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Powering Progress with Sustainable Solutions

GHG REDUCTION FEASIBILITY STUDY

Prepared For: Town of Goderich

Date: July 28, 2025

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Executive Summary

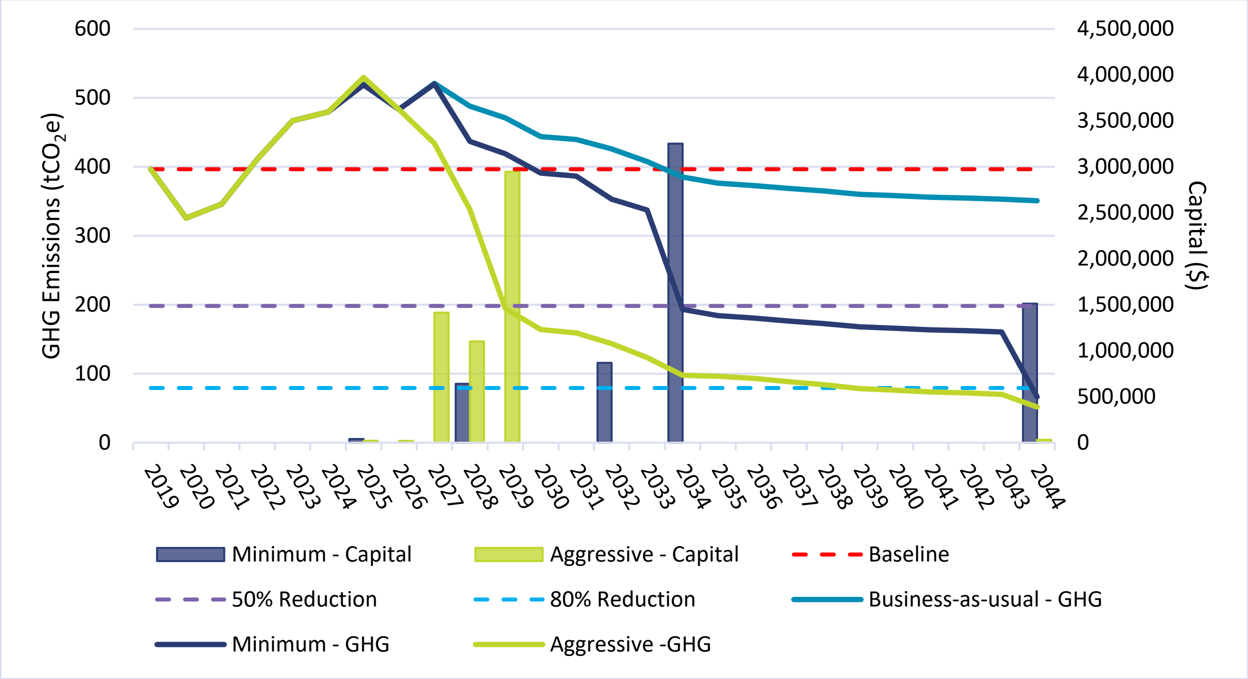
This Greenhouse Gas (GHG) Reduction Feasibility Study evaluates opportunities for reducing GHG emissions at two key municipal facilities within the Town of Goderich: the Maitland Recreation Centre (MRC) and the Goderich Wastewater Treatment Plant (WWTP). The study explores targeted retrofit strategies, assessing multiple pathways and meeting the targets prescribed by the Federation of Canadian Municipalities GHG Reduction Pathways feasibility study funding. The pathways studied include:

- **A Minimum Performance Scenario:** Achieve at least 50% GHG reduction by year 10 and at least 80% GHG reduction by year 2045, and
- **An Aggressive Deep Retrofit Scenario:** Achieve 50% GHG reduction within 5 years and at least 80% GHG reduction by 2045

Facility-specific benchmarking analyses provided context for energy performance. The MRC currently operates with an Energy Use Intensity (EUI) significantly above national benchmarks for similar recreation facilities, largely due to its year-round arena operation. The WWTP, in contrast, performs better than provincial benchmarks, with an EUI approximately 60% lower than comparable wastewater facilities in Ontario.

Maitland Recreation Centre

Both the Minimum Performance and Aggressive Deep Retrofit pathways assessed for the MRC meet or exceed the Town's 80% emissions reduction target by 2045. The Minimum Performance Scenario aligns capital investments closely with natural equipment replacement cycles, reducing upfront financial impacts, while the Aggressive Deep Retrofit Scenario accelerates the timeline for deeper short-term reductions, enhancing operational resilience and energy independence.



The following table highlights the key metrics related to the modeled GHG Reduction Pathways and the Business As Usual Scenario.

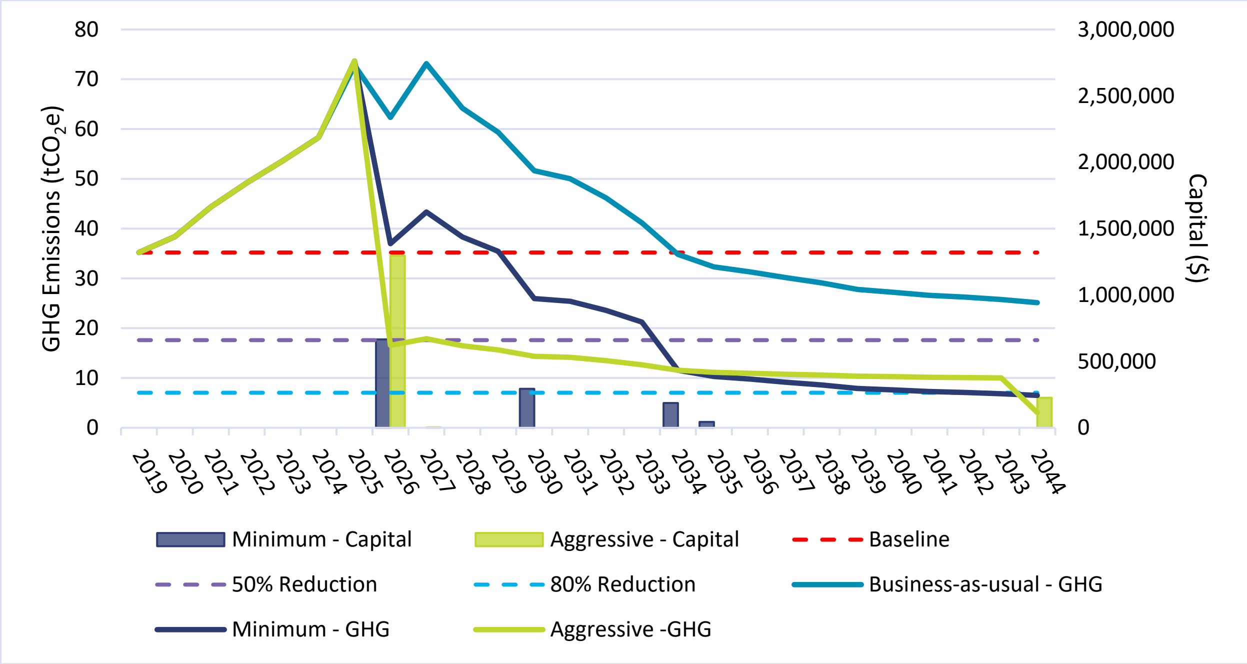
Metric	Minimum Performance	Aggressive Deep Retrofit	Business As Usual
Capital Cost	$6,313,490	$5,532,788	$2,208,394
External Funding	$1,294,266	$1,383,197	-
Incremental Costs	$2,810,831	$1,941,196	-
Operating Costs	$11,572,724	$11,725,763	$10,472,299
Incremental Life-Cycle Cost (20-year)	$2,551,485	$2,885,506	-

The primary measures contributing significantly to the GHG reductions at the MRC are:

- Installation of water-source heat pumps, leveraging the existing geothermal loop to offset natural gas consumption for space heating and domestic hot water.
- Electrification of air-handling equipment and unit heaters using air-source heat pumps.
- Recommissioning the existing geothermal system, a critical foundational measure enhancing system efficiency and enabling subsequent electrification projects.

Goderich Wastewater Treatment Plant

Both pathways assessed at the WWTP similarly meet or exceed the Town's GHG emissions reduction targets. The Minimum Performance Scenario achieves incremental reductions through gradual implementation of projects, while the Aggressive Deep Retrofit Scenario accelerates project timelines to achieve deeper, earlier reductions and greater operational cost savings.



The following table highlights the key metrics related to the modeled GHG Reduction Pathways and the Business As Usual Scenario.

Metric	Minimum Performance	Aggressive Deep Retrofit	Business As Usual*
Capital Cost	$1,190,016	$1,525,183	-
External Funding	$297,504	$381,296	-
Operating Costs	$1,733,395	$679,080	$2,836,827
20-Year Operational Cost Savings	$1,103,432	$2,157,747	-
20-Year Life-Cycle Cost	$2,463,747	$1,706,924	-

*WWTP analysis does not contain incremental cost analysis due to the absence of a BCA

The primary measure for achieving substantial emissions reductions at the WWTP is the installation of a large-scale ground-mounted solar photovoltaic (PV) system. Additional impactful measures include electrifying natural gas-fired heating equipment with air-source heat pumps and targeted efficiency upgrades to process equipment.

Pathways Recommendations

Both the Minimum Performance and Aggressive Deep Retrofit pathways identified for the MRC and WWTP are technically viable and financially feasible, and they effectively achieve the Town's decarbonization objectives. At the MRC, operational costs are projected to increase moderately due to the focus on fuel-switching heating systems from natural gas to electricity, a cleaner but currently higher-cost energy source. This reflects the facility's already efficient operation, where further improvements primarily involve electrification rather than reduced energy usage. For the MRC, the Minimum Performance scenario is recommended, as it provides a lower life-cycle cost and moderates operating cost impacts. Conversely, for the WWTP, predominantly an electricity-consuming facility, the Aggressive Deep Retrofit scenario is recommended, as it maximizes operational cost savings through efficiency improvements and renewable energy generation.

Aladaco extends sincere gratitude to the Town of Goderich staff for their active involvement and valuable contributions throughout this project. Their practical insights, operational knowledge, and collaborative approach greatly enhanced the development of actionable and realistic solutions. We also applaud the Goderich Town Council for their continued support, leadership, and commitment to advancing sustainability and climate resilience. This feasibility study provides a robust foundation to guide informed decisions and support the Town in meeting its long-term GHG reduction and sustainability goals.

1. Introduction

This GHG Reduction Pathway Feasibility Study assesses viable strategies for reducing on-site GHG emissions from the Town of Goderich's municipal buildings. The study follows the guidance provided by the Federation of Canadian Municipalities (FCM) Community Buildings Retrofit (CBR) Initiative, which aims to help municipalities integrate energy efficiency and GHG reductions into long-term capital planning. This feasibility study is made possible through grant funding provided by the FCM CBR initiative.

The study was conducted on two buildings: the Maitland Recreation Centre (MRC) located at 190 Suncoast Drive East, Goderich, ON, and the Goderich Wastewater Treatment Plant (WWTP) located at 211 Sunset Drive, Goderich, ON. These two facilities were selected by the Town of Goderich due to their significant GHG emissions. In 2019, the Town conducted a Community and Corporate-level GHG inventory as part of FCM's Partners for Climate Protection (PCP) program Milestone 1. The results of this initiative identified the MRC and WWTP as the two largest sources of GHG emissions from municipally owned facilities. For the purposes of this report, the GHG emissions baseline values align with the 2019 emissions inventory.

The study explores multiple pathways to achieving significant GHG reductions while balancing capital investment and operational efficiency. It includes the evaluation of different retrofit scenarios to reduce on-site emissions, aligning with CBR initiative targets. Specifically, the selected pathways analyzed in this study include:

1. **Minimum Performance Scenario**:
    - A 10-year roadmap achieving a minimum of **50% GHG reduction** compared to the facility's baseline emissions.
    - A 20-year roadmap achieving a minimum of **80% GHG reduction** compared to baseline emissions.
2. **Aggressive Deep Retrofit Scenario:**
    - Achieves 50% GHG reduction within the first 5 years, followed by additional measures to meet or exceed the 80% reduction target within 20 years.
3. **Business-As-Usual Scenario:**
    - A scenario with "like-for-similar" upgrades based on the site-specific requirements of the building condition and equipment replacement schedule.

The feasibility study includes a systematic evaluation of energy conservation measures (ECMs) through the development of several energy models for each facility. It also includes capital planning considerations, operational impacts, and life cycle cost implications. Additionally, the study integrates funding opportunities to optimize project feasibility.

Throughout the study process, the Town of Goderich has been an active participant in guiding the project scope, direction, and selected pathways. Several engagement sessions were conducted over the life of this project, beginning in October 2024, including monthly meetings between Aladaco and the Town of Goderich project leads, Design Workshops, and Decision-Making Workshops. These sessions provided a forum for in-depth discussions, technical evaluations, and alignment of the proposed strategies with municipal priorities.

Relevant stakeholders, including municipal executives and operations personnel, were actively involved in these sessions to ensure a comprehensive approach to decision-making. Their input has been incorporated into the results of this report to ensure the selected measures and pathways align with the Town's sustainability goals, operational objectives, and budgetary constraints. These discussions also helped to identify key challenges and opportunities related to implementation, ensuring that the recommendations presented in this study are both practical and effective in achieving long-term GHG reductions.

The findings will support the Town of Goderich in making informed investment decisions that contribute to its long-term sustainability goals while ensuring alignment with municipal capital planning and funding opportunities. By integrating industry best practices and aligning with national GHG reduction targets, this study provides a structured framework for achieving measurable emissions reductions and improving overall energy performance.

1.1 Key Terms

Building Automation System (BAS)

An integrated network of hardware and software that automatically monitors and controls a building's mechanical and electrical systems such as heating, ventilation, and air conditioning (HVAC), lighting, security, and energy management. Its primary goal is to optimize occupant comfort, system performance, and energy efficiency.

Building Commissioning

A systematic process that ensures a building's systems, such as HVAC, BAS, lighting, electrical, and plumbing, are designed, installed, tested, and operated according to the owner's requirements and performance expectations. The goal is to optimize the building's energy efficiency, functionality, and comfort while minimizing operational issues. Commissioning typically occurs during the design, construction, and post-construction phases and includes verification of system performance, documentation, and training for building operators. It can also be applied retroactively in existing systems.

Building Condition Assessment (BCA)

A comprehensive evaluation of the physical condition and performance of a building's structure, systems, and components. It typically involves inspecting key elements such as the foundation, roof, electrical, plumbing, HVAC systems, and interior finishes to identify any deficiencies, required repairs, or upgrades. The assessment helps in understanding the building's current state, estimating maintenance costs, and planning for future improvements or renovations.

Business-As-Usual (BAU) Avoided Costs

Costs that would be incurred under the Business-as-Usual capital renewal plan but are avoided by selecting alternative replacement options.

Capital Cost

Refers to the initial expenditure required to acquire, construct, or set up an asset or project, such as buildings, equipment, or infrastructure. It includes all costs associated with the development or purchase, excluding ongoing operational or maintenance expenses.

Discount Rate

The interest rate used to calculate the present value of future cash flows or investments. It reflects the time value of money.

Energy Use Intensity (EUI)

Refers to the amount of energy consumed per unit of output, such as per square meter of building space or per unit of product produced. It is used to assess the energy efficiency of buildings, industries, or processes, helping to track and reduce energy consumption.

Equivalent Energy (ekWh)

A standardized unit used to compare energy consumption from different sources, typically electricity and natural gas, on a common basis. It expresses all energy use as the amount of electricity (in kilowatt-hours) that would provide the same energy content.

GHG Baseline

Refers to the measurement of greenhouse gas emissions over a specified period, representing the level of emissions before any reduction efforts are implemented. It serves as a reference point to evaluate the effectiveness of mitigation strategies and track progress toward emission reduction goals.

Greenhouse Gas Intensity (GHGI)

A metric that quantifies the amount of greenhouse gas (GHG) emissions produced per unit of building area, typically expressed in tonnes of carbon dioxide equivalent per square meter (tCO_2e/m^2). It allows for a normalized comparison of emissions performance across buildings of different sizes and types.

Peak Electricity Demand (kW)

The highest rate of electricity consumption, measured in kilowatts (kW), recorded over a 15-minute period within a billing month. In Ontario, this value is shown on utility bills as the monthly peak demand and is a critical metric in determining demand charges.

Tonne of Carbon Dioxide Equivalent (tCO_2e)

A unit of measurement used to compare the emissions of various greenhouse gases based on their global warming potential. It represents the amount of carbon dioxide that would have the same warming effect as one tonne of another greenhouse gas, such as methane or nitrous oxide.

Thermal Energy Demand Intensity (TEDI) (kWh/m^2)

The annual heat loss from a building's envelope and ventilation after accounting for all passive heat gains and losses, measured in kilowatt-hours per unit of modelled floor area (kWh/m^2).

Incremental Cost

The increase or decrease in the cost of construction, relative to the baseline costs outlined by the facility BCA.

Incremental Life Cycle Cost (ICCL)

The additional costs incurred when comparing two or more alternatives over their entire lifespan. It includes the extra costs of owning, operating and maintaining one option versus another, helping to evaluate the financial impact of choosing a particular solution or investment over time.

Incremental Life Cycle Cost per Tonne of Carbon Abated ($ILCC/t$CO_2$e)

The additional cost incurred to reduce one tonne of carbon dioxide (or its equivalent) emissions through a specific mitigation measure or pathway.

International Protocol for Measurement and Verification (IPMVP)

A globally recognized framework for evaluating and verifying the energy savings and performance of energy efficiency projects. Developed by the Efficiency Valuation Organization (EVO), it provides standardized methods for measuring and confirming the impact of energy conservation measures, ensuring consistency, transparency, and accuracy in reporting energy savings across different regions and sectors.

IPMVP Option A

Under IPMVP Option A, commonly called Retrofit Isolation with Key Parameter Measurement, energy savings are calculated using a mix of measured and estimated parameters. Estimates are acceptable only if their combined uncertainty is minimal or agreed upon by all parties.

