DISTRICT OF CENTRAL SAANICH – FIRE HALL #1

Project No.: 000b-1476-24
1512 Keating Cross Rd, Saanichton, BC V8M 1W9

Integrated Energy Audit Report

December 6, 2024

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1. EXECUTIVE SUMMARY

The AME group was retained by the District of Central Saanich to investigate opportunities for energy conservation, electrification, installing demand response capacity, and installing behind-the-meter power generation at four of their facilities. This report describes the AME Group's findings for Fire Hall #1; these reports have been developed under CleanBC's Integrated Energy Audit program. This report investigated twelve different opportunities including energy efficiency measures, electrification measures, and one demand response measure. The impact of these measures is summarized in the following table.

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-1	Re-Configure DHW + Solar Thermal Collector Plant	60	-	$720	3.0	$20,800	25+
ECM-2	Install Electric Resistance Heater to Heat Pump Plant	73	(16,755)	$(751)	3.5	$56,680	N/A
ECM-3	Lower HP Plant CHWST Setpoint	20	(4,183)	$(164)	1.0	$8,450	N/A
ECM-4	Change HP Controls to Reject Heat to Ground As Priority Over DC-1	-	5,875	$572	0.1	$15,600	25+
ECM-5	Cross Connect Geo-Plant to Solar Collectors	18	-	$218	0.9	$8,760	25+
ECM-6	Fan Coil Recommissioning and Balancing	-	5,728	$558	0.1	$11,700	21.0
ECM-7	Add Low-Temp Hydronic Heaters to Perimeter Spaces	-	5,728	$558	0.1	$128,700	25+
ECM-8	CFL Lighting Conversion to LED	-	84,239	$8,202	1.0	$120,000	14.6
ECM-9	Recommission Radiant Floor Heating Water Pump Speed Control	-	3,179	$310	0.0	$17,450	25+
ECM-10	DHW CO2 Heat Pumps	228	(18,074)	$970	11.2	$88,400	25+
ECM-11	Hyper-Low Hot Water Fixtures	5	-	$64	0.3	$18,850	25+
ECM-12	Wallpack Battery for Demand Response	-	-	$500	-	$150,000	25+

It is recommended that ECM-3, ECM-5, ECM-6, and ECM-8 are considered by the District of Central Saanich for implementation. These measures offer either relatively high emissions savings per unit of capital cost, will allow for improved occupancy thermal comfort, or is expected to have a favorable business case. ECM-2 and ECM-10 may also be considered for long term implementation as more capital cost-intense mechanical upgrades with high emissions savings.

2. INTRODUCTION

The AME group was retained by the District of Central Saanich to investigate opportunities for energy conservation, electrification, installing demand response capacity, and installing behind-the-meter power generation at four of their facilities. This report describes the AME Group's findings for Fire Hall #1; these reports have been developed under CleanBC's Integrated Energy Audit program.

3. BUILDING DESCRIPTION

This section provides a description of the building as a whole, its mechanical systems and primary energy consumers, and its current on-site power generation.

3.1 General Description

The Fire Hall is located along Keating Cross Road, and was awarded with LEED Silver in 2015. It consists of a main lobby, office spaces on the ground floor, training rooms and dormitories on the upper floor, a kitchen, and changerooms for workers. The building has four main garage entrances for fire engines serving Central Saanich. The building has approximately 21,000 square feet of service area.

3.2 Heating & Cooling System

The Fire Hall's heating and cooling plant consists of a hybrid geothermal heat pump plant with a backup natural-gas heater. During heating conditions (i.e. during winter), the heat pump plant sends chilled water to the geo-thermal loop to absorb heat from the ground and sends heating water to the building's terminal unit fan coils and the hydronic radiant floor in the garage. If the heating water supply temperature is not able to be met by the geo-thermal heat pumps, then the back-up gas-fired heater is activated to supplement the heating load. During cooling conditions (i.e. during summer), the heat pump plant sends chilled water to the building's terminal units and circulates heating water to the ground and to a dry cooler DC-1 located on the roof; in this condition, the dry cooler activates to reject heat from the heating water into outdoor air.

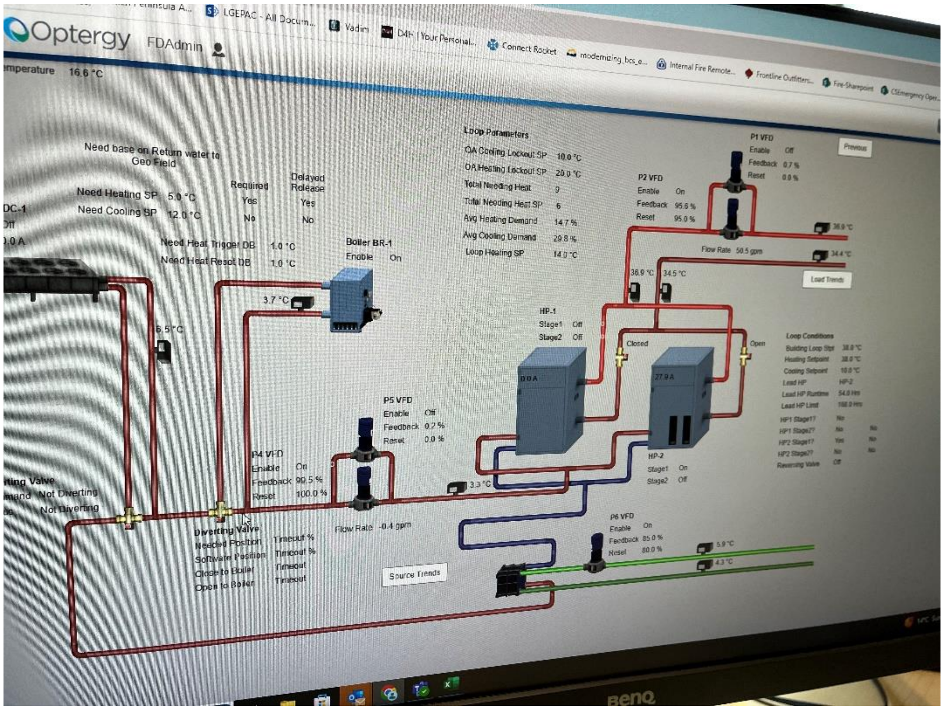

Figure 1: Heating and Cooling System DDC Graphic

Figure 2: Heat Pump (Lower Mechanical Room)

Figure 3: Heating Plant Gas-Fired Boiler (Lower Mechanical Room)

Figure 4: Dry Cooler (Rooftop)

3.3 Ventilation System

The building is ventilated through a central heat recovery ventilator (HRV), which brings in fresh outdoor air, and recovers heat from exhaust air. This system sends fresh air to terminal units throughout the building; the HRV is located on the roof and has a hydronic switchover coil to pre-heat or pre-cool ventilation air.

Figure 5: Heat Recovery Ventilator (Rooftop)

3.4 Domestic Hot Water System

The building’s domestic hot water (DHW) system consists of two large storage tanks on the second level, a gas-fired heater, and four large solar thermal collectors located on the roof. A mixture of water and anti-freeze is circulated through the solar thermal collector and through a heat exchanger; the heat exchanger is also connected to the first of the two hot water storage tanks. As the water in the first tank is heated up, the water in the solar collector will increase in temperature, providing more heat from the sun.

