DISTRICT OF CENTRAL SAANICH – PUBLIC WORKS

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 their Public Works property; these reports have been developed under CleanBC's Integrated Energy Audit program. This report investigated seven different opportunities for energy conservation including energy efficiency measures, electrification measures, on site generation measures, and one demand response measure. The impact of these measures is summarized in the following table.

Table 1: ECM Savings Summary Table

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-1	Convert Garage Heating Unit to DX Heat Pump Split w/ Gas Fired Back-Up	124	(9,526)	$786	6.1	$56,550	25+
ECM-2	Convert Office and Locker Room Ductless Units to Heat Pump Capacity	-	14,484	$1,410	0.2	$27,300	19.4
ECM-3	DHW CO2 Heat Pumps	-	2,482	$242	0.0	$27,950	25+
ECM-4	Convert Upper Office Area to Forced Air	-	3,623	$353	0.0	$80,600	25+
ECM-5	PV Panel Array	-	20,000	$1,480	-	$100,000	25+
ECM-6	LED Lighting Conversion	-	2,695	$190	0.0	$2,000	10.5
ECM-7	Convert Window Units to HP Ductless Splits	-	3,623	$353	0.0	$21,450	25+

It is recommended that ECM-1 is carried out as the highest priority for decarbonization since the garage heater is the only major consumer of natural gas and can be retrofitted to a hybrid heating system. ECM-2, ECM-3, and ECM-7 may be considered as long term retrofits towards more highly efficient mechanical heating equipment, albeit with mixed financial performances.

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 their Public Works property; these reports have been developed under CleanBC's Integrated Energy Audit program.

3. BUILDING DESCRIPTION

This section provides a description of the property as a whole, its mechanical systems, and its primary energy consumers.

3.1 General Description

The Public Works site is located along Keating Cross Road, and is used for storing tools, training municipal workers, and acting as a logistical hub for the municipality. It consists of small front office, office spaces on the upper floor, training rooms and changerooms on the ground level, several isolated office spaces, a kitchen on the upper level in the main building. The secondary building is used mainly for storage and as a covered garage for service vehicles, but includes small workshops and some distributed office spaces. Several other structures exist on the property including two small workshops heated by electrical resistance unit heaters, and two outdoor storage buildings. The property includes three level 2 (6-7kW) electric vehicle (EV) chargers along its outdoor parking stalls.

3.2 Heating & Cooling Systems

The main building's heating is primarily provided through electric resistance baseboards, with a small DX spit serving the front office and "window-shaker" condensing units serving the upper office spaces. The main building's garage space is heated through a central gas-fired air handling unit located along its upper ceiling.

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Figure 1: Main Building Gas-Fired Air Handling Unit

Figure 2: Front Office Wall-Mounted Cassette

Figure 3: Common Space Wall-Mounted Cassette

Figure 4: Upper Office "Window-Shaker" Condensing Unit

Figure 5: Locker Room Wall-Mounted Cassette

The secondary building has distributed electric resistance unit heaters that are activated by workers on an as-needed basis during winter, and is not fitted with distributed cooling capacity.

Figure 6: Typical Secondary Building Unit Heater

3.3 Ventilation System

Neither the main building or secondary building are fitted with a central ventilation system aside from the air handler serving the garage in the main building. Passive ventilation is understood to be used through opening windows or propping open doors.

3.4 Domestic Hot Water System

The main building's domestic hot water system consists of one electric hot water tank with 48 gallons of storage volume and 5,250 watts of hot water heating capacity. This tank is used mainly to provide hot water to sinks in the kitchen and washrooms.

Figure 7: Main Building Domestic Hot Water Tank

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.