IPMVP Option B

IPMVP Option B, or Retrofit Isolation with All Parameter Measurement, requires measuring all energy or demand quantities, or all key parameters used to calculate them. It is suitable for most energy efficiency measures, though complexity and cost increase with more comprehensive metering.

IPMVP Option C

IPMVP Option C uses utility, whole-facility, or sub-meter data along with independent variables to assess overall facility energy performance. It captures the combined impact of all implemented measures within the measurement boundary, including any unrelated changes that may affect energy use.

IPMVP Option D

IPMVP Option D (Calibrated Simulation) uses energy modeling software to estimate energy use when baseline data is unavailable. Savings are calculated from detailed simulations of physical systems. Accuracy depends on model quality, calibration level, and user expertise.

Life Cycle Cost (LCC)

The total cost of owning, operating, maintaining, and disposing of an asset over its entire lifespan. It includes initial capital costs, as well as ongoing expenses like maintenance and energy use, helping to assess the long-term financial impact of a project or investment.

Measurement and Verification (M&V)

A process used to quantify and confirm the actual energy savings or emission reductions achieved by a project or initiative. It involves measuring the performance of systems or processes and verifying that the claimed benefits, such as energy efficiency improvements or carbon reductions, have been realized in practice, often using established standards or protocols.

Net-Present Value (NPV)

A financial metric used to evaluate the profitability of an investment or project. It calculates the difference between the present value of cash inflows and the present value of cash outflows over a specified period, discounted at a particular rate. A positive NPV indicates a profitable investment, while a negative NPV suggests a loss.

Residual Value

The estimated amount that an asset is worth at the end of its useful life, after accounting for depreciation or wear and tear.

Simple Payback Period

The period it takes for an investment to recover its initial cost through savings or profits. It is calculated by dividing the initial investment by the annual cash inflows or savings generated by the investment.

2. Facility Descriptions

This section provides a detailed description of the Maitland Recreation Centre (MRC) and the Goderich Wastewater Treatment Plant (WWTP). The data and information presented here was either provided by the Town of Goderich or collected on-site by Aladaco staff during several site visits.

The descriptions cover key aspects relevant to energy performance and GHG reduction potential, addressing building envelope characteristics, HVAC systems, water heating, lighting, and energy-intensive equipment. These components are crucial in establishing a baseline energy model and identifying opportunities for energy efficiency improvements.

Site investigations included walkthroughs, interviews with facility staff, and a review of mechanical and electrical documentation, maintenance records, and historical utility data. This information was used to calibrate the energy models and support the evaluation of energy-saving measures. Further details on the site investigations can be found in Appendix A: Design Workshop Summary Report.

2.1 Maitland Recreation Centre

The Maitland Recreation Centre (MRC) was constructed in 2003 and is approximately 75,000 ft^2 (5,000 m^2) in size. It is a 2-story structure containing a single ice pad arena, public pool, gymnasium, fitness centre, and community spaces. Access to the pool, gymnasium, and arena is from the main level. The upper level houses the fitness centre, a walking track, and areas for community use.

Figure 1: The Maitland Recreation Centre, 190 Suncoast Drive East

A Building Condition Assessment (BCA, 2015) was supplied to Aladaco for this facility. The BCA was leveraged to supply the expected remaining useful life (EUL) of several of the facility's components and assets. Additionally, an Asset Inventory, created and maintained by the Town of Goderich staff, was supplied to provide information about EUL and expected like-for-similar replacement costs.

2.2 Building Schedule

In consultation with site staff, the following occupancy schedules were determined for each space. It was confirmed that the facility's BAS accurately reflects these schedules, and our energy model has been calibrated to match the following:

Table 1: MRC Occupancy Schedules

Arena & Common Areas		
	Open	Close
Weekdays	5:30 AM	11:30 PM
Weekends	7:30 AM	10:00 PM
YMCA, Gymnasium, and 2nd Level Fitness Centre		
	Open	Close
Weekdays	6:00 AM	10:00 PM
Saturdays	8:00 AM	6:00 PM
Sundays	8:00 AM	4:00 PM
Canteen		
	Open	Close
Wed-Fri Afternoons	12:00 PM	2:00 PM
Wed-Fri Evenings	4:00 PM	9:00 PM
Saturdays	8:00 AM	10:00 PM
Sundays	11:00 AM	8:00 PM

2.2.1 Building Envelope

The building construction is primarily concrete block with a brick façade which the BCA found to be in good condition. The replacement of exterior walls is expected to be outside the timeframe of this study.

Exterior windows are a double pane glazed construction with hollow metal frames. Main entrance doors are also hollow metal construction with glazing. The primary entrances are controlled via automated openers and motion sensors. The BCA found the exterior windows and doors to be in good condition.

The roof structure is primarily open web joists with structural steel pan. Some areas of the roof are insulated 2-ply modified bitumen roofing. Some areas of the bitumen rooftop have small blisters in the roofing membrane and areas where moisture has penetrated the envelope. A Roof Condition Assessment was conducted in 2023 with destructive testing to determine the extent of the moisture ingress and damage. This assessment found that the roof requires repair in several small areas, however overall, the EUL of the existing roof will extend beyond the timeframe of this study. The Town of Goderich intends to conduct these repairs within the next 2 to 3 years of capital work and it is not expected that these repairs will result in efficiency savings.

2.2.2 Ground Source Heat Pump System and Arena Refrigeration

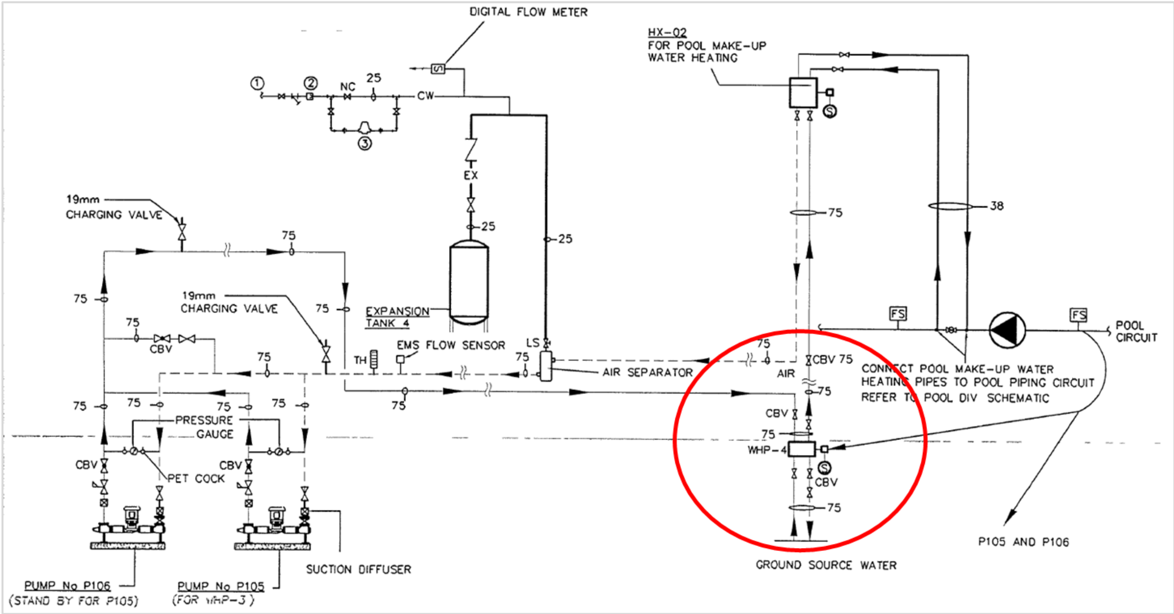
The HVAC system consists of 22 water-source heat pumps (WSHPs) distributed throughout the facility; all connected to a ground loop for heat rejection. This ground loop also supports the modular refrigeration system (Ice Kube heat pumps) for the arena. To supplement this system, a boiler and cooling tower are available to provide additional heating and heat rejection from the ground loop as required. The ground loop also provides in-floor heating throughout much of the facility.

The ground loop system at this facility does not operate as would be expected of a typical geothermal heating and cooling system. This is largely due to the inclusion of the Ice Kube heat pumps, which are a significant source of high-grade heat. Due to the yearlong operation of the arena and ice making equipment, a consistent supply of heat is available.

Aladaco installed independent energy meters on the Ice Kube heat pumps and the primary ground loop pumps. The existing BAS was also leveraged to provide trend data on numerous variables related to the ground loop system. The results of this analysis showed that even in the most extreme conditions (OAT < -20°C), the ground loop system continues to reject heat into the ground (i.e. the system continues to have surplus heat energy even during the coldest temperatures). A typical geothermal heating system would charge the ground source during the summer months and extract the heat energy during the heating season. Since this system always has an excess of heat, the ground serves only as a heat sink. This presents a significant opportunity to leverage more of this heat source when decarbonizing the remaining heating loads within the facility.

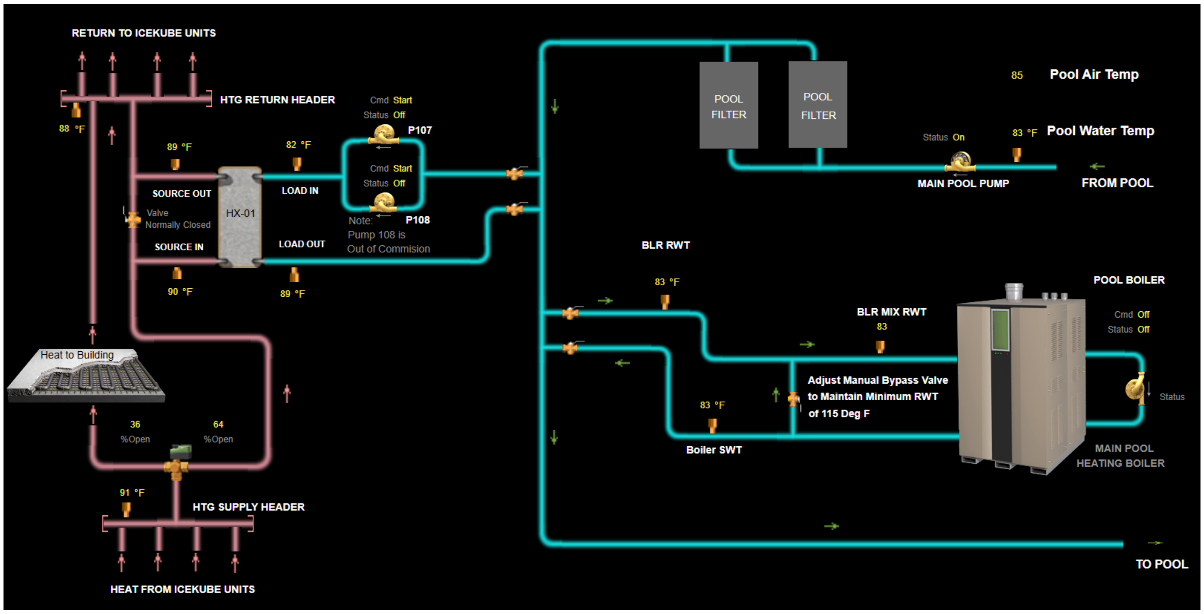
Additionally, when comparing the design drawings for the ground loop system and the equipment observed on-site, there are significant deviations from the original planned installation. Notably, there are four (4) water-to-water source heat pumps included in the design drawings which are absent from the built facility. These heat pumps were intended to support the heating of the domestic hot water (DHW) and the pool make-up water. An example of a missing heat pump is shown below, the equipment in this drawing does not exist.

Figure 2: Water to Water Source Heat Pump Design Drawing



The BAS screenshot below shows the as-built configuration. The ground loop has been connected directly to a heat exchanger, providing limited pre-heating of the pool make up water. BAS trending of the pre-heat temperatures (HX-01 Load-In and Load-Out) is not enabled within the system and Aladaco was unable to quantify the amount of energy supplied by HX-01.

Figure 3: As-Built Pool Make Up Water Pre-Heat



Additionally, pumps P107 and P108 were observed to be non-operational during this study. Without these pumps the efficacy of the heat exchanger is severely limited and, for the purposes of the energy model, the energy recovery for HX-01 was considered negligible.

From engagement sessions held with Town of Goderich staff and facility operators, the reasoning for the exclusion of the additional WSHPs is not clear. It does appear, however, that the existing ground source system is likely over-sized based on the amount of excess heat energy being dissipated into the ground.

2.2.3 Ventilation and Dehumidification Systems

Ventilation air for the change rooms in both the arena (HRU-2) and pool (HRU-1) is supplied by roof-mounted air handling units equipped with DX cooling, gas heating, and exhaust air heat recovery. Mechanical details for HRU-2 were limited, as the equipment nameplate is too worn to be legible. HRU-2 was assumed to be of the same nameplate information as HRU-1 as they serve similar locations and were installed at the same time.

A dedicated roof-mounted Pool Dehumidification Unit is responsible for controlling humidity in the pool area, ensuring proper air quality and comfort levels. This unit was replaced in early 2025 and is equipped with DX cooling, natural gas heating, and a pool water reheat coil. The dehumidifier uses the waste heat from the DX cooling to aid in reheating the dehumidified air, increasing the unit's efficiency.

For the arena, two Dectron mechanical dehumidifiers manage humidity, while ventilation is facilitated through two large exhaust fans interlocked with dampers that introduce fresh air when the exhaust system is in operation. The exhaust fans operate when CO_2 levels rise above the setpoint of 650 PPM in the arena. One Dectron unit is original to the facility while the second was replaced in 2023. The newer unit is only marginally more efficient than the previous unit as the system only requires cooling of the air, with no reheat capabilities. Thus, the only efficiencies gained are found in the motor and compressor efficiencies of the new unit.

The concession stand/canteen is served by a small make-up air unit interlocked with a kitchen exhaust hood, ensuring proper ventilation during food preparation.

2.2.4 Domestic Hot Water and Pool Water Heating

The pool water is pre-heated through the ground loop but also has a dedicated boiler as a backup. A separate boiler provides heat for the whirlpool and is not connected to the ground loop. Domestic cold water is pre-heated via the ground loop and a heat exchanger prior to entering the Domestic Hot Water (DHW) boilers. One DHW boiler, B-1, is a conventional mid-efficiency atmospheric boiler, and the second, B-2, is a high-efficiency instantaneous hot water boiler. All boilers operate on natural gas to facilitate water heating.

2.2.5 Lighting

The facility's lighting consists of a mix of LED, fluorescent, and compact fluorescent fixtures. While some fixtures remain from the original 2003 construction, others have been recently upgraded. Lighting in the arena, the pool, and the gymnasium have all been upgraded to LED models. Additionally, much of the exterior lighting has also been upgraded to LEDs, including wallpacks and parking lot lamps. The remaining fluorescent fixtures at the facility are planned to be replaced by attrition over the coming years.

2.2.6 Process and plug loads

Plug loads at MRC include common appliances found within office spaces and include refrigerators, computers and printers, televisions, and other small loads. There are several pieces of fitness equipment in the fitness centre that require power; however these are not considered significant sources of energy usage. Overall, plug-loads do not represent a significant portion of the building's total energy usage.

2.3 Goderich Wastewater Treatment Plant

The Goderich Wastewater Treatment Plant is an enclosed 367,000 square foot Class III Treatment Facility with a Class II Collection System. The wastewater treatment system was originally constructed in 1967 and has undergone many expansions. The latest expansion completed in 2009 saw the installation of the ultraviolet light (UV) disinfection system.

There are seven building structures located at the Plant, consisting of one Main Building (4,392 ft^2) and 5 Auxiliary Buildings. These Auxiliary Buildings are the Blower Building (291 ft^2), Primary Pumphouse #1 (592 ft^2), Primary Pumphouse #2 (398 ft^2), Raw Activated Sludge (RAS) Pumphouse #1 (323 ft^2), RAS Pumphouse #2 (334 ft^2), and Screening Building (334 ft^2).

The wastewater treatment facility is owned by the Town of Goderich and operated by the Town's Operating Authority, Veolia Water. There is no BCA available for this facility.

Figure 4: The Goderich Wastewater Treatment Plant, 211 Sunset drive

2.3.1 Building Schedule

In consultation with site staff, the following occupancy schedules were determined for the WWTP.

Table 2: WWTP Occupancy Schedules

Main Building		
	Occupied	Unoccupied
Weekdays	7:00 AM	3:30 PM
Weekends	Intermittent Inspections Only	
Auxiliary Buildings		
	Open	Close
Weekdays	Intermittent Inspections Only	
Weekends		

2.3.2 Building Envelope

The Main Building at the WWTP is a mixture of concrete block construction and brick façade walls. There are several large, windowed sections on the eastern side of the building. Windows are aged and several need repairs. The primary entrance is a vestibuled single door entry. There are additional exit doors located on all sides of the building. On the northern wall is a roller bay door which allows for truck access to the interior for hauling of solid waste.

The Auxiliary Buildings vary in age and size however they are all similar constructions. The building walls are concrete block construction with several small windows and a single door. The windows are double pane and generally are in good condition, as are the doors. The roofs are flat and ballasted, except for the Screening Building which has a sloped roof with steel sheeting.

2.3.3 HVAC

The Main Building is equipped with natural gas radiant tube heaters, a make-up air unit (MAU), and a two-speed exhaust unit with an activated carbon filter (ACA Exhaust). There are also several smaller exhaust fans throughout. The radiant tube heaters provide heating throughout the Main Building and operate on wall mounted manual thermostats. The ACA Exhaust unit is primarily used to exhaust odours from the Belt Filter Press area by operating continuously at low speed. When the Belt Filter Press is in operation the ACA Exhaust operates at high speed and the MAU replenishes the exhausted air. The MAU is equipped with a natural gas heating coil. There is one small window-mounted air conditioning unit in the Chlorine Room of the Main Building which is the only source of cooling in the facility.

All Auxiliary Buildings are heated via suspended electric unit heaters which operate on wall mounted manual thermostats. Each building has at least one small exhaust fan that operates when the interior temperature is above a specified setpoint manually set by the building staff. There are no cooling capabilities in the Auxiliary Buildings.