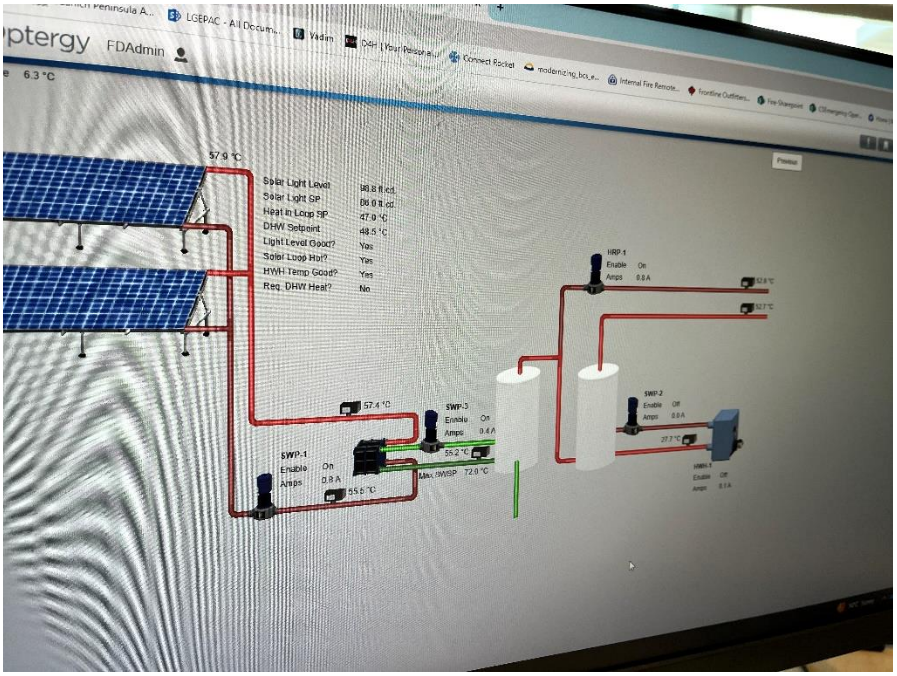

Figure 6: DHW Plant DDC Graphic

Figure 7: DHW Storage Tank Nameplate (Upper Mechanical Room)

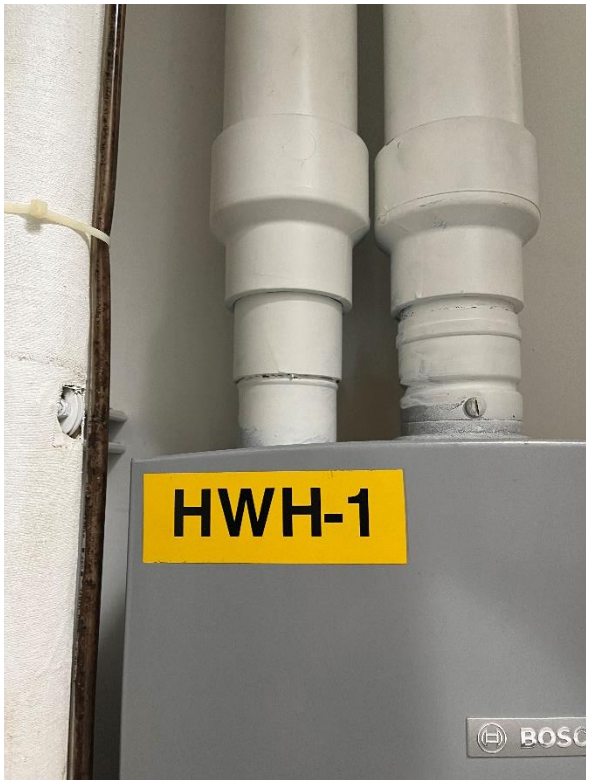

Figure 8: DHW Gas-Fired Water Heater (Upper Mechanical Room)

Figure 9: Solar Thermal Collectors (Rooftop)

Figure 10: Solar Thermal Collector Heat Exchanger (Upper Mechanical Room)

3.5 PV Array

This building is already fitted with a large photovoltaic (PV) panel array of approximately 138kW of nameplate electrical generation capacity; this array is actively generating electricity for the net metering program in BC. As described by a previous report from Hakai Energy Solutions, this system is expected to generate 144,000 kWh per year. Because this system is already in place, additional behind-the-meter generation measures are not considered for this building within this report.

Figure 11: PV Array, 138kW (Rooftop)

4. UTILITY ANALYSIS

This section provides insight to the energy use in this building, with a focus on the proportion of energy use between electricity and natural gas. This is used to provide context for energy savings associated with energy conservation measures (ECMs) explored in later sections of this report.

4.1 Energy Proportion Breakdown

The building's energy use is broken down by source type in the following figure.

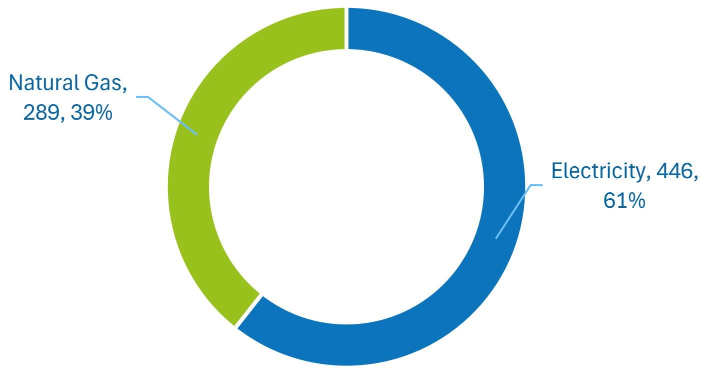

Figure 12: Energy Use Proportion By Source Type (2023)[1]

Despite its high performance rating and design including geothermal heat pump and solar collectors, 39% of the building's utility consumption is represented by natural gas.

The building's utility costs are broken down by source type in the following figure.

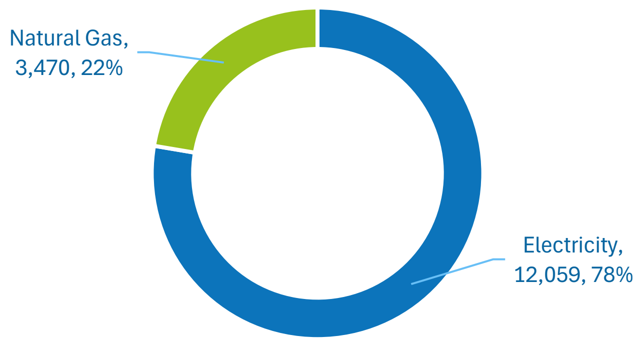

Figure 13: Energy Utility Costs By Source Type (2023)[2]

The utility costs associated with electricity represent 78% of the building's total energy costs; this is reflective of the fact that electricity costs more per unit of energy than natural gas.

The building's energy-related emissions are broken down by source type in the following figure.

[1] Natural gas use quantities shown in gigajoules (GJ).
[2] Utility costs are shown in dollars ($CAD)

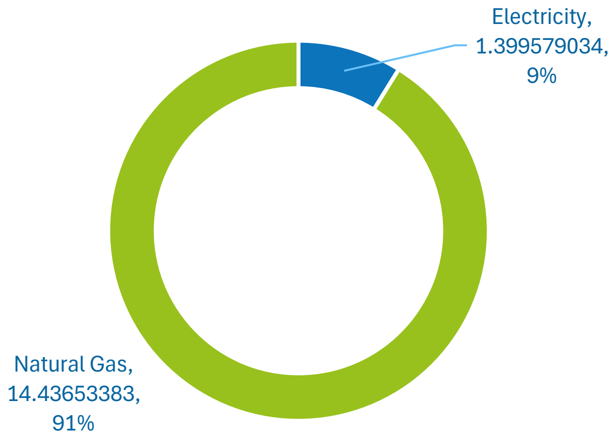

Figure 14: Energy Emissions by Source Type (2023)[3]

Despite only accounting for 39% of the building's total energy use, natural gas accounted for 91% of all energy-related emissions; this is reflective of the fact that electricity is has a much lower emission rate per unit energy than natural gas.

4.2 Load Distribution Curve

A load distribution curve of the property's electricity consumption is shown in the following graph.

