2022 and replaced the asphalt shingles on the pitched roof in 2023. 12 inches of fiberglass insulation is noted in the attic, though some has been compressed. The roof insulation is expected to be approximately R-30. No significant deficiencies have been reported.

During the on-site assessment, it was noted that all windows and doors at the facility were in good condition with minimal gaps in the weatherstripping. The building was air-sealed and weatherized in 2024 as part of a Green Communities grant.

Based on the building assessment, the windows are original. The windows are wood-framed and metal-framed with double-paned glass. All seals around the observed windows were in good condition. There is no recommendation to replace or upgrade these windows as an improvement

measure and load reduction strategy ahead of full electrification. Furthermore, the windows throughout the facility appeared to make up about 15% of the exterior wall space.

LIGHTING SYSTEMS

Shutesbury Elementary School currently operates mainly LED fixtures with built-in occupancy sensors. All exterior lighting fixtures including wall packs, canopy lights, and pole lights were also observed to be LED. There are no building-wide controls for the lighting as they are turned on and off locally. The exterior lights are controlled by a time clock, which was disconnected and in need of repair during the site visit. Furthermore, there is a panel in the main electrical room that can provide emergency power from the generator to some lighting circuits when needed.



Figure 2: Typical LED Fixture

DOMESTIC HOT WATER

The domestic hot water load at this facility is served by one 315 MBH A.O. Smith oil-fired DHW heater installed in 2020. This unit has a nominal capacity of 84 gallons and operates at an efficiency of 82%. There is also a DHW storage tank that was likely installed when the building was built. The building's circulation loop is served by a pair of lead/lag Bell & Gossett 1/12 hp pumps. Neither of the pumps are ECM motors that can modulate speed based on demand. Most of the DHW piping is insulated although the insulation is slightly aged.

Although there are no reports that the existing DHW plant fails to meet demand, the site should consider replacing this oil-fired equipment at the end of its useful life with a higher efficiency heat pump system. If possible, the day tank could be used to store the oil for the DHW heater when the underground oil tank is removed and the boilers replaced with electric heating equipment.

AIR SIDE MECHANICAL: HEATING & COOLING

The building is heated by a combination of hydronic baseboard heaters and three AHUs. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium. These units are installed on the ceiling and so their nameplates could not be read during the site visit. However,

based on the piping and ductwork, they provide ventilation to the space and provide heating to the space by utilizing the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop within the AHU.



Figure 3: AHU-1

The library/media center is the only location that has permanently installed cooling. This space utilizes a heat pump mini split with three indoor fan coil head units. There is another heat pump mini split for the data room. Reportedly, window A/C units are often used in the office areas in the summer although these will be disregarded in the following analysis as they are temporary.

WATER SIDE MECHANICAL: HEATING & COOLING

The building is heated by two Weil McLain 810 MBH output boilers that were likely installed when the building was built. These boilers are approximately 85% efficient and operate primarily in a lead/lag configuration. The burners were replaced in 2022 with Carlin ignitors and Honeywell burner controls. The boilers each have a small Bell & Gossett fractional hp circulation pump and there are four Grundfos distribution pumps with Grundfos pump packages that supply the HHW to the building.



Figure 4: Boilers

According to the custodian, the hot water supply temperature (HWST) setpoint is a constant 180°F and does not reset based on outdoor air temperatures.

ELECTRICAL INFRASTRUCTURE

This facility has a single electric account and service providing power. The main distribution panel (MDP) is in the boiler room, opposite the boilers. This 3-phase, 4-wire MDP is rated for 600A and is original to construction. This 208/120V distribution panel is provided power from the main utility pad mounted transformer located outside of the facility. The MDP provides power to several 208V, 3-phase loads in addition to a step-down transformer that is used to provide 120/240V power to downstream equipment, lighting, and plug loads. There is a propane-fired generator outside with a transfer switch tied into an emergency lighting panel downstream of the MDP. The largest connected loads appear to be the lighting circuits, AHU-1, and the mini splits. It is expected based on lighting technologies between now (LED) and the time the school was built (T-8 Fluorescent) that the connected lighting load has been reduced by about half.

There used to be a small solar PV panel used by the students and teachers as an educational tool. However, this was removed at the end of its life and there is no solar PV currently in place.

Based on the building's peak kW, 61.6kW in January, the max connected load is approximately 200A. The existing electrical infrastructure has some spare capacity, but it is likely that any electrification and efficiency upgrades implemented at this facility will require some re-working of the connected loads.

The only equipment that consumes oil are the boilers and the DHW heater. Electrifying these systems will require a significant amount of electricity and the site may not be able to fully handle

these loads even if the oil-fired equipment is replaced with HP systems that can provide a Coefficient of Performance (COP) greater than 3 and a Seasonal Energy Efficiency Ratio (SEER) greater than 18. It is recommended that the facility works with an electrical engineer to determine if the existing infrastructure and current conditions can support decarbonization and efficiency upgrades discussed within this report.

Given the existing distribution capacity of the facility and the existing and connected loads, it is important to ensure that the distribution system can accommodate the new and electrified equipment displacing natural gas. Below is a table that estimates the total connected load, the existing capacity, and the connected load that would be added as a result of introducing heat pump systems.

Table 4: Electrical Capacity Review Summary

Existing Conditions		
Rated Capacity	**Estimated Peak Demand**	**Available Spare Capacity[2]**
600A	200A	280A
Proposed		
	Equipment	**Est. Additional Amps Required**
ELX 1a	Partial A2W	200 A
ELX 1b	Full A2W	250 A
ELX 2a	Partial ASHP	200 A
ELX 2b	Full ASHP	250 A
ELX 3	GSHP	250 A
ELX 4	HP DHW Heater	30A

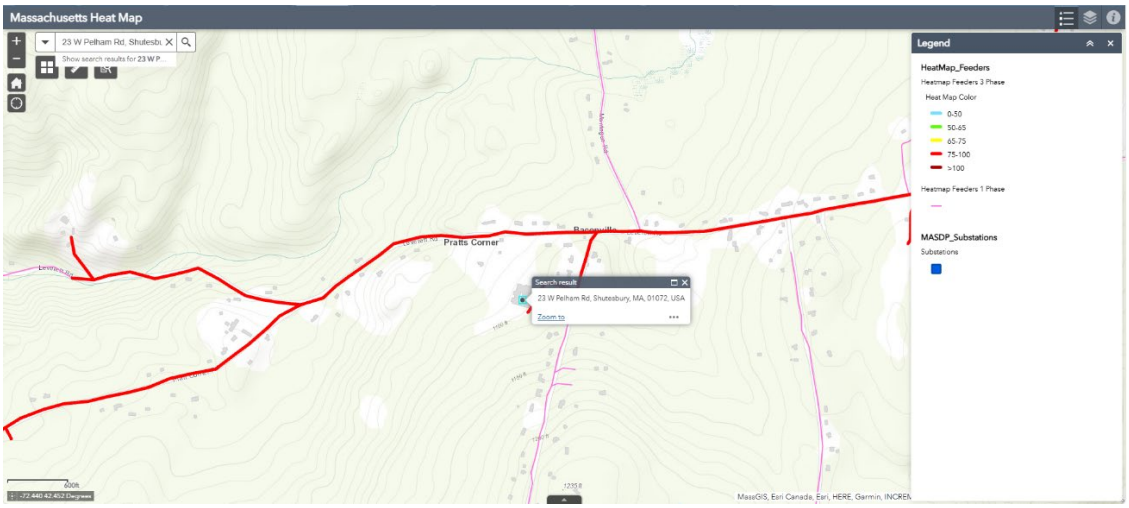
Rated capacity is based on the ratings observed on the main distribution panel nameplate. Peak Demand is from National Grid provided data. The amp draw of heat pumps is based on 3.5 amps/ton. Total tonnage estimated for entire school is based on 300 sqft/ton.

