DISTRICT OF CENTRAL SAANICH – LIBRARY & CULTURAL CENTRE

Project No.: 000b-1476-24
1209 Clarke Rd, Brentwood Bay, BC V8M 1P8

Integrated Energy Audit Report

December 6, 2024

PREPARED FOR:

District of Central Saanich
1903 Mt Newton Cross Rd
Saanichton, BC V8M 1T2
T 250-652-4444

ATTN:

Jennifer Lukianchuk
E Jennifer.Lukianchuk@csaanich.ca

PREPARED BY:

Ryan Antonsen, EIT, CEM
Project Manager – Building Performance
E ryanantonsen@amegroup.ca

REVIEWED BY:

Mike Kasuya, P.L.Eng., AScT, PTech, CPHD, LEED AP BD+C
Principal
E mikekasuya@amegroup.ca

638 Smithe, Vancouver BC V6B 1E3
T 604-684-5995

Permit to Practice: 1000236
Association of Professional Engineers and Geoscientists of the Province of British Columbia
M. J. T. KASUYA
PROFESSIONAL LICENSEE ENGINEERING
Licence 58622

2024-12-06

PROFESSIONAL'S SEAL & SIGNATURE

TABLE OF CONTENTS

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 the Library and Cultural Centre; these reports have been developed under CleanBC's Integrated Energy Audit program. This report investigated seven different opportunities 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

No.	Description	Natural Gas Savings (GJ)	Electricity Savings (kWh)	Utility Cost Savings ($)	Emissions Savings (tCO2e)	Capital Cost ($)	Payback Period (year)
ECM-1	Convert North Activity Room RTU To Electric Resistance w/ Heat Pump	-	39,044	$3,867	0.4	$94,250	24.4
ECM-2	DHW CO2 Heat Pumps	-	3,103	$307	0.0	$74,100	25+
ECM-3	Hyper-Low Flow Hot Water Fixtures	-	2,172	$215	0.0	$28,275	25+
ECM-4	PV Panel Array	-	35,000	2,590	-	$158,000	25+
ECM-5	Retrofit Library AHUs/ RTUs to Electric Resistance w/ Heat Pump	-	43,871	$4,345	0.5	$200,200	25+
ECM-6	Retrofit Auditorium AHU with Heat Pump Capacity	-	23,109	$2,289	0.3	$73,450	25+
ECM-7	Wallpack Battery for Demand Response	-	-	$500	-	$150,000	25+

It is recommended that ECM-1, ECM-5, and ECM-6 are considered for implementation as equipment lifecycle replacements for the air handlers and rooftop units serving the building's different spaces. ECM-2 may also be considered for implementation as part of an extension on the building's domestic hot water heating capacity.

This report has been prepared by the AME Group for the exclusive use of District of Central Saanich and the design team. The material in this report reflects the best judgement of the AME Group with the information made available to them at the time of preparation. Any use a third party may make of this report, or any reliance on or decisions made based upon the report, are the responsibility of such third parties. The AME Group accepts no responsibility for damages suffered by any third party as a result of decisions made or actions taken based upon this report.

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 the Library and Cultural Centre; 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 District of Central Saanich's Library and Cultural Centre is located in Brentwood Bay along Clarke Road, and consists of two primary service zones including the Library and Seniors Centre.

3.2 Heating & Cooling System

The library is served by three primary HVAC zones, mainly consisting of rooftop units, condensing units, and air handling units. The roof top units installed at this building have cooling capacity but do not have heat pump heating capacity; heating is provided through perimeter electric resistance baseboard heaters.

Figure 1: Typical Rooftop Unit

Figure 2: North Activity Room (Showing Ceiling Terminal Units)

Figure 3: Typical Baseboard Heaters

3.3 Domestic Hot Water System

The building's domestic hot water is distributed through separate electric resistance hot water tanks. Hot water is mainly used by handwash sinks in washrooms.

Figure 4: Typical Domestic Hot Water Tank

A summary of domestic hot water tanks is shown in the following table.

