ENERGY AUDIT REPORT

Energy Efficiency Audit – Draft: 74 Main Street

prepared for

Town of Bedford

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1 Executive Summary

1.1 Introduction

This report details the recommendations and conclusions of an energy efficiency audit prepared for the town of Bedford, New York. The town of Bedford has shown tremendous initiative in promoting sustainability, spreading awareness of incented energy efficiency measures, and leading by example by upgrading their municipal buildings to reach optimal efficiency. As part of this study, four of the town's municipal buildings will be audited, 74 Main Street, 425 Cherry Street, 321 Bedford Avenue and 21 Park Avenue, and studied to identify capital projects to improve the facilities' energy efficiency. In addition, the town requested a feasibility study to evaluate upgrading their HVAC systems to ground and/or air source heat pumps, in an effort to electrify their facilities in response to the Westchester gas moratorium.

Due to decision-making timing by the Town, ERS prioritized the study on the town's community house (BHCH) located at 74 Main Street, Bedford, NY 10507. As a result, the following report details ERS's findings at the town's community house only. ERS will submit the study on the remaining three buildings in a separate report within the timeline described in the work plan. Due to the short report turnaround, ERS could not deploy monitoring equipment to log various system operations. Subsequently, ERS made assumptions to inform the savings calculations, which will be outlined throughout the report.

Mr. Alain Tayoun of ERS conducted a site visit at 74 Main Street on October 7, 2019. He met with the town's supervisor, Mr. Chris Burdick, as well as the town's Director of Energy and Sustainability, Mr. Mark Thielking, and several other personnel knowledgeable about the facility's operation and mechanical systems. During the site visit, Mr. Tayoun collected information on the building's operation, schedules, envelope, mechanical systems, and maintenance. Furthermore, it was determined that the current HVAC system does not meet the facility's cooling load. As a result, conventional as well as clean cooling and heating options will be studied.

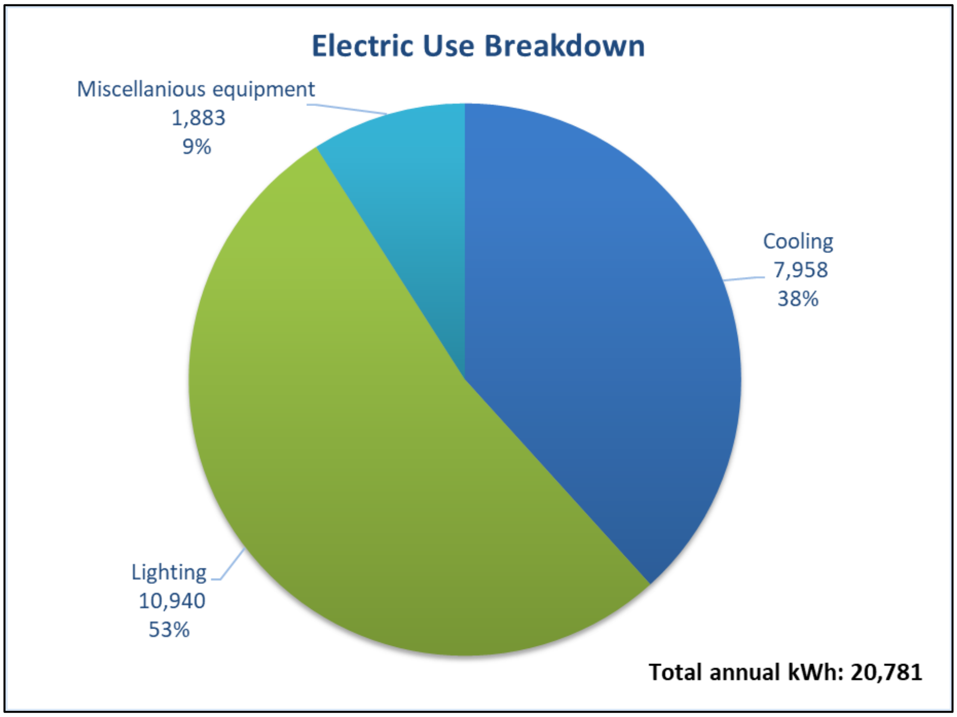
1.2 Summary of Current Energy Use

The utilities at this facility include electricity and natural gas. The following discussion presents electric and natural gas billing and usage information for the facility.