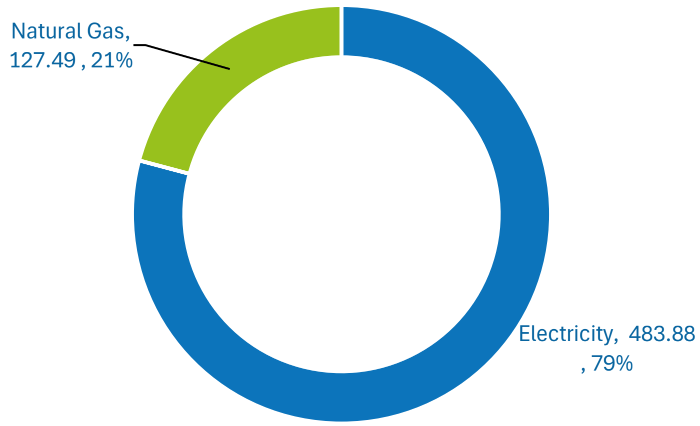

Figure 8: Energy Use Proportion By Source Type (2023)[1]

While the overall proportion of natural gas use may seem small compared to the property's electricity consumption (21% for natural gas and 79% for electricity), it should be noted that the only piece of equipment that uses natural gas on site is the air handling unit serving the garage in the main building; this means that this equipment uses 21% of the site's energy.

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

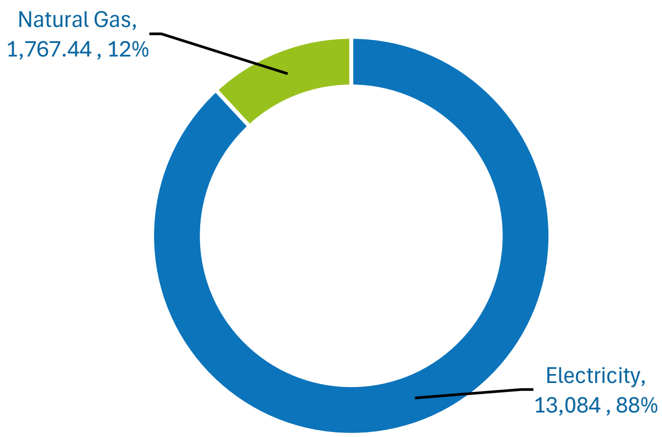

Figure 9: Energy Utility Costs By Source Type (2023)[2]

The utility costs associated with electricity represent 88% of the building's total energy costs; this is reflective of the fact that electricity costs more per unit of energy than natural gas.

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

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

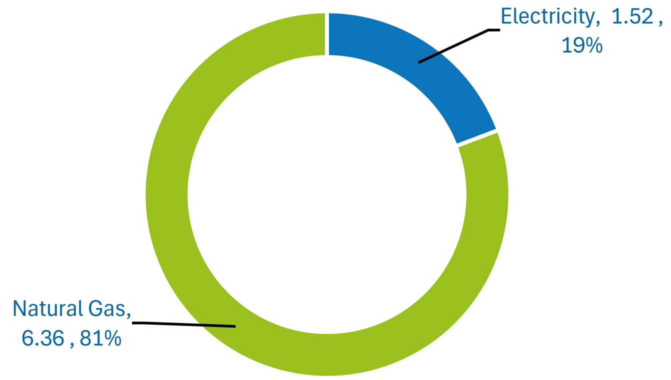

Figure 10: Energy Emissions by Source Type (2023)[3]

Despite only accounting for 21% of the building's total energy use, natural gas accounted for 81% 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.