2.3.4 Ventilation Systems

As described in the previous section, the MAU and the ACA Exhaust systems are the primary ventilation equipment on site at the WWTP. All Auxiliary Buildings have small exhaust fans. The MAU and ACA Exhaust are controlled automatically by the WWTP's SCADA system. The ACA Exhaust operates continuously at low speed unless the Belt Filter Press is in operation. At that time the ACA Exhaust begins operating at high speed and the MAU also operates to replenish the exhaust air.

2.3.5 Domestic Hot Water Heating

There is one 38-Gal electric conventional tank hot water heater located in the Locker Room of the Main Building that is the sole source of hot water at the WWTP. The heater was installed in 2023 and is in good condition.

2.3.6 Lighting

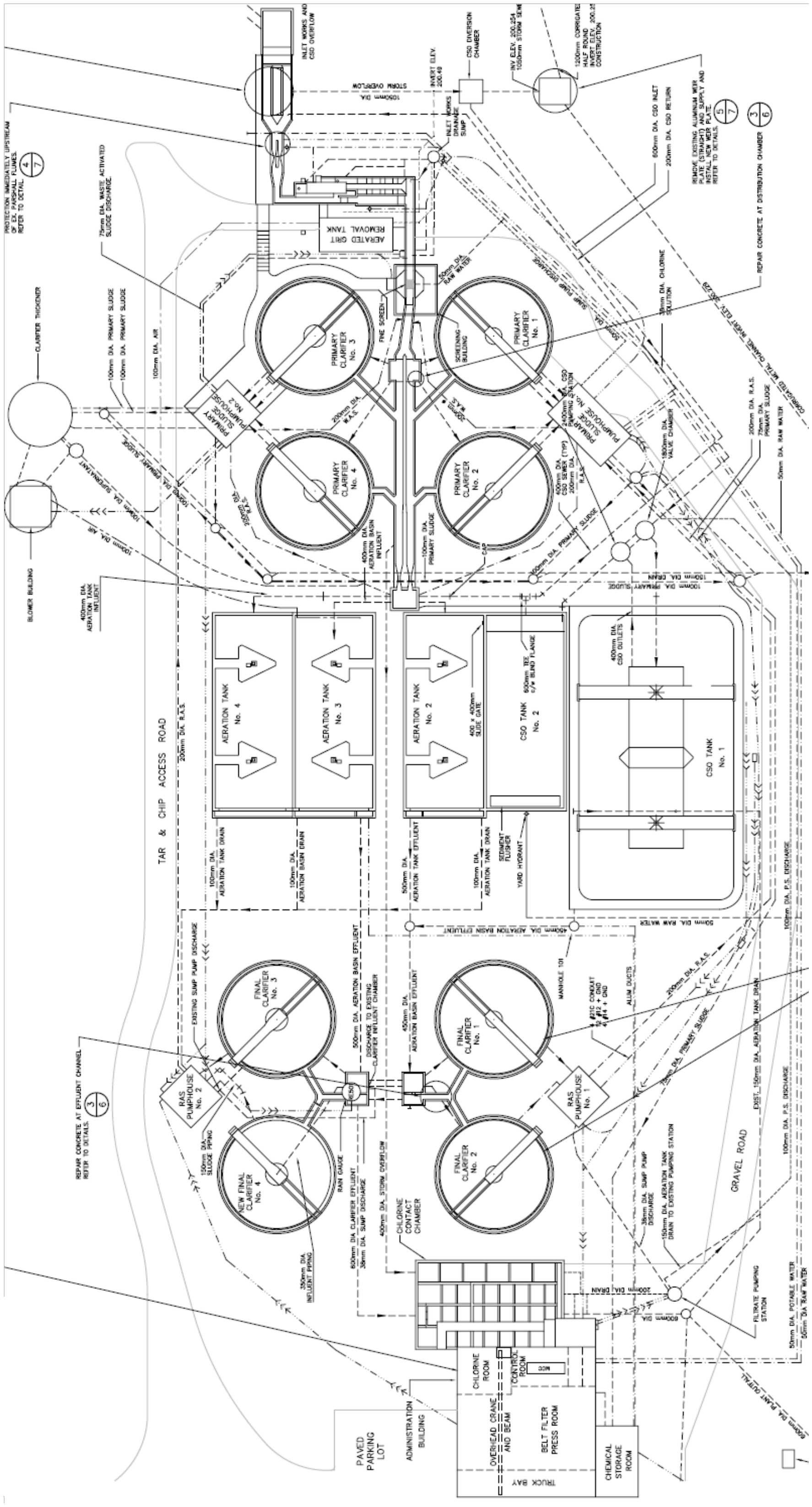
Interior lighting in all buildings at the WWTP is a mixture of LED tubes and T8 lamps. Staff have reported an on-going initiative to replace all interior lighting with LED tubes over the next 3-5 years. Our business-as-usual scenario captures this ongoing retrofit.

Exterior lighting is a mixture of wallpacks and post lamps which have all been retrofitted to LED models.

2.3.7 Process Loads

The wastewater treatment system consists of the following primary components: a course fixed bar screen, an aerated grit tank and grit removal system, an inclined mechanical fine screen and compactor, four (4) primary clarifiers, two (2) raw sludge pumps, one (1) waste return pump, three (3) aeration tanks with two (2) mechanical aerators in each, four (4) secondary clarifiers, six (6) return activated sludge pumps, a UV disinfection system, a belt filter press, a by-pass diversion chamber and two (2) combined sewer outflow (CSO) tanks. The following schematic provides an overview of these systems.

Figure 5: WWTP Process Schematic



The treatment process is controlled by the on-site SCADA system which was recently upgraded to increase control capabilities. The system responds dynamically to wastewater flows and the RAS pumps are equipped with VFDs to further modulate their operation to match system requirements. The mechanical aerators provide oxygen to the aeration tanks and operate continuously. The aerators use two speed motors which allow them to operate at either high or low speed. Speed settings are manually adjusted by site staff to meet the demands of the treatment process, which varies depending on the biological properties of the wastewater and temperature.

Aladaco has worked with site staff to collect SCADA trend data and to install on-site real-time energy metering to better understand and model these process demands.

3. Historical Utility Data

Aladaco has reviewed 36 months of utility data from the Town of Goderich for both the MRC and the WWTP. The data spans 2021 to 2023 and includes electrical and natural gas consumption and costs. The monthly data has been used to determine utility rates and to benchmark the facilities. Additionally, hourly interval data for electrical energy consumption was provided for both facilities covering all of 2023. This hourly data was used in calibrating the energy models and in determining the peak and average power consumption of the facilities.

3.1 Energy and GHG Factors

Current and future energy and GHG emission factors are unique to Ontario and have been sourced from the Canada Green Building Council's Zero Carbon Building Workbook, Version 4 (ZCB v4). The following factors are applied to 2023 annual energy consumption:

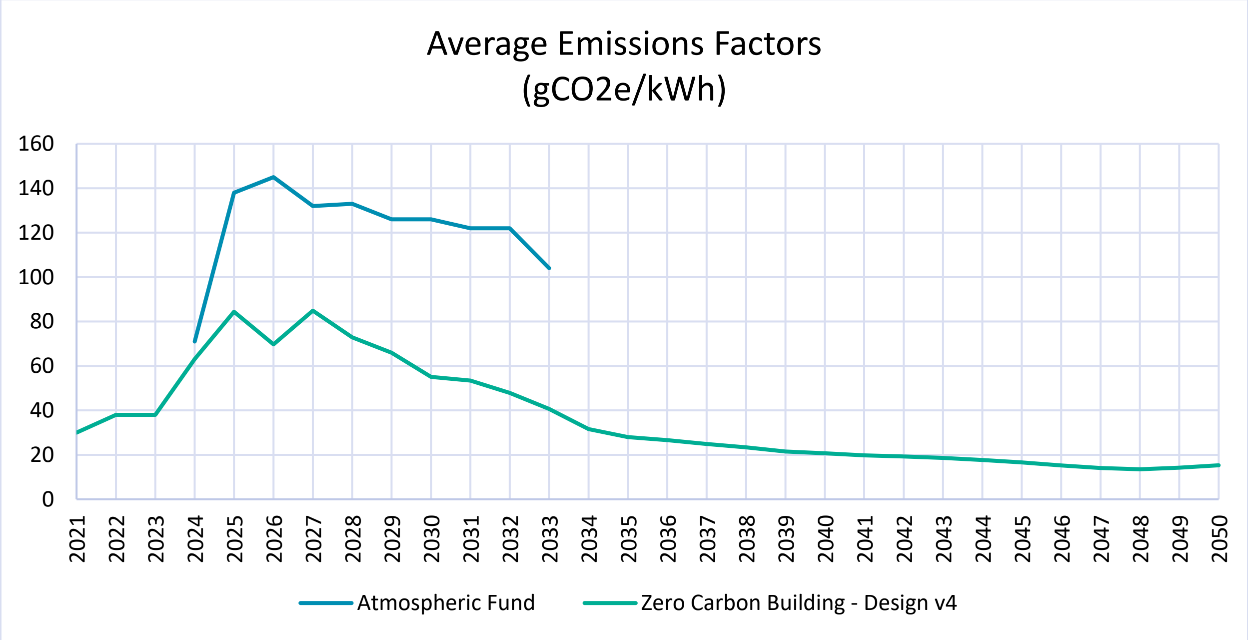
- Electricity: 0.038 kgCO2e/kWh
- Natural Gas: 1.921 kgCO2e/m^3

3.1.1 Future Grid Emission Factors

Like the method applied to the 2023 emissions calculations, future grid emission factors are sourced from the ZCB v4 workbook. In all calculations, the date of implementation is referenced to apply the appropriate future Ontario grid emission factor.

During the Design Workshop the Town of Goderich and Aladaco staff discussed varying sources of projections for future grid emissions, and how the range of these projections could affect meeting their decarbonization goals. The chart below is a comparison between the ZCB v4 projections and those released by The Atmospheric Fund (TAF) in a 2024 study published for the IESO.

Figure 6: Grid Emission Factors



(The Atmospheric Fund, June 2024)

There is significant variation between these estimates, particularly in the first ten years, and this variation could have a significant impact on future emissions for both facilities. Included within Appendix F: Sensitivity Analysis, is a recalculation of the pathways using TAF emission factors to better understand these impacts.

At the conclusion of the Design Workshop, the decision was jointly made to adopt the ZCB v4 projections for use in the final pathways analysis due to the longer-term forecasts available from this reference. The Town of Goderich does however acknowledge that Ontario's grid emissions are likely to see significant increases in the short term, and that the magnitude of these increases is uncertain. When reviewing progress towards the decarbonization goals outlined in this report, the Town of Goderich will need to monitor these factors and may need to adjust the final pathways to achieve their goals.

3.2 Maitland Recreation Centre

Monthly utility data for the MRC was analyzed over a 36-month period, spanning 2021 to 2023. The 36-month period was analyzed to identify trends or anomalies prior to the on-site investigations. Included in this section are both the 3-year analyses, as well as a presentation of the 2023 energy consumption used to calibrate the energy model.

Table 3: 2023 MRC Energy Consumption Summary

	2023 Billed Consumption	2023 GHG Emissions	2023 Billed Cost
Electricity	2,471,575 kWh 8,897 GJ	94 tCO_2e	$356,545
Natural Gas	167,123 m^3 6,423 GJ	321 tCO_2e	$82,974
Totals	4,255,780 ekWh 15,320 GJ	415 tCO_2e	$439,519

Figure 7 and Figure 8 are visual representations of the utility costs and emissions by source.

Figure 7: MRC 2023 Utility Costs

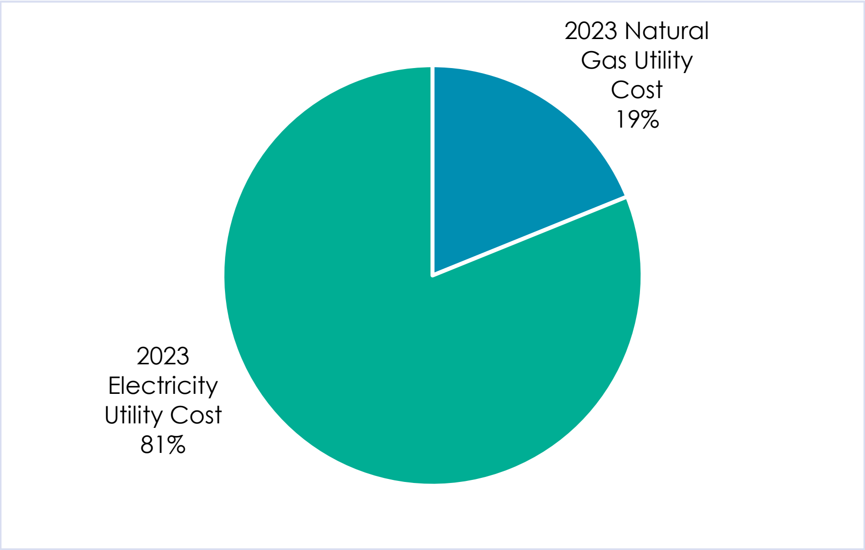
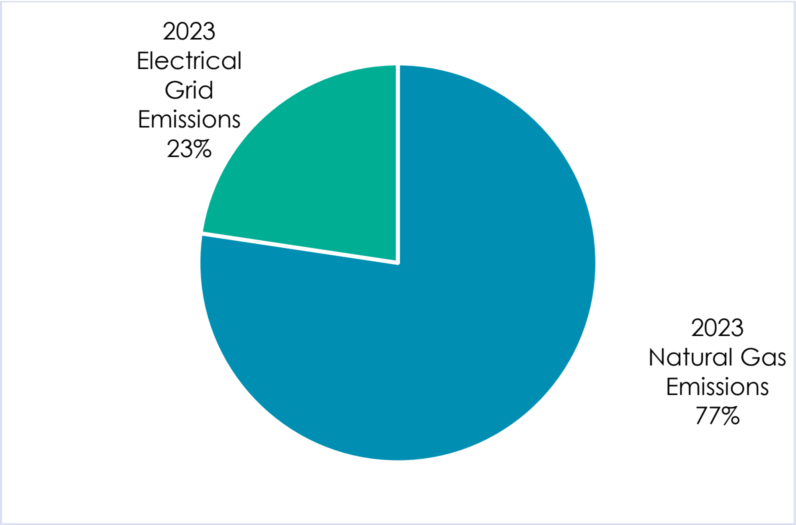


Figure 8: MRC 2023 Emissions

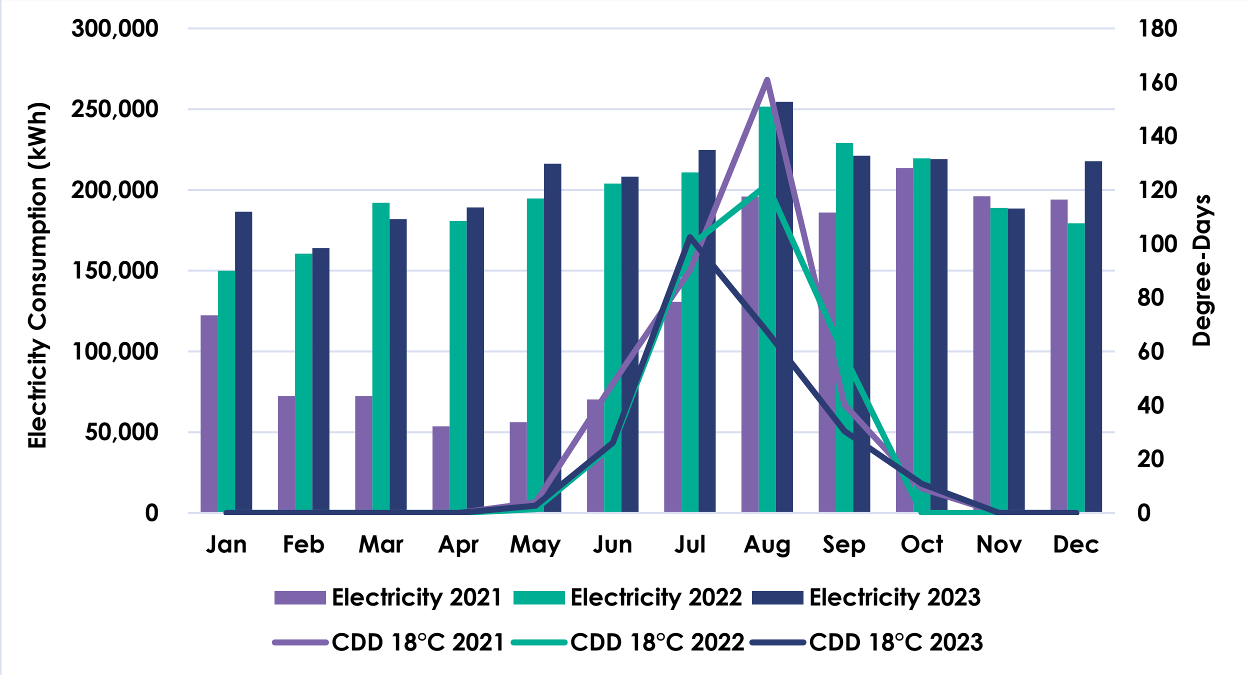


3.2.1 Electricity

Electricity consumption constitutes approximately 58% of the total energy consumed by the MRC in 2023. It accounts for approximately 23% of the facility's total greenhouse gas (GHG) emissions.

Monthly billing data was analyzed and a graphical representation of the facility's monthly consumption covering a period of 2021 to 2023 is presented in Figure 9.