[2] Accounts for only loading a panel to 80% per NEC standards

LOCAL CAPACITIES

Based on the National Grid database showing local capacities within their electric distribution territories (Figure 5 below), this site has low capacity during the summer peaks. Electrification projects are not likely to impact summer peaks but will impact winter peaks as facilities continue to decarbonize and electrify their heating load. If the town decides to electrify this facility, the site will need to work with National Grid's "Step Zero" process which studies and checks available capacity if electrification is going to happen. It should be noted that grid capacity upgrades may not occur before the site's proposed or projected timeline to implement electrification upgrades. Early engagement with the utility is highly encouraged.

Figure 5: National Grid Heat Map



ENERGY MANAGEMENT SYSTEM

This facility was originally built to utilize a pneumatic control system, which was decommissioned in 2022 and replaced with a Schneider Electric DDC building management system (BMS) managed by CTC Inc. As part of this upgrade, all pneumatic three-way valves were replaced by Belimo two-way valves. Despite the up-to-date controls, the custodian and other staff responsible for operating the school on a daily basis do not have the login credentials or training. Therefore, it was not possible to determine if any energy saving sequences of operation are currently in place.

It is highly recommended that daily users have training on the system and are able to have at least read-only access so that it is easier to diagnose issues and maintain the system in a functional manner.

KITCHEN EQUIPMENT

Although there is no process system equipment used in the school area, there is a kitchen which currently utilizes electric powered equipment to cook food for the students. Two meals are cooked for the students every day. The equipment includes a stove with plancha, ovens, and warming drawers.



Figure 6: Cooking Equipment

EXISTING ON-SITE RENEWABLES

There used to be a small solar PV panel used by the students and teachers as an educational tool. However, this was removed at the end of its life and there is no solar PV currently in place. Based on the site visit and satellite imagery, there appears to be suitable space for a Solar PV array which should be considered in the near future to support the Massachusetts state emissions goals and to reduce operational utility costs. When the site fully electrifies, depending on the electric penalties incurred, the overall grid-based consumption, and the available space for a solar array, there is a chance the facility can offset or come close to completely offsetting grid-based fuel GHG emissions. The school district should consider working with MassCEC Technical Assistance Services to perform a Renewable Feasibility Assessment.

UTILITY INFORMATION

UTILITIES

Electricity Delivery: National Grid

Electric Accounts	
Rate Category	**Account number**
G2A	628504900

	Program Administrator	Utility Cost	Annual Usage	Annual Cost
Electric Delivery	National Grid	$0.311/kWh*	209,163	$65,050
Delivered Fuel (Oil)	Sprague	$2.585/Gallon	13,101	$33,864

**MassSave default electric rate*

ANNUAL SUMMARY

The graphs and discussion on the following pages are based on National Grid utility data and Sprague invoices. Based on the available usage data, the raw consumption for electricity for the 2025-2026 school year and the raw deliveries for oil for calendar years 2024-2025 is shown. Please note that neither June 2025 nor 2026 electrical data was available from the utility data so June 2025's consumption was assumed to be the same as July 2025.

A summary of the monthly electricity consumption is shown in the graphs below. Electricity data is normalized for the calculations within the report by multiplying the daily usage in a billing cycle by the days in the month of the billing cycle to improve comparison across years. Weather normalization is also performed on a monthly basis using the monthly electricity consumption data.

The oil deliveries are not weather normalized as they appear to be delivered an average of three times a year, presumably when the tank is low.

Provided that the facility mainly operates during the school year, the electric consumption during the summer months is somewhat lower than during months with more consistent occupancy. However, the usage from 2026 is slightly more than 2025 even after weather normalization. It is possible that this is simply a seasonal change, but it should be monitored to make sure that there is not a reason that the usage has increased.

This site is not enrolled in any Demand Response programs.

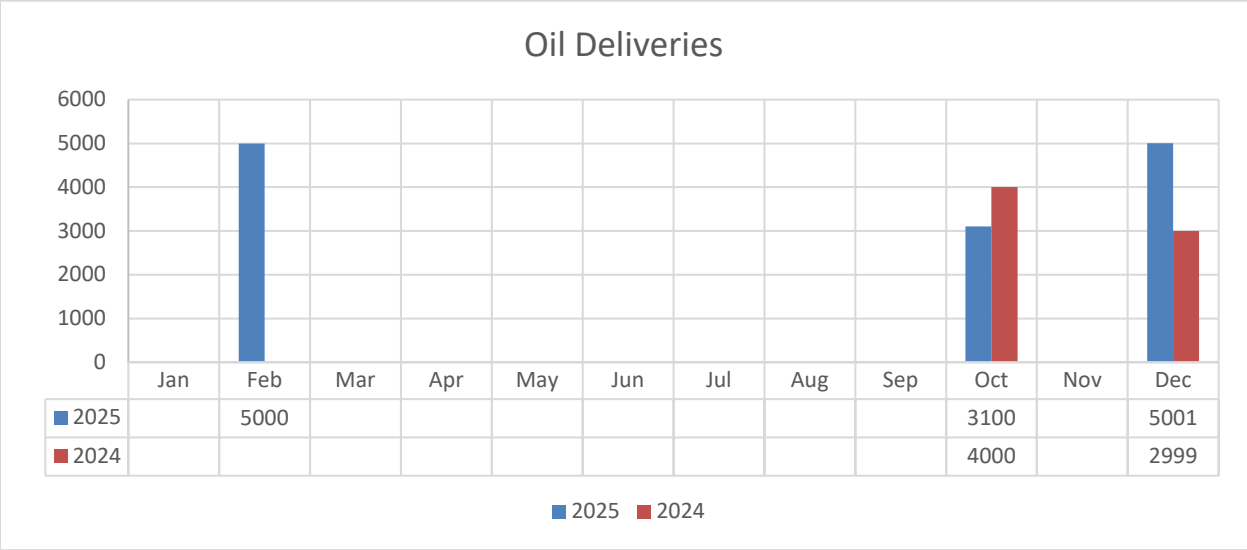


Figure 7: Monthly oil deliveries

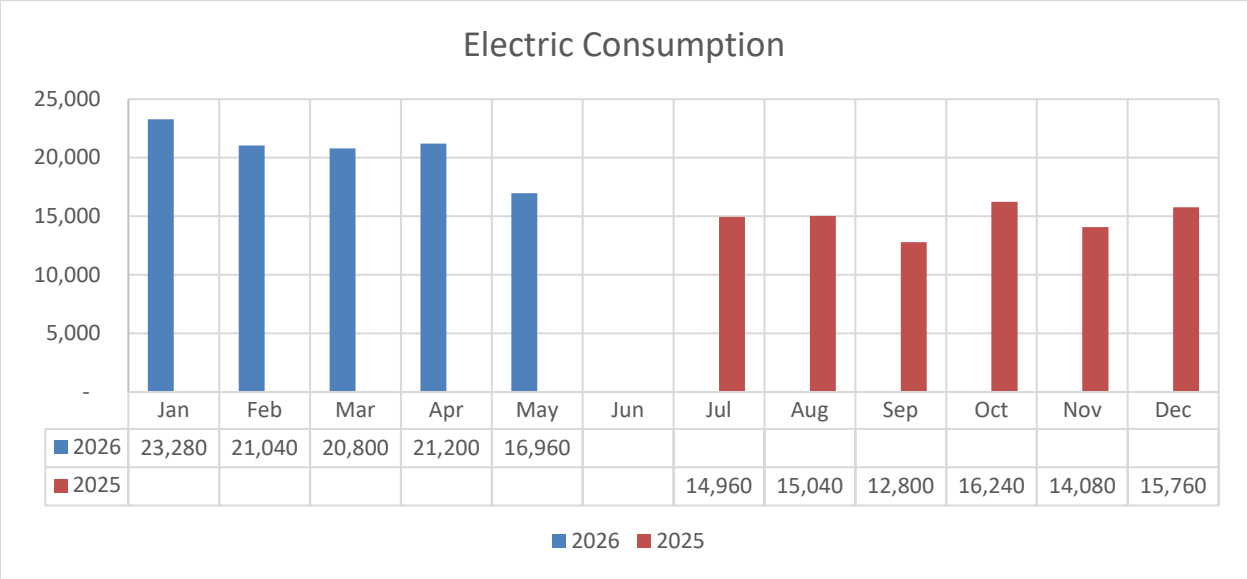


Figure 8: Monthly grid-based electricity consumption.