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

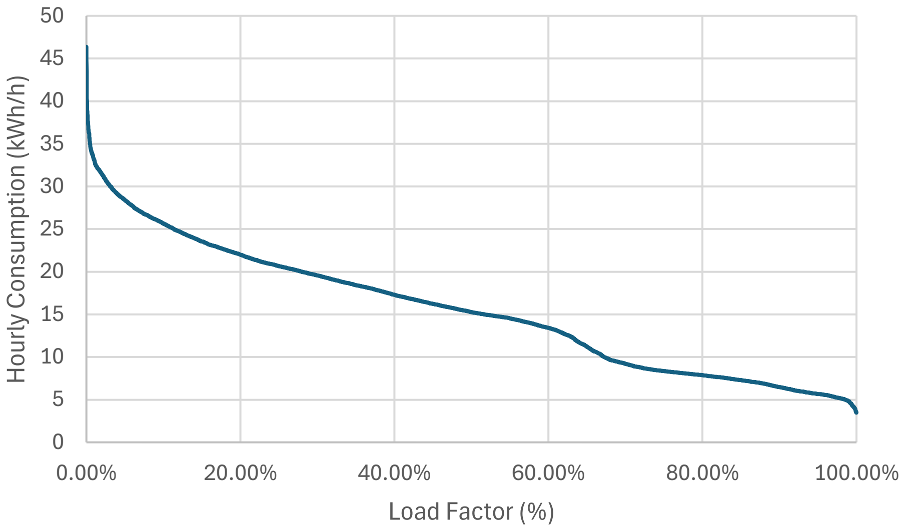

Figure 11: Electricity Load Distribution Curve

This load distribution curve helps to highlight how often the property draws different rates of energy per hour; key takeaways from the load distribution curve are that the building's power consumption never dropped below 3kW and that although the building's highest hourly consumption was 46.4kW, less than 1% of hours were spend with more than 34kW.

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 property'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.

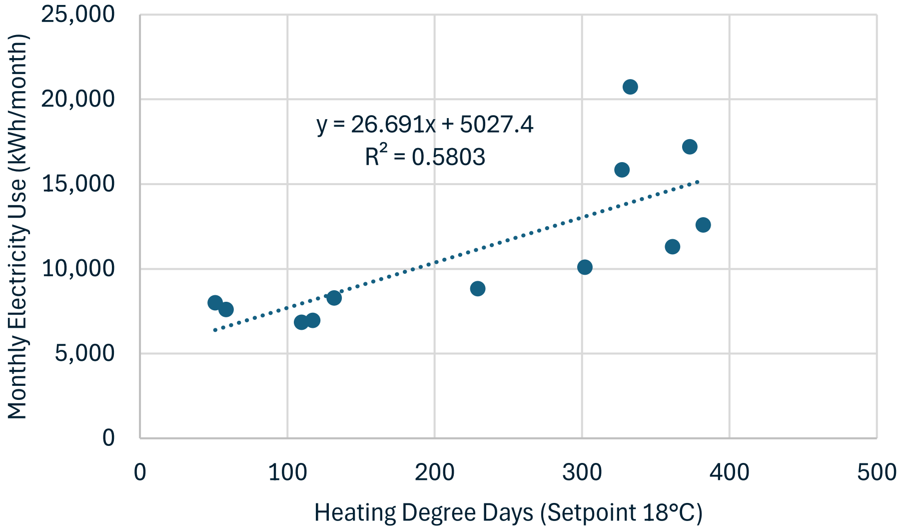

Figure 12: Electricity Linear Regression VS HDD (2023)

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 0.5803. 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 buildings on site are heated using electric resistance unit heaters and the property has relatively little air conditioning.

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

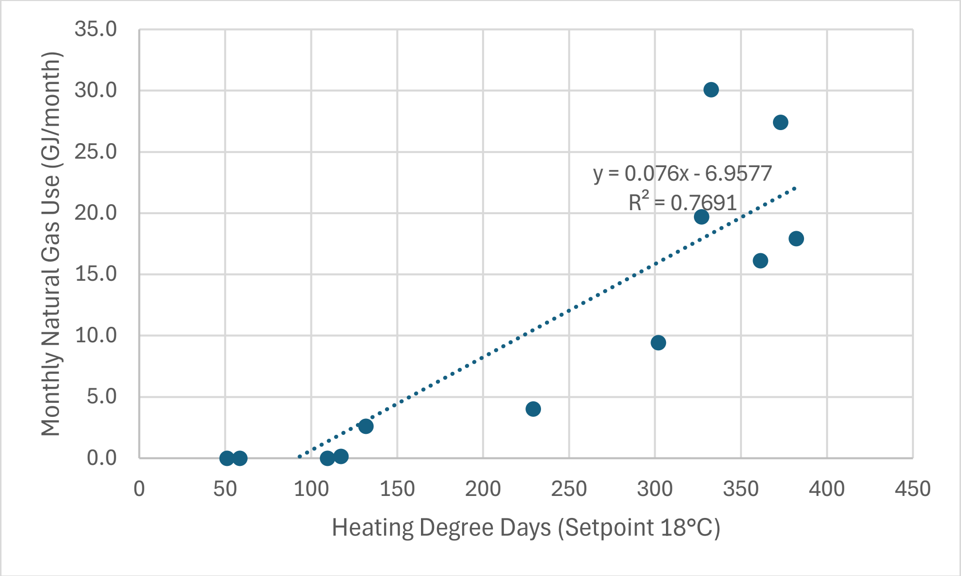

Figure 13: Natural Gas Linear Regression VS HDD (2023)