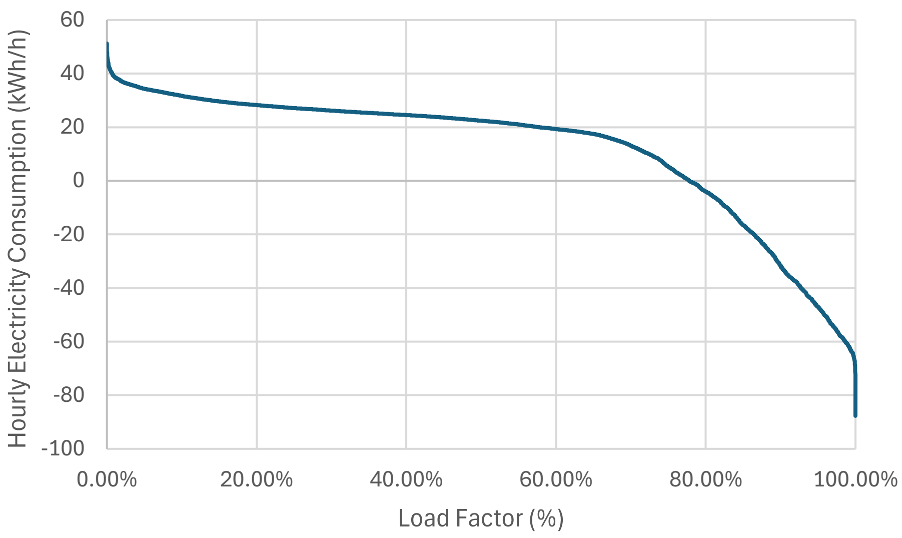

Figure 15: Electricity Load Distribution Curve (Utility Side)

[3] Emission quantities shown in equivalent-tonnes of carbon dioxide (tCO_2e).

This load distribution curve helps to highlight how often the property draws – or provides – rates of energy per hour; key takeaways from the load distribution curve are that the building was a net-energy-producer for approximately 22% of 2023, the highest rate at which power was given back to the grid was 87kW, and that although the highest hourly power consumption from the grid was 51.2kW it spent less than 1% of hours drawing more than 39kW.

4.3 Energy Use Regression Curve

Using utility data from the 2023 calendar year, the AME Group was able to develop a linear regression reflecting the building's electricity and natural gas use using heating-degree days as an independent variable.

The linear regression developed for the building's electricity use is shown in the following figure.

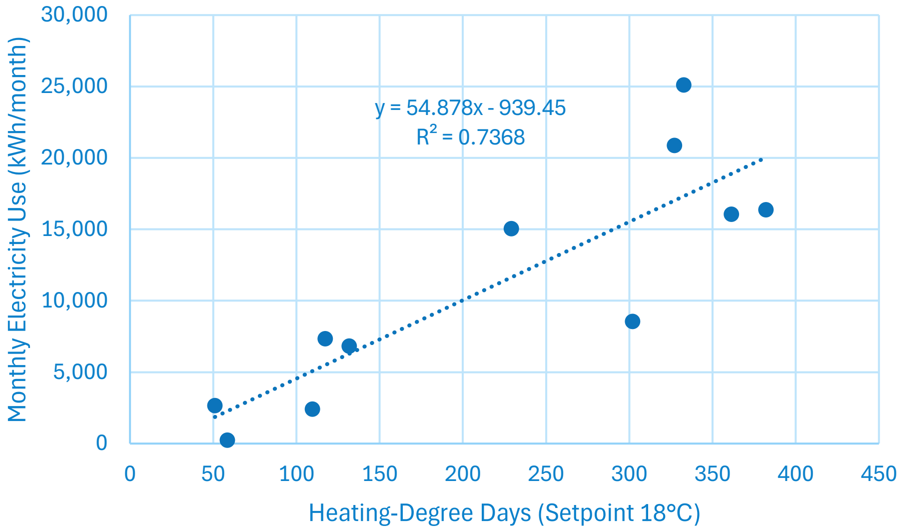

Figure 16: Electricity Linear Regression VS HDD (2023)

The linear correlation between electricity and heating degree days is considered relatively weak, as the threshold for being considered a reliably correlated regression requires an R^2 correlation factor of 0.75 or higher; as shown in the previous graph, the model's correlation factor results in 0.7368. Although this may not be a reliable way to model or predict energy use, it does shown that electricity consumption generally increases when outdoor air temperatures decrease. This reflects the fact that the solar array would be expected to generate less electricity in the winter when days are shorter and weather becomes more cloudy, and reflects the fact that the building's geo-thermal heat pump plant must increase its heating output as temperatures decrease.

The linear regression developed for the building's natural gas use is shown in the following figure.

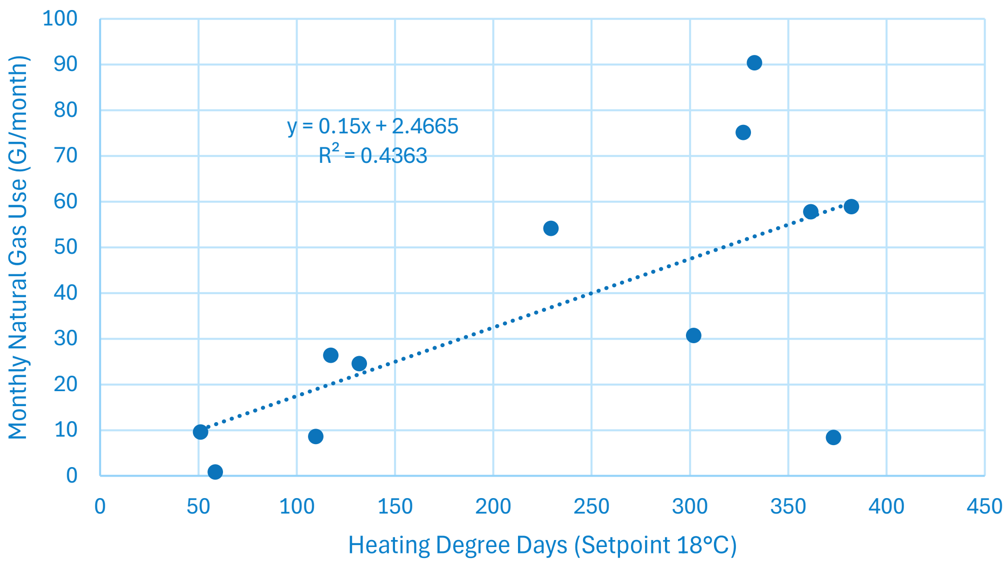

Figure 17: Natural Gas Linear Regression VS HDD (2023)

As shown in the previous figure, the correlation between natural gas and heating degree days is weaker than that of electricity; this is unusual for building's that include a natural gas heating plant, since heating output should be expected increase relatively consistently with outdoor air temperatures. While this regression does show a general increase in natural gas use as outdoor temperatures decrease, the rate of increase is not consistent. This could be explained by the domestic hot water plant relying on its natural gas heater more often than the building's solar thermal collectors.

5. KEY INPUTS AND ASSUMPTIONS

Several common key inputs applied to the building's ECMs are summarized in the following table.

Table 1: Summary of Key Inputs and Assumptions

Description	Quantity	Unit
Blended Cost of Electricity	0.097 (27.04)	\$/kWh (\$/eGJ)
Blended Cost of Natural Gas	11.99 (0.043)	\$/GJ (\$/ekWh)
Electricity Emission Factor	11.3	tCO_2e/GWh
Natural Gas Emission Factor	49.87	$kgCO_2e/GJ$

6. ENERGY CONSERVATION MEASURES

This section describes the energy conservation measures (ECMs) investigated as part of this report. These measures are intended to help provide insight to the building's largest energy consumers and to describe opportunities for energy conservation in the building at a high level.