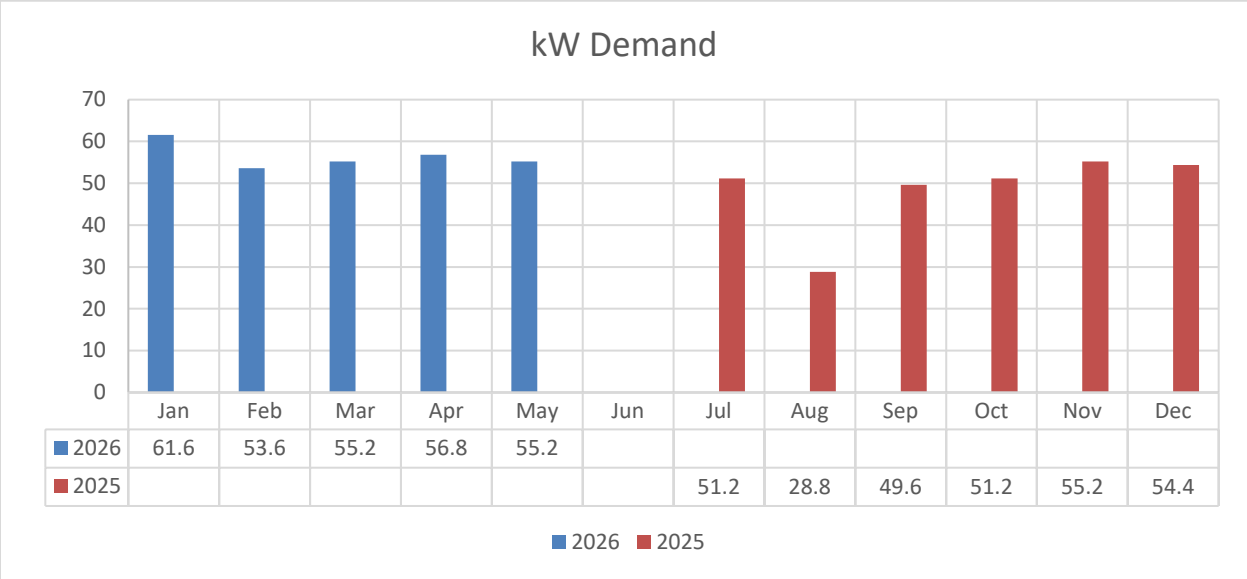


Figure 9: Monthly electric peak demand.

BENCHMARKING

Table 1 summarizes the annual energy use, energy use intensity (EUI), and carbon emissions index (CEI) for the building. Although Energy Star Portfolio Manager (ESPM) access for this site was not provided and is not used in this analysis, the usage data can still be compared and benchmarked with respect to values for buildings of the same usage type defined by Energy Star and the Commercial Building Energy Consumption Survey (CBECS)[3]. A review of Energy Star metrics indicates that this building is consuming more energy than others of its size, with a calculated EUI of 72.3 kBtu/ft^2 compared to the median EUI of 48.5 kBtu/ft^2 for Elementary Schools (according to CBECS). This is likely due to the high impact fuel oil has on the total EUI and given the age of the facility. The fuel oil is responsible for more than 50 kBtu/ft^2 of the site EUI (more than 70%). Based on the electric penalties associated with full electrification within this report, removing fuel oil and relying solely on electricity can reduce the site EUI by about 40% (well below the CBECs median EUI for this building use type).

Additionally, the site currently has a GHG emissions intensity of 5.35 kg CO_2e/ft^2 (or .00535 $MTCO_2e$/ft^2) and emits approximately 187 $MTCO_2e$ annually.

[3]https://www.energystar.gov/buildings/benchmark/understand_metrics/how_score_calculated

RESILIENCY

BACKUP GENERATOR

The school utilizes a propane-fired backup generator which is exercised regularly. Although the generator name plate was not accessible during the visit, this unit is expected to be about 75-100kW based on the size and form factor of the enclosure. There is a block heater and battery charger which is indicated by the load schedule within one of the electrical panels. This backup power is provided to emergency lighting circuits for egress during power outages and likely serves the heating plant to ensure there is some level of freeze protection. Other than the on-site generator, there is no other system such as BESS or other equipment that provides further resiliency to the site. When the site electrifies the heating load, this generator may not be large enough to handle that increased backup electric load.

ADDITIONAL RESILIENCY CONSIDERATIONS

As this facility only utilizes (1) backup generator, the only source of resiliency is this propane-fired unit. In the future, this site may benefit from the introduction of a battery energy storage solution (BESS) when the complete removal of fossil fuels is required by state and local energy codes. This battery backup system should be considered, especially when the generator reaches a point where it does not operate or carries large cost to maintain. This battery storage system can be tied into future solar infrastructure and provide backup power to emergency egress lighting and other emergency systems. The exact load of these emergency systems that are currently powered by the generator during outages is unknown. Sizing a battery storage system will need to account for the hours of use and the total load.

CLIENT'S GOALS & FUTURE PLANS & CONSIDERATIONS

As a member of the Climate Leadership level of Green Communities, the town is invested and committed to decarbonization and are looking into all possibilities, including ground source heat pumps; they had a preliminary study completed by Brightcore in May 2026.

The most pressing concern for the school is the oil tank, which is located in an underground vault under the turnaround, on the opposite side of the building from the boiler room. The oil from the tank is pumped to a day tank in the boiler room, where it is then used by the heating and DHW systems. Last year, there was an oil leak from the tank into the vault, which was then pumped out by the sump pump. The issue is currently under control and is in compliance with the state, though a new $20-25k oil leak alarm will be required to keep using the current tank. Due to its unreliability, this oil tank will need to be removed, which will cost approximately $25-50k. A new aboveground tank could be added near the boiler room for a further $25-50k; however, this would be postponing the decarbonization of the school.

Another upcoming project that the school is looking into is replacing the parking lot surface due to age and wear and tear. As part of this, they have shown interest in carport solar.

HEALTH AND SAFETY

Based on the age of the building, there is unlikely to be any lead or asbestos containing material that could be disturbed as part of recommended projects. The main concern is the possibility of further oil leaks from the underground tank.

POTENTIAL ECMS AND DECARBONIZATION MEASURES

The following section provides suggestions for potential measures to reduce both energy consumption and GHG emissions at Shutesbury Elementary School. Compared to the preliminary and high-level nature of this study, the detailed TA study in the next step will provide a more rigorous analysis and may alter the recommended approach for each system type.