As shown in the previous figure, the correlation between natural gas and heating degree days is stronger than that of electricity; this could be explained by the fact that the main building's garage air handling unit's heating is only activated to maintain the temperature in the garage during winter seasons and its heating demand is expected to increase as outdoor air temperatures decrease.

5. KEY INPUTS AND ASSUMPTIONS

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

Table 2: Summary of Key Inputs and Assumptions

Description	Quantity	Unit
Blended Cost of Electricity	0.097 (27.04)	$/kWh ($/eGJ)
Blended Cost of Natural Gas	13.86 (0.050)	$/GJ ($/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: Convert Garage Heating Unit to DX Heat Pump Split w/ Gas Fired Back-Up

The first measure considered in this report includes adding heat pump-based heating capacity to the main building's garage.

.1 Measure Description

This measure would include the addition of a 5 ton air-source heat pump (ASHP) to supplement the heating demand of the garage. This would involve installing the ASHP's condensing unit to the opposite side of the wall from the garage on the roof and connecting a refrigerant-based heating coil in the supply air stream of the current air handling unit. This would allow the new ASHP to act as the main heat source for the air handling unit, with the gas-fired heater acting as backup. This measure would also have the added benefit of installing cooling to the garage space, since the ASHP would be able to switch to a cooling mode during summer conditions.

.2 Design Considerations

This measure could be implemented in other ways than that described in the previous section; although the main priority of this measure would be to mitigate gas-fired heating from the air handling unit, the installation of an ASHP could be expanded to other spaces in the building, installed as wall-hung cassettes in the garage, or installed as a shared hydronic loop for other spaces in the building.

.3 Savings Summary

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

Table 3: 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	Convert Garage Heating Unit to DX Heat Pump Split w/ Gas Fired Back-Up	124	(9,526)	$786	6.1	$56,550	25+

6.3 ECM-2: Convert Office and Locker Room Ductless Units to Heat Pump Capacity

This measure explores the opportunity to supplement the office and locker rooms with heat pump capacity.

.1 Measure Description

This measure would include the replacement of the current ductless mini-splits serving the upper office and locker room. This would help mitigate heating supplied from baseboard heaters during winter.

.2 Design Considerations

This measure would aim to re-use the power supplies from the current DX cooling units for the new ASHPs, and would aim to use the same refrigerant line routing plan as the current cooling system to minimize capital cost.

.3 Savings Summary

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

Table 4: ECM-2 Annual Savings Summary

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-2	Convert Office and Locker Room Ductless Units to Heat Pump Capacity	-	14,484	$1,410	0.2	$27,300	19.4

6.4 ECM-3: DHW CO2 Heat Pumps

This measure explores the installation of CO_2 Heat Pumps to help provide domestic hot water to the main building.

.1 Measure Description

This measure would include the installation of a CO_2 air source heat pump for DHW production for the main building; this would be selected as 1-2 condensing units which would be located at the roof level, with a piped connection between the DHW supply and DCW makeup line. This would allow the new ASHP to slowly heat the cold water in the existing storage tank, such that the tank could be heated overnight ahead of any hot water use from the morning shift. This hot water tank is expected to have relatively high demand for its size since it serves the main building's handwash sinks.

.2 Design Considerations

Although this opportunity helps to mitigate electricity consumption, some controls recommissioning would be required to ensure that the existing tank does not activate its heating element unless the tank is either about to run out of hot water after a peak demand period, or if the heat pump is unable to provide hot water back to the tank. The new CO_2 ASHP would also need to be selected with a dedicated circulator pump.