Table 2: DHW System Summary

Location	Heating Capacity	Storage Volume (Gal)
Near North Entrance	5,250 W (17,900 BTU/h) (0.36GPH at 100F Temp Rise)	48
Kitchenette (Tankless)	1,500 W (5,120 BTU/h) (0.10GPH at 100F Temp Rise)	N/A
Kitchen	5,250 W (17,900 BTU/h) (0.36GPH at 100F Temp Rise)	48

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 uses only electricity, making electricity the sole source of energy-related utility costs and emissions.

4.2 Load Distribution Curve

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

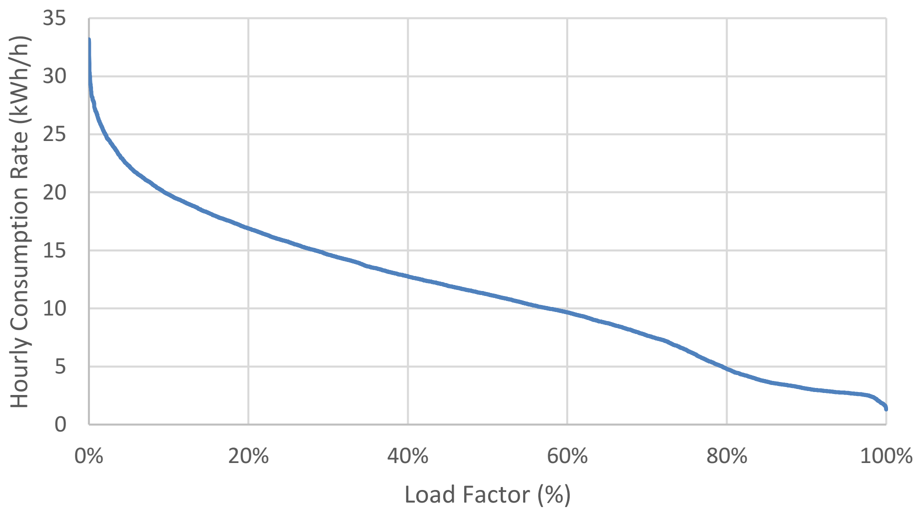

Figure 5: Electricity Load Distribution Curve (Utility Side)

This load distribution curve helps to highlight how often the property draws electrical energy per hour; key takeaways from the load distribution curve are that the building's average hourly consumption never dropped below 1kW, and that although the highest hourly power consumption from the grid was 33kW it spent less than 1% of hours drawing more than 27kW.

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 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.

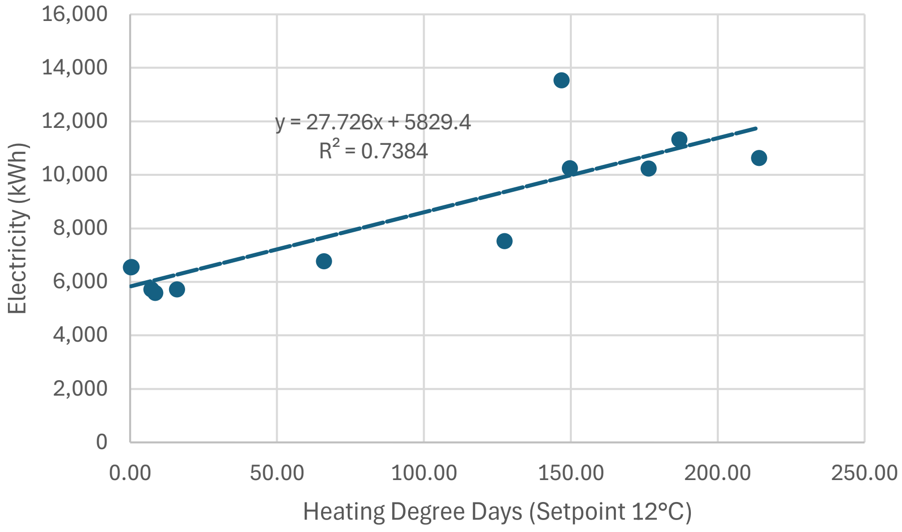

Figure 6: Electricity Linear Regression VS HDD (2023)

The linear correlation between electricity and heating degree days is considered only slightly strong, 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 0.7384. Although this may not be considered a reliable way to predict electricity use using outdoor air temperatures, it shows that electricity consumption generally increases when outdoor air temperatures decrease. This reflects the fact that the building uses electric resistance baseboard heaters.