1.2.1 Electric Energy Use Breakdown

In preparing this energy report, ERS studied the current (baseline) electricity use at the facility. The lighting energy use was estimated by doing an inventory of the facility's lighting, collecting the various fixture and lamp nameplates and using the operating hours provided by the facility personnel. We determined the energy usage of the cooling equipment by collecting nameplate information (make, model, capacity, and efficiency) and calculating the estimated energy usage throughout the year. The other miscellaneous end users represent the various office and kitchen equipment at the facility. Figure 1-1 presents the electric energy end-use breakdown plot.

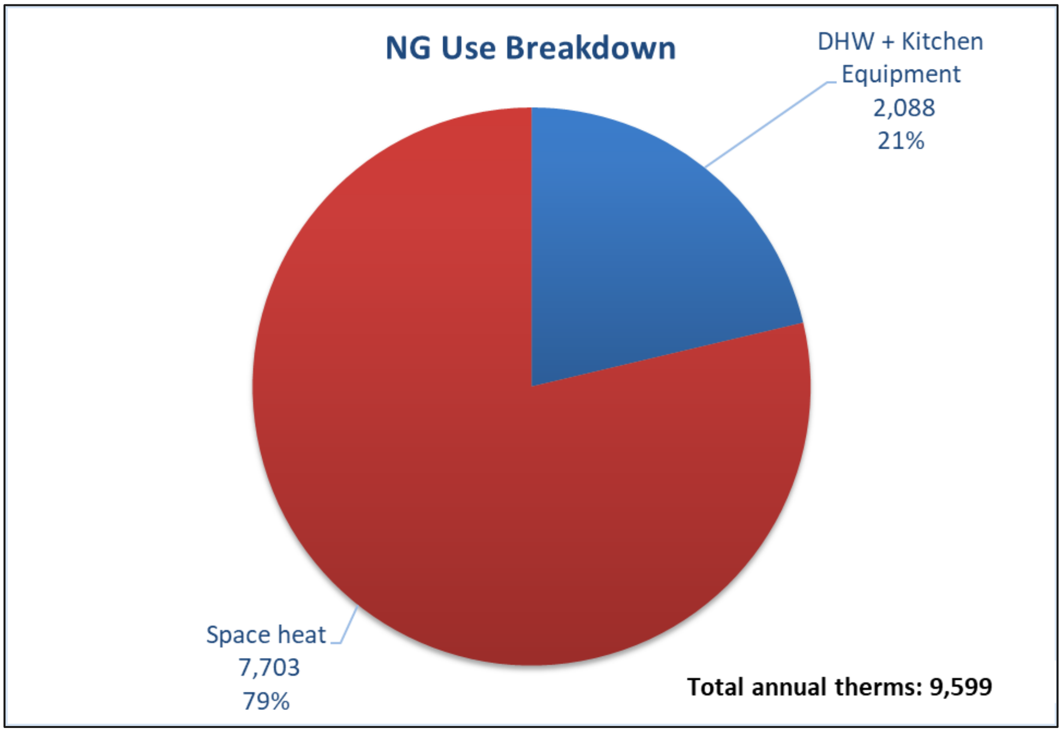
Figure 1-1. Facility Electricity End-Use Breakdown



1.2.2 Natural Gas Energy Use Breakdown

In preparing this energy report, ERS also studied the current (baseline) natural gas use at the facility. As anticipated, space heating makes up the greater portion of gas use at 79% of the facility consumption. Figure 1-2 presents the natural gas energy end-use breakdown plot.

Figure 1-2. Facility Natural Gas End-Use Breakdown



1.3 Summary of Recommended Energy Efficiency Measures

ERS recommends three energy efficiency measures (EEMs) for implementation and an additional informational measure. Details on EEMs 1 and 2 are shown in table 1-1, the HVAC upgrade summary is shown in table 1-2 and the interactive savings of EEMs 1, 2 and 3 are shown in table 1-3. As mentioned before, the HVAC system does not have the capacity to cool the entire building. Therefore, 6 options were studied to appropriately air condition the facility and described in section 1.3.3. We have also included an estimated NYSERDA, and utility incentive for each measure where applicable. Please note that these incentive levels are based on current utility and state offerings. We recommend contacting ERS before implementing any recommended measures, for an update on the utility and state offerings available at the time of equipment purchase.

