



Staff Report for Decision

File Number: A4-1-2 / D1-8-44

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AUTHORED BY SCOTT PAMMINGER, MANAGER
INFRASTRUCTURE PLANNING AND ENERGY

SUBJECT PORT THEATRE – CHILLER EQUIPMENT RENEWAL AND LOW
CARBON ELECTRIFICATION OPTIONS

OVERVIEW

Purpose of Report

To provide information to Council on equipment renewal options for the Port Theatre, and request additional funding to support replacing the existing chiller with one of the heat pump systems recommended.

Recommendation

That the Finance and Audit Committee recommend that Council direct Staff to:

- 1) Proceed with installing the recommended Option A – Air Source Heat Recovery Heat Pump system to replace the existing chiller; and,
- 2) Increase the budget for the Port Theatre Chiller Replacement project by \$500,799 in 2021 funded by \$150,000 from the Emission Reduction Reserve and \$350,799 from the General Asset Management Reserve.

BACKGROUND

The Port Theatre, which opened in 1998, has separate cooling and heating systems comprised of a refrigeration-based chiller and natural gas fired hot water boilers. Through the Asset Management Program and completed condition assessments, it has been determined that the chiller needs replacing.

To determine equipment renewal options, which take into consideration Council's Energy Conservation and Management Policy and the Climate Emergency declaration, a Low Carbon Electrification Study of the building's overall cooling and heating system was conducted in 2020. This study was 50% funded through the Provincial government's CleanBC Program. Results of the study recommended replacing the chiller with a heat pump system.

A budget of \$211,400 was allocated in 2020 for replacement of the chiller and was carried forward to 2021.

DISCUSSION

Three chiller renewal options were presented in this study, including a business as usual "like-for-like" replacement, and two other concepts that use electric heat pumps. Both heat pump systems proposed provide both heating and cooling, however, one of the proposed systems is also able

to recover heat from the theatre during events and eliminate the existing natural gas boiler heating under normal operating requirements.

This building currently consumes approximately 2,100 gigajoules per year of natural gas, contributing to Greenhouse Gas (GHG) emission of approximately 110 tonnes of carbon dioxide (equivalent) per year (tCO₂e per year).

Heat Pump Systems do come at a higher initial capital cost but provide annual energy cost-savings, reduce emissions, and may be eligible for a CleanBC financial incentive of up to \$159,000 for this project.

Staff have applied for CleanBC incentives for the options presented in the study, and expect to be notified within the next two weeks regarding results.

OPTION A – Air Source Heat Recovery Heat Pump

This option involves the replacement of the existing chiller with an electric heat recovery Direct Expansion (DX) heat pump system. This system utilizes distributed “Hydro Kits” to transfer heat from refrigerant pipe to the existing chilled and hot water loops.

This system capitalizes on the load diversity within the building with potential to recover heat from the theatre into the perimeter zones, thus eliminating use of the natural gas boilers except as a backup source of heating.

- Provides highest GHG reduction of 106 tCO₂e annually; 92% reduction of building heating using natural gas, unless backup heating is required.
- Highest estimated annual energy cost savings of \$19,154.
- 25 year net incremental cost per tCO₂e = \$108.

Disadvantages of this option:

- Highest capital cost of \$712,199 (includes PST and 10% contingency).
- Additional funding of \$500,799 would be required, unless CleanBC incentive funding is successfully obtained.

OPTION B – Air to Water Chiller / Heat Pump

In this option, the existing chiller is replaced with a similar air-to-water chiller / heat pump. When in heating mode, free cooling would be utilized for the theatre. During shoulder seasons, when mechanical cooling is required, heating would be provided by the boilers.

- The majority of natural gas use would be avoided but not eliminated entirely.
- Provides significant GHG reduction of 78 tCO₂e annually; a 62% reduction of building heating using natural gas.
- Requires rehabilitation of the existing chilled water lines, estimated cost of \$30,000.
- Estimated annual energy cost savings of \$13,902.
- 25 year net incremental cost per tCO₂e = \$87.