The building's electricity usage and utility costs are summarized in the following table.

Table 3: Electricity Consumption Summary

Description	Quantity
Consumption (2023)	100,450 kWh
Utility Costs	$9,948

5. KEY INPUTS AND ASSUMPTIONS

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

Table 4: Summary of Key Inputs and Assumptions

Description	Quantity	Unit
Blended Cost of Electricity	0.099 (27.5)	$/kWh ($/eGJ)
Electricity Emission Factor	11.3	tCO_2e/GWh

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 North Activity Room RTU To Electric Resistance With Heat Pump

The first measure shows the impact of retrofitting the rooftop unit serving the north activity room to an integral heat pump with electric resistance backup.

.1 Measure Description

This measure would include replacing the current rooftop unit serving the north activity room adjacent to the library with a hybrid heat pump packaged unit with electric resistance backup heating capacity. This type of system would be able to heat and cool the activity room first by using the heat pump, and then either using the electric resistance heating element or baseboard heaters already located in the space. Because the heat pump would be able to operate at a higher coefficient of performance (between 2 and 4) than the baseboard heaters or electric resistance heating element (coefficient of performance of 1.0), this would be expected to substantially reduce the amount of electricity needed to meet this space's heating demand.

.2 Design Considerations

The savings associated with this measure depends heavily on the size of the air-source heat pump (ASHP) selected in the new packaged hybrid unit. These units are typically sized against peak cooling capacity since the ASHP would be required to meet the space's cooling demand during summer conditions as well; under this design method, the ASHP would be sized for peak cooling demand, and the unit has access to the same condenser's heating capacity in winter conditions. The unit would be expected to require the existing heating system to activate during peak winter conditions.

This measure would require a short shutdown for the space while the current unit is removed and the new unit is installed on the roof. This measure would not require other changes to ductwork or terminal units.

.3 Savings Summary

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

Table 5: 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 North Activity Room RTU To Electric Resistance w/ Heat Pump	-	39,044	$3,867	0.4	$94,250	24.4

6.3 ECM-2: DHW CO_2 Heat Pumps

This measure describes the impact of installing CO_2 heat pumps to provide domestic hot water heating for the building.

.1 Measure Description

The opportunity exists to install an additional heat source to the domestic hot water tanks in the form of CO_2 heat pumps; this would consist of 1-2 small condensing units located on the building's outer roof or at grade 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.

.2 Design Considerations

For this measure to be implemented, new condensing units would need to be installed on the outer roof or at grade, and pipework would need to be run from the DHW tanks to the new condensing units. Although it would be possible to install these heat pumps to each domestic hot water tank, this measure may also be considered for a smaller subset of the building's DHW tanks, focusing on those service areas with higher occupancy. Choosing to install heat pumps to a smaller portion of the building's DHW services would reduce energy savings, but would lower this measure's up-front capital cost.

.3 Savings Summary

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

Table 6: 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	DHW CO2 Heat Pumps	-	3,103	$307	0.0	$74,100	25+

6.4 ECM-3: 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 electricity required by the DHW systems 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 7: 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	Hyper-Low Flow Hot Water Fixtures	-	2,172	$215	0.0	$28,275	25+

6.5 ECM-4: PV Panel Array

The opportunity exists to install a photovoltaic (PV) panel array on the roof of this building.

.1 Measure Description

This measure would involve the installation of a PV panel array on the roof with the intention of subscribing to BC Hydro's net-metering program.

.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 8: 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	PV Panel Array	-	35,000	2,590	-	$158,000	25+

6.6 ECM-5: Retrofit Library RTUs to Electric Resistance With Heat Pump

This measure explores the impact of retrofitting the RTU serving the library with hybrid ASHP and electric resistance heating capacity.