.3 Savings Summary

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

Table 5: 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	DHW CO2 Heat Pumps	-	2,482	$242	0.0	$27,950	25+

6.5 ECM-4: Convert Upper Office Area to Forced Air

This measure explores the potential methods for retrofitting the upper office to a forced air system.

.1 Measure Description

This measure would include the installation of an HRV to bring in fresh air to the upper office space, along with a forced air duct capable of bringing ventilation air to the common area on the upper floor. This would involve the installation of a rooftop unit (RTU) to the main building with an integral HRV and ASHP. This measure would have the added benefit of added outdoor air turnover and ASHP heating capacity to the space.

.2 Design Considerations

This measure may be implemented in other ways than what was previously described; instead of installing an RTU, a wall-based HRV may be installed along with a separate wall-mounted DX cassette with heating and cooling capacity; an RTU may be simpler to expand to any other spaces, but a wall-based HRV is expected to have a lower capital cost.

.3 Savings Summary

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

Table 6: 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	Convert Upper Office Area to Forced Air	-	3,623	$353	0.0	$80,600	25+

6.6 ECM-5: PV Panel Array

For more information on this measure, refer to the report under separate cover.

.1 Savings Summary

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

Table 7: 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	PV Panel Array	-	20,000	$1,480	-	$100,000	25+

6.7 ECM-6: LED Lighting Conversion

This measure would seek to replace the fluorescent T5 bulbs currently used in the secondary building's garage spaces.

.1 Measure Description

The opportunity exists to retrofit the lighting fixture in the secondary building's garage spaces from T5 fluorescent to LED. This would be expected to lower electricity use and building peak demand.

.2 Design Considerations

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

.3 Savings Summary

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

Table 8: 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	LED Lighting Conversion	-	2,695	$190	0.0	$2,000	10.5

6.8 ECM-7: Convert Window Units to HP Ductless Splits

This measure explores retrofit options for the "window-shaker" condensing units currently used in the upper office area.

.1 Measure Description

Under this measure, the window-mounted condensing units in the upper office would be replaced with wall-hung heat pump cassettes with both heating and cooling capacity. This would be expected to mitigate electricity consumption from the baseboard heaters in this space during winter.

.2 Design Considerations

This new arrangement would require an ASHP to be mounted on the main building's outer roof, with refrigerant routed through the wall to the wall-hung cassette.

.3 Savings Summary

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

Table 9: 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	Convert Window Units to HP Ductless Splits	-	3,623	$353	0.0	$21,450	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: Convert Garage Heating Unit to DX Heat Pump Split w/ Gas Fired Back-Up – Financial Performance

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

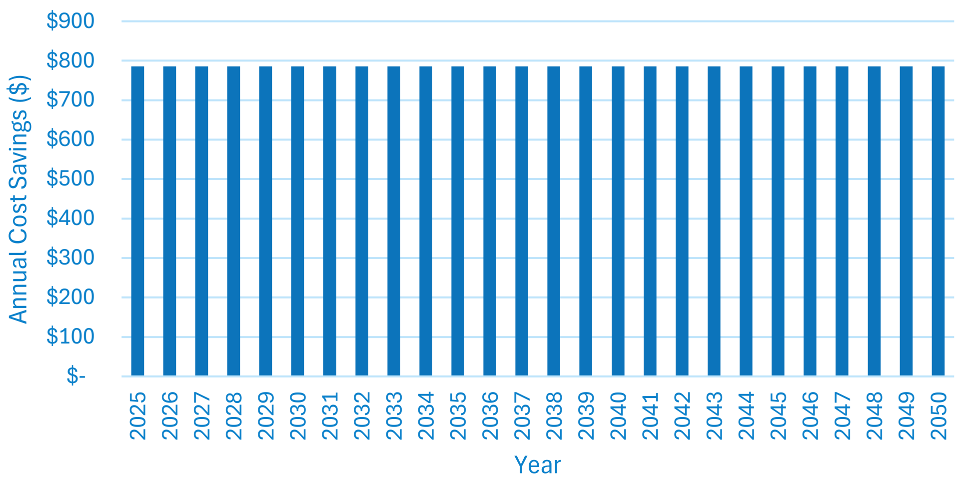

Figure 14: ECM-1 Annual Cost Savings

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

Table 10: ECM-1 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$786	$-	$786
2030 Annual Cost Savings	$786	$-	$786