Table 1-1. Summary of EEM 1 and 2

Measure	Peak Demand Reduction (kW)	Electrical Energy Savings (kWh/yr)	Thermal Energy Savings (therms/yr)	Cost Savings ($/yr)	CO2 Reduction (Metric Ton)[1]	Measure Cost ($)	Simple Payback (years)	Potential Incentive ($)	Simple Payback w/Incentive (years)
EEM-1: Install Energy Efficient Lighting and Lighting Controls	7.0	7,326	n/a	$1,281.83	0.98	$6,773.00	5	$970	4.5
EEM-2: Improve the Building's Insulation and Air Tightness[2]	n/a	828	852	$1,148.02	4.64	$21,700.00	19	N/A	N/A
Totals	**7.0**	**8,154**	**852**	**$2,429.84**	**5.62**	**$28,473.00**	**12**	**$969.67**	**11**

[1]Those numbers are calculated based on the emission coefficients of 0.005311 ton-CO_2/therm and 0.000134 ton-CO_2/kWh

[2]EEM-2 and EEM-3 are interactive measures. Implementing both measures simultaneously would yield less savings than the sum of savings from both measures. Table 1-3 shows the interactive savings of those two measures

N/A= Not applicable

Table 1-2. Summary of HVAC Upgrades (Without EEM1 and EEM2)

Options	Notes	Savings				Cost Savings				Incentive Calculations[2]	
		Peak Demand Reduction[1]	kWh Savings	Therms Savings	Metric Ton CO2 Reduction	Cost Savings	Implementation Cost	Incremental Cost	Payback (Incremental Cost Only) (Yrs)	Estimated Incentive	Payback
Existing (current system)	Insufficient cooling	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Option 3-a Add Mini-Splits to Serve Current Non-Cooled Areas and Replace Window Acs	Existing split units in main area will not be replaced.	-6.0	(1,767)	0	N/A	$ (309.2)	$ 8,613.3	N/A	N/A	N/A	N/A
Option 3-b Install Gas Fired Rooftop Units	All previous HVAC system will be replaced by a ducted central RTU. This will eliminate the need to upgrade current heating distribution system.	3.5	1,025	0	0.1	$ 179.4	$ 28,320.0	$ 19,706.7	109.8	N/A	N/A
Option 3-c Install Air Source Heat Pump	All previous HVAC system will be replaced by a multi-zone Air Source Heat Pump. This will eliminate the need to upgrade current heating distribution system.	7.4	(49,391)	7,703	34.3	$ 427.1	$ 26,600.0	$ 17,986.7	42.1	$ 4,720.0	31.1
Option 3-d Install Variable Refrigerant Flow	All previous HVAC system will be replaced by a multi-zone Variable Refrigerant Flow system. This will eliminate the need to upgrade current heating distribution system.	15.0	(44,234)	7,703	35.0	$ 1,329.3	$ 62,000.0	$ 53,386.7	40.2	N/A	N/A
Option 3-e Install Ground Source Heat Pump	All previous HVAC system will be replaced by a multi-zone Ground Source Heat Pump. This will eliminate the need to upgrade current heating distribution system.	14.5	(38,711)	7,703	35.7	$ 2,295.7	$ 188,800.0	$ 180,186.7	78.5	$ 39,176.0	61.4
Option 3-f Install Variable Refrigerant Flow Ground Source Heat Pump	All previous HVAC system will be replaced by a multi-zone Variable Refrigerant Flow Ground Source Heat Pump. This will eliminate the need to upgrade current heating distribution system.	17.7	(28,829)	7,703	37.1	$ 4,024.8	$ 236,000.0	$ 227,386.7	56.5	$ 35,400.0	47.7

[1]Peak demand reduction reflects kW savings during the Summer.

[2]Further cost reductions can be achieved by entering into a pay for performance agreement (PPA) with a qualified vendor to take advantage of the investment tax credit (ITC).