.1 Measure Description

Similar to ECM-1, this measure would include replacing the current rooftop unit serving the library with a hybrid heat pump packaged unit with electric resistance backup heating capacity. This type of system would be able to heat and cool the activity room first by using the heat pump, and then using the electric resistance heating element. Because the heat pump would be able to operate at a higher coefficient of performance (between 2 and 4) than the baseboard heaters or electric resistance heating element (coefficient of performance of 1.0), this would be expected to substantially reduce the amount of electricity needed to meet this space's heating demand.

.2 Design Considerations

The savings associated with this measure depends heavily on the size of the air-souce heat pump (ASHP) selected in the new packaged hybrid unit. These units are typically sized against peak cooling capacity since the ASHP would be required to meet the space's cooling demand during summer conditions as well; under this design method, the ASHP would be sized for peak cooling demand, and the unit has access to the same condenser's heating capacity in winter conditions. The unit would be expected to require the existing heating system to activate during peak winter conditions.

This measure would require a short shutdown for the space while the current unit is removed and the new unit is installed on the roof. This measure would not require other changes to ductwork or terminal units.

.3 Savings Summary

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

Table 9: 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	Retrofit Library AHUs/ RTUs to Electric Resistance w/ Heat Pump	-	43,871	$4,345	0.5	$200,200	25+

6.7 ECM-6: Retrofit Auditorium AHU to Electric Resistance With Heat Pump

This measure explores the impact of retrofitting the RTU serving the auditorium with an ASHP refrigerant coil.

.1 Measure Description

Similar to ECM-1 and ECM-5, this measure would include the installation of a refrigerant based heating and cooling switchover coil in the supply air duct serving the auditorium. This type of system would be able to heat and cool the activity room first by using the heat pump, and then using the electric resistance heating element. Because the heat pump would be able to operate at a higher coefficient of performance (between 2 and 4) than the baseboard heaters or electric resistance heating element (coefficient of performance of 1.0), this would be expected to substantially reduce the amount of electricity needed to meet this space's heating demand.

.2 Design Considerations

The savings associated with this measure depends heavily on the size of the air-source heat pump (ASHP) selected in the new packaged hybrid unit. These units are typically sized against peak cooling capacity since the ASHP would be required to meet the space's cooling demand during summer conditions as well; under this design method, the ASHP would be sized for peak cooling demand, and the unit has access to the same condenser's heating capacity in winter conditions. The unit would be expected to require the existing heating system to activate during peak winter conditions.

This measure would require a short shutdown for the space while the new refrigerant coil is added to the supply air duct.

.3 Savings Summary

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

Table 10: 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	Retrofit Auditorium AHU with Heat Pump Capacity	-	23,109	$2,289	0.3	$73,450	25+

6.8 ECM-7: Wallpack Battery for Demand Response

With new programs from CleanBC refocusing from full electrification to a more holistic review of grid integrity, opportunities for onsite 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 near the building's north electrical service room, 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 implementation of a PV array. 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 11: 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-7	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: Convert North Activity Room RTU To Electric Resistance w/ Heat Pump– Financial Performance