ENERGY EFFICIENCY MEASURES

ECM-1: CONTROL SEQUENCES: HWOAT RESET, DCV FOR AHU-2 AND 3

SUMMARY

Annual Electric Savings (kWh)	Annual Oil Savings (Gallons)	Annual GHG Emissions Reduction (Metric tons CO_2e)	Annual Energy Cost Savings	Estimated Installed Cost	Simple Payback (Years)
377	419	5.17	$1,201	$20,000	16.6

EXISTING CASE

The existing controls at this facility are up to date but were not able to be observed during the site visit as local staff are not able to access the system. Reportedly, the HWST setpoint is always 180°F when the boilers are running.

PROPOSED CASE

It is highly recommended that daily users have training on the system and are able to have at least read-only access so that it is easier to diagnose issues and maintain the system in a functional manner. As it is unknown if the equipment is scheduled, the town should verify what control sequences are in place and implement night setbacks, scheduling, and start/stop time optimization if not already in place. These savings have not been accounted for in this measure in case they are already implemented.

Based on the interview with the custodian, it is unlikely that hot water outdoor air temperature (HWOAT) reset or demand control ventilation (DCV) is currently in place. RISE recommends that the HWST setpoint be reset linearly from 180°F at 20°F (adj.) OAT to 140°F at 50°F (adj.) OAT. To implement DCV, CO_2 sensors should be installed in the gym and linked to the OA dampers, allowing them to bring in outdoor air only when the space is occupied.

INSTALLATION COST

This measure has an estimated installation cost of $20,000. This includes hardware, installation labor, programming labor, and project management time. This cost is an estimate based on previous experience with similar projects. Depending on the total number of points and sequences needed within the system and the various zones, this cost may vary significantly. This measure may be eligible for incentives through MassSave.

ECM-2: Boiler Circulation Pump and DHW Pump EC Motors

Summary

Annual Electric Savings (kWh)	Annual Oil Savings (Gallons)	Annual GHG Emissions Reduction (Metric tons CO_2e)	Annual Energy Cost Savings	Estimated Installed Cost	Simple Payback (Years)
1,028	0	0.13	$320	$4,800	15.0

Existing Case

During the site visit it was noted that the fractional hp motors on the pumps for the boiler circulation and the DHW distribution are not equipped with any sort of speed control.

Proposed Case

It is recommended that the existing constant-speed circulation pump be replaced with a high-efficiency electronically commutated (EC) motor pump equipped with integrated speed control. An EC motor circulator would modulate pump speed based on system demand, temperature differentials, or programmed schedules, significantly reducing electrical energy consumption during periods of low or no demand. In addition to energy savings, the reduced operating speed and runtime would decrease mechanical wear, extend equipment life, and improve overall system reliability while maintaining adequate domestic hot water availability throughout the facility.

Installation Cost

This measure has an estimated installation cost of $4,800. This is based on replacing the existing motors with EC motors and the full integration to a connected management software. This cost is an estimate based on prior experience and real-world examples. There are likely prescriptive incentives through Mass Save.

ECM-3: ENERGY RECOVERY VENTILATORS (ERVS) FOR AHUS

SUMMARY

Annual Electric Savings (kWh)	Annual Oil Savings (Gallons)	Annual GHG Emissions Reduction (Metric tons CO_2e)	Annual Energy Cost Savings	Estimated Installed Cost	Simple Payback (Years)
-853	412	4.92	$799	$100,000	-

EXISTING CASE

Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium. As these were on the ceiling, their nameplates were not able to be read; however, based on the piping and ductwork, they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU. There is no current energy recovery equipment.

PROPOSED CASE

As part of the electrification measures recommended in the next section, the AHUs should have energy recovery ventilators (ERVs) added to them so that conditioned air can transfer its heat to the outdoor air, reducing the amount of conditioning that will need to be done to the fresh air. This should be done during whichever electrification option is selected, as the coils within the AHUs will likely need to be changed regardless of the selection.

This approach would allow heat to be transferred between the exhaust and incoming outdoor air streams without direct air mixing, improving overall ventilation efficiency while maintaining proper air quality. By recovering energy that would otherwise be exhausted from the building, the ERV would reduce the heating demand on the existing AHUs during cold weather and help stabilize supply air temperatures, resulting in lower energy consumption, improved system performance, and reduced operating costs for the school. While the upfront installation cost may appear high relative to the modeled energy savings, these calculations do not fully capture the broader energy efficiency benefits, including reduced peak heating loads, improved system performance, enhanced occupant comfort, and long-term operational resilience. Depending on the size of the unit, an ERV may be required by code.

INSTALLATION COST

The cost for this measure is estimated to be $65,000, which accounts for the combined cost of materials and hardware installation labor. This cost is an estimate based on previous experience with similar projects and industry standard pricing. Custom incentives through Mass Save may be available for this measure.

ECM-4: REPAIR TIMECLOCK FOR EXTERIOR LIGHTING

SUMMARY

Annual Electric Savings (kWh)	Annual Oil Savings (Gallons)	Annual GHG Emissions Reduction (Metric tons CO_2e)	Annual Energy Cost Savings	Estimated Installed Cost	Simple Payback (Years)
1,183	0	0.15	$368	$200	0.5

EXISTING CASE

There is a time clock in the boiler room connected to the exterior lighting. At the time of the site visit, it was disconnected from the circuit, causing the exterior lighting to be on at all times. The staff is aware of the issue and plans to fix it. All existing exterior lighting is already LED so the controlled watts and energy waste is much less than if the fixtures were metal halide or incandescent.

PROPOSED CASE

Reconnecting and utilizing the time clock will prevent electricity from being wasted by lighting the exterior during daylight hours.

INSTALLATION COST

The cost for this measure is $200 for the installation labor as the existing time clock is still in place. If this is able to be performed internally, there may be no direct costs. If the timeclock needs to be replaced, it is estimated that will cost about $100-200 extra. The site may also be able to install a photocell if desired instead of a timeclock to achieve the same result.

ELECTRIFICATION MEASURES, TECHNOLOGIES CONSIDERED

Shutesbury Elementary School has expressed interest in furthering their decarbonization goals through full electrification of their main heating system and other measures to reduce and improve energy consumption. As part of this study, replacing the existing oil-fired equipment serving the space heating equipment and DHW equipment was reviewed. There is no other oil-fired equipment, but the backup generator operates on propane. There is already some use of heat pump technology but that can be further expanded throughout the site.

Electrification planning can be coordinated with future equipment replacement projects that would likely occur under a business-as-usual scenario, helping to offset the incremental costs associated with decarbonization.

Several technologies were considered, including air-to-water heat pumps (A2WHPs), air-source heat pumps (ASHPs), and ground-source heat pumps (GSHPs).

Both partial and full electrification were reviewed as part of this assessment. From a decarbonization perspective, full electrification represents the preferred long-term solution, provided the site's electrical infrastructure and grid provided service can accommodate the increased winter peak demand associated with all-electric heating. Under such a scenario, the existing boilers could be retained primarily for resilience and emergency backup rather than as a critical component of day-to-day heating operation. The proposed measures are intended to be practical and cost-effective pathways that balance emissions reductions, equipment life-cycle considerations, project cost, and facility operational requirements.

Additional information on each option can be found in their respective ECM sections. All results including energy calculations, costs, and applicable incentives are preliminary and are used to provide the site with recommendations to reach EUI and CEI target goals. It is important to note that new technologies are being rapidly developed, giving way to more market-ready and market-available Heat Pump options with higher COPs during design day temperatures. This facility will need to both displace fuel oil and reduce electric consumption to reach its emissions goals and using equipment with high efficiencies at low temperatures will need to be considered. Furthermore, based on the age of the site and the availability of information, a detailed study on ventilation rates with respect to ventilation requirements should be performed to ensure the health and safety of the occupants.