6.1 Base Case

Before exploring the ECMs investigated in this report, the base case considered should be made clear; the base case for these measures is considered to be the continued operation of the building in a business-as-usual fashion, with no major mechanical equipment retrofits considered in the short-term future. Energy consumption from the 2023 calendar year was used as a reference when developing these energy savings, utility cost savings, and emissions savings amounts.

6.2 ECM-1: Reconfigure DHW + Solar Thermal Collector Plant

The first measure considered in this report includes the re-arrangement of the domestic hot water heating plant to maximize heat gains from the solar collector.

.1 Measure Description

This measure would include changing the piping arrangement of the domestic hot water plant to ensure that the solar collectors always receive the lowest possible temperature of water in the system, and that the natural gas heater is able to heat both storage tanks. The solar thermal collectors on the building's roof are a flat plate type, which offer relatively high heat gain from the sun during the day but rely on having lower temperature water supplied to them to achieve that heat gain; generally, the water entering these panels should be kept as low as possible as often as possible to maximize their contribution to domestic hot water heating demand. In addition to this, the domestic hot water plant is slightly limited in its design because the natural gas heater can only ever heat the second hot water storage tank and the solar thermal collectors can only ever heat the first hot water storage tank. This causes two conditions that limit performance of the domestic hot water plant:

A. The solar thermal collector can only ever heat half of the system's stored water

B. The natural gas heater can only ever heat half of the system's stored water

To improve the performance of the DHW system, the solar collector and natural gas heater would both be configured parallel to the hot water storage tanks. The flow rates to the heat exchanger connecting the solar thermal collector to the hot water storage tanks would also be reduced to maximize temperature differences on either side.

.2 Design Considerations

For this measure to be implemented, pipework would be re-organized in the upper mechanical room serving the DHW system, connecting the entering-water line to bot the natural gas heater and the solar thermal collectors to the domestic cold water makeup line. The pumps serving the solar thermal collectors may also need to be replaced at lower flows and pressure drops to maximize temperature differences in the solar thermal heat exchanger's entering and leaving water temperatures.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 2: ECM-1 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-1	Re-Configure DHW + Solar Thermal Collector Plant	60	-	$720	3.0	$20,800	25+

6.3 ECM-2: Install Electric Resistance Heater to Heat Pump Plant

This measure explores the opportunity to supplement the heating plant with additional heating capacity from an electric resistance heater.

.1 Measure Description

This measure would include the connection of an electric resistance hot water heater to the building's main heating system. This heater would be used as an intermediate heat source to the rest of the mechanical system, intended to mitigate a portion of the heating demand that would have otherwise been met with the heating plant's natural gas water heater. This would not necessarily require a high amount of heating capacity because of its role as a partial or supplemental heat source.

.2 Design Considerations

This measure would serve as a fuel switching, or electrification measure for the main heating plant. Because the electric resistance heater would only ever activate to meet heating demand that would have been met by the natural gas heater, this measure would be expected to increase utility costs while also reducing the building's emissions. This measure would thus function as a long-term method for offsetting the building's natural gas usage using electricity in exchange for increased utility costs.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 3: ECM-2 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period
ECM-2	Install Electric Resistance Heater to Heat Pump Plant	73	(16,755)	$(751)	3.5	$56,680	N/A

6.4 ECM-3: Lower HP Plant CHWST Setpoint

While considered exploratory at this stage, this measure would seek to increase the heating capacity of the geothermal heat pump plant by lowering its chilled water supply temperature (CHWST) during winter seasons.

.1 Measure Description

During the review of trend log data from the geo-thermal heat pump plant, it was noted that during winter chilled water supply temperatures (CHWST) from the heat pumps did not lower below 0-1°C; this is relatively high for geo-thermal system of this type. The amount of heat that the heat pumps are able to draw from its geothermal loop is dictated by the temperature difference between the CHWST and the earth. While ground temperatures in BC are generally expected to remain at 10°C, geothermal systems often require their CHWST to reach temperatures between -4°C to -6°C in order to increase heat drawn from the ground. This measure would require the heat pump plant to go through a recommissioning effort to incorporate a lower CHWST before calling on the natural gas water heater during winter seasons.

.2 Design Considerations

In order for this measure to be carried out, a recommissioning effort with the heat pump manufacturer would be required, where the limits for the heat pumps' CHWST can be explored and tested. No new equipment would be required for this measure.

Although this would be expected to increase the load share from the heat pumps and lower demand on the natural gas water heater, it would also be expected to cause the heat pumps to operate less efficiently since they would be operating at a higher temperature lift (temperature difference between CHWST and heating water supply temperature or HWST). As such, this would be expected to decrease the building's natural gas consumption and increase the building's electricity consumption.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 4: ECM-3 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-3	Lower HP Plant CHWST Setpoint	20	(4,183)	$(164)	1.0	$8,450	N/A

6.5 ECM-4: Change HP Controls to Reject Heat to Ground As Priority Over DC-1

This measure would explore recommissioning the heat pump plant to ensure that the geo-thermal wells are at a high temperature before activating the system's dry cooler.

.1 Measure Description

The geo-thermal system in the building relies on the temperature of the ground to be at least consistent throughout the winter in order to maintain a relatively high heating efficiency in the heat pump plant, but the opportunity exists to recommission the heat pump plant to increase its efficiency by storing heat in the ground as much as possible during summer and shoulder season to help delay the requirement for low CHWST in the winter. This would require the system to reject heat to the ground through the geo-thermal loop as a higher priority than DC-1. This would mean that after periods of high outdoor air temperatures, the system will be able to draw heat out of a significantly warmer geo-thermal loop compared to the temperature of the geo-thermal loop if heat had been rejected through the dry cooler.

.2 Design Considerations

While it can be favorable to store heat in the ground to be used during later periods with heating demand, operation of the dry cooler should still be used to maintain adequately low entering water temperatures to the heat pump plant's condensers; in summary, if the building cannot reject heat fast enough to the ground, then the dry cooler should be activated to provide additional heat rejection capacity.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 5: ECM-4 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-4	Change HP Controls to Reject Heat to Ground As Priority Over DC-1	-	5,875	$572	0.1	$15,600	25+

6.6 ECM-5: Cross Connect Geo-Plant to Solar Collectors

The opportunity exists to use the solar thermal collectors as a heat source for the main heating plant and for the domestic hot water plant.

.1 Measure Description

This measure would add a new heat exchanger to the solar thermal collectors' water loop, which is currently used only for domestic hot water heating, to the geo-thermal heat pumps' heating water water return line with a dedicated circulation pump. Under this new configuration, the solar thermal collectors would heat domestic hot water until temperature requirements in the domestic hot water storage tanks are met, and then would begin to bring heat from the solar thermal collector to the geo-thermal heating line instead of simply turning off. This would mean that the amount of free heat gained from the sun would be increased, but could now used as a heat source to the rest of the heating plant. This solar heat gain would then be circulated to the building's heating terminal units including fan coils and the garage's hydronic radiant floor.

.2 Design Considerations

For this measure to be implemented, an additional heat exchanger and circulation pump would need to be connected in the DHW system mechanical room, with a connection to the building's heating water line. This would require new pipework to be routed from the adjacent hallway to the DHW plant.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 6: ECM-5 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-5	Cross Connect Geo-Plant to Solar Collectors	18	-	$218	0.9	$8,760	25+

6.7 ECM-6: Fan Coil Recommissioning and Balancing

This measure would seek to improve thermal comfort along the building's perimeter spaces by recommissioning and balancing the airflow through fan coils in these spaces.

.1 Measure Description

In discussions with building occupants, they claimed that outer spaces in the building have issues meeting temperature setpoints during winter, leading occupants to bring in electric resistance radiant heaters to their office spaces. This measure would seek to increase the amount of airflow and the supply air temperature provided to these perimeter spaces from their respective fan coil units during winter periods. This would be done as a way to help prevent the need for added electric resistance heaters, which would incur more energy use and utility costs than heat from the central heating plant.