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

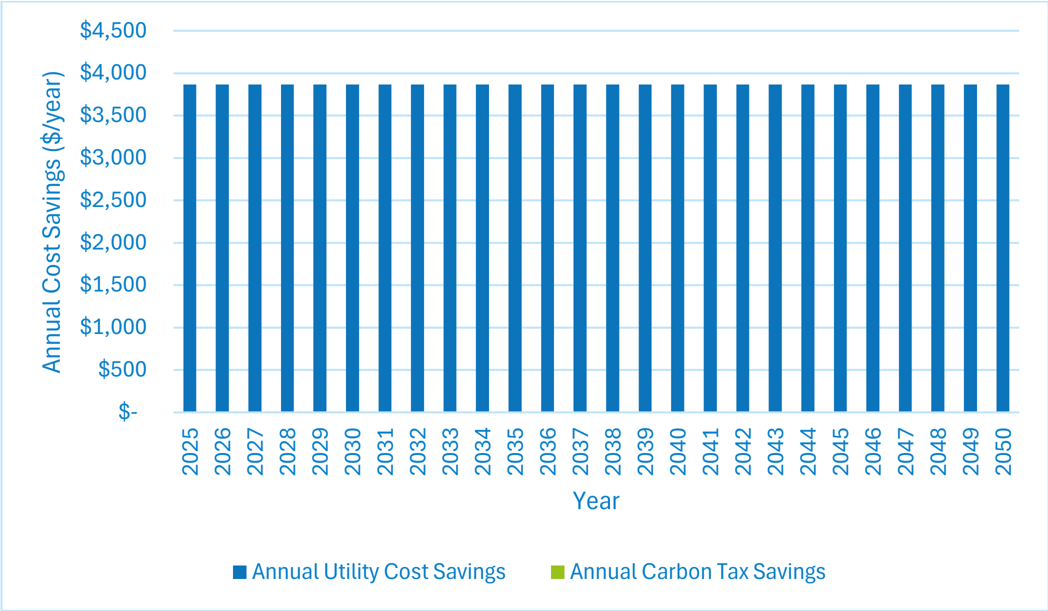

Figure 7: ECM-1 Annual Cost Savings

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

Table 12: ECM-1 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$3,867	$-	$3,867
2030 Annual Cost Savings	$3,867	$-	$3,867

7.2 ECM-2: DHW CO2 Heat Pumps – Financial Performance

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

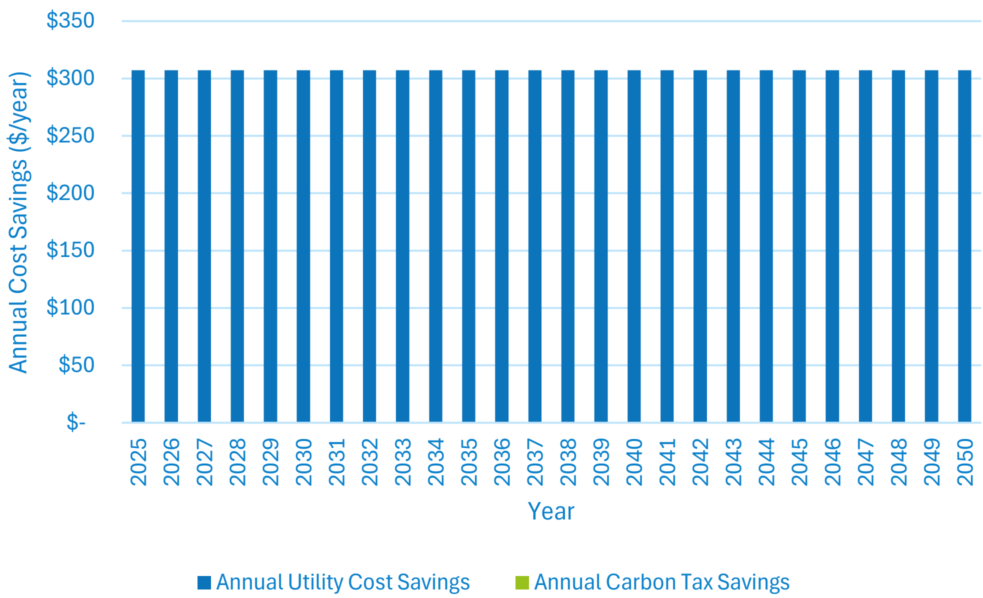

Figure 8: ECM-2 Annual Cost Savings

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

Table 13: ECM-2 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$307	$-	$307
2030 Annual Cost Savings	$307	$-	$307