Figure 9: MRC Annual Electrical Consumption



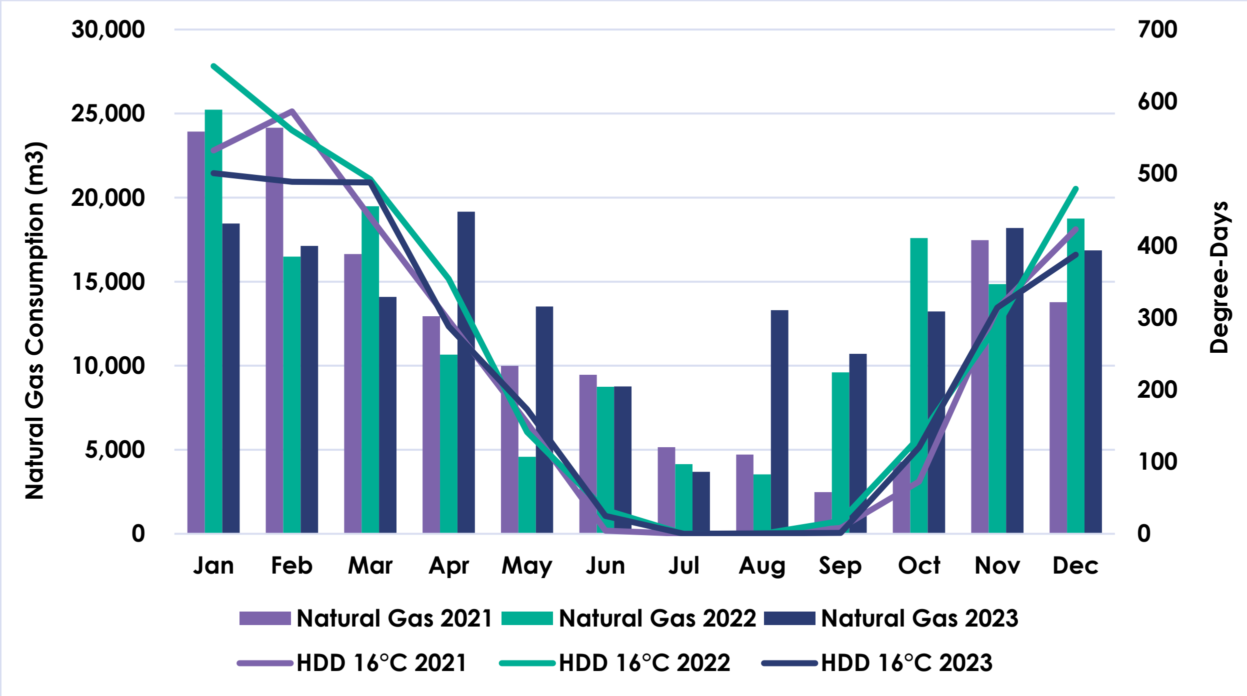
As can be observed, the MRC experienced significant decreases to overall energy consumption during 2021 and 2022 due to the on-going impacts of the COVID-19 pandemic. The MRC is somewhat unique in that the indoor arena operates year-round, resulting in a significant base electrical requirement. Additional loads are observed during the summer periods, which reflects these additional cooling requirements.

3.2.2 Natural Gas

Natural gas use constitutes approximately 42% of the total energy consumed by the MRC in 2023. It accounts for approximately 77% of the facility's total greenhouse gas (GHG) emissions.

Monthly billing data was analyzed, and a graphical representation of the facility's monthly consumption is presented in the figure below. The data covers the periods of 2021 to 2023.

Figure 10: MRC Annual Natural Gas Use



Natural gas use at the MRC is strongly related to heating demands as can be observed in the above figure. Usage peaks during the cold winter months and drops significantly in the summer periods. Deviations from this trend can largely be attributed to estimated meter readings in the utility billing data. The smaller baseload of gas consumption during the summer months represents the proportion of natural gas required to provide domestic hot water heating and some of the pool heating requirements.

3.2.3 Utility Rate Structures

Electricity

The Town of Goderich purchases electricity for the MRC from Erie Thames Power Corporation under a General Service >50 kW rate structure. The facility Power Factor was noted as consistently being lower than 90%, resulting in additional fees on all monthly bills in 2023.

- Blended Electricity Rate: $0.15/kWh
- Demand Rate: $9.95/kW

Natural Gas

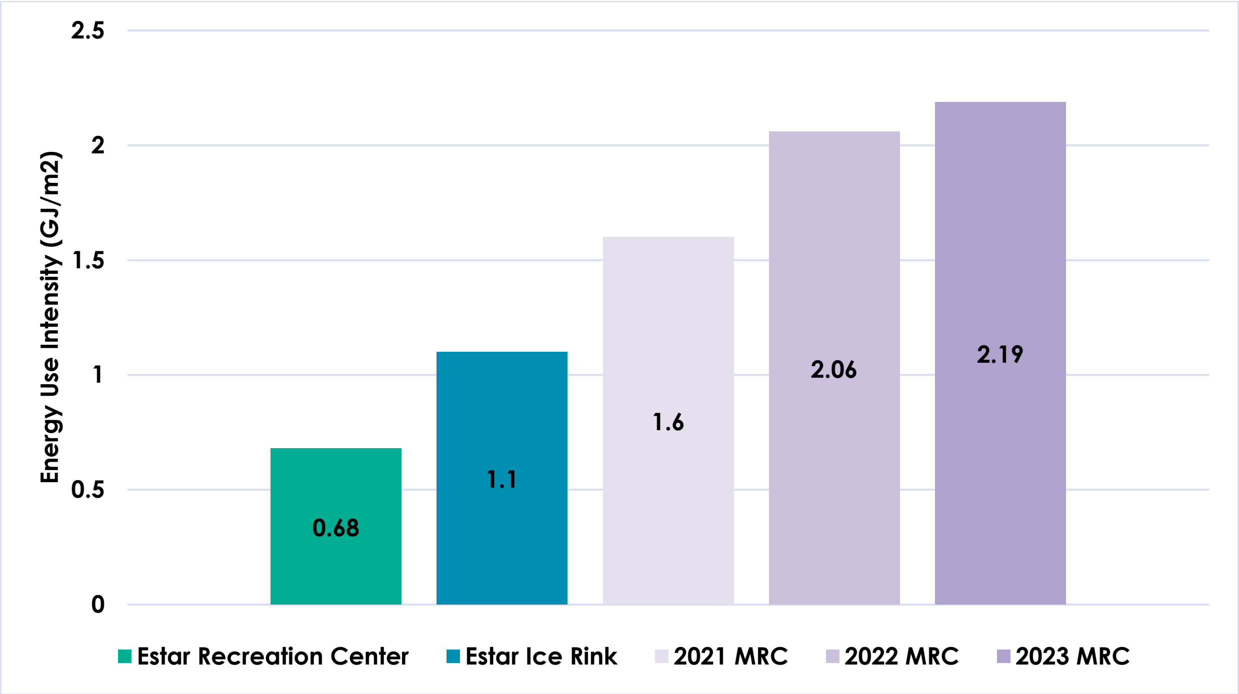
Natural gas for the MRC is supplied by Enbridge Gas under a commercial rate structure, Rate M2 Union South. The blended rate includes all pre-tax charges from the utility bills, with the exception of the Carbon Tax charge, which has been calculated separately from this rate.

- Blended Natural Gas Rate: $0.38/m^3

All utility rates are calculated as averages using monthly billing data for 2023, as supplied by the Town of Goderich.

3.2.4 Benchmarking

Figure 11: Maitland Recreation Centre Benchmarking



The above figure compares Maitland Recreational Centre's annual energy use intensity (EUI) from 2021 to 2023 to benchmark EUI's for Recreation Centre's and Ice Rinks. These benchmarks are sourced from publicly available national median values (Energy Star Portfolio Manager, 2023). As none of the published Primary Function categories exactly match the primary uses of the MRC, both the Recreation Centre and Ice Rinks EUI's are included in this benchmark analysis.

For all three years analyzed, the MRC had an EUI greater than either of the benchmark values. In 2021, the facility's EUI was approximately 80% above the average benchmark, and this difference increased significantly to 150% by 2023. A key reason for this discrepancy is that the benchmark provided for ice rinks assumes seasonal operation during winter months only, whereas the MRC operates its rink year-round.

Additionally, Figure 11 clearly illustrates the operational impact of Covid-19, with substantial shutdowns and activity restrictions between 2020 and 2022. Normal facility operations resumed in late 2022, making the 2023 EUI a more accurate representation of typical energy use at the MRC. Notably, the facility's EUI in the 2019 baseline was 2.21 GJ/m², closely aligning with its 2023 performance.

3.2.5 Target and Savings Estimate

In alignment with the FCM CBR Guidance Document, the GHG Reduction targets for the MRC are defined as follows:

1. **Minimum Performance Scenario**:
    - A 10-year roadmap achieving a minimum of **50% GHG reduction** compared to the facility's baseline emissions.
    - A 20-year roadmap achieving a minimum of **80% GHG reduction** compared to baseline emissions.
2. **Aggressive Deep Retrofit Scenario:**
    - Achieves **50% GHG reduction within the first 5 years**, followed by additional measures to meet or exceed the 80% reduction target within 20 years.

In 2019, the Town of Goderich conducted a Community and Corporate-level GHG inventory as part of FCM's Partners for Climate Protection (PCP) program Milestone 1. The Town has elected to use the results of this inventory as the baseline for this study, aligning baseline emissions with 2019 energy usage.

Table 4: MRC Baseline and Target Emissions (tCO_2e)

2019 Electrical Consumption	2,505,070 kWh
2019 Natural Gas Use	168,570 m^3
2019 Baseline Emissions	396.5 tCO_2e
Target 1: 50% of Baseline Emissions	198.3 tCO_2e
Target 2: 80% of Baseline Emissions	79.3 tCO_2e

Achieving an 80% reduction in facility GHG emissions at MRC would result in a savings of 317.2 tCO_2e annually.

Based on the data used to generate the 2019 baseline emissions, the following table represents the baseline and target greenhouse gas intensity (GHGI) for MRC.

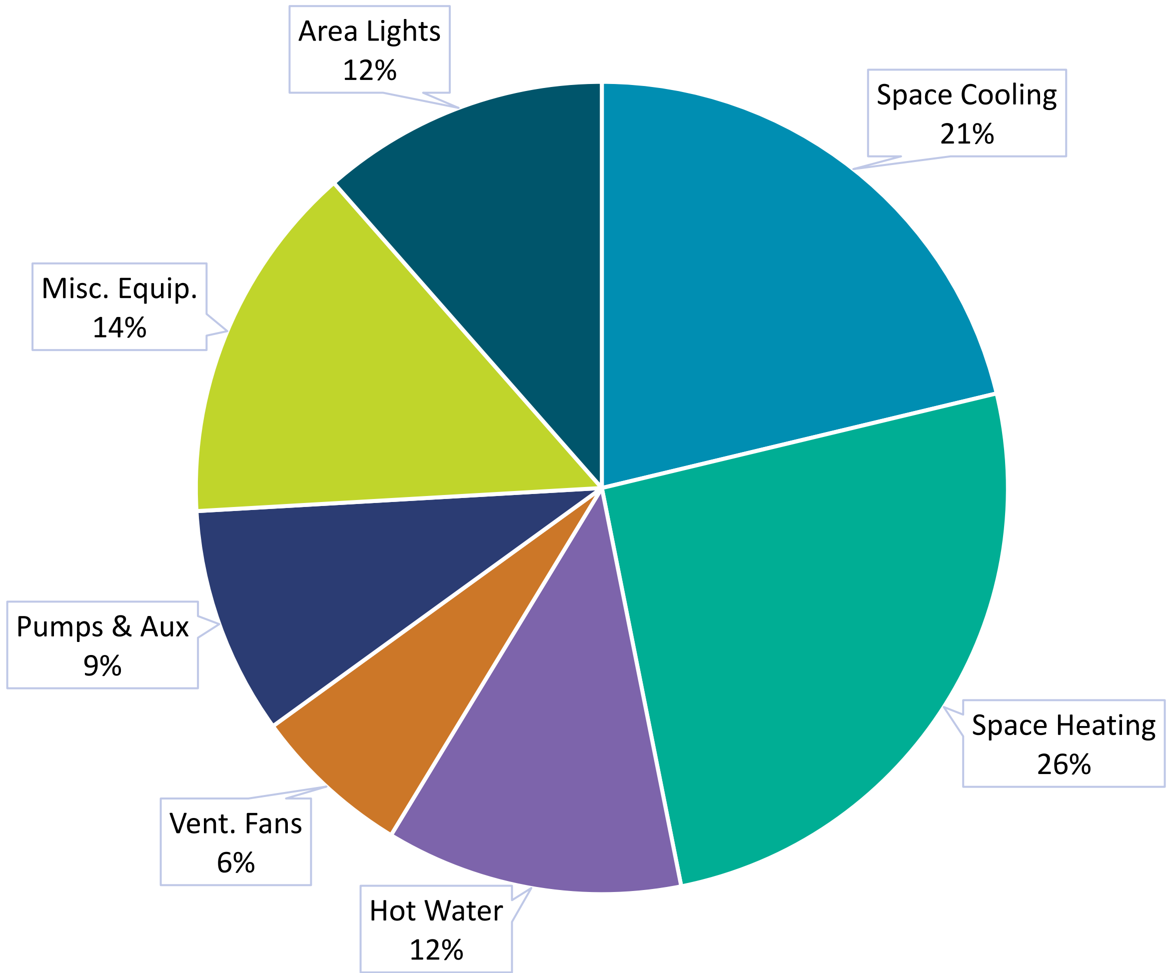
Table 5: Baseline and Target GHGI for MRC

Baseline GHGI	56.6 $kgCO_2e/m^2$
Target 1 GHGI: 50% of Baseline Emissions	28.3 $kgCO_2e/m^2$
Target 2 GHGI: 80% of Baseline Emissions	11.3 $kgCO_2e/m^2$

3.2.6 End-use breakdown

The following figure details the energy end-use breakdown for the MRC. The distribution is based on the total energy consumed by each end-use category as determined through calibrated energy model, on-site investigation, sub-metered data, and engineering calculations.

Figure 12: MRC Energy End-use Breakdown



3.3 Goderich Wastewater Treatment Plant

Monthly utility data for the WWTP was analyzed over a 36-month period, spanning 2021 to 2023. The 36-month period was analyzed to identify trends or anomalies prior to the on-site investigations. Included in this section are both the 3-year analyses, as well as a presentation of the 2023 energy consumption used to calibrate the energy model.

Table 6: 2023 WWTP Energy Consumption Summary

	Billed Consumption	GHG Emissions (tCO_2e)	Billed Cost
Electricity	699,928 kWh 2,520 GJ	27 tCO_2e	$111,592
Natural Gas	6,408 m^3 246 GJ	12 tCO_2e	$3,702
Totals	768,340 ekWh 2,766 GJ	39 tCO_2e	$115,294

Figure 7 and Figure 8 are a visual representation of the utility costs and emissions by source.

Figure 13: WWTP 2023 Utility Costs

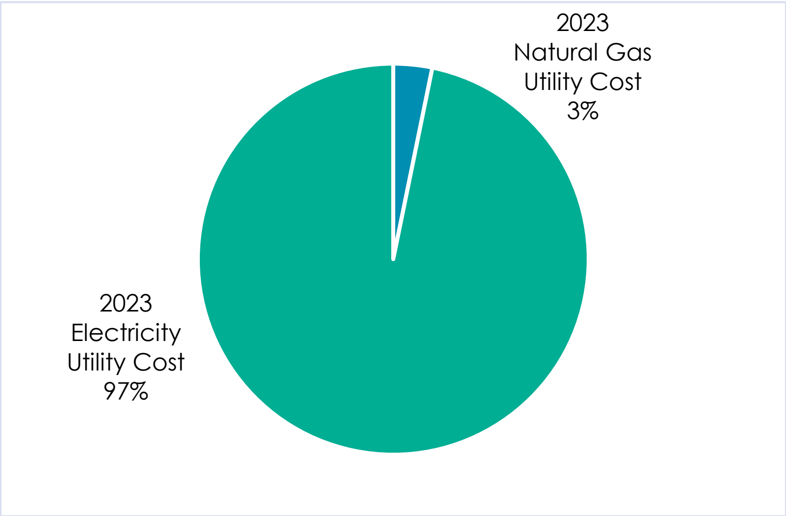
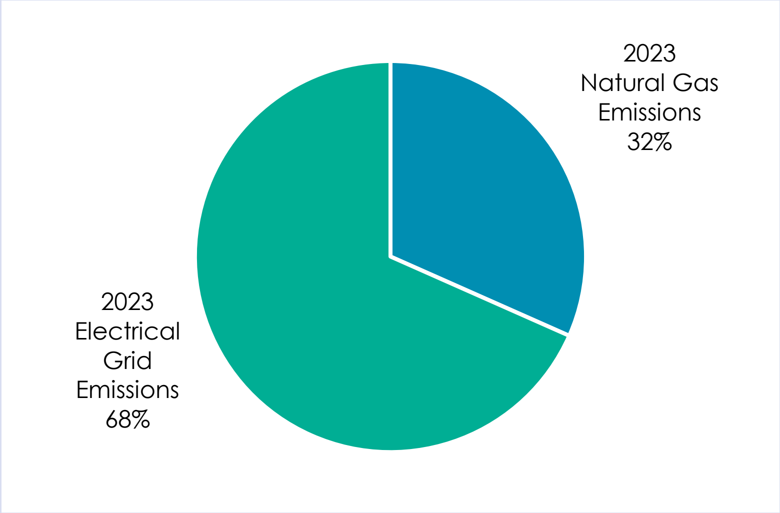


Figure 14: WWTP 2023 Emissions

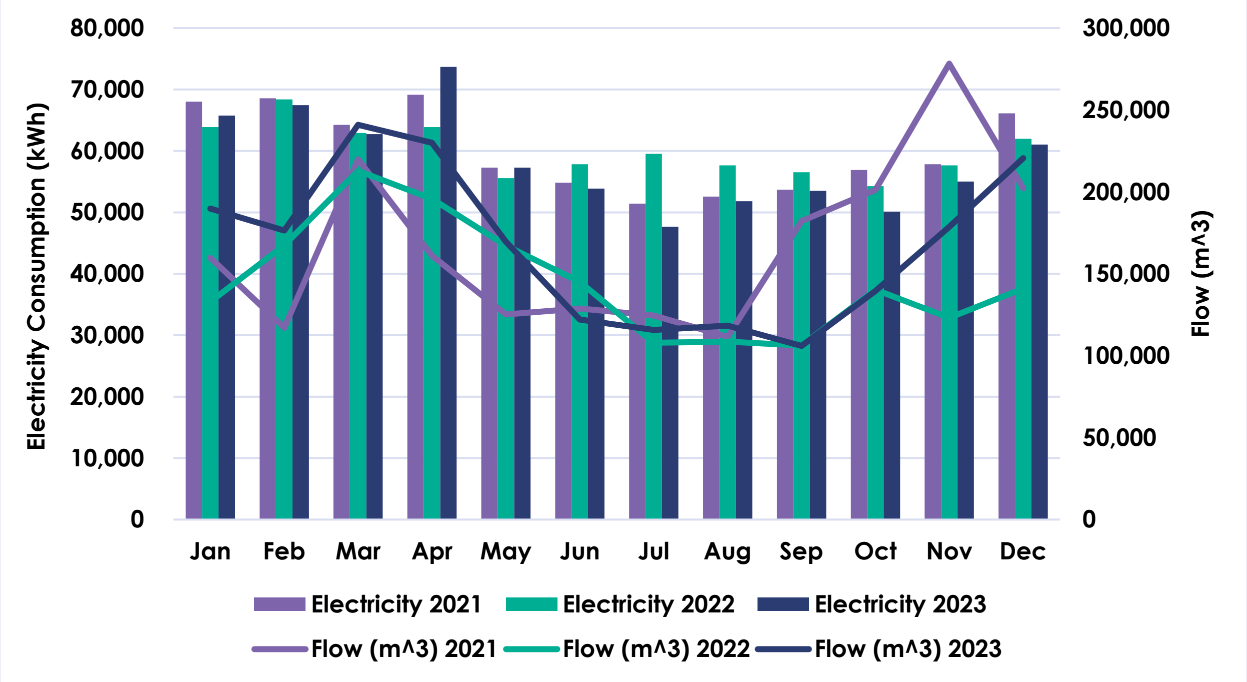


3.3.1 Electricity

Electricity consumption constitutes approximately 91% of the total energy consumed by the WWTP in 2023. It accounts for approximately 68% of the facility's total greenhouse gas (GHG) emissions.