7.2 ECM-2: Convert Office and Locker Room Ductless Units to Heat Pump Capacity – Financial Performance

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

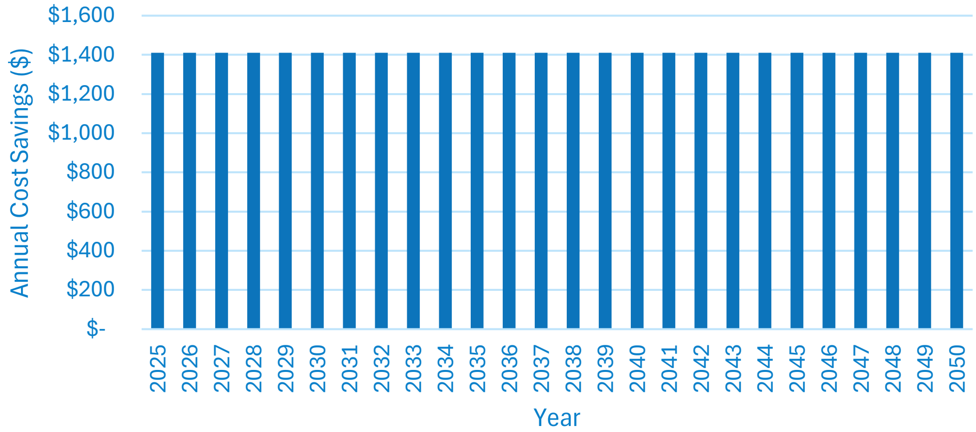

Figure 15: ECM-2 Annual Cost Savings

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

Table 11: ECM-2 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$1,410	$-	$1,410
2030 Annual Cost Savings	$1,410	$-	$1,410

7.3 ECM-3: DHW CO2 Heat Pumps – Financial Performance

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

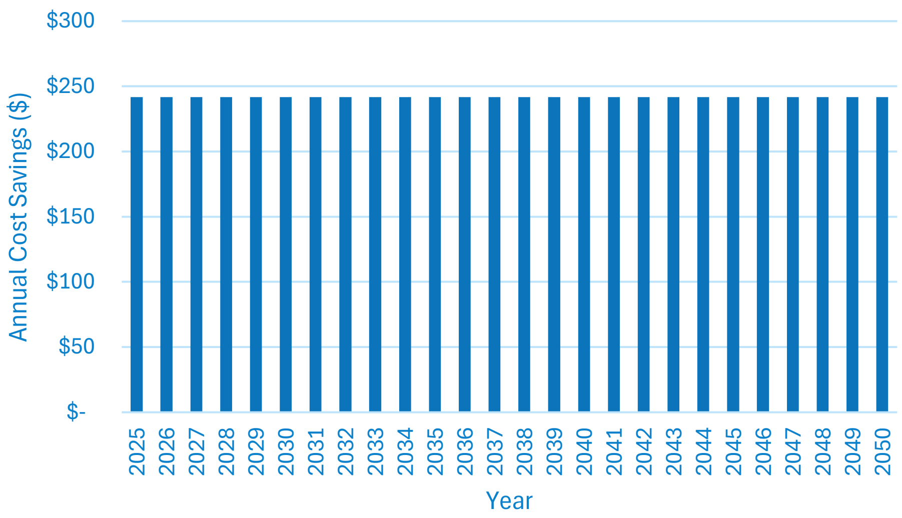

Figure 16: ECM-3 Annual Cost Savings

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

Table 12: ECM-3 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$242	$-	$242
2030 Annual Cost Savings	$242	$-	$242