7.3 ECM-3: Hyper-Low Flow Hot Water Fixtures – Financial Performance

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

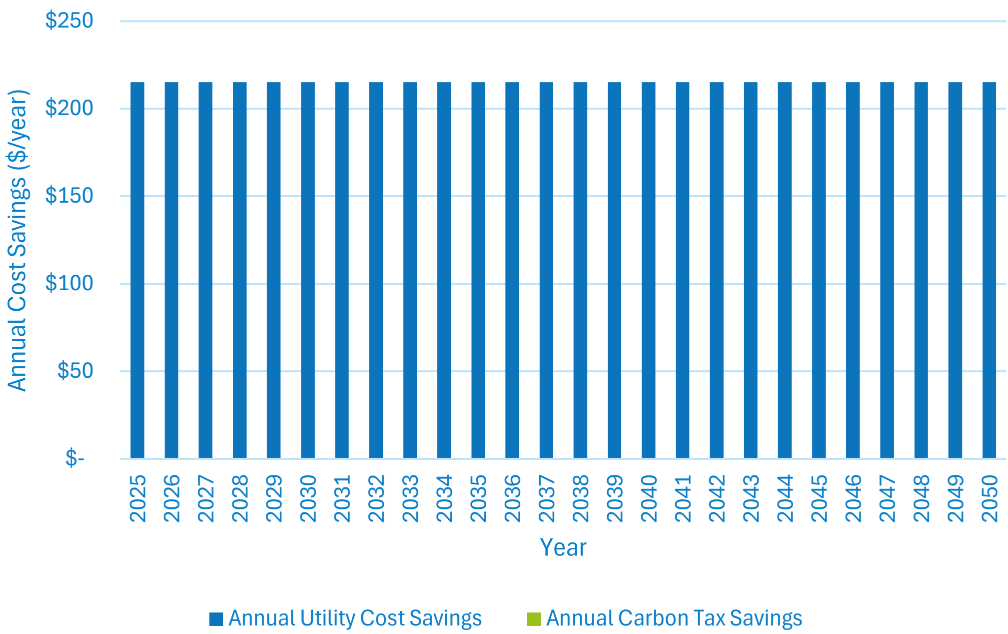

Figure 9: ECM-3 Annual Cost Savings

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

Table 14: ECM-3 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$215	$-	$215
2030 Annual Cost Savings	$215	$-	$215

7.4 ECM-4: PV Panel Array – Financial Performance

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

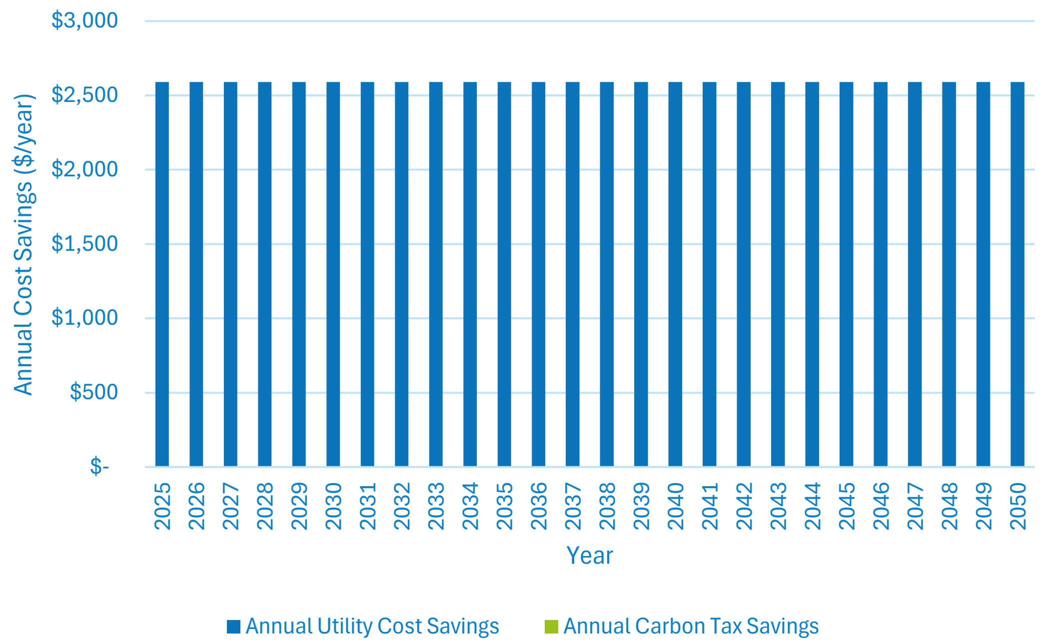

Figure 10: ECM-4 Annual Cost Savings

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

Table 15: ECM-4 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$2,590	$-	$2,590
2030 Annual Cost Savings	$2,590	$-	$2,590