.2 Design Considerations

This measure would rely on there being adequate flow to the furthest spaces served by the main heating plant; it is possible that the amount of airflow available to the perimeter spaces could be found to be at its limit during the system's rebalancing and cannot be increased. Other opportunities for adding heat to the perimeter spaces are described under separate report sections.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 7: ECM-6 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-6	Fan Coil Recommissioning and Balancing	-	5,728	$558	0.1	$11,700	21.0

6.8 ECM-7: Add Low-Temp Hydronic Heaters to Perimeter Spaces

As an alternative to re-balancing the airflow to the perimeter spaces, local hydronic radiant heaters may be installed on an as-needed basis.

.1 Measure Description

Under this measure, any un-met heating demand in the building's perimeter spaces would be met through added, wall-mounted radiant heaters. These would be located in spaces with high temperature control complaints, and would require pipework to be routed to them with a control valve and thermostat to add heat to the space when needed.

.2 Design Considerations

While this would be expected to add more heat to perimeter spaces, it would be expected to be a higher cost measure compared to an air-balancing and recommission effort of the spaces' existing heating terminal units.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 8: ECM-7 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-7	Add Low-Temp Hydronic Heaters to Perimeter Spaces	-	5,728	$558	0.1	$128,700	25+

6.9 ECM-8: CFL Lighting Conversion to LED

This measure reflects a high level of conversion from CFL lighting to LED fixtures, maintaining a consistent lighting intensity. More information will be available under separate cover.

.1 Measure Description

The opportunity exists to retrofit the lighting fixtures in the building to LED from their original fluorescent selections. This would be expected to lower electricity use and building peak demand.

.2 Design Considerations

For more design considerations for this measure, refer to report under separate cover.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 9: ECM-8 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-8	CFL Lighting Conversion to LED	-	84,239	$8,202	1.0	$120,000	14.6

6.10 ECM-9: Recommission Radiant Floor Heating Water Pump Speed Control

The circulation pump currently serving the radiant floor is set to a constant, partial speed. This measure would seek to provide this pump with independent variable speed.

.1 Measure Description

In order to lower the amount of power needed for the garage's hydronic radiant floor loop, the opportunity exists to install a new controller capable of changing the pump's control based on the return temperature from the radiant floor. This would allow the pump to lower its speed under most conditions, requiring significantly less electricity for circulation. The garage is expected to be the largest single consumer of thermal energy from the heat pump plant, making this pump crucial to the plant's overall operation; reducing flow to the radiant floor would be expected to increase its runtime and lower its return temperature, slightly improving the electrical efficiency of the heat pump plant and reducing the pump's power consumption.

.2 Design Considerations

For this measure to be implemented, the current pump must be able to either interface with a new controller based on return water temperature or be replaced with a pump with an integral temperature sensor. No other mechanical changes would be required for this measure.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 10: ECM-9 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-9	Recommission Radiant Floor Heating Water Pump Speed Control	-	3,179	$310	0.0	$17,450	25+

6.11 ECM-10: DHW CO_2 Heat Pumps

This measure explores the use of CO_2 heat pump technology in the building's DHW system.

.1 Measure Description

The domestic hot water plant is expected to be the main consumer of natural gas in the building based on the current configuration of the gas-fired heater and the solar thermal collector. The opportunity exists to install an additional heat source to the domestic hot water plant in the form of a CO_2 heat pump; this would consist of 2-4 small condensing units located on the building's outer roof with a piped connection to the

DHW supply line and DCW makeup water line. This would be intended to operate as the primary heat source for DHW production, and would be expected to run at a low but constant heating output.

CO_2 heat pumps excel at providing a low flow of hot water at a high temperature difference, making them well suited to DHW production. They are relatively expensive, and as such they benefit from being used with a high amount of hot water storage, which the building already has.

.2 Design Considerations

For this measure to be implemented, new condensing units would need to be installed on the outer roof, and pipework would need to be run from the DHW system mechanical room to the new condensing units. For the new CO_2 heat pump to work well with the solar collectors, the solar collectors should be recommissioned to operate at as high of a domestic water temperature difference as possible (ideally from 40F to 140F) to avoid bringing hot water into the new condensing units.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 11: ECM-10 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-10	DHW CO2 Heat Pumps	228	(18,074)	$970	11.2	$88,400	25+

6.12 ECM-11: Hyper-Low Flow Hot Water Fixtures

The opportunity exists to retrofit the building's hand-washing sinks to lower flow. The flow rate of the current fixtures is approximately 1GPM, and may be lowered to 0.5GPM while still offering effective flow for hand washing.

.1 Measure Description

The opportunity exists to replace some of the building's hand wash sinks with lower flow fixtures that still provide adequate flow. Reducing flow in these fixtures would both reduce the amount of water consumed by the building and reduce the amount of natural gas and solar heat gain used per minute of fixture use.

.2 Design Considerations

Although there may be an opportunity to lower the flow rate of the water fixtures in the washrooms to 0.5GPM, it should be noted that lower flow fixtures are sometimes not preferred by building tenants and may cause tenants to wash their hands for longer periods of time if fixtures at too low of a flow rate are selected. In addition, savings associated with reducing flow are high when reducing from high flow to low flow, and the hand wash sinks in this building, which are estimated to have 1GPM of flow, are not necessarily considered to be high flow (2.0 GPM+).

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 12: ECM-11 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-11	Hyper-Low Hot Water Fixtures	5	-	$64	0.3	$18,850	25+

6.13 ECM-12: Wallpack Battery for Demand Response

With new programs from CleanBC refocusing from full electrification to a more holistic review of grid integrity, opportunities for on site power reserves may be explored for the purposes of peak demand period response.

.1 Measure Description

This measure would involve the installation of DC batteries to the upper mezzanine adjacent to the solar controllers, which would be used to help trim the building's electrical demand during BC's typical peak demand period of 4PM-8PM. These batteries would be activated to help supplement the building's power demand during this period, reducing the building's electrical consumption during this time. The battery array would then be charged overnight before being called upon again during the next peak demand period.

.2 Design Considerations

This measure is a relatively new consideration from CleanBC, but may be considered by building owners as a way of integrating on-site storage for other purposes as well, including power supply during power outages. This may couple well with the building's high PV array capacity; for more information regarding this measure, refer to report under separate cover.

.3 Savings Summary

Savings associated with this measure are shown in the following table.

Table 13: ECM-12 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-12	Wallpack Battery for Demand Response	-	-	$500	-	$150,000	25+

7. FINANCIAL MODELLING

This section shows the expected impacts of utility cost savings and cumulative cost savings between 2025 and 2050.

7.1 ECM-1: Re-Configure DHW + Solar Thermal Collector Plant – Financial Performance

The annual cost savings under this measure are shown in the following figure.

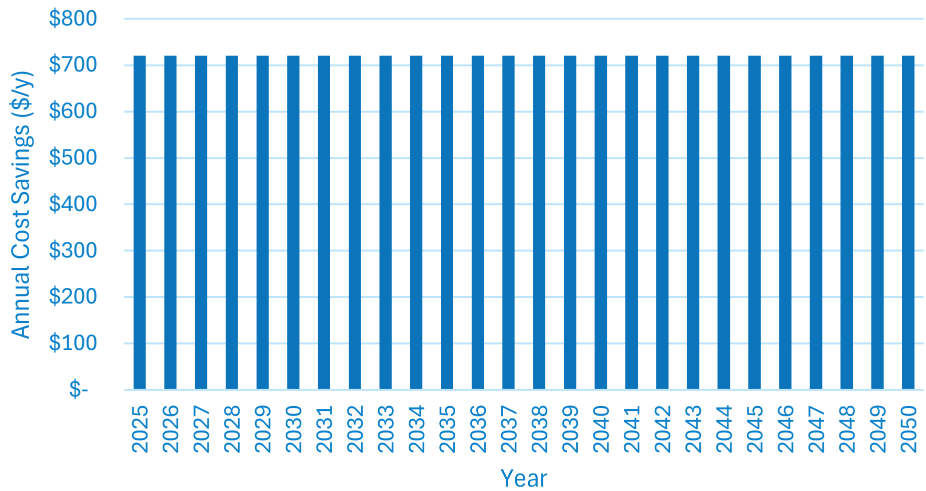

Figure 18: ECM-1 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 14: ECM-1 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$720	$-	$720
2030 Annual Cost Savings	$720	$-	$720

7.2 ECM-2: Install Electric Resistance Heater to Heat Pump Plant – Financial Performance

The annual cost savings under this measure are shown in the following figure.