7.4 ECM-4: Convert Upper Office Area to Forced Air – Financial Performance

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

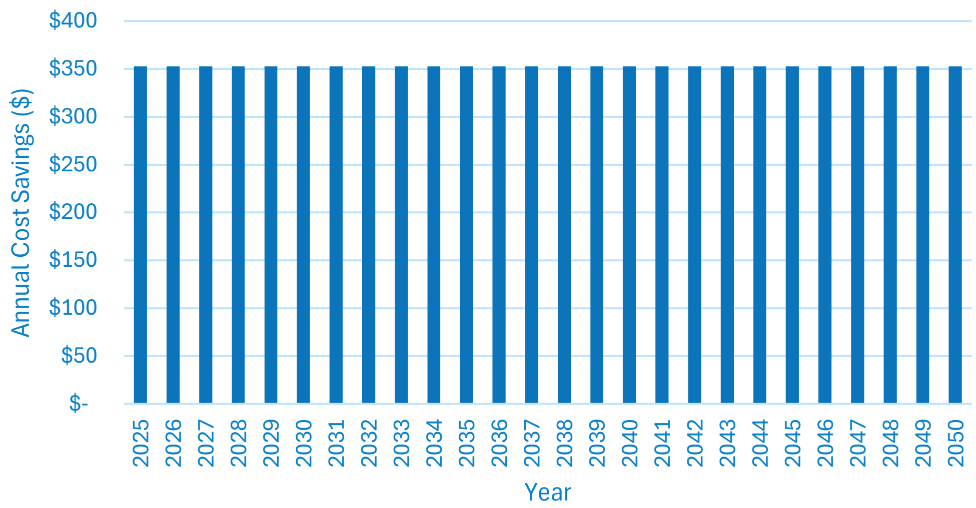

Figure 17: ECM-4 Annual Cost Savings

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

Table 13: ECM-4 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$353	$-	$353
2030 Annual Cost Savings	$353	$-	$353

7.5 ECM-5: PV Panel Array – Financial Performance

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

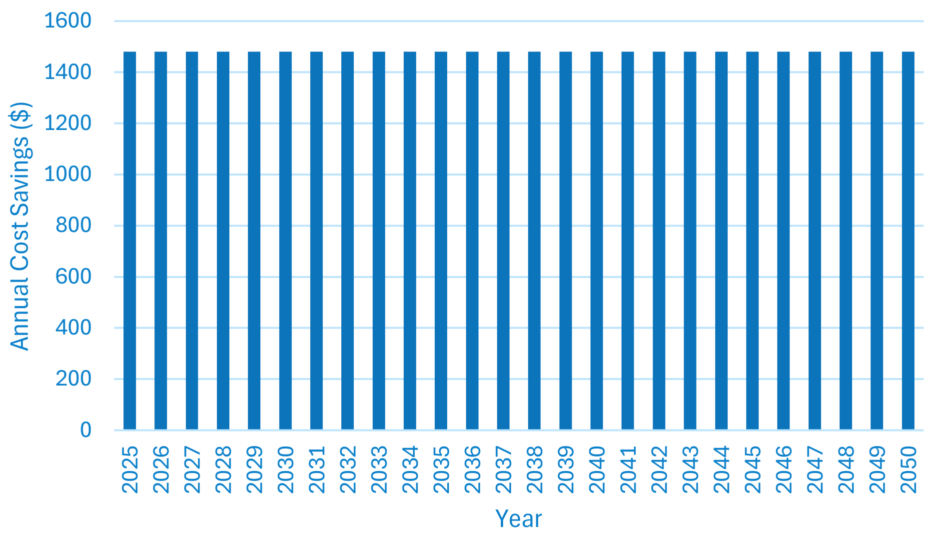

Figure 18: ECM-5 Annual Cost Savings

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

Table 14: ECM-5 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$1,480	$-	$1,480
2030 Annual Cost Savings	$1,480	$-	$1,480