7.5 ECM-5: Retrofit Library AHUs/ RTUs to Electric Resistance w/ Heat Pump – Financial Performance

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

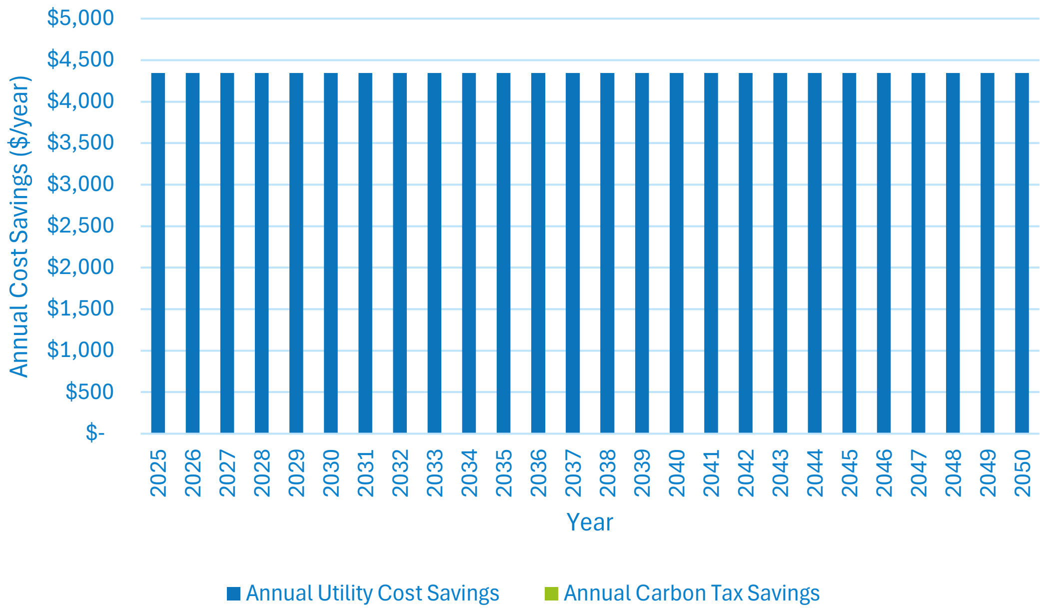

Figure 11: ECM-5 Annual Cost Savings

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

Table 16: ECM-5 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$4,345	$-	$4,345
2030 Annual Cost Savings	$4,345	$-	$4,345