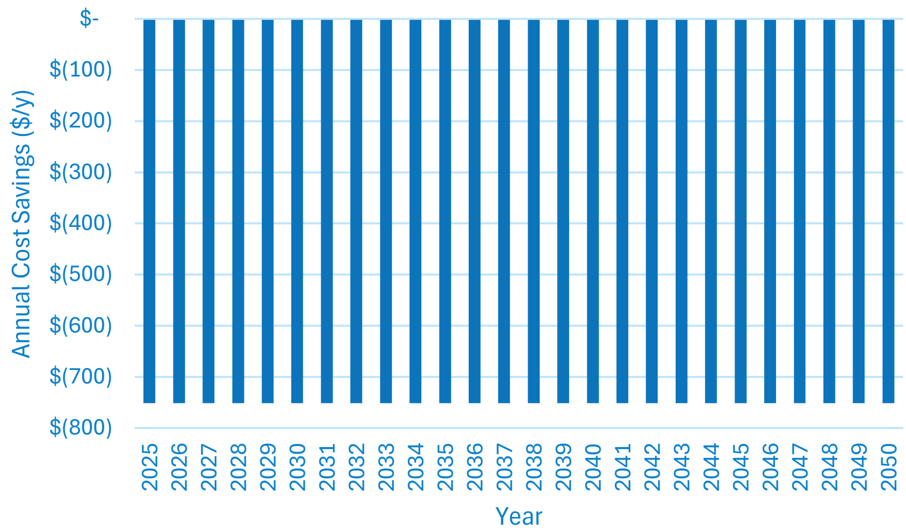

Figure 19: ECM-2 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 15: ECM-2 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$(751)	$-	$(751)
2030 Annual Cost Savings	$(751)	$-	$(751)

7.3 ECM-3: Lower HP Plant CHWST Setpoint – Financial Performance

The annual cost savings under this measure are shown in the following figure.

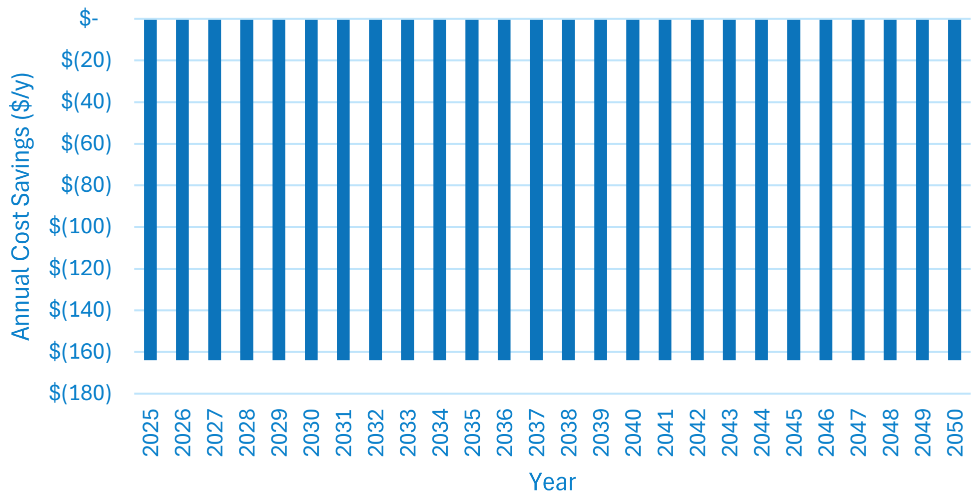

Figure 20: ECM-3 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 16: ECM-3 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$(164)	$-	$(164)
2030 Annual Cost Savings	$(164)	$-	$(164)

7.4 ECM-4: Change HP Controls to Reject Heat to Ground As Priority Over DC-1 – Financial Performance

The annual cost savings under this measure are shown in the following figure.

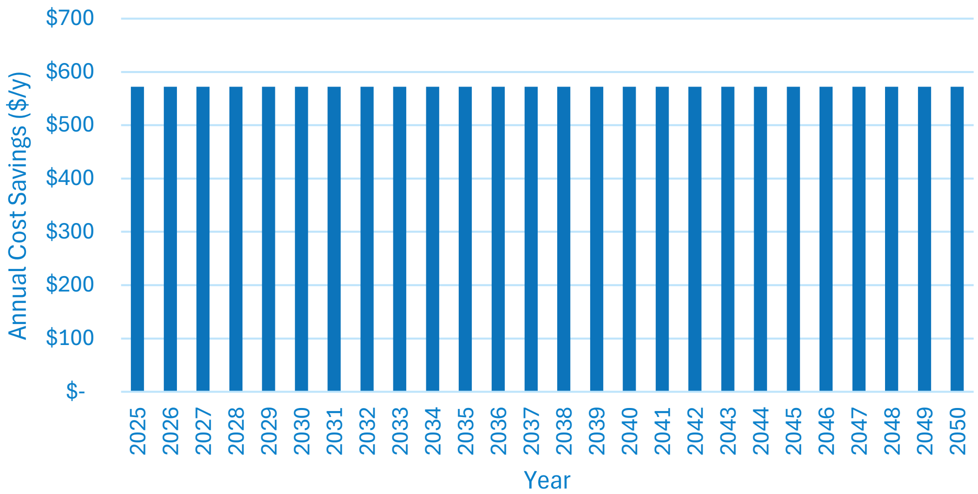

Figure 21: ECM-4 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 17: ECM-4 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$572	$-	$572
2030 Annual Cost Savings	$572	$-	$572

7.5 ECM-5: Cross Connect Geo-Plant to Solar Collectors – Financial Performance

The annual cost savings under this measure are shown in the following figure.

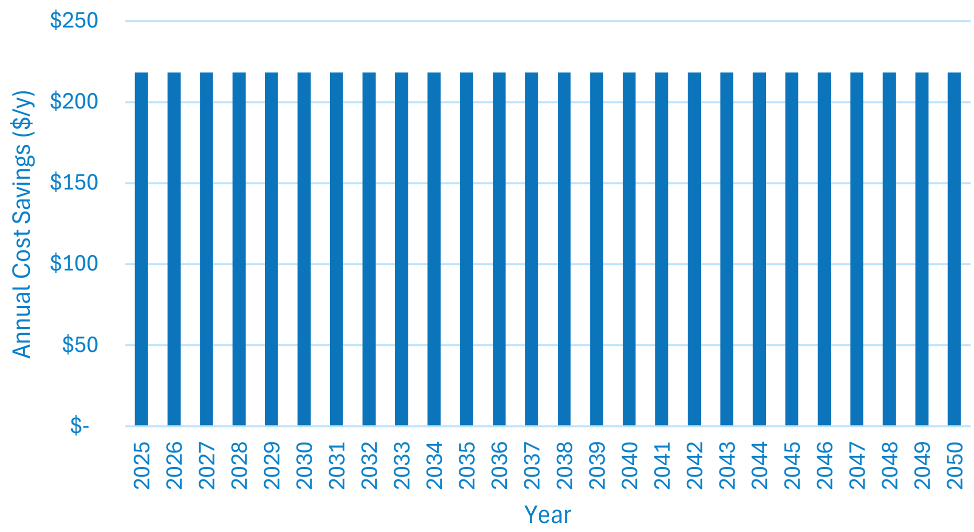

Figure 22: ECM-5 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 18: ECM-5 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$218	$-	$218
2030 Annual Cost Savings	$218	$-	$218

7.6 ECM-6: Fan Coil Recommissioning and Balancing – Financial Performance

The annual cost savings under this measure are shown in the following figure.