Disadvantages of this option:

- Capital cost of \$550,514 (includes rehabilitation of chilled water pipe couplings, PST and 10% contingency).
- Additional funding of \$339,114 would be required, unless CleanBC incentive funding is successfully obtained.

OPTION C – Like for Like Chiller

With this option, the existing chiller would be replaced with a new unit and would require rehabilitation of the chilled water pipe couplings.

- Lowest cost of \$203,110 (includes rehabilitation of chilled water pipe couplings, PST and 10% contingency); and falls within the current budget.

Disadvantages of this option:

- Project is not eligible for financial incentives from CleanBC.
- No savings in energy consumption or GHG emissions would be expected.

OPTIONS

1. That the Finance and Audit Committee recommend that Council direct Staff to:
 - 1) Proceed installing the recommended Option A – Air Source Heat Recovery Heat Pump system to replace the existing chiller; and,
 - 2) Increase the budget for the Port Theatre Chiller Replacement project by \$500,799 in 2021 funded by \$150,000 from the Emission Reduction Reserve and \$350,799 from the General Asset Management Reserve.
 - The advantages of this option: This option has the highest GHG reduction of 92% and the highest estimated annual energy cost savings. No need for new heating water pipes to be installed through the theatre. The only option with a heat recovery system.
 - The disadvantages of this option: This option has the highest capital cost.
 - Financial Implications: The Final 2021 – 2025 Financial Plan would be amended to include the additional funding. Any successful incentive funding will be used to reduce the funding from the Emission Reductions Reserve and the General Asset Management Reserve. The Port Theatre Society is responsible for the theatre's utility bills and this option has the potential to provide cost savings.
2. That the Finance and Audit Committee recommend that Council direct Staff to:
 - 1) Proceed with installing Option B – Air to Water Chiller / Heat Pump; and,
 - 2) Increase the budget for the Port Theatre Chiller Replacement project by \$339,114 in 2021 funded by \$150,000 from the Emission Reduction Reserve and \$189,114 from the General Asset Management Reserve.
 - The advantages of this option: The majority of natural gas use would be avoided. This option has a significant reduction in GHG emissions and also includes energy cost savings.

- The disadvantages of this option: Increased capital cost that exceeds the current budget.
 - Financial Implications: The Final 2021 – 2025 Financial Plan would be amended to include the additional funding. Any successful incentive funding will be used to reduce the funding from the Emission Reductions Reserve and the General Asset Management Reserve. The Port Theatre Society is responsible for the theatre's utility bills and this option has the potential to provide cost savings.
3. That the Finance and Audit Committee recommend that Council replace the existing chiller with Option C – a like-for-like chiller unit.
- The advantages of this option: This option is within the existing budget.
 - The disadvantages of this option: No savings in energy consumption or GHG emissions would be expected.
 - Financial Implications: No additional funding is required and this option falls within the existing budget.

SUMMARY POINTS

- The existing chiller used for cooling at the Port Theatre has reached end of operational expectations and is scheduled for replacement in 2021 with a project budget of \$211,400.
- An electrification study has been completed which outlines three options, two which use heat pump systems which would reduce GHG emissions and energy costs.
- Both heat pump systems have higher initial capital costs compared to the like-for-like replacement of the existing chiller.
- CleanBC Incentives of up to \$159,000 are potentially available for the proposed new heat pump systems.

ATTACHMENTS:

ATTACHMENT A: Excerpt from the Port Theatre Low Carbon Electrification Report |

Submitted by:

Scott Pamminger
Manager, Infrastructure Planning & Energy |

Concurrence by:

Art Groot
Director, Facility and Parks Operations

And by:

Richard Harding
General Manager, Parks, Recreation & Culture

And by:

Laura Mercer
Director, Finance |

1. EXECUTIVE SUMMARY

This report summarizes a low carbon electrification (LCE) study conducted by Prism Engineering Limited (Prism) for the City of Nanaimo, Port Theatre building and describes the measures prescribed to reduce greenhouse gas (GHG) emissions.