Monthly billing data was analyzed and a graphical representation of the facility's monthly consumption covering a period of 2021 to 2023 is presented in Figure 14.

Figure 15: WWTP Annual Electrical Consumption



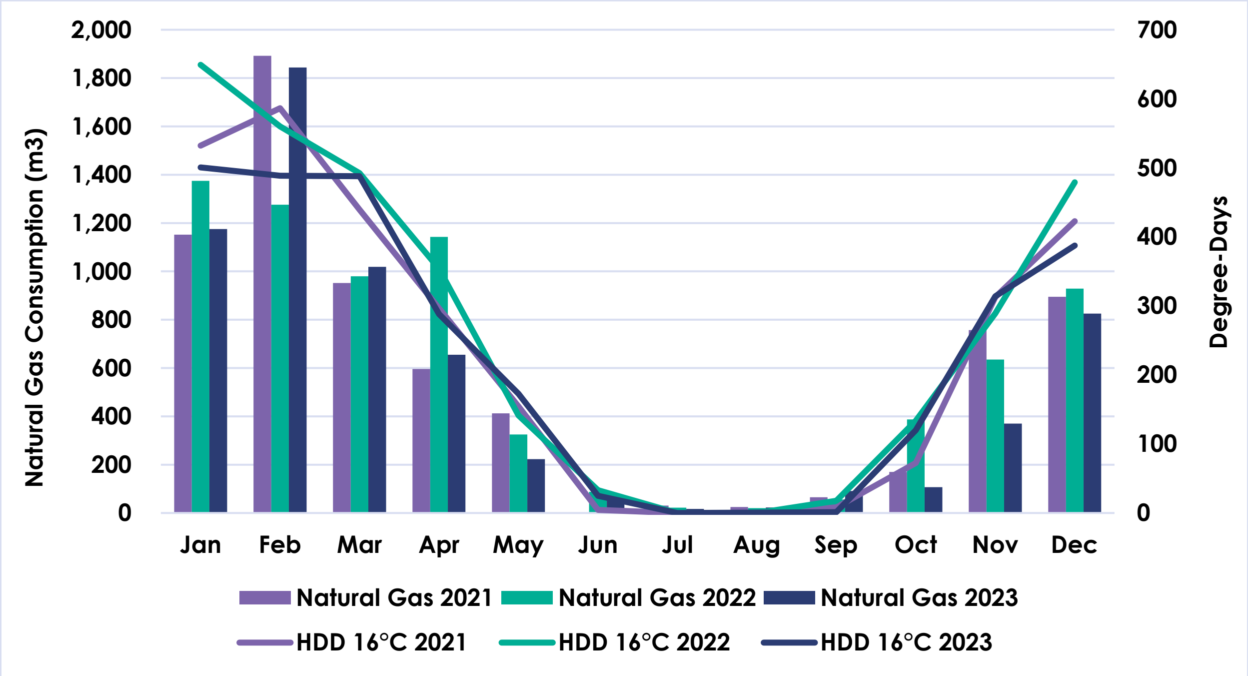
The above figure demonstrates the relatively high electrical baseload at the WWTP. Monthly consumption shows little correlation to wastewater flowrates despite SCADA programming to vary equipment operation in response to influent flows. This may be due to some equipment operating in step-wise or on/off configurations, however it is also likely due to the influent storage capabilities at the WWTP. With significant on-site overflow capacity, the WWTP can control the flow of influent to the processing equipment, this control normalizes the amount of water processed over time and reduces the variability in process energy use.

3.3.2 Natural Gas

Natural gas use constitutes approximately 9% of the total energy consumed by the WWTP over the past 12 months. It accounts for approximately 68% of the facility's total greenhouse gas (GHG) emissions.

Monthly billing data was analyzed, and a graphical representation of the facility's monthly consumption is presented in the figure below. The data covers the periods of 2021 to 2023.

Figure 16: WWTP Annual Natural Gas Use



Natural gas use at the WWTP is strongly related to heating demands as only the radiant tube heaters and the MAU utilize natural gas. Minor amounts of natural gas consumption during the summer months may be representative of overnight heating of the interior space as a result of using manual thermostats.

3.3.3 Utility Rate Structures

Electricity

The Town of Goderich purchases electricity for the WWTP from Erie Thames Power Corporation under a General Service >50 kW rate structure. The facility Power Factor was noted as consistently being lower than 90%, resulting in additional fees on all monthly bills in 2023.

- Blended Electricity Rate: $0.16/kWh
- Demand Rate: $9.73/kW

Natural Gas

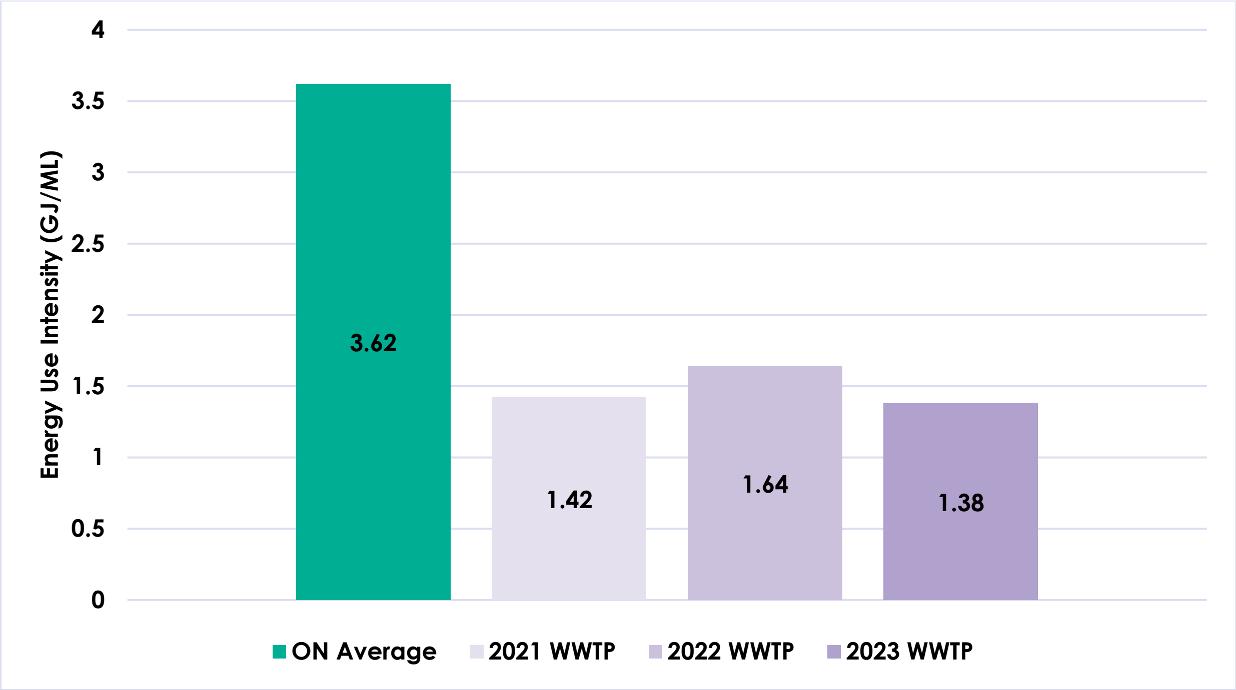
Natural gas for the MRC is supplied by Enbridge Gas under a commercial rate structure, Rate M2 Union South. The blended rate includes all pre-tax charges from the utility bills, with the exception of the Carbon Tax charge which has been calculated separately from this rate.

- Blended Natural Gas Rate: $0.72/m^3

All utility rates are calculated as averages using monthly billing data for 2023, as supplied by the Town of Goderich.

3.3.4 Benchmarking

Figure 17: Goderich WWTP Benchmarking



The WWTP's energy use intensity (EUI) was measured against a Benchmark EUI (Posterity Group, 2018)for wastewater treatment plants in Ontario based on effluent flow. The facility's EUI was measured for the years of 2021, 2022, and 2023. The results show consistent energy consumption in all three years. The WWTP is overperforming when compared to the benchmark, using less than 40% of the energy used in the benchmark case for all observed years.

The consistency in the years examined can present an issue despite good performance indicators such as being under the benchmark in EUI. Having a consistent energy use intensity when measured against flow can mean that the facility operations are always running regardless of other variables. When looking at the electricity consumption graphs in Section 3.3.1, it is clearer that the usage is not entirely correlated to the volume of flow that is being processed. As an example, in 2022 there was 13% less flow processed at the facility than in 2023, however 2022 has a higher EUI. This may represent additional conservation opportunities in the processing of wastewater.

The relationship between this facility's performance compared to other Ontario facilities is perhaps not a great indicator of the facility's overall efficiency. This is due to the benchmark value being pulled from a wide variety of treatment sites around the province. Outlier sites with greater flow rates or unique processes will skew the median value. There is also little oversight into the self-reported values in the Broader Public Sector data used in the benchmark analysis. This could lead to confusion as to what constitutes a "Wastewater Treatment Plant" by those who submit the data, potentially incorporating pumping stations and other low consumption facilities into the database.

As the impacts of WWTP's continue to grow in importance to municipal owners, it is expected that more valuable and realistic benchmarks for WWTPs in general, or for specific sub-types, will become available and allow for more valuable insight into the energy performance of wastewater plants.

3.3.5 Target and Savings Estimate

In alignment with the FCM CBR Guidance Document, the GHG Reduction targets for the WWTP are defined as follows:

3. **Minimum Performance Scenario**:
   - A 10-year roadmap achieving a minimum of **50% GHG reduction** compared to the facility's baseline emissions.
   - A 20-year roadmap achieving a minimum of **80% GHG reduction** compared to baseline emissions.
4. **Aggressive Deep Retrofit Scenario:**
   - Achieves **50% GHG reduction within the first 5 years**, followed by additional measures to meet or exceed the 80% reduction target within 20 years.

In 2019, the Town of Goderich conducted a Community and Corporate-level GHG inventory as part of FCM's Partners for Climate Protection (PCP) program Milestone 1. The Town has elected to use the results of this inventory as the baseline for this study, aligning baseline emissions with 2019 energy usage.

Table 7: WWTP Baseline and Target Emissions (tCO_2e)

2019 Electricity Consumption	750,797 kWh
2019 Natural Gas Use	6,480 m^3
2019 Baseline Emissions	35.2 tCO_2e
Target 1: 50% of Baseline Emissions	17.6 tCO_2e
Target 2: 80% of Baseline Emissions	7.0 tCO_2e

Achieving an 80% reduction in facility GHG emissions at WWTP would result in a savings of 28.2 tCO_2e annually.

Based on the data used to generate the 2019 baseline emissions, the following table represents the baseline and target greenhouse gas intensity (GHGI) for the WWTP.

Table 8: Baseline and Target GHGI for WWTP

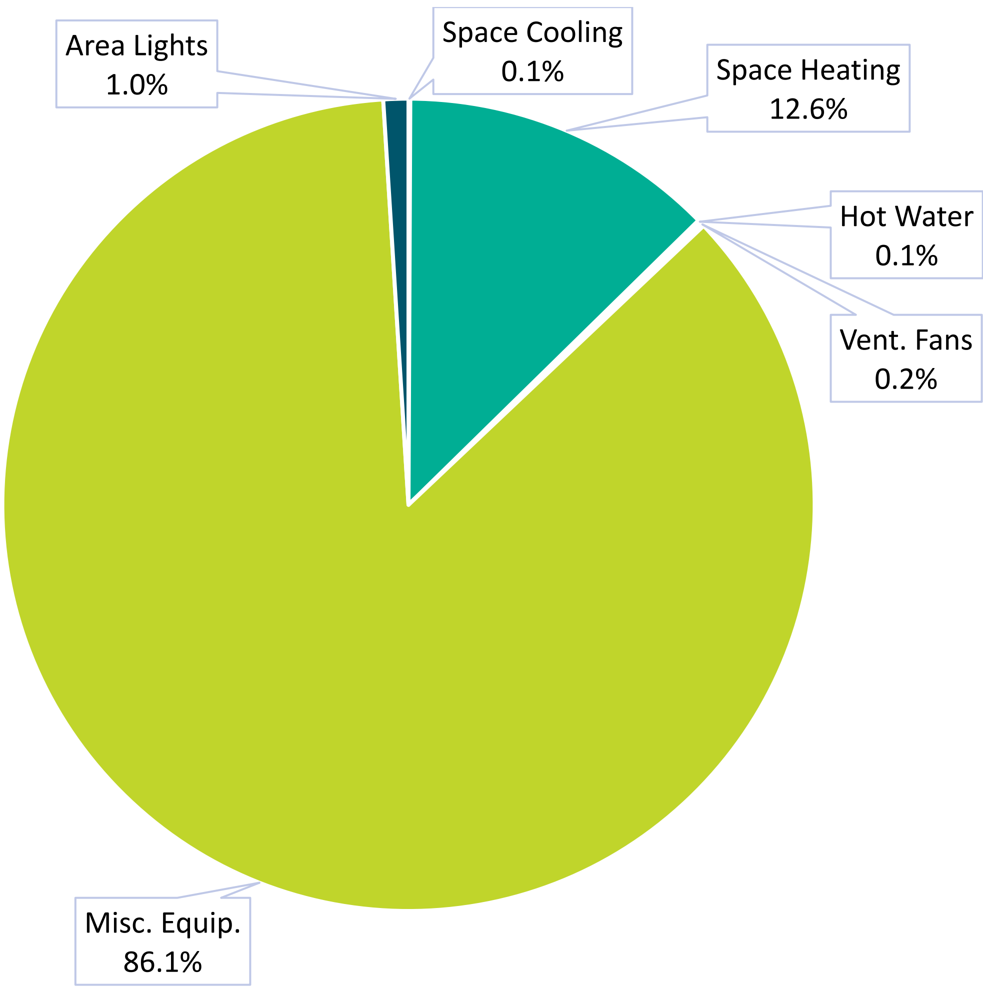
Baseline GHGI	18.1 $kgCO_2e/ML$
Target 1 GHGI: 50% of Baseline Emissions	9.0 $kgCO_2e/ML$
Target 2 GHGI: 80% of Baseline Emissions	3.6 $kgCO_2e/ML$

As noted in the previous section, performance indicators for the WWTP are normalized using Mega Litres of annual flow value, rather than on a floor area basis, as was conducted for the MRC. This follows industry standards for the normalization of WWTP energy consumption and emission values.

3.3.6 End-use breakdown

The following figure details the energy end-use breakdown for the WWTP. The distribution is based on the total energy consumed by each end-use category as determined through calibrated energy model, on-site investigation, sub-metered data, and engineering calculations.

Figure 18: WWTP Energy End-use Breakdown



The above figure details the energy end-use breakdown for the WWTP. The distribution is based on the total energy consumed by each end-use category as determined through calibrated energy model, on-site investigation, sub-metered data, and engineering calculations.

4. Workshop Summaries

4.1 Design Workshop

On February 5, 2025, Aladaco conducted Design Workshops for each of the facilities. The in-person workshops took place at the Town of Goderich offices located at 57 West St, Goderich. The intent of the Design Workshops was to gather all relevant stakeholders to review preliminary decarbonization measures and their feasibility, while also encouraging engagement and discussion on the challenges and opportunities at each facility. At the conclusion of the Workshop consensus was formed on the selected ECMs for further analysis in the Measure Level Analysis phase of the Feasibility Study. See the Design Workshop Summary Report in Appendix A for more details.

4.2 Decision-making Workshop

On June 2, 2025, Aladaco conducted an in-person Decision-making workshop with the Town of Goderich. The workshop took place at Town's offices located in Goderich ON and was attended by key stakeholders from finance and operations department, as well as facility operators. The workshop included the selection of specific ECMs to form each of the GHG Reduction Pathways for both facilities, and consensus was formed on the appropriate implementation dates for each selected ECM. At the end of the workshop, each facility had both the Minimum Performance and Aggressive Deep Retrofit Pathways defined, along with an understanding of the financial metrics of each path. For further details on the workshop and its attendees, please see the Decision-making Workshop slide decks in Appendix E.

5. Measures Level Analysis

The following analyses represent the savings and GHG reductions for project implementations in 2025. Measure level analyses adjust future cashflows using the following variables as provided by the Town of Goderich.