7.6 ECM-6: Retrofit Auditorium AHU with Heat Pump Capacity – Financial Performance

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

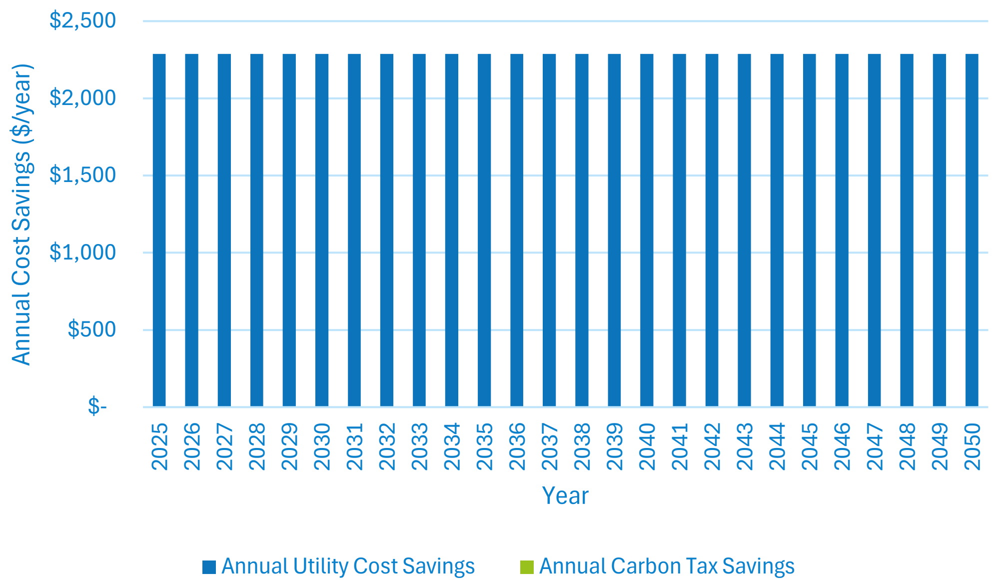

Figure 12: ECM-6 Annual Cost Savings

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

Table 17: ECM-6 Cost Savings Summary

Description	Utility Cost Savings ($)	Carbon Tax Cost Savings ($)	Combined Cost Savings ($)
2025 Annual Cost Savings	$2,289	$-	$2,289
2030 Annual Cost Savings	$2,289	$-	$2,289

7.7 ECM-7: Wallpack Battery for Demand Response – Financial Performance

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

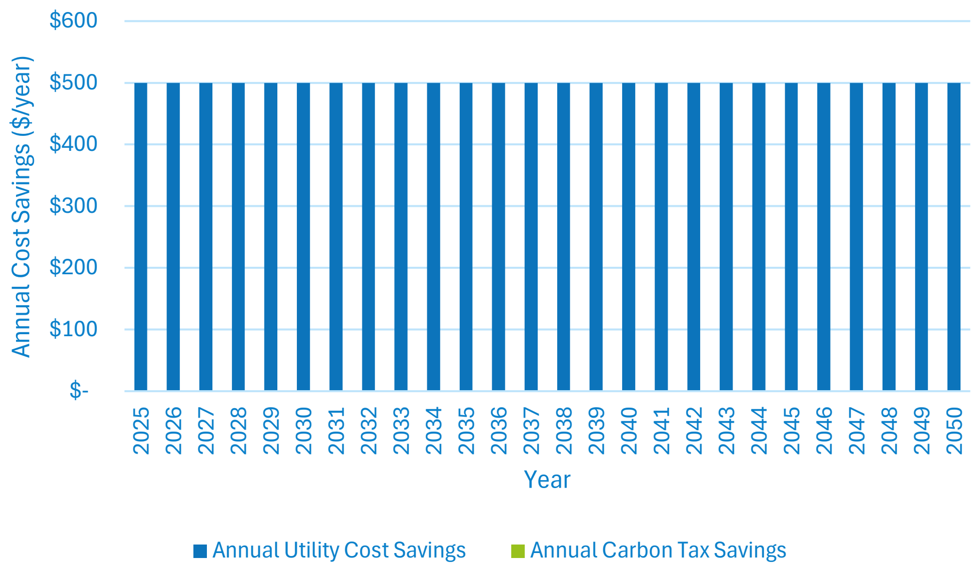

Figure 13: ECM-7 Annual Cost Savings

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

Table 18: ECM-7 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 seven different opportunities for energy conservation at the District of Saanich's Library and Cultural Centre, 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 19: 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	Convert North Activity Room RTU To Electric Resistance w/ Heat Pump	-	39,044	$3,867	0.4	$94,250	24.4
ECM-2	DHW CO2 Heat Pumps	-	3,103	$307	0.0	$74,100	25+
ECM-3	Hyper-Low Flow Hot Water Fixtures	-	2,172	$215	0.0	$28,275	25+
ECM-4	PV Panel Array	-	35,000	2,590	-	$158,000	25+
ECM-5	Retrofit Library AHUs/ RTUs to Electric Resistance w/ Heat Pump	-	43,871	$4,345	0.5	$200,200	25+
ECM-6	Retrofit Auditorium AHU with Heat Pump Capacity	-	23,109	$2,289	0.3	$73,450	25+
ECM-7	Wallpack Battery for Demand Response	-	-	$500	-	$150,000	25+

It is recommended that ECM-1, ECM-5, and ECM-6 are considered for implementation as equipment lifecycle replacements for the air handlers and rooftop units serving the building's different spaces. ECM-2 may also be considered for implementation as part of an extension on the building's domestic hot water heating capacity.

END OF REPORT