

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.