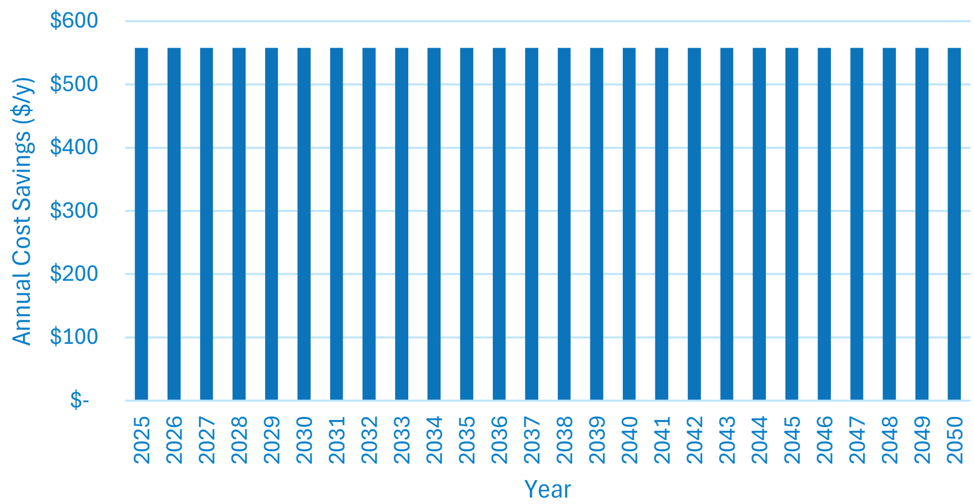

Figure 23: ECM-6 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 19: ECM-6 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$558	$-	$558
2030 Annual Cost Savings	$558	$-	$558

7.7 ECM-7: Add Low-Temp Hydronic Heaters to Perimeter Spaces – Financial Performance

The annual cost savings under this measure are shown in the following figure.

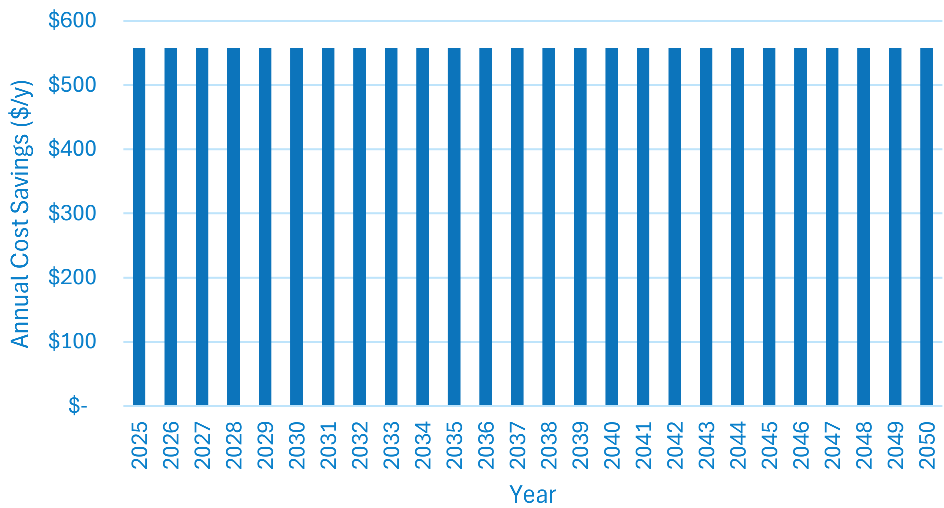

Figure 24: ECM-7 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 20: ECM-7 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$558	$-	$558
2030 Annual Cost Savings	$558	$-	$558

7.8 ECM-8: CFL Lighting Conversion to LED – Financial Performance

The annual cost savings under this measure are shown in the following figure.

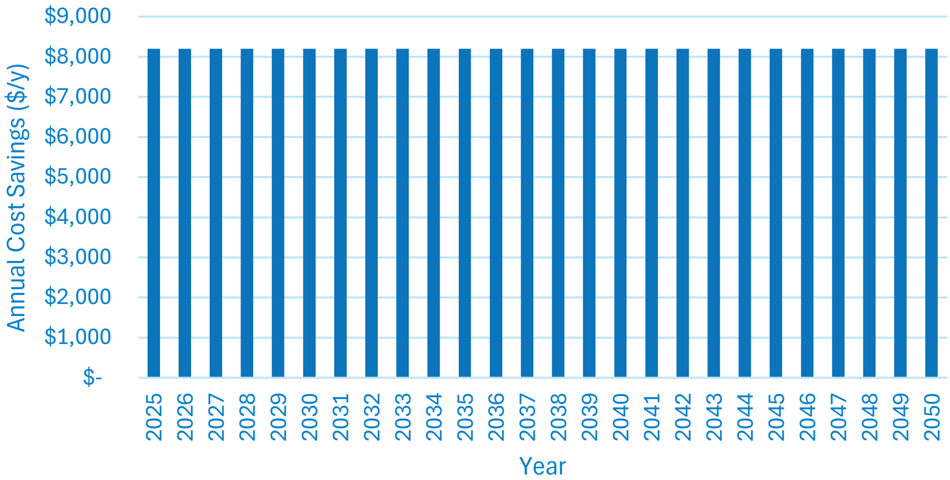

Figure 25: ECM-8 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 21: ECM-8 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$8,202	$-	$8,202
2030 Annual Cost Savings	$8,202	$-	$8,202

7.9 ECM-9: Recommission Radiant Floor Heating Water Pump Speed Control – Financial Performance

The annual cost savings under this measure are shown in the following figure.

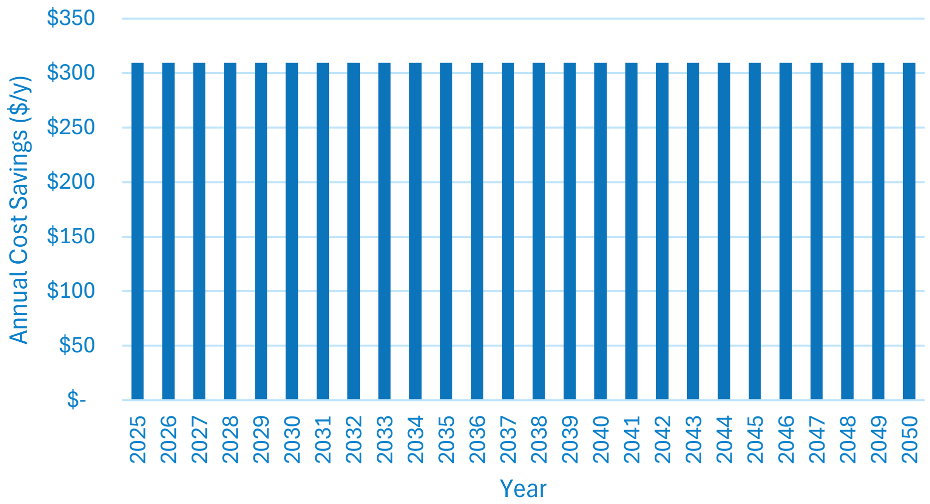

Figure 26: ECM-9 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 22: ECM-9 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$310	$-	$310
2030 Annual Cost Savings	$310	$-	$310

7.10 ECM-10: DHW CO2 Heat Pumps – Financial Performance

The annual cost savings under this measure are shown in the following figure.