N/A= Not applicable

Table 1-3. Summary of All Measures

Options	Savings				Cost Savings				Incentive Calculations[2]	
	Peak Demand Reduction[1]	kWh Savings	Therms Savings	Metric Ton CO2 Reduction	Cost Savings	Implementation Cost	Incremental Cost	Payback (Incremental Cost Only) (Yrs)	Estimated Incentive	Payback
EEM1 + EEM 2 + EEM 3-a	9.0	7,931	829	5.5	$ 2,363.5	$ 37,086.3	$ 37,086.3	15.7	$ 969.7	15.3
EEM1 + EEM 2 + EEM 3-b	12.2	8,877	829	5.6	$ 2,528.9	$ 56,793.0	$ 48,179.7	19.1	$ 969.7	18.7
EEM1 + EEM 2 + EEM 3-c	15.9	(36,079)	7,703	36.1	$ 2,756.1	$ 55,073.0	$ 46,459.7	16.9	$ 5,323.1	14.9
EEM1 + EEM 2 + EEM 3-d	22.8	(31,411)	7,703	36.7	$ 3,572.9	$ 90,473.0	$ 81,859.7	22.9	$ 969.7	22.6
EEM1 + EEM 2 + EEM 3-e	22.3	(26,487)	7,703	37.4	$ 4,434.6	$ 217,273.0	$ 208,659.7	47.1	$ 39,852.4	38.1
EEM1 + EEM 2 + EEM 3-f	25.3	(17,639)	7,703	38.6	$ 5,982.6	$ 264,473.0	$ 255,859.7	42.8	$ 36,369.7	36.7

[1]Peak demand reduction reflects kW savings during the Summer.

[2]Further cost reductions can be achieved by entering into a pay for performance agreement (PPA) with a qualified vendor to take advantage of the investment tax credit (ITC).

Table 1-4 below shows the suggested equipment's average useful life.

Table 1-4. Average Useful Life of Suggested Equipment

Equipment	Average Useful Life
LED Lights	11+ years
Insulation	80+ years
Mini-Splits	15-25 years
Gas Fired RTU	15-25 years
ASHP (EEM - 3c and 3d)	15-25 years
GSHP (EEM - 3e and 3f)	20 - years for heat pump 50+ years for well

1.3.1 EEM-1: Install Energy Efficient Lighting and Controls in Entire Facility

The lights at the facility typically operate when the facility is hosting an activity or event, which amounts to approximately 1,600 hours per year. The interior lighting technologies observed in the facility include T8 fixtures with electronic ballasts, T12 fixtures with magnetic ballasts, metal halides, and incandescent lamps. Light-emitting diode (LED) lamps and fixtures can offer significantly improved light quality with greater system efficiency and options for better control. We recommend replacing all the existing lights with equivalent LED designs with lighting controls in designated areas.

1.3.2 EEM-2: Improve the Building's Insulation and Air Tightness

The facility was built in 1929 and has not been renovated or modernized since. As a result, wall insulation is very minimal and outdated, the roof/attic is exposed and not insulated, the crawl space allows for major air infiltration and is also not insulated, the windows are single-paned with cracked wooden frames, and the window ACs at the facility remain in place during the winter and do not have insulated sleeves. Poor insulation increases the building's thermal load because of increased heat transfer with the outdoors; air infiltration leads to outdoor air being mixed with conditioned indoor air; both of which lead to an inconsistency in the building's indoor air temperature and results in wasted energy on the additional cooling or heating. We recommend an exhaustive upgrade on the building's envelope to ensure thermal insulation and air tightness.

1.3.3 EEM-3: Upgrade Current HVAC System

The town of Bedford is interested in evaluating several options to provide heating and cooling loads to their entire BHCH facility which is currently under-cooled. As it stands, the whole building is heated with a 400,000 Btu/hr hot water boiler that distributes hot water to baseboard heaters and radiators throughout the facility. Five 17,500 Btu/hr window AC units provide cooling in various offices and conference rooms, two 35,000 Btu/hr and two 42,500 Btu/hr split units provide cooling to the main room (event room). However, no cooling equipment is installed in the kitchen, the basement rooms or any restrooms or hallways. It is estimated that the additional cooling load is 129,200 Btu/hr. The latter accounts for non-cooled areas and rooms with window AC units. Table 1-4 summarizes the HVAC equipment information.

Table 1-4. Current HVAC Equipment at BHCH

FL	Location Served	Equipment Type	Approximate Age	Make	Model	Capacity (BTU/HR)	Efficiency[1]	Quantity
2	Play Room	Window AC	+10 years	Friedrich	SM18L30A-E	17,500	10.8	1
2	Bedford Community Theater	Window AC	+10 years	Friedrich	SM18L30A-E	17,500	10.8	1
1	Lounge Room	Window AC	+10 years	Friedrich	SM18L30A-E	17,500	10.8	1
1	Board Room	Window AC	+10 years	Friedrich	SM18L30A-E	17,500	10.8	1
1	Sun Room	Window AC	+10 years	Friedrich	SM18L30A-E	17,500	10.8	1
1	Main Room	Condensing Unit	>5 years	Mitsubishi Electric	PUY-A42NHA6	42,000	14.4	2
1	Main Room	Make-up Air Unit	>5 years	Mitsubishi Electric	PUY-A36NHA6	35,000	14.2	2
Bsmnt	Entire Facility	Hot Water Boiler	>5 years	Weil-McLain	NV	400,000	80%	1