CleanBC Custom Incentives target GHG reductions from low-carbon electrification measures that result in significant reductions in fossil fuel use. Incentives are available to customers that can demonstrate a strong potential to reduce their GHG emissions by at least 1,200 tonnes of CO₂ equivalent (tCO_{2e}) over the lifetime of a measure.

The boundary of the study focuses on the hydronic heating and cooling system. Heating is provided primarily by two 600 MBH boilers, several areas are served by electric re-heat coils. At present, the existing 78-ton air cooled chiller providing chilled water is at end of life. The system consumes approximately 2,100 GJ/year of natural gas, contributing to GHG emissions of approximately 105 tCO_{2e} per year.

This study assesses the concept of replacing the existing chiller with a heat pump system that will provide both heating and cooling, with the potential to recover heat from the theatre during events and eliminate natural gas boilers heating energy.

Two heat pump retrofit options have been assessed:

Option 1: Air-Source Heat Recovery Heat Pump

This option involves the replacement of the existing chiller with a heat recovery Direct Expansion (DX) heat pump that utilizes distributed “hydro-kits” to transfer heat from refrigerant pipe to the existing chilled and hot water loops. The proposed system capitalizes on the load diversity within the building with potential to recover heat from the theatre into perimeter zones, thus eliminating use of natural gas boilers. Considering the location of the chiller and the boilers, integrating the heating and cooling systems is relatively complex and costly. Therefore, by distributing refrigerant-to-water hydro-kits only a refrigerant pipe is required between the outdoor condensing unit through the theatre to the north mechanical room. This option would avoid the need for new heating water pipes to be installed through the theatre and avoid the need to replace aging Victaulic couplings serving the existing chilled water lines. The office heating and cooling would be served by a separate air source heat pump using the existing DX coil, with electric reheat coils for zone level heating control.

Option 2: Air-to-Water Chiller/Heat Pump

In this option, the existing chiller is replaced with a similar air to water chiller/heat pump that will be connected to the existing chilled water system. Heating would be provided through the existing cooling coils. When in heating mode, free cooling would be utilized for the theatre and dimming room cooling requirements in the winter. During shoulder seasons, when mechanical cooling is required, heating will be provided by the existing boilers.

This configuration would eliminate the need to run new piping through the Theatre, however it will continue to rely on the existing aging chilled water pipe in the theatre. Although majority of natural gas use will be avoided, it would not eliminate the need for heating boilers during shoulder seasons.

The following table summarizes the energy and GHG impact, estimated implementation cost, incentives, and project financials for the two options presented.

Table 1: Summary of Recommended LCE Measures

Measure	Demand Savings (kW)	Electrical Savings (kWh)	Gas Savings (GJ)	GHG Savings (Tonnes eCO ₂)	Energy Cost Savings (\$)	Estimated Retrofit Costs (\$)	Estimated Base Case Costs (\$)	Incremental Retrofit Costs (\$)	Estimated Incentives (\$)	Internal rate of Return *	NPV Over 25 Yrs (\$)*
Option 1 - Air Source Heat Recovery Chiller	-32	-44,382	2,145	106	\$19,154	\$712,199	\$234,890	\$277,309	\$200,000	7%	\$20,251
Option 2 - Air Source Heat Pump	-23	-33,908	1,562	78	\$13,902	\$517,960	\$234,890	\$83,070	\$200,000	14%	\$129,260
2019 Data		630,675	2,145	114							

*NPV and IRR analysis based on incremental retrofit cost. Refer to Appendix D for full analysis

Although both options significantly reduce overall building fuel consumption, heat recovery from the Theatre offsets the low cost of gas.

For this reason, it is recommended that Option 1 is considered for implementation based on the merit of environmental impact through GHG emission reduction, and other non-energy benefits including chilled water piping upgrade.

In addition to the energy impact of the LCE measure assessed, the following non-energy benefits may also be realized through implementation, and should be considered the City of Nanaimo:

- environmental and air quality improvements through the significant reduction in greenhouse gas emissions through the conversion; and
- renewal of the existing cooling system.