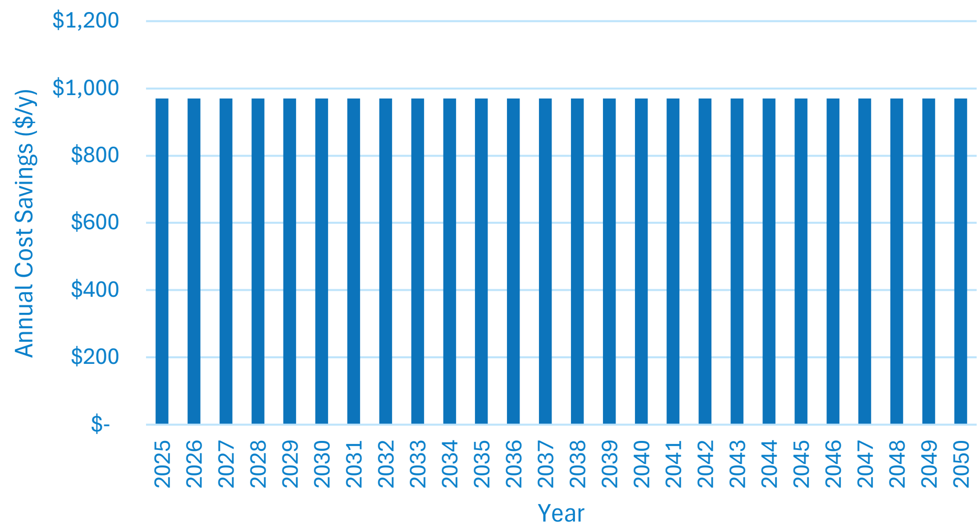

Figure 27: ECM-10 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 23: ECM-10 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$970	$-	$970
2030 Annual Cost Savings	$970	$-	$970

7.11 ECM-11: Hyper-Low Hot Water Fixtures – Financial Performance

The annual cost savings under this measure are shown in the following figure.

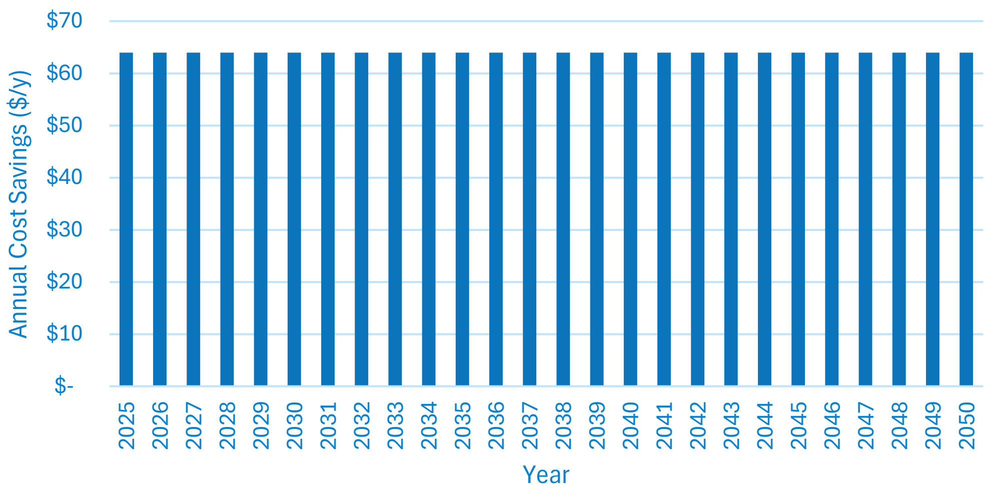

Figure 28: ECM-11 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 24: ECM-11 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$64	$-	$64
2030 Annual Cost Savings	$64	$-	$64

7.12 ECM-12: Wallpack Battery for Demand Response – Financial Performance

The annual cost savings under this measure are shown in the following figure.

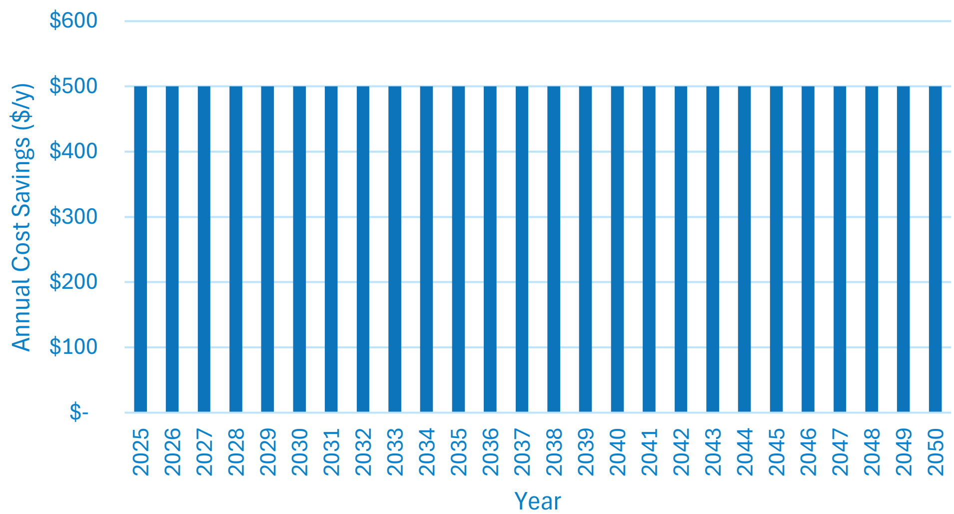

Figure 29: ECM-12 Annual Cost Savings

The assumed cost savings in 2025 versus 2050 is shown in the following table (shown in 2024 dollars).

Table 25: ECM-12 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$500	$-	$500
2030 Annual Cost Savings	$500	$-	$500

8. RECOMMENDATIONS AND CONCLUSION

This report investigated twelve different opportunities for energy conservation at the District of Saanich's Firehall #1, including energy efficiency measures, electrification measures, and one demand response measure. The impact of these measures is summarized in the following table.

Table 26: ECM Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-1	Re-Configure DHW + Solar Thermal Collector Plant	60	-	$720	3.0	$20,800	25+
ECM-2	Install Electric Resistance Heater to Heat Pump Plant	73	(16,755)	$(751)	3.5	$56,680	N/A
ECM-3	Lower HP Plant CHWST Setpoint	20	(4,183)	$(164)	1.0	$8,450	N/A
ECM-4	Change HP Controls to Reject Heat to Ground As Priority Over DC-1	-	5,875	$572	0.1	$15,600	25+
ECM-5	Cross Connect Geo-Plant to Solar Collectors	18	-	$218	0.9	$8,760	25+
ECM-6	Fan Coil Recommissioning and Balancing	-	5,728	$558	0.1	$11,700	21.0
ECM-7	Add Low-Temp Hydronic Heaters to Perimeter Spaces	-	5,728	$558	0.1	$128,700	25+
ECM-8	CFL Lighting Conversion to LED	-	84,239	$8,202	1.0	$120,000	14.6
ECM-9	Recommission Radiant Floor Heating Water Pump Speed Control	-	3,179	$310	0.0	$17,450	25+
ECM-10	DHW CO2 Heat Pumps	228	(18,074)	$970	11.2	$88,400	25+
ECM-11	Hyper-Low Hot Water Fixtures	5	-	$64	0.3	$18,850	25+
ECM-12	Wallpack Battery for Demand Response	-	-	$500	-	$150,000	25+

It is recommended that ECM-3, ECM-5, ECM-6, and ECM-8 are considered by the District of Central Saanich for implementation. These measures offer either relatively high emissions savings per unit of capital cost, will allow for improved occupancy thermal comfort, or is expected to have a favorable business case. ECM-2 and ECM-10 may also be considered for long term implementation as more capital cost-intense mechanical upgrades with high emissions savings.

END OF REPORT