TECHNICAL FEASIBILITY

The following table discusses the various types of Electrification of HVAC solutions that are commonly used. Although not all electrification options are mentioned as feasible options recommended specifically for Shutesbury Elementary School the table can provide further understanding as to the advantages and disadvantages to support the decision-making process for future ELX upgrades. The listed advantages and disadvantages typically apply to the ELX scenarios listed but are not necessarily applicable to all situations and all facilities such as whether electrical infrastructure upgrades are required or if new hydronic piping infrastructure is needed.

Option	Advantages	Disadvantages
Air to Water Partial	• Allows for redundancy with dual fuel sources • Can use existing hydronic hot water distribution system • One centralized piece of equipment could be easier to operate and maintain compared to multiple distributed compressors for each area for existing staff • Service upgrade likely not required	• Limited added cooling without extensive and expensive piping and coil changes • Heating capacity decreases as outside air temperature decreases • Oil tank will need to be replaced • Boilers remain in place
Air to Water Full	• Can use existing hydronic hot water distribution system • One centralized piece of equipment could be easier to operate and maintain compared to multiple distributed compressors for each area for existing staff • Cooling available • Full electrification and removal of oil possible	• Service upgrade likely required • Limited added cooling without extensive and expensive piping and coil changes • Heating capacity decreases as outside air temperature decreases
Air to Air Partial	• Allows for redundancy with dual fuel sources • Can use existing hydronic hot water distribution system for supplementary heat • Air conditioning is now provided to space • Service upgrade likely not required	• Oil tank will need to be replaced • Boilers remain in place • Increased points of failure/pieces of equipment to maintain from smaller, distributed equipment • Potential safety / maintenance concern of refrigerant in occupied spaces or aesthetic concern for exterior piping • Likely requires architectural locations to mount indoor units on walls or in ceilings • Maximum capacity per heat pump circuit/condenser unit is typically relatively limited (20-30 tons each) requiring many parallel distribution systems to serve a large building. This may also create a challenge for electrical distribution.
Air to Air Full	• Allows for full electrification • Air conditioning is now provided to space where it does not currently exist • More efficient at low ambient temperatures than A2W	• Service upgrade likely required • Increased points of failure/pieces of equipment to maintain from smaller, distributed equipment • Potential safety / maintenance concern of refrigerant in occupied spaces • Likely requires architectural locations to mount indoor units on walls or in ceilings • Maximum capacity per heat pump circuit/condenser unit is typically relatively limited (20-30 tons each) requiring many parallel distribution systems to serve a large building. This may also create a challenge for electrical distribution.
GSHP	• Better efficiencies at lowest ambient temperature • Cooling available • Full electrification possible • Service upgrade likely not required	• High install cost versus increase in savings

ELX-1A: AIR TO WATER HEAT PUMP: PARTIAL DISPLACEMENT

SUMMARY

	Estimated HP Cooling Capacity (Tons)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
Heating	52	-110,400	8,353	87.9		-$12,743			13,193
Cooling	52	-23,134	0	-3.0		-$7,195			-1,342
Total	52	-133,534	8,353	84.9	45.5%	-$19,937	$712,400	$493	11,851

EXISTING CASE

The building is heated by a combination of hydronic baseboard heaters and three AHUs. The 180° F HHW is provided by two 85% efficient Weil McLain 810 MBH output boilers that were likely installed when the building was built. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium; they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU.

PROPOSED CASE

This measure proposes that one of the boilers is replaced with an air to water heat pump (A2WHP). This heat pump will produce heat for the HHW loop above 25°F. Below this temperature threshold the remaining oil boiler will produce hot water for space heating below that outdoor air temperature. The minimum heat pump tonnage (heating capacity) required for this facility was determined to be 52 tons, which was based on 300 square feet per ton and a switchover temperature of 25°F. In addition, through valving or additional piping, the A2WHP will be able to provide chilled water to AHU-1 and possibly AHU-2 and 3, depending on cost. This will temper the air provided to the classrooms, if not fully cool the building during the warmer months. Any piping running chilled water should be properly insulated.

An A2WHP system would require storage tanks (a.k.a., buffer tanks) to store heated water to manage the proper temperature, volume, and flow in the system. At six gallons per ton, this option would require storing approximately 312 gallons of heated water in approximately three 120 gal tanks. For the longevity and overall efficiency of the tank(s), it is recommended that they are located indoors. However, if there is no room indoors for the tanks, they can be located outside, so long as they are properly weatherized and have glycol in the system to prevent freezing. When determining if there is enough room in the Boiler Room and the adjacent room, the electric, plumbing, and any other applicable codes for the existing equipment in the space should be considered in order to ensure that the new setup is compliant.

INSTALLATION COST

This measure is estimated to cost approximately $712,400 based on industry standards and prior experience. This total includes the estimated cost of a new 52-ton A2WHP system, three water storage tanks, and upgrades to the piping for AHU-1. This also includes the new $20-25k oil leak alarm, the $25-50k existing oil tank removal, and a new $25-50k aboveground tank, using the low ends of the estimates. Please note that the costs are high-level estimates based on similar projects and may vary due to recent tariffs and general inflation. Incentives for heat pumps are available through the sponsors of MassSave.

Item	Qty	Unit Price	units	total
A2W HP	52	$ 9,000	/Tons	$ 468,000
Terminal unit upgrade	1	$ 10,000	each	$ 10,000
Oil Tank Upgrade	1	$ 70,000	each	$ 70,000
O&P		10%		
Contingency		5%		
Commissioning		5%		
Engineering		10%		
Total				$ 712,400

ELX-1B: Air to Water Heat Pump: Full Displacement

Summary

	Estimated HP Cooling Capacity (Tons)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
Heating	70	-171,178	12,194	127.0		-$21,716			18,679
Cooling	52	-23,134	0	-3.0		-$7,195			-1,342
Total	70	-194,312	12,194	124.1	66.5%	-$28,910	$2,626,000	$1,245	17,337

Existing Case

The building is heated by a combination of hydronic baseboard heaters and three AHUs. The 180° F HHW is provided by two 85% efficient Weil McLain 810 MBH output boilers that were likely installed when the building was built. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium; they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU.

Proposed Case

This measure proposes that both of the boilers are replaced with a pair of air to water heat pumps (A2WHPs) for redundancy. The minimum heat pump tonnage (heating capacity) required for this facility was determined to be 70 tons, which was based on 300 square feet per ton. A study should be conducted to determine if the existing distribution system is able to heat the building with lower temperature HHW during the coldest days. If not, a cascading A2WHP system should be installed to produce higher temperature hot water or the coils should be replaced with ones rated for the lower temperature.

In addition, through valving or additional piping, the A2WHP will be able to provide chilled water to the AHUs and the terminal boxes, while not running this water through the perimeter radiators. This will cool the air provided to the building during the warmer months. Any piping running chilled water should be properly insulated.

An A2WHP system would require storage tanks (a.k.a., buffer tanks) to store heated water to manage the proper temperature, volume, and flow in the system. At six gallons per ton, this option would require storing approximately 420 gallons of heated water in approximately four 120 gal tanks. For the longevity and overall efficiency of the tank(s), it is recommended that they are located indoors. However, if there is no room indoors for the tanks, they can be located outside, so long as they are properly weatherized and have glycol in the system to prevent freezing. When determining if there is enough room in the Boiler Room and the adjacent room, the electric,

plumbing, and any other applicable codes for the existing equipment in the space should be considered in order to ensure that the new setup is compliant.

INSTALLATION COST

This measure is estimated to cost approximately $2,626,000 based on industry standards and prior experience. This total includes the estimated cost of two new 70-ton A2WHP systems, four water storage tanks, an electrical service increase, upgrades to the piping for the AHUs and terminal units, and potential coil upgrades or upgrading to a cascading heat pump. Please note that the costs are high-level estimates based on similar projects and may vary due to recent tariffs and general inflation. Incentives for heat pumps are available through the sponsors of MassSave.

Item	Qty	Unit Price	units	total
A2W HP	70 x 2	$ 9,000	/Tons	$ 1,260,000
Terminal unit upgrade	66	$ 10,000	each	$ 660,000
Service upgrade	1	$ 100,000	each	$ 100,000
O&P		10%		
Contingency		5%		
Commissioning		5%		
Engineering		10%		
Total				$ 2,626,000

ELX-1C: CASCADING AIR TO WATER HEAT PUMP: FULL DISPLACEMENT

SUMMARY

	Estimated HP Cooling Capacity (Tons)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
Heating	70	-183,359	12,194	135.11		-$21,490			20,257
Cooling	52	-23,306	0	-2.98		-$7,248			-1,352
Total	70	-206,665	12,194	132.13	71%	-$28,738	$3,139,500	$1,398	18,905

EXISTING CASE

The building is heated by a combination of hydronic baseboard heaters and three AHUs. The 180° F HHW is provided by two 85% efficient Weil McLain 810 MBH output boilers that were likely installed when the building was built. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium; they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU.

PROPOSED CASE

This measure proposes that both of the boilers are replaced with a pair of cascading air to water heat pumps (A2WHPs) for redundancy. The minimum heat pump tonnage (heating capacity) required for this facility was determined to be 70 tons, which was based on 300 square feet per ton. A study should be conducted to determine if the existing distribution system is able to heat the building with lower temperature HHW during the coldest days. If not, a cascading A2WHP system should be installed to produce higher temperature hot water or the coils should be replaced with ones rated for the lower temperature.

In addition, through valving or additional piping, the A2WHP will be able to provide chilled water to the AHUs and the terminal boxes, while not running this water through the perimeter radiators. This will cool the air provided to the building during the warmer months. Any piping running chilled water should be properly insulated.

An A2WHP system would require storage tanks (a.k.a., buffer tanks) to store heated water to manage the proper temperature, volume, and flow in the system. At six gallons per ton, this option would require storing approximately 420 gallons of heated water in approximately four 120 gal tanks. For the longevity and overall efficiency of the tank(s), it is recommended that they are located indoors. However, if there is no room indoors for the tanks, they can be located outside, so long as they are properly weatherized and have glycol in the system to prevent freezing. When determining if there is enough room in the Boiler Room and the adjacent room, the electric, plumbing, and any other applicable codes for the existing equipment in the space should be considered in order to ensure that the new setup is compliant.

INSTALLATION COST

This measure is estimated to cost approximately $2,818,400 based on industry standards and prior experience. This total includes the estimated cost of two new cascading 70-ton A2WHP system, four water storage tanks, an electrical service increase, and upgrades to the piping for the AHUs and terminal units. Please note that the costs are high-level estimates based on similar projects and may vary due to recent tariffs and general inflation. Incentives for heat pumps are available through the sponsors of MassSave.

Item	Qty	Unit Price	units	total
A2W HP	70 x 2	$ 11,000	/Tons	$ 1,540,000
Terminal unit upgrade	66	$ 8,000	each	$ 528,000
Service upgrade	1	$ 100,000	each	$ 100,000
O&P		10%		
Contingency		5%		
Commissioning		5%		
Engineering		10%		
Total				$ 2,818,400

ELX-2A: AIR SOURCE HEAT PUMP: PARTIAL DISPLACEMENT

SUMMARY

	Estimated HP Cooling Capacity (Tons)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
Heating	52	-92,437	6,707	70.1		-$11,411			10,373
Cooling	52	-23,134	0	-3.0		-$7,195			-1,342
Total	52	-115,571	6,707	67.1	36.0%	-$18,606	$670,800	$588	9,031

EXISTING CASE

The building is heated by a combination of hydronic baseboard heaters and three AHUs. The HHW is provided by two 85% efficient Weil McLain 810 MBH output boilers that were likely installed when the building was built. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium; they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU.

PROPOSED CASE

This measure proposes that each room is equipped with an air source heat pump (ASHP). The AHUs will also be replaced with packaged heat pump AHUs. These heat pumps will produce heat for the rooms for as long as they can, estimated to be 30°F, at which point the oil boiler will produce heating hot water for the radiators and terminal boxes to supplement the heat pumps. As it gets colder outside, more of the load will be shifted to the HHW loop. The minimum heat pump tonnage (heating capacity) required for this facility was determined to be 52 tons, which was based on 300 square feet per ton and an estimated supplemental heating temperature of 30°F. These ASHPs and ASHP AHUs will also provide full cooling to the building during the warmer months.

This measure calculated the savings and costs associated with standalone mini splits and heat pumps. If desired, this could instead be achieved with heat recovery variable refrigerant flow (VRF) units instead, which shares refrigerant between the indoor units to increase the efficiency of the system. In this case, it is recommended to run refrigerant piping on the outside of the building to avoid leaks within the occupied spaces.

Depending on code requirements, it may be possible to replace one of the boilers with a heating hot water storage tank similar to ELX-1 to provide a buffer for the hot water produced by the remaining oil boiler. This would be able to add flexibility and some resilience to the HW system while removing some of the oil-fired equipment.

INSTALLATION COST

This measure is estimated to cost approximately $670,800 based on industry standards and prior experience. This total includes the estimated cost of a new 52-ton ASHP system, removal of the three AHUs, and also includes the new $20-25k oil leak alarm, the $25-50k existing oil tank removal, and a new $25-50k aboveground tank, using the low ends of the estimates. Please note that the costs are high-level estimates based on similar projects and may vary due to recent tariffs and general inflation. Incentives for heat pumps are available through the sponsors of MassSave.

Item	Qty	Unit Price	units	total
AHU ASHPs	52	$ 8,000	/Tons	$ 416,000
AHU demo	3	$ 10,000	each	$ 30,000
Oil tank upgrade	1	$ 70,000	each	$ 70,000
O&P		10%		
Contingency		5%		
Commissioning		5%		
Engineering		10%		
Total				$ 670,800

ELX-2B: Air Source Heat Pump: Full Displacement

Summary

	Estimated HP Cooling Capacity (Tons)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
Heating	70	-174,105	12,194	126.7		-$22,626			18,509
Cooling	52	-23,134	0	-3.0		-$7,195			-1,342
Total	70	-197,239	12,194	123.7	66.3%	-$29,821	$1,313,000	$624	17,167

Existing Case

The building is heated by a combination of hydronic baseboard heaters and three AHUs. The HHW is provided by two 85% efficient Weil McLain 810 MBH output boilers that were likely installed when the building was built. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium; they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU.

Proposed Case

This measure proposes that each room is equipped with an air source heat pump (ASHP). The AHUs will also be replaced with packaged heat pump AHUs, and the terminal units will have their coils removed. The HHW piping and radiator system will either be removed or capped and abandoned in place. The minimum heat pump tonnage (heating capacity) required for this facility was determined to be 70 tons, which was based on 300 square feet per ton. These standalone ASHPs and ASHP AHUs will also provide full cooling to the building during the warmer months.

This measure calculated the savings and costs associated with standalone mini splits and heat pumps. If desired, this could instead be achieved with heat recovery variable refrigerant flow (VRF) units instead, which shares refrigerant between the indoor units to increase the efficiency of the system. In this case, it is recommended to run refrigerant piping on the outside of the building to avoid leaks within the occupied spaces and to avoid any health and safety concerns.

INSTALLATION COST

This measure is estimated to cost approximately $1,313,000 based on industry standards and prior experience. This total includes the estimated cost of a new 70-ton ASHP system, including three AHU ASHPs and standalone ASHPs for each room, removal of the three AHUs and (32) terminal box coils, and an electrical service increase. Please note that the costs are high-level estimates based on similar projects and may vary due to recent tariffs and general inflation. Incentives for heat pumps are available through the sponsors of MassSave.

Item	Qty	Unit Price	units	total
AHU ASHPs	52	$ 8,000	/Tons	$ 416,000
Supplemental ASHPs	18	$ 8,000	/Tons	$ 144,000
Existing AHU demo	3	$ 10,000	each	$ 30,000
Existing terminal box demo	32	$ 10,000	each	$ 320,000
Service upgrade	1	$ 100,000	each	$ 100,000
O&P		10%		
Contingency		5%		
Commissioning		5%		
Engineering		10%		
Total				$ 1,313,000

ELX-3: GEOTHERMAL SYSTEM

SUMMARY

	Estimated HP Cooling Capacity (Tons)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
Heating	70	-158,649	12,194	128.6		-$17,819			28,538
Cooling	52	-19,805	0	-2.5		-$6,159			-1,689
Total	70	-178,454	12,194	126.1	67.6%	-$23,979	$9,958,000	$3,159	26,848

EXISTING CASE

The building is heated by a combination of hydronic baseboard heaters and three AHUs. The HHW is provided by two 85% efficient Weil McLain 810 MBH output boilers that were likely installed when the building was built. Two of the AHUs (AHU-2 and 3) are small and serve the cafeteria/gym/auditorium; they provide ventilation to the space and are heated by the heating hot water loop. The main AHU (AHU-1) serves the ventilation air to the rest of the school via ductwork in the drop ceiling. There are VAV boxes (operated as constant volume) in the ceilings with hot water heating coils on Belimo two-way valves connected to local thermostats. This fresh air is also tempered by the heating hot water loop at the AHU.

PROPOSED CASE

This measure proposes that both of the boilers are replaced with ground source heat pumps (GSHPs) with wells in the adjacent field. The minimum heat pump tonnage (heating capacity) required for this facility was determined to be 70 tons, which was based on 300 square feet per ton. A study should be conducted to determine if the existing distribution system is able to heat the building with lower HHW distribution temperatures during the coldest days. If not, the distribution system will need to be replaced. In addition, through valving or additional piping, the GSHP will be able to provide chilled water to the AHUs and the terminal boxes, while not running this water through the perimeter radiators. This will cool the air provided to the building during the warmer months. Any piping running chilled water should be properly insulated.

The GSHP system may benefit from storage tanks (a.k.a., buffer tanks) to store heated water to manage the proper temperature, volume, and flow in the system. For the longevity and overall efficiency of the tank(s), it is recommended that they are located indoors. However, if there is no room indoors for the tanks, they can be located outside, so long as they are properly weatherized and have glycol in the system to prevent freezing. When determining if there is enough room in the Boiler Room and the adjacent room, the electric, plumbing, and any other applicable codes for the existing equipment in the space should be considered in order to ensure that the new setup is compliant.

INSTALLATION COST

This measure is estimated to cost approximately $9,958,000 based on industry standards and prior experience. This total includes the estimated cost of a new 70-ton GSHP system, upgrades to the piping for the AHUs and terminal units, and potential coil upgrades. Please note that the costs are high-level estimates based on similar projects and may vary due to recent tariffs and general inflation. Incentives for heat pumps are available through the sponsors of MassSave.

Item	Qty	Unit Price	units	total
GSHP	70	$ 100,000	/Tons	$ 7,000,000
Terminal unit upgrade	66	$ 10,000	each	$ 660,000
O&P		10%		
Contingency		5%		
Commissioning		5%		
Engineering		10%		
Total				$ 9,958,000

ELX-4: HEAT PUMP DOMESTIC HOT WATER

SUMMARY

Estimated HP Capacity (MBH)	Electric Impacts (kWh)	Oil Savings (Gal)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated Installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
10	-774	74	0.81	0.4%	-$48	$15,500	$1,127	99

EXISTING CASE

The domestic hot water load at this facility is served by one 315 MBH 82% eff 84 gal A.O. Smith oil-fired DHW heater installed in 2020. There is also a DHW storage tank that was likely installed when the building was built.

PROPOSED CASE

The proposed upgrade to the existing oil-fired Domestic Hot Water heaters is a heat pump water heater system. Heat Pump water heaters can achieve a Coefficient of Performance (COP) much higher than the current efficiency. Given the size of the site and the overall DHW load, a split system A2WHP for DHW is expected to carry higher costs that may be deemed unnecessary. Therefore, RISE suggests the use of a fully integrated HPWH with extra storage capacity. Extra storage capacity is typically needed for HPWH equipment because it relies on thermal storage to manage peak demand given that oil and gas fired heaters have much higher first hour ratings than heat pumps. The calculated savings are based on an estimated base load (BTUs) and the savings that would be generated from increasing the efficiency between the existing and proposed cases. This heat load in conjunction with the base case efficiency of 0.82 and an estimated Heat Pump efficiency of 3.2 was used to calculate the total kWh required to meet the heat load required for the school. Before this is installed, a further study should be performed to ensure that the heat pump implemented operates accordingly and can effectively heat water even during low-temperature conditions.

Based on a review of the electrical capacity on site, there is no immediate concern regarding the power requirements for the new equipment. Furthermore, if the existing unit is removed, there would be plenty of space within the mechanical room where this equipment is located to install this new system.

INSTALLATION COST

This measure is estimated to cost approximately $15,500 based on experience with prior projects. MassSave incentives are available for HPDHW heaters.

Item	Qty	Unit Price	units	total
Fully Integrated 80-Gal Storage Type HPWH	1	$ 5,000	/Each	$ 5,000
Thermal Storage Tank(s)	1	$ 5,000	/Each	$ 2,000
Installation/Piping	1	$ 5,000	/Each	$ 5,000
Electrical Upgrades	1	$ 3,000	/Each	$ 1,500
OPM & Design	1	$ 2,000	/Each	$ 2,000
Total				$ 15,500

Additional Programs & Considerations

Through the review of this facility, its existing equipment, and noted deficiencies, the ECMs listed in the report sections above should be highly considered for implementation. However, additional opportunities have been identified as potential measures but are not recommended to be implemented either because the site has expressed that they are not interested or because it would not be in the best interest of the site.

Demand Response Options

This site is not currently enrolled in a demand response program. There are multiple different programs available which include ISO New England based programs, Massachusetts Municipal programs, and a U.S. Department of Energy Programs. Demand response programs allow customers to receive benefits for reducing their energy consumption during times of high demand in which the electric grid needs downstream support from consumers to balance the supply and demand on the grid. The town is encouraged to discuss opportunities and explore such options with program administrators and energy managers.

Gym Destratification Fans

The school should consider installing destratification fans on the ceiling of the gym/cafeteria/auditorium space. These fans would push warm air downwards and mix the air, enabling the AHUs to work more efficiently.

Convert AHU-1 to VAV with VFD

AHU-1 is designed to be variable air volume (VAV) but is operated as constant volume (CV) according to the controls drawings. It is not equipped with a variable frequency drive (VFD) to adjust the volume of air to match the needs of the VAV boxes. This may require substantial work to implement but would allow DCV to be implemented for the rest of the building.

Existing Buildings Commissioning (EBCx)

It is recommended that the site performs regular retro-commissioning every 5 years to ensure the system is operating at its highest potential.