7.6 ECM-6: LED Lighting Conversion – Financial Performance

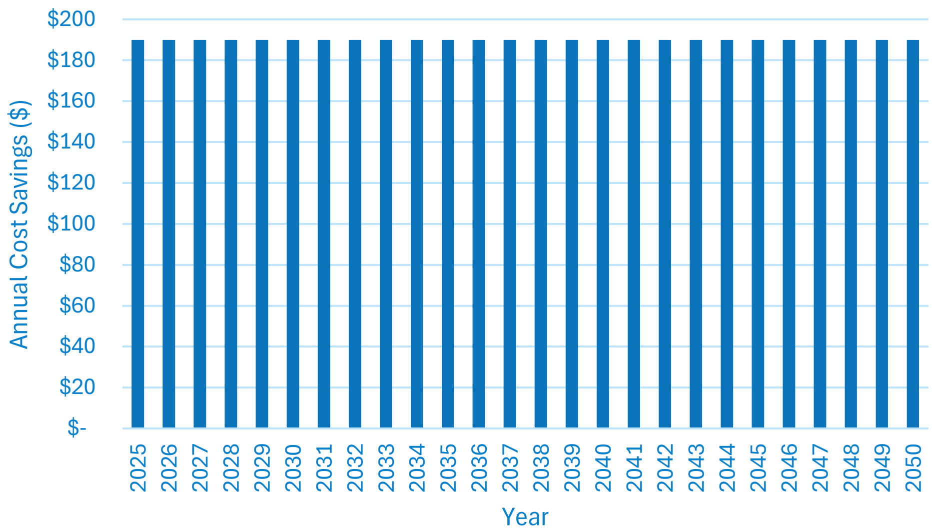

Figure 19: ECM-6 Annual Cost Savings

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

Table 15: ECM-6 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$190	$-	$190
2030 Annual Cost Savings	$190	$-	$190

7.7 ECM-7: Convert Window Units to HP Ductless Splits – Financial Performance

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

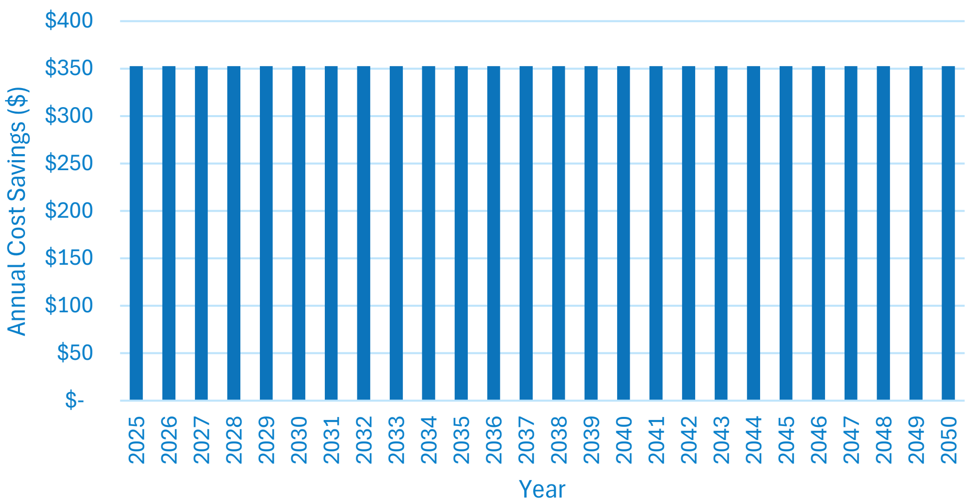

Figure 20: ECM-7 Annual Cost Savings

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

Table 16: ECM-6 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$353	$-	$353
2030 Annual Cost Savings	$353	$-	$353

8. RECOMMENDATIONS AND CONCLUSION

This report investigated seven different opportunities for energy conservation at the District of Saanich's Public Works complex, including energy efficiency measures, electrification measures, on site generation measures, and one demand response measure. The impact of these measures is summarized in the following table.

Table 17: ECM Savings Summary Table

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It is recommended that ECM-1 is carried out as the highest priority for decarbonization since the garage heater is the only major consumer of natural gas and can be retrofitted to a hybrid heating system. ECM-2, ECM-3, and ECM-7 may be considered as long term retrofits towards more highly efficient mechanical heating equipment, albeit with mixed financial performances.

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