[1]The cooling equipment efficiency metric is presented in Seasonal Energy Efficiency Ratio (SEER)

The town is interested in both conventional and clean energy options to satisfy the building's cooling and heating loads, and as such, is considering converting their HVAC systems to either air source or ground source heat pump if the study is found to be economically viable. The electrification of the heating sytem provides multiple non-energy benefits. Including, reduction in Green House Gas (GHG) emmissions, and increase occupant comfort.

Below is a brief technology description of the six different options that ERS studied as part of this project.

EEM-3-a: Add Mini-Splits to Serve Current Non-Cooled Areas and Replace Window ACs

Mini-splits are a relatively low-cost option to cool a space that does not have a great cooling load. Installing mini-splits in non-cooled areas and replacing current window ACs with them as well is a low-capital way of accomplishing total facility cooling. It is important to mention that implementing this measure will have no effect on the heating system.

EEM-3-b: Install Gas Fired Rooftop Units

Another conventional way of heating and cooling a building would be through a ducted gas fired RTU. However, due to a marginal increase in efficiency compared to EEM 3-a, energy savings will be minimal which would yield longer paybacks.

EEM-3-c: Air Source Heat Pump (ASHP)

An ASHP uses a refrigerant system involving a compressor and a condenser to absorb heat at one place and release it at another. Unlike water source heat pumps, the refrigerant of ASHPs exchanges heat with the ambient air. ASHPs are at most a two-speed system; therefore, the unit’s compressor can only operate at one of two different levels depending on the load it has to provide. They are a low-cost electric space heater or cooler. A high efficiency heat pump can provide up to four times as much heat as an electric resistance heater using the same amount of electricity.

EEM-3-d: Variable Refrigerant Flow Air Source Heat Pump (VRF)

A VRF is a more efficient air source heat pump with variable speed compressors and a modulating refrigerant fluid valve. Depending on the load a unit has to provide, its built-in logic controls the compressor’s speed (0% to 100%) and modulates the refrigerant valve (0% to 100%) to optimize the energy usage. VRFs are a great solution for multi-zone facilities since the units adapt and optimize for the required overall load in all zones and are not restricted to one or two levels of operation.

EEM-3-e: Ground Source Heat Pump (GSHP)

Ground source heat pumps are similar in concept to ASHPs; however, with ground source, the refrigerant exchanges heat with the underground soil instead of air, hence the name ground source. The advantage of having an underground system is that in most cases, the geological properties of the ground allows for optimal temperatures that favor efficient heat transfer.

EEM-3-f: Variable Refrigerant Flow Ground Source Heat Pump (VRF GSHP)

VRF GSHP is a GSHP that operates under a similar manner to a VRF. Depending on the load a unit has to provide, the compressor’s speed along with the refrigerant valve modulate (0% to 100%) to optimize the energy usage. In addition, under small loads, a reduced volume of refrigerant is required to be circulating through the underground loop resulting in additional energy savings.

1.3.4 Interactive Savings from Implementing EEMs 2 and 3

ERS calculated EEMs 2 and 3 separately to inform savings expectations if the measures were implemented independently. However, implementing both measures concurrently will yield additional energy savings. Since the building is poorly insulated and air-sealed, the overall building load is high. As a result, improving the building's envelope leads to a decrease in the overall heating and cooling loads. If the loads were decreased, the facility would have the option to size a smaller heat pump system, which further cuts down energy usage.

1.4 Summary of Informational Measures

1.4.1 IM-1: Replace the Existing Gas-Fired Domestic Hot Water Heater with a Heat Pump Hot Water Heater

The facility currently has a 40-gallon gas-fired domestic hot water heater with a 77% efficiency. Heat pump hot water heaters are an electric alternative to providing domestic hot water in a facility at a comparable price to gas (varies based on electric and natural gas costs). ERS is listing this upgrade as an informational measure since it has no cost savings associated with it. However, this measure is being reported since the town of Bedford has shown interest in electrifying their facility in response to the Westchester gas moratorium.