Additional Controls Measures

It is highly recommended that daily users have training on the system and are able to have at least read-only access so that it is easier to diagnose issues and maintain the system in a functional manner. As it is unknown if the equipment is scheduled, the town should verify what control sequences are in place and implement night setbacks, scheduling, and start/stop time optimization if these are not already in place.

Night setback is when the temperatures in the spaces are set up or down, depending on the season, during the times when the school is unoccupied. Time of day scheduling typically automatically turns on equipment, such as the AHUs or boilers, when the building is occupied and turns them off when the building is unoccupied, as determined by a set schedule. Start/stop optimization determines when the equipment needs to be turned on to satisfy the occupied needs without turning it on too early and allows the building to coast towards the stop time to avoid conditioning it past occupied hours.

APPENDIX

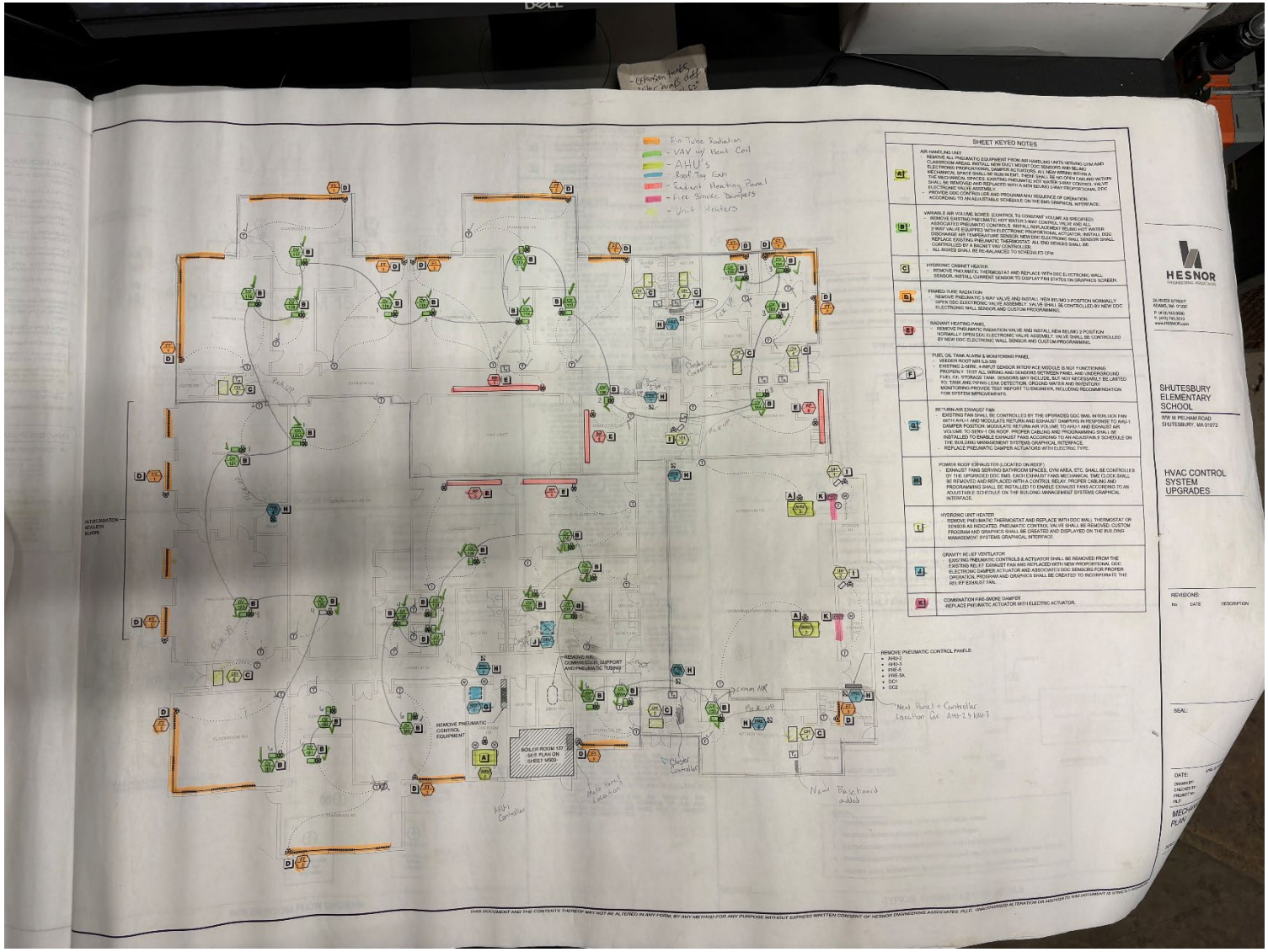
Common factors:

CO_2e impacts for each EE/ELX option, lifetime:

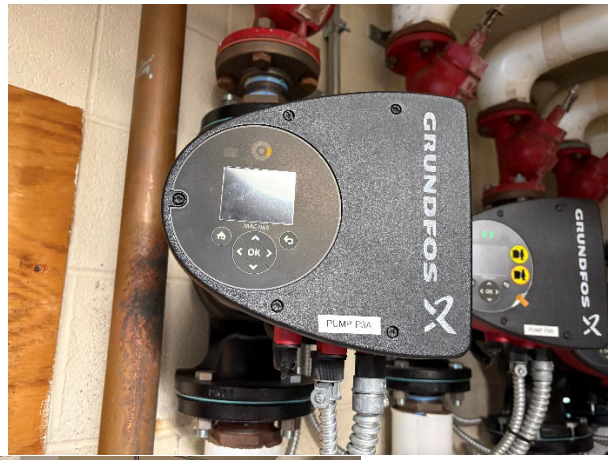
ML = 17 years VRF, ASHP, AWHP, 25 Years GHSP, 13 years HPDHW

Electric Carbon Savings: 0.1277 $MTonCO_2e$ / MWh
Natural Gas Carbon Savings: 0.06534 $MTonCO_2e$ / MMBTU
Oil Carbon Savings: 0.08848 $MTonCO_2e$ / MMBTU
Propane Carbon Savings: 0.07849 $MTonCO_2e$ / MMBTU

MECHANICAL SYSTEMS PHOTOS






GRUNDFOS
OK
PUMP P3A
GRUNDFOS


A.O. Smith



ELX Appendix Summary Table

#	Measure Description	Est. HP heating capacity (MBH)	Est. HP cooling capacity (Tons)	Cooling Electric impacts (kWh)	Heating Electric impacts (kWh)	Oil Savings (gallons)	Annual GHG Emissions Reduction (Metric tons CO2e)	Percent GHG Emissions Reduction	Energy Cost Savings	Estimated installed Cost	$/ Lifetime GHG reduction	Lifetime MMBTUs
ELX1A	Air to Water Partial	624	52	-23,134	-110,400	8,353	84.9	45.5%	-$19,937	$712,400	$493	11,851
ELX1B	Air to Water Full	840	52	-23,134	-171,178	12,194	124.1	66.5%	-$28,910	$2,626,000	$1,245	17,337
ELX2A	Air to Air Partial	624	52	-23,134	-92,437	6,707	67.1	36.0%	-$18,606	$670,800	$588	9,031
ELX2B	Air to Air Full	840	52	-23,134	-174,105	12,194	123.7	66.3%	-$29,821	$1,313,000	$624	17,167
ELX3	GSHP	840	52	-19,805	-158,649	12,194	126.1	67.6%	-$23,979	$9,958,000	$3,159	26,848
ELX4	HP DHW Heater	10	1	0	-774	74	0.8	0.4%	-$48	$15,500	$1,127	99

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