- Inflation (Capital, Labour, Utilities): 2%
- Discount Rate: 4%
- **Utility rates:** As determined in Section 3 of this report.
- **Federal Carbon Tax:** $95/tonne in 2025, increasing by $15/tonne/yr until reaching a maximum of $170/tonne in 2030.
- **Grid Emissions Factor:** Adjusted annually as defined in Appendix B.

The measure level analysis evaluates each energy conservation measure independently and does not account for interactive effects between measures. This means the energy savings, cost impacts, and GHG reductions are calculated in isolation, without considering how one measure may influence the performance or outcome of another. All measures within this section are presented as though implemented in 2025.

In contrast, the analyses used in the GHG Reduction Pathway Capital Plans incorporates interactive effects by integrating packages of measures into the calibrated energy model. This allows for a more comprehensive assessment, where combined impacts are captured. As a result, the values presented in the measure-level analysis may differ from the pathways due to the inclusion of measure interactions, fluctuating grid emissions factors, and inflationary adjustments applied within the long-term modeling framework.

Capital costs in the Measure-Level Analysis are generally equivalent to Class C estimates, which reflect a preliminary level of accuracy suitable for planning purposes. These estimates are based on a combination of technical data, RSMeans costing references, vendor-supplied quotes, and Aladaco's experience with similar projects. While care has been taken to ensure reasonable accuracy, current economic conditions, including supply chain volatility and material cost fluctuations, may significantly affect the actual costs at the time of implementation. Capital Costs shown in this report include all labour, materials, engineering, and contingency to fully implement the project.

Aladaco is unable to provide incremental cost analysis under the WWTP Measure Level Analysis due to the absence of a BCA for the Goderich WWTP. Additionally, there are no incremental cost analysis under the GHG Reduction Pathway Capital Plan for the WWTP.

5.1 Maitland Recreation Centre Recommended Measures

The following sections detail the ECMs analyzed by Aladaco for the MRC. These measures were developed through site investigations and analysis of energy data, and they were selected for inclusion in the GHG Reduction Pathways by the Town of Goderich through the collaborative Decision-making Workshop.

5.1.1 ECM – Recommissioning of the Geothermal Systems

Utility Savings	
Electricity (kWh)	34,157
Demand (kW)	0.0
Natural Gas (m^3)	0.0
GHG (tCO_2e)	2.9
GHG Baseline Reduction	1%
EUI Reduction ($ekWh/m^2$)	4.9
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$21,500
Engineering & PM	$ -
Contingency	$ -
Total Capital Cost	$21,500
Utility Savings	$5,124
Annual O&M	$972
Simple Payback (yrs)	4.4
Net-Present Value	$21,706

Existing Conditions:

The facility's original geothermal system provides both heating and cooling through a network of water-source heat pumps and serves the ice-making system. Although the system remains operational, several indicators suggest that recommissioning is warranted. Observations during the site visit, combined with operational data trends, indicate that there may be untapped capacity within the geothermal field that could support additional thermal loads. For example, loop return temperatures observed on the BAS were notably high, implying that excess heat is being rejected without being effectively recovered, which suggests that the system may be underutilized.

A full assessment could not be completed for this report due to limitations in the available data. Annual and seasonal performance trends are not currently recorded, and the BAS does not provide reliable temperature readings for several key variables. In particular, geothermal field temperatures, which appear abnormally high and are likely the result of faulty sensors or calibration issues. Without accurate and continuous metering of loop temperatures, flow rates, and system loads across different times of the year, it is not possible to confirm the system's true capacity or evaluate the feasibility of expanding its use to displace existing fossil fuel-based heating systems.

Proposed Measure:

To address these issues and fully evaluate the capabilities of the geothermal system, Aladaco recommends conducting a detailed recommissioning study, in collaboration with qualified geothermal and controls specialists. This effort would include a thorough performance assessment of the entire system—including the geothermal field, circulation pumps, heat pump loops, and integration with the ice-making process. The primary objective will be to optimize system functionality, correct known BAS metering inaccuracies, and restore accurate sensor readings, control logic, and data trending capabilities. Special focus should be placed on heat pump loop temperatures, system balancing, and seasonal variations in performance.

The second objective of the study is to assess the system's available capacity to support additional thermal loads, specifically the potential to replace or offset heating currently provided by natural gas boilers. This information is essential to validate the assumptions made in Measure 6.1.6, which proposes the installation of additional water-source heat pumps. At present, that measure assumes a conservative approach due to the uncertainty surrounding geothermal capacity. As part of the recommissioning process, Goderich staff should confirm metering requirements with the selected commissioning agent to ensure that sufficient trending and seasonal data is captured moving forward. This will allow the Town to make informed, evidence-based decisions regarding system expansion and investment, and to maximize the use of existing infrastructure to reduce GHG emissions and operational costs.

Implementation and Non-Financial Considerations:

Recommissioning the geothermal system can be carried out with minimal disruption to facility operations, though some coordination will be needed to schedule short service interruptions. Town staff will need to support the process by assisting with data collection, system access, and responding to technical inquiries during the study.

Beyond energy savings, this measure will improve system reliability, extend equipment life, and enhance control accuracy. It will also support future planning by confirming the system's capacity to offset natural gas use.

Measurement and Verification:

M&V should follow IPMVP Option B – All Parameter Measurement. By conducting the recommissioning, it is expected that all parameters will be accurately measured. Pre and post project energy usage can be trended with weather related data to determine energy savings.

5.1.2 ECM – Recommissioning of the BAS and Related Systems

Utility Savings	
Electricity (kWh)	36,788
Demand (kW)	0.0
Natural Gas (m^3)	3,982
GHG (tCO_2e)	10.8
GHG Baseline Reduction	3%
EUI Reduction ($ekWh/m^2$)	11.38
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$18,060
Engineering & PM	$-
Contingency	$-
Total Capital Cost	$18,060
Utility Savings	$7,016
Annual O&M	$1,944
Simple Payback	2.9
Net-Present Value	$47,264

<u>Existing Conditions:</u>

The facility is equipped with a BAS that provides control and monitoring of several key mechanical and electrical systems. While the BAS is operational, the current programming and control sequences have not been reviewed or updated in several years. Several areas were observed during the site visit where setpoints, schedules, and sensor calibration may be misaligned with actual operational needs. A detailed assessment and recommissioning of the BAS is recommended to address these issues and ensure systems are operating optimally.

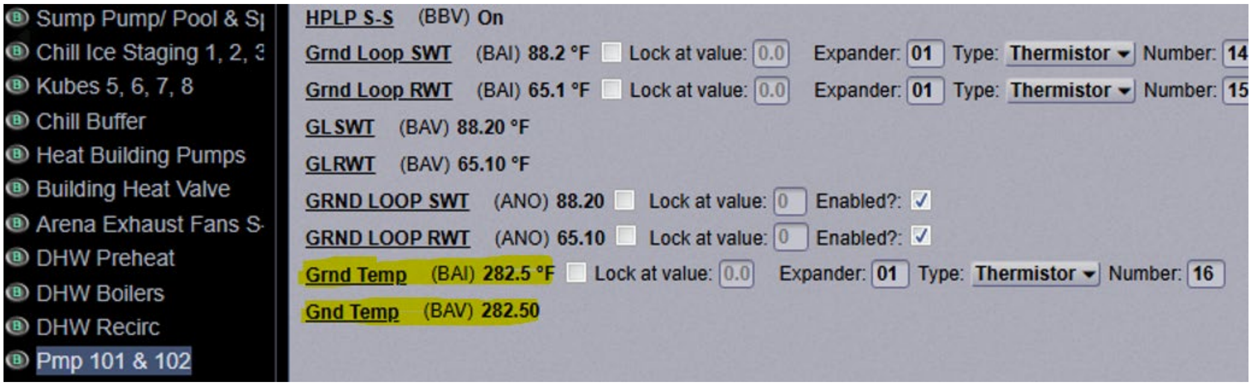
System Controlled by BAS	Equipment Description	Notes
HVAC System	22 Water-source heat pumps	Occupied/unoccupied scheduling
Arena Refrigeration	Modular system w/ ground loop	Monitoring only
Pool Heating and Dehumidification	Pool boilers and dehumidifier	Temperature and humidity setpoints, heat recovery optimization
Change Room Ventilation	Roof-mounted AHUs with DX and gas heat	Exhaust air heat recovery present
Makeup Air Ventilation	Roof-mounted MAU with DX and gas heat	Occupied/unoccupied scheduling and fresh air rates
Arena Ventilation and Dehumidification	Exhaust fans and Dectron units	CO2 setpoints and verification
Domestic Hot Water System	Dedicated DHW boilers	Tank setpoint verification needed, heat recovery optimization

Proposed Measure:

Recommissioning of the BAS to restore optimal performance and energy efficiency is recommended. The scope will include testing and verification of all existing BAS points, updating control sequences, confirming time-of-day schedules, recalibrating sensors, and addressing any identified faults or overrides. Custom programming changes will be implemented based on operational needs and energy-saving opportunities discovered during the site investigation.

As an example, below is a screenshot from the BAS showing an erroneous ground loop temperature of 282.5 °F. Other similar items identified during a brief review of the BAS include extremely low DHW temperatures below 100 °F and sensors in adjacent or similar spaces showing greater variation than expected.

Figure 19: MRC BAS Ground Temperature Reading



Expected energy savings from this measure are approximately 3% of energy use from BAS controlled systems.

<u>Implementation and Non-Financial Considerations:</u>

Work can be completed with minimal disruption to operations if scheduled during off-hours or in coordination with facility staff. Operational staff may require minor training to sustain optimized performance after recommissioning.

Recommissioning often results in improved occupant comfort and reduced maintenance from more stable and predictable system behavior.

<u>Measurement and Verification:</u>

M&V should follow Option A – Retrofit Isolation with Key Parameter Measurement. Pre- and post-implementation BAS trend logs will be reviewed for critical control points such as temperature setpoints, scheduling adherence, and equipment cycling. Spot measurements and operational testing will verify improvements. Since recommissioning affects multiple systems, savings are recommended to be validated against historical energy consumption patterns using utility data normalized for weather and operational changes.

5.1.3 ECM – Install Water-Source Heat Pump Boilers

Utility Savings	
Electricity (kWh)	-243,811
Demand (kW)	-198
Natural Gas (m^3)	73,780
GHG (tCO_2e)	121.2
GHG Baseline Reduction	31%
EUI Reduction ($ekWh/m^2$)	78.05
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$2,177,139
Engineering & PM	$326,571
Contingency	$217,714
Total Capital Cost	$2,721,424
Utility Savings	-$32,464
Annual O&M	$4,900
Simple Payback	-84
Net-Present Value	-$2,582,732

Existing Conditions:

The MRC currently relies on natural gas-fired boilers to provide hot water for the pool, whirlpool, and domestic hot water systems. These boilers are a significant source of fossil fuel consumption at the facility and contribute directly to its operational greenhouse gas emissions. The equipment is aging and represents an opportunity for both emissions reduction and operational efficiency improvement through electrification.

Existing Equipment	Heating Capacity (BTUh)
Pool Boiler B1	688,500
Domestic Hot Water Boiler B1	1,062,500
Whirlpool Water Heater	323,190

Proposed Measure:

This measure proposes replacing the existing gas boilers with water-source heat pumps (WSHPs) connected to the facility's existing geothermal system. The heat pumps are conservatively sized to match the existing equipment; however additional downsizing may be appropriate based on the results of 5.1.1 ECM Recommissioning of the Geothermal System. By utilizing the geothermal loop as a heat source, the new system will operate efficiently to meet the water heating demands of the facility.

Proposed Equipment	Heat Pump Capacity (BTUh)
Pool Boiler B1	760,900
Domestic Hot Water Boiler B1	1,014,600
Whirlpool Water Heater	507,300

Implementation and Non-Financial Considerations:

Installing the new WSHP units is expected to have a minimal impact on operations. Installation periods are short and can be aligned with regular maintenance activities to reduce downtime. WSHPs may take longer to reach setpoints than traditional boilers, this could impact occupant comfort if systems are not programmed with appropriate preheating schedules.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A or B is recommended, based on the availability of BAS data and energy meter data.

5.1.4 ECM – Electrification of HRU's and MAU

Utility Savings	
Electricity (kWh)	-173,044
Demand (kW)	-6.2
Natural Gas (m^3)	34,728
GHG (tCO_2e)	52.1
GHG Baseline Reduction	13%
EUI Reduction ($ekWh/m^2$)	28.38
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$455,780
Engineering & PM	$79,762
Contingency	$68,367
Total Capital Cost	$603,909
Utility Savings	-$13,265
Annual O&M	$4,300
Simple Payback	-45.8
Net-Present Value	-$746,191

Existing Conditions:

The rooftop HVAC units at the MRC provide heating, cooling, and fresh air to the facility. These units are equipped with natural gas heating coils that significantly contribute to MRC's overall carbon emissions.

Existing Equipment	Cooling Capacity (Tons)	Heating Capacity (BTUh)
MAU-1	4	200,000
HRV-1	22	800,000
HRV-2	22	800,000

Proposed Measure:

The measure proposes replacing the existing HVAC equipment with modern heat pump equipped alternatives. The heat pumps are sized to meet the existing cooling loads and will operate to meet heating demand to an outdoor temperature of 2 °C. Below this temperature an electric resistive back-up heater will operate to provide heating during these low temperatures. Due to the increased size and weight of the heat pump units, an allocation has been made in the project pricing to provide for structural assessments prior to installation and the contingency has been increased to account for potential remediation actions.

Proposed Equipment	Heat Pump Capacity (BTUh)	Supplementary Electric Capacity (BTUh)
MAU-1	48,000	200,000
HRV-1	264,000	800,000
HRV-2	264,000	800,000

Implementation and Non-Financial Considerations:

Installing the new HVAC units is expected to have a minimal impact on operations. Installation periods are short and should be implemented during shoulder seasons when heating and cooling loads are lowest. This approach to scheduling will reduce impacts on occupant comfort.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A or B is recommended, based on the availability of BAS data and energy meter data.

5.1.5 ECM – Electrification of DH3

Utility Savings	
Electricity (kWh)	-383,662
Demand (kW)	-45.1
Natural Gas (m³)	50,828
GHG (tCO_2e)	65.3
GHG Baseline Reduction	16%
EUI Reduction (ekWh/m²)	22.82
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$783,328
Engineering & PM	$137,082
Contingency	$117,499
Total Capital Cost	$1,037,910
Utility Savings	-$41,125
Annual O&M	$2,600
Simple Payback	-25.3
Net-Present Value	-$1,593,429

Existing Conditions:

The rooftop air handling unit, DH-3, provides fresh air, heating, cooling, and humidity control for the pool area. DH-3 is equipped with a natural gas burner to heat the fresh air and is a significant source of GHG emissions at the facility. The unit was installed in 2025 and has significant remaining useful life. To compensate for this, its replacement is deferred to as late as possible within the GHG Reduction Pathways while still achieving the required reduction targets.

Existing Equipment	Cooling Capacity (Tons)	Heating Capacity (BTUh)
DH-3	80	1,100,000

Proposed Measure:

The measure proposes replacing DH-3 with a modern heat pump equipped alternative. The heat pump is sized to meet the existing cooling loads and will operate to meet heating demand to an outdoor temperature of 2 °C. Below this temperature an electric resistive back-up heater will operate to provide heating during these low temperatures. Due to the increased size and weight of the heat pump units, an allocation has been made in the project pricing to provide for structural assessments prior to installation and the contingency has been increased to account for potential remediation actions.

Proposed Equipment	Heat Pump Capacity (BTUh)	Supplementary Electric Capacity (BTUh)
DH-3	446,000	1,100,000

Implementation and Non-Financial Considerations:

Installing the new HVAC units is expected to have a minimal impact on operations. Installation periods are short and should be implemented during shoulder seasons when heating and cooling loads are lowest. This approach to scheduling will reduce impacts on occupant comfort.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A or B is recommended, based on the availability of BAS data and energy meter data.

5.1.6 ECM – Electrification of Unit Heaters

Utility Savings	
Electricity (kWh)	-22,969
Demand (kW)	0.1
Natural Gas (m^3)	3,195
GHG (tCO_2e)	4.2
GHG Baseline Reduction	1%
EUI Reduction ($ekWh/m^2$)	1.60
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$17,907
Engineering & PM	$2,686
Contingency	$403
Total Capital Cost	$20,996
Utility Savings	-$2,238
Annual O&M	$-
Simple Payback	-9.4
Net-Present Value	-$48,470

Existing Conditions:

Five (5) natural gas Unit Heaters are located throughout MRC's utility rooms. Providing heat to these areas through natural gas combustion these unit heaters are a source of GHG emissions for the facility.

Existing Equipment	Heating Capacity (BTUh)
UH-1 to UH-5	250,000

Proposed Measure:

The measure proposes replacing the existing Unit Heaters with new equivalent capacity electric models to significantly reduce GHG emissions.

Existing Equipment	Electric Heating Capacity (BTUh)
UH-1 to UH-5	250,000

Implementation and Non-Financial Considerations:

The measure is not expected to have any impact on occupant comfort or facility operations. Implementation of this measure is also not expected to impact operations.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A or B is recommended, based on the availability of BAS data and energy meter data.

5.1.7 ECM – Install Rooftop Solar PV System

Utility Savings	
Electricity (kWh)	400,000
Demand (kW)	0.0
Natural Gas (m^3)	0.0
GHG (tCO_2e)	33.8
GHG Baseline Reduction	9%
EUI Reduction (ekWh/m^2)	57.41
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$582,250
Engineering & PM	$115,750
Contingency	$58,225
Total Capital Cost	$756,225
Utility Savings	$60,000
Annual O&M	$5,115
Simple Payback	12.7
Net-Present Value	$410,923

Existing Conditions:

The MRC currently purchases all electricity from the Local Distribution Company.

Proposed Measure:

The property has significant opportunity to accommodate a large number of solar panels on its Southern rooftop. This measure recommends installing a behind-the-meter system of 340 kW DC solar PV panels to offset 400,000 kWh of facility consumption.

Proposed Measure	Installed Capacity (kW DC)	Estimated Generation (kWh)
Roof Mount Solar PV System	340	400,000

Under a behind-the-meter scenario the energy generated by the panels is consumed on-site, with no excess energy exported to the grid. The energy generated offsets energy which would have been purchased from the grid and reduces overall utility costs.

A Solar PV System of the size above is sufficient to provide approximately 90% of the average baseload for the facility after all decarbonization measures have been implemented. This maximizes the amount of useable energy while minimizing over-generation which may not be useable onsite.

Implementation and Non-Financial Considerations:

Implementing a roof mounted solar PV system requires suitable electrical approvals, structural assessments, and coordination with local utility and ESA standards. Construction may temporarily impact site access, but long-term disruption is minimal. Non-financial considerations include aesthetics and future roof-top use flexibility.

Measurement and Verification:

Renewable energy installations typically will meet IPMVP Option B M&V as independent metering of energy generation is commonly included with installation. This metering measures all energy generated, typically in real time, to allow for continuous monitoring and tracking of the Solar PV System's performance.

5.2 Goderich Wastewater Treatment Plant Recommended Measures

Aladaco is unable to provide incremental cost analysis under the WWTP Measure Level Analysis due to the absence of a BCA for the Goderich WWTP. Additionally, there are no incremental cost analysis under the GHG Reduction Pathway Analysis for the WWTP.

5.2.1 ECM – Thermostat Upgrades

Utility Savings	
Electricity (kWh)	20,371
Demand (kW)	0.0
Natural Gas (m^3)	2,597
GHG (tCO_2e)	6.7
GHG Baseline Reduction	19%
EUI Reduction ($ekWh/m^2$)	1.41
TEDI Reduction[1]	-66%

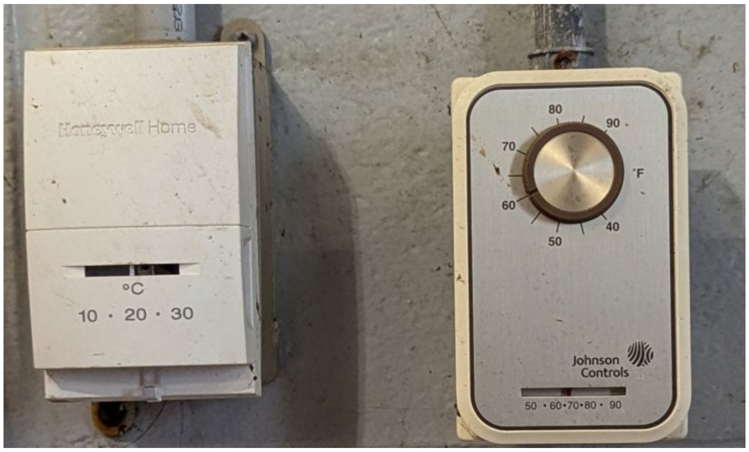
Financial Analysis	
Materials & Labour	$3,900
Engineering & PM	$-
Contingency	$390
Total Capital Cost	$4,290
Utility Savings	$5,119
Annual O&M	$510
Simple Payback	0.9
Net-Present Value	$97,464

<u>Existing Conditions:</u>

The heating equipment at the WWTP is controlled via wall-mounted manual thermostats. This includes the electric heaters in the Pumphouses, Office, and Chemical Room, as well as the natural gas radiant tube heaters in the Administration Building and Workshop. This type of HVAC control often leads to excessive heating during unoccupied periods. The manual nature of these controls also increases the risk of over-heating the space if they are inadvertently set at a higher temperature for long periods.

[1] Note that TEDI is increasing for this measure due to the Occupied temperatures enabled through increased controls will be higher than current settings for many areas. While occupied energy consumption is increased, overall energy is reduced due to the lower and extended unoccupied periods enabled through this measure.

Figure 20: WWTP Existing HVAC Controls



Proposed Measure:

The measure proposes replacing the existing manual thermostats with programmable thermostats. Thermostats outside of the normally occupied areas of the Control Room and the Chlorine Room will be equipped with occupancy sensors to further reduce energy consumption.

Thermostats with on-board occupancy sensors will be set to occupied temperatures when movement is detected and will maintain that set point for a period of 2 hours before reverting to the unoccupied set point.

Thermostats in normally occupied areas will be programmed to follow an occupancy schedule of Monday to Friday, 7:00 AM to 3:30 PM, with setback temperatures enabled for unoccupied periods.

Implementation and Non-Financial Considerations:

The implementation of this proposed measure is not expected to impact facility operations. After initial installation, the occupancy schedules can be adjusted as required to maintain staff comfort. If the unoccupied setbacks are maintained, these minor variations in settings will not have a significant impact on energy savings estimates.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A is recommended to keep M&V costs in line with savings estimates.

5.2.2 ECM – Electrification of the MAU

Utility Savings	
Electricity (kWh)	-1,535
Demand (kW)	-3.5
Natural Gas (m^3)	186
GHG (tCO_2e)	0.2
GHG Baseline Reduction	1%
EUI Reduction ($ekWh/m^2$)	0.01
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$29,344
Engineering & PM	$4,402
Contingency	$2,934
Total Capital Cost	$36,681
Utility Savings	-$523
Annual O&M	$1,500
Simple Payback	-73.0
Net-Present Value	-$69,316

Existing Conditions:

The MAU operates when the Belt Filter Press is in operation, providing fresh make-up air to the conditioned space. The make-up air is heated via natural gas combustion.

Existing Conditions	CFM	Heating Capacity (BTUh)
MAU-1	4,000	12,000

Proposed Measure:

The measure proposes replacing the existing MAU with a new model of equivalent capacity but equipped with an electric heating element to significantly reduce GHG emissions.

Proposed Measure	CFM	Electric Heating Capacity (BTUh)
MAU-1	4,000	12,000

Implementation and Non-Financial Considerations:

Installing the new MAU will have a minimal impact on operations. Due to the intermittent use of the MAU and the requirement for rapid heating of the outdoor air, a heat pump replacement for this unit is not appropriate to meet these operating criteria.

Measurement and Verification:

To measure the electrical energy savings IPMVP Option A or B is recommended, based on the availability of SCADA data and energy meter data.

5.2.3 ECM – Electrification of Tube Heaters

Utility Savings	
Electricity (kWh)	-36,278
Demand (kW)	-52.0
Natural Gas (m^3)	6,387
GHG (tCO_2e)	9.2
GHG Baseline Reduction	26%
EUI Reduction ($ekWh/m^2$)	0.94
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$124,476
Engineering & PM	$18,671
Contingency	$12,448
Total Capital Cost	$155,595
Utility Savings	-$3,254
Annual O&M	$-
Simple Payback	-47.8
Net-Present Value	-$190,014

Existing Conditions:

The majority of the Administration Building is heated via natural gas radiant tube heaters. These heaters, while an efficient means of heating the space, are a significant source of GHG emissions.

Location	Radiant Tube Heating Capacity (BTUh)
Control Room	80,000
Locker Room	40,000
Truck Bay	80,000
Filter Press Room	80,000
Workshop	80,000
Chlorine Room	80,000

Proposed Measure:

The measure proposes replacing the existing radiant tube heaters with mini-split heat pumps with electric backup heating. The mini-split heat pumps will operate at outdoor air temperatures above 2° C and the electric heating will supply heat at lower temperatures, ensuring the interior temperature is consistently maintained.

Location	Heat Pump Capacity (BTUh)	Supplementary Electric Capacity (BTUh)
Control Room	60,000	80,000
Locker Room	30,000	40,000
Truck Bay	60,000	80,000
Filter Press Room	60,000	80,000
Workshop	60,000	80,000
Chlorine Room	60,000	80,000

Implementation and Non-Financial Considerations:

Installation costs include penetration to the building envelope to accommodate the new systems. The actual placement of the interior fan coil units will differ from the current heating system as the interior fan coil units will be limited in the distance away from the exterior units they can be located.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A is recommended to keep M&V costs in line with savings estimates.

5.2.4 ECM – Reduce Exhaust Area for Filter Press

Utility Savings	
Electricity (kWh)	7,023
Demand (kW)	9.7
Natural Gas (m^3)	0
GHG (tCO_2e)	0.6
GHG Baseline Reduction	2%
EUI Reduction ($ekWh/m^2$)	0.21
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$2,135
Engineering & PM	$320
Contingency	$213
Total Capital Cost	$2,668
Utility Savings	$1,218
Annual O&M	$1,020
Simple Payback	3.0
Net-Present Value	$1,256

Existing Conditions:

The WWTP's Belt Filter Press is located in the rear workshop area of the Main Building. When the Belt Filter Press operates, the ACA Exhaust unit operates at high speed, and the MUA provides make-up fresh air. This fresh air requires heating during the winter months, increasing the amount of fossil fuels consumed on-site. When the Belt Filter Press is not operating, the ACA Exhaust runs continuously at low speed. In the current configuration, the total area exhausted by the ACA Exhaust is 40,150 ft^3.

Existing Conditions	CFM	Motor HP	Air Changes per Hour
ACA Exhaust High Speed	48,000	20	71
ACA Exhaust Low Speed	24,000	5	35

Proposed Measure:

The measure proposes reducing the total area exhausted by the ACA Exhaust through the installation of a vinyl strip curtain wall. The curtain wall will reduce the exhaust area to approximately 15,000 ft^3, allowing for lower exhaust ventilation and heating requirements.

Operating the ACA Exhaust at low speed provides sufficient ventilation to achieve the same number of air changes within the reduced workshop area as is currently achieved with the high-speed operation.

Proposed Measure	CFM	Motor HP	Air Changes
ACA Exhaust Low Speed	24,000	5	97

Implementation and Non-Financial Considerations:

Installing the vinyl curtain wall should not result in any significant changes in operations for the WWTP and the implementation of the measure could occur at any time. It is however recommended that the HVAC replacements take place during the summer months to minimize the heat loss from the interior space.

Access to all areas of the Belt Filt Press will be maintained and the flexible nature of the curtain wall will ensure that maintenance or other modifications to the Belt Filter Press or other equipment in the area remains feasible.

On-going cleaning of the curtain wall will be required as soiling is expected during normal operation of the Blet Filter Press. Installing a PVC or Vinyl material curtain allows site staff to utilize existing power washers to clean the curtain the wall.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A or B is recommended, based on the availability of SCADA data and energy meter data.

5.2.5 ECM – Install Aeration Blower

Utility Savings	
Electricity (kWh)	88,936
Demand (kW)	10.2
Natural Gas (m^3)	0
GHG (tCO_2e)	7.5
GHG Baseline Reduction	21%
EUI Reduction (ekWh/m^2)	2.61
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$212,749
Engineering & PM	$31,912
Contingency	$21,275
Total Capital Cost	$265,936
Utility Savings	$15,425
Annual O&M	$3,400
Simple Payback	17.5
Net-Present Value	-$49,307

<u>Existing Conditions:</u>

Aeration tanks at the WWTP utilize mechanical surface aerators to provide the required oxygen for the wastewater treatment process. These aerators operate at either Fast or Slow speed, depending on the requirements of the facility. Each mechanical aerator uses a gearbox to reduce the RPMs of the impellers. Based on motor RPM and gearbox ratio, the existing units can be classified as low-speed aerators.

Existing Conditions	Motor HP	Metered Input kW	Transfer Rate (lb O_2/HP*h)
Aerator No.3 – Low Speed	8.4	5.8	2.5
Aerator No.4 – Low Speed	8.4	5.8	2.5
Aerator No.5 – Low Speed	8.4	5.8	2.5
Aerator No.6 – Low Speed	8.4	5.8	2.5
Aerator No.7 – Low Speed	8.4	5.8	2.5
Aerator No.8 – Low Speed	8.4	5.8	2.5
Aerator No.3 – High Speed	15	8.9	3.5
Aerator No.4 – High Speed	15	8.9	3.5

Aerator No.5 – High Speed	15	8.9	3.5
Aerator No.6 – High Speed	15	8.9	3.5
Aerator No.7 – High Speed	15	8.9	3.5
Aerator No.8 – High Speed	15	8.9	3.5

Proposed Measure:

Replace the surface aerators with one (1) variable speed turbo aeration blower. The blower can be installed within the existing blower building, with underground piping delivering air to the aeration tanks via fine bubble tube diffusers installed at the bottom of each tank.

Proposed Measure	Power (kW)	Flow Rate (Nm^3/hr)	Transfer Rate (lb O_2/HP*h)
Variable Speed Aeration Blower	27.6	7.5	29.1

Implementation and Non-Financial Considerations:

Implementation of this measure will require significant impact to site operations and as such will need to be carefully staged in consultation with facility operators. The turbo blower can be installed with minimal impacts to operations, as can the underground piping. The piping, however, should be installed during the summer months to reduce installation costs. Care will need to be taken to ensure installation does not damage existing underground piping. To reduce the risk of damaging existing infrastructure, the proposed new piping will be installed on the West side of the aeration tanks (see Appendix D: Schematics). When installing the diffuser tubes within the aeration tanks, the tanks will need to be drained and cleaned. This should be scheduled during periods of low flow and may require the use of the plant's overflow holding tanks to allow for this work to occur. The installation of the diffuser tanks is recommended to occur one tank at a time to reduce the impacts to the plant's capacity.

The Town of Goderich may elect to maintain the existing surface aerators as a back-up system should the new Turbo Blower require repairs or maintenance.

Measurement and Verification:

IPMVP Option B is recommended for verifying the energy savings for this measure due to the availability of SCADA and energy metering data for the current conditions. The proposed measure's energy consumption can be recorded using the on-board VFD controller for a direct comparison of energy usage.

5.2.6 ECM – Install Ground Mount Solar PV System 260 kW DC

Utility Savings	
Electricity (kWh)	300,000
Demand (kW)	0.0
Natural Gas (m^3)	0
GHG (tCO_2e)	25.3
GHG Baseline Reduction	72%
EUI Reduction (ekWh/m^2)	8.80
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$497,250
Engineering & PM	$98,750
Contingency	$49,725
Total Capital Cost	$645,725
Utility Savings	$48,000
Annual O&M	$3,900
Simple Payback	13.5
Net-Present Value	$228,373

Existing Conditions:

The WWTP currently purchases all electricity from the Local Distribution Company.

Proposed Measure:

The property has significant opportunity to accommodate a large number of solar panels. On the Northen and Western sides of the facility are large areas of open land that could be used for electricity generation via ground mounted solar panels. This measure recommends installing a net-metered system of 260 kW DC solar PV panels to offset 300,000 kWh of facility consumption.

Proposed Measure	Installed Capacity (kW DC)	Estimated Generation (kWh)
Ground Mount Solar PV System	260	300,000

Under a net-metering scenario the energy generated by the panels is sent to the distribution system for a credit towards electricity costs. Excess generation credits can be carried forward to offset future electricity costs for a period of up to 12 months.

A Solar PV System of the size above is sufficient to offset 90% of the remaining electricity loads after all decarbonizing measures have been implemented.

Implementation and Non-Financial Considerations:

Implementing a ground-mounted solar PV system requires suitable land, zoning and electrical approvals, and coordination with utility interconnection standards.

Construction may temporarily impact site access, but long-term disruption is minimal. Non-financial considerations include aesthetics and future land use flexibility.

Measurement and Verification:

Net-metered renewable energy installations will meet IPMVP Option B M&V requirements as they will be independently metered by the distribution company. Generation data is commonly provided on a monthly basis.

5.2.7 ECM – Install Ground Mount Solar PV System 510 kW DC

Utility Savings	
Electricity (kWh)	600,000
Demand (kW)	0.0
Natural Gas (m^3)	0
GHG (tCO_2e)	50.6
GHG Baseline Reduction	144%
EUI Reduction ($ekWh/m^2$)	17.60
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$975,375
Engineering & PM	$193,125
Contingency	$97,538
Total Capital Cost	$1,266,038
Utility Savings	$96,000
Annual O&M	$7,650
Simple Payback	13.3
Net-Present Value	$485,131

Existing Conditions:

The WWTP currently purchases all electricity from the Local Distribution Company.

Proposed Measure:

The property has significant opportunity to accommodate a large number of solar panels. On the Northen and Western sides of the facility are large areas of open land that could be used for electricity generation via ground mounted solar panels. This measure recommends installing a net-metered system of 510 kW DC solar PV panels to offset 600,000 kWh of facility consumption.

Proposed Measure	Installed Capacity (kW DC)	Estimated Generation (kWh)
Ground Mount Solar PV System	510	600,000

Under a net-metering scenario the energy generated by the panels is sent to the distribution system for a credit towards electricity costs. Excess generation credits can be carried forward to offset future electricity costs for a period of up to 12 months.

A Solar PV System of the size above is sufficient to offset 90% of the remaining electricity loads after all decarbonizing measures have been implemented.

Implementation and Non-Financial Considerations:

Implementing a ground-mounted solar PV system requires suitable land, zoning and electrical approvals, and coordination with utility interconnection standards. Construction may temporarily impact site access, but long-term disruption is minimal. Non-financial considerations include aesthetics and future land use flexibility.

Measurement and Verification:

Net-metered renewable energy installations will meet IPMVP Option B M&V requirements as they will be independently metered by the distribution company. Generation data is commonly provided on a monthly basis.

5.2.8 Low or No-Cost Additional Recommendations

The following recommendations are considered low- or no-cost measures and have not been quantified through energy modeling. While their energy savings may be minimal or difficult to measure, they are expected to contribute positively to overall energy performance. These actions typically involve operational adjustments, minor equipment improvements, or behavioral changes that require little to no capital investment. Due to their low implementation cost and potential to support broader energy management efforts, they are recommended as practical steps to enhance efficiency. Even if the impact is small, these measures often help reinforce a culture of energy awareness and can complement larger retrofit initiatives.

5.2.8.1 Truckway Isolation

Located in the workshop of the Administration Building is a bay door that allows vehicle access for the removal of bio-solids from the facility. The area where the vehicles park for loading is referred to as the Truckway.

During the site visit it was noted that there are two doors between the Truckway and the main workshop area. One of these doors, a self-closing standard door, remains closed at all times. While the other, a sliding door that spans from floor to ceiling, remains open.

It is suggested that site staff close this door permanently and only allow access to the Truckway through the self-closing standard door. This will reduce the amount of outside air that enters the main workshop area when the garage bay door is open and will reduce the heating requirements for this space.

5.2.8.2 Truckway Bay Door Heating Lockout

When vehicles enter the Administration Building through the Truckway bay door, a substantial amount of heat energy escapes to the outside environment. This heat loss becomes even more significant if the bay door remains open while the heating system continues to operate, leading to unnecessary energy consumption and increased operating costs. To address this issue, it is recommended that a simple lockout control be installed to link the bay door with the heating system. This control would prevent the heating system from operating when the door is open, thereby avoiding wasteful heating during periods of exposure. This low-cost measure offers an effective way to reduce energy losses and improve the overall efficiency of the space with minimal investment.

5.3 Energy modelling approach

Building energy simulations were prepared for the Maitland Recreation Centre, located in Goderich, Ontario using eQuest, a DOE-2 driven software that has been tested according to ANSI/ASHRAE Standard 140-2017 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs. The Proposed design energy model reflects most up to date drawings provided combined with information gathered from an on-site walkthrough of the building and systems.

Energy Modeling Software and Notes:

- eQuest v3.65 Build 7173 – DOE 2.2
- All building components and loads have been considered, including building envelope, heating, ventilation and air conditioning systems and plant, service and domestic water heating, lighting and miscellaneous plug loads.
- The results shown are based on the output of the hourly energy simulation software and are reflective of the modelling assumptions and design parameters listed throughout this report.
- While the work was performed with reasonable care and in accordance with the latest professional standards, the actual energy use of the building will differ based on various factors that influence the actual energy cost of the building including but not limited to: weather, variations in occupancy, workmanship, depreciation of the thermal resistance of building materials, occupant and operator behaviour, and building operation.

Documents Referenced:

- Architectural Drawings: 1981-2006, 2024 Site Visit Data
- Mechanical Drawings: 1981-2006, 2024 Site Visit Data
- Electrical Drawings: 1981-2006, 2024 Site Visit Data

For Simulation Inputs, Parameters used, and Simulation Results, please see Appendix G: Energy Model Documentation.

5.4 Embodied Carbon Impacts

Embodied carbon refers to the greenhouse gas emissions released during the production, transport, installation, maintenance, and disposal of building materials and systems. Unlike operational carbon, which is tied to a building's energy use, embodied carbon is "locked in" once construction or retrofit work is complete. As buildings become more energy efficient and grids decarbonize, embodied carbon makes up a growing share of total lifecycle emissions, making it a critical consideration in deep retrofits and long-term climate strategies. The following describes the impacts on Embodied Carbon in relation to the deep retrofit measures recommended within this report.

Window Glass Replacement Measures

These recommended measures propose the replacement of the existing double-glazed glass with a high-performance triple-glazed system. The new systems will significantly enhance thermal performance, reduce heating and cooling loads, and improve occupant comfort. Beyond operational energy savings, this upgrade will also involve a one-time increase in embodied carbon due to the manufacture and transport of new glazing units and framing materials, and the disposal of existing components.

Embodied carbon associated with the triple-glazed glass and curtain walls was estimated using benchmark values from the Building Transparency Organization's Embodied Carbon in Construction Calculator's database of Environmental Product Declarations (Building Transparency, 2024). Based on these sources:

- Double-glazed Exterior Glass systems typically have an embodied carbon intensity of approximately 98.5 kg CO_2e/m^2 of façade area.
- Triple-glazed Exterior Glass systems with improved thermal breaks range average 164 kg CO_2e/m^2

To illustrate, a placement of approximately 150 m^2 of curtain wall (approximate size of the pool exterior glass at the MRC) translates to:

- Baseline embodied carbon: ~14,775 kg CO_2e
- Proposed system: ~24,600 kg CO_2e
- Net increase: ~9,825 kg CO_2e

While the proposed curtain wall retrofit introduces an initial increase in embodied carbon, this is fully offset within the operational life of the asset through improved thermal performance. Continued energy savings over the lifespan of the system provide a strong net carbon benefit and align with long-term decarbonization goals.

Heat Pump Installation Measures

Facilities currently use conventional natural gas-fired HVAC systems for a significant portion of space heating, typically relying on mid-efficiency furnaces or boilers. Recommended measures propose replacing these fossil fuel-based systems with electric air-source heat pumps (ASHPs), which offer high-efficiency performance—often exceeding 100% due to their ability to transfer rather than generate heat. This transition is expected to significantly reduce operational greenhouse gas (GHG) emissions, particularly when powered by relatively clean electricity grid.

In retrofits aiming to decarbonize HVAC systems, the embodied carbon difference between keeping a gas-fired unit vs. installing a new electric heat pump unit is relatively small. Conventional rooftop MAUs, HRVs, and dehumidifiers all carry an upfront carbon footprint largely influenced by the quantity of steel, aluminum, and other materials used in manufacturing. Replacing a gas burner with a heat pump or electric heater does not drastically change the manufacturing emissions – it may add slightly to the complexity (and thus a few hundred extra kg CO_2e at most), but the magnitude remains in the same range (Santos, 2023). For instance, a large heat recovery unit's embodied carbon is ~24 tons CO_2e whether it's paired with a gas furnace or an electric coil (IVL Swedish Environmental Research Institute, 2024).

From a climate perspective, this means the Town of Goderich owners can pursue electrification for operational carbon reduction without worrying about a significant "embodied carbon penalty." The embodied carbon of the new electric HVAC equipment will typically be paid back in operational savings (emissions avoided by not burning gas) in just a few years of use (Finnegan, Jones, & Sharples, 2018). It is still important to source equipment with Environmental Product Declarations when possible, to accurately account for these impacts. In North American cold climates, manufacturers are beginning to provide EPDs which will improve the data available.

In summary, commercial heat pump systems offer major operational CO_2 reductions with only minimal embodied carbon differences compared to conventional gas units, making them an attractive choice for low-carbon retrofits.

6. GHG Reduction Pathway Capital Plan

This section summarizes the results from the GHG reduction pathway analysis, illustrating a strategic plan for achieving the Town's emission reduction goals. Three pathways were developed, each detailing a sequence of energy conservation measures (ECMs) and capital replacements, with differing levels of GHG reductions and investment timelines.

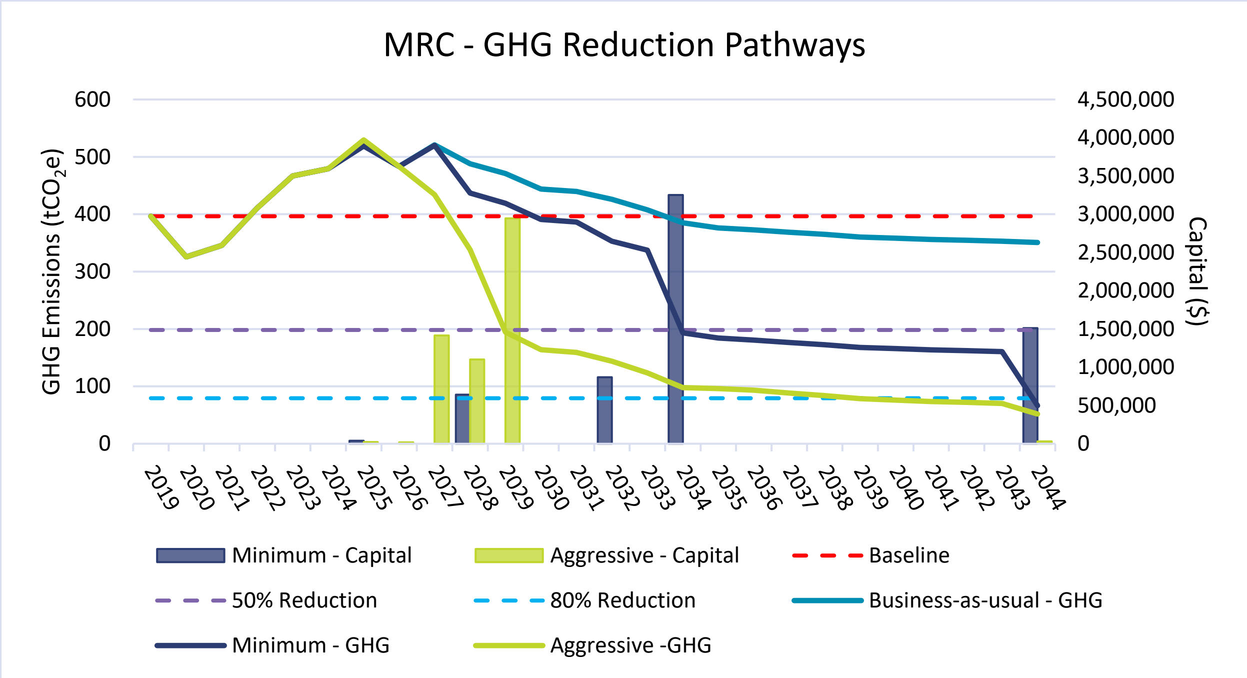
Pathways Analyzed:

- **Minimum Performance Scenario:**
    - Achieves at least **50% GHG reduction by year 10**.
    - Achieves at least **80% GHG reduction by year 20**.
    - Balances incremental investment over a longer time frame.
- **Aggressive Dep Retrofit Scenario:**
    - Accelerates implementation timeline significantly.
    - Achieves **50% GHG reduction within 5 years**.
    - Meets or exceeds **80% GHG reduction by year 20**.
    - Front-loads investments for quicker GHG reductions.
- **Business-As-Usual Scenario (BAU):**
    - Reflects "like-for-similar" equipment replacements without targeted emission reductions.
    - Serves as a baseline for comparing emission impacts and capital investments.

Additional analyses of these pathways can be found in Appendix F: Sensitivity Analysis, where key variables such as the Carbon Tax, grid emissions factors, and future weather impacts are investigated.

6.1 MRC Pathway Analyses

Figure 21: MRC Pathways Results



The table below summarizes the key financial and GHG-related outcomes of each pathway over the 20-year analysis period:

Table 9: MRC Pathways Results

Metric	Minimum Performance	Aggressive Deep Retrofit	Business As Usual
Capital Cost	$6,313,490	$5,532,788	$2,208,394
External Funding	$1,294,266	$1,383,197	-
BAU Avoided Costs	$2,208,394	$2,208,394	
Residual Value at Study End	$1,757,764	$707,148	$397,994
Incremental Costs	$2,810,831	$1,941,196	-
Operating Costs	$11,572,724	$11,725,763	$10,472,299
5-year GHG Reduction (tCO2e)	-23 (-5.7%)	**202 (50.9%)**	
10-year GHG Reduction (tCO_2e)	**203 (51.3%)**	299 (75.3%)	
20-year GHG Reduction (tCO_2e)	**330 (83.3%)**	**345 (86.9%)**	
Incremental LC Cost (20-year)	$2,551,485	$2,885,506	-
Cost per tonne CO2e abated ($ILCC/$tCO_2e$)	$386	$419	-

- **Capital Cost:** Refers to the initial expenditure required to acquire, construct, or set up an asset or project, such as buildings, equipment, or infrastructure. It includes all costs associated with the development or purchase, excluding ongoing operational or maintenance expenses.
- **BAU Avoided Costs:** The avoided costs from the Business-As-Usual capital renewal plan from the selection of alternative replacements.
- **Residual Value:** Residual value is the estimated amount that an asset is worth at the end of its useful life, after accounting for depreciation or wear and tear.
- **Incremental Costs:** The increase or decrease in the cost of construction, relative to the baseline costs outlined by the facility BCA.
- **Incremental Lifecycle (LC) Cost:** Incremental life cycle cost refers to the additional costs incurred when comparing two or more alternatives over their entire lifespan. It includes the extra costs of owning, operating and maintaining one option versus another, helping to evaluate the financial impact of choosing a particular solution or investment over time.
- **Cost per tonne CO_2e abated ($ILCC/t$CO_2e$):** Incremental cost per tonne of carbon abated refers to the additional cost incurred to reduce one tonne of carbon dioxide (or its equivalent) emissions through a specific mitigation measure or pathway.

Recommended ECM Comparison Matrix

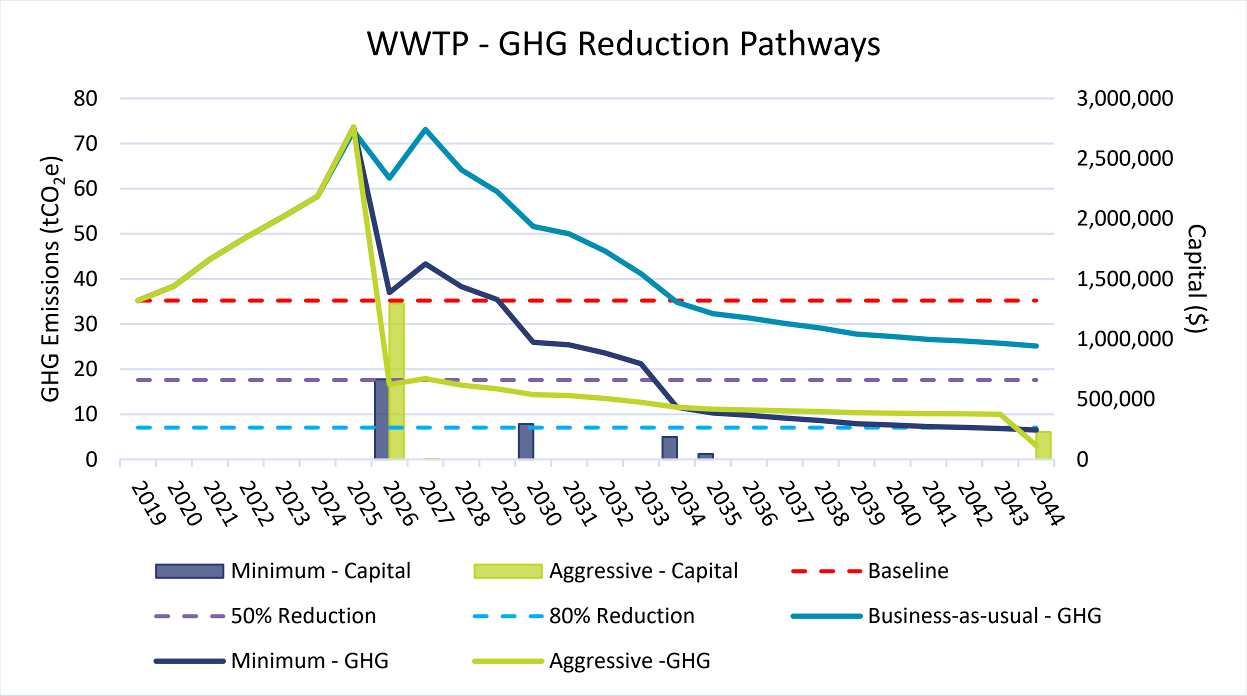
The following matrix summarizes the recommended energy conservation measures and indicates their year of implementation for each of the GHG reduction pathways.

Table 10: MRC Recommended ECMs

ECM Description	Year of Implementation	
	Minimum Performance	Aggressive Deep Retrofit
Recommissioning of the Geothermal Systems	2025	2025
Recommissioning of the BAS and Related Systems	2025	2026
Electrification of HRU's and MAU	2028	2027
Electrification of Unit Heaters	-	2044
Install Rooftop Solar PV System	2032	2027
Install Water-Source Heat Pump Boilers	2034	2029
Electrification of DH3	2044	2028

6.2 WWTP Pathway Analyses

Figure 22: WWTP Pathways Results



The table below summarizes the key financial and GHG-related outcomes of each pathway over the 20-year analysis period:

Table 11: WWTP Pathways Results

Metric	Minimum Performance	Aggressive Deep Retrofit	Business As Usual*
Capital Cost	$1,190,016	$1,525,183	-
External Funding	$297,504	$381,296	-
Residual Value at Study End	$162,161	$116,042	-
Operating Costs	$1,733,395	$679,080	$2,836,827
20-Year Operational Cost Savings	$1,103,432	$2,157,747	-
20-Year LCC	$2,463,747	$1,706,924	-
5-year GHG Reduction (tCO_2e)	0 (-0.6%)	**20 (55.5%)**	-
10-year GHG Reduction (tCO_2e)	**24 (67.1%)**	24 (67.2%)	-
20-year GHG Reduction (tCO_2e)	**29 (81.5%)**	**32 (91.3%)**	-

*Aladaco is unable to provide incremental cost analysis under the GHG Reduction Pathway Analysis due to the absence of a BCA for the Goderich WWTP.

- **Capital Cost:** Refers to the initial expenditure required to acquire, construct, or set up an asset or project, such as buildings, equipment, or infrastructure. It includes all costs associated with the development or purchase, excluding ongoing operational or maintenance expenses.
- **Residual Value:** Residual value is the estimated amount that an asset is worth at the end of its useful life, after accounting for depreciation.
- **20-Year Operational Cost Savings:** The operational cost savings between the business-as-usual scenario and the GHG Reduction Pathway over the 20-year study period.
- **20-Year Life-Cycle Cost (LCC):** The combined 20-year cost off the GHG Reduction Pathways, accounting for capital costs, operating costs, external funding, and residual value.

Recommended ECM Comparison Matrix

The following matrix summarizes the recommended energy conservation measures and indicates their year of implementation for each of the GHG reduction pathways.

Table 12: WWTP Recommended ECMs

ECM Description	Year of Implementation	
	Minimum Performance	Aggressive Deep Retrofit
Thermostat Upgrades	2026	2026
Reduce Exhaust Area for Filter Press	2026	2027
Install 260 kW Ground Mount Solar PV System	2026	-
Install 510 kW Ground Mount Solar PV System	-	2026
Install Aeration Blower	2030	-
Electrification of Tube Heaters	2034	2044
Electrification of the MAU	2035	-

6.3 Recommended Pathways for Implementation

6.3.1 Maitland Recreation Centre

The Minimum Performance Pathway is recommended for implementation at the MRC. This scenario more closely aligns energy upgrades and decarbonization measures with the natural replacement cycles of existing building systems, reducing disruption to facility operations and minimizing additional capital expenditures. By coordinating project timing with the lifecycle of key equipment, the Town can effectively balance infrastructure renewal with targeted emissions reductions.

Benchmarking analysis indicates that the MRC currently operates above median energy-use intensities for similar recreation facilities, primarily due to its year-round ice rink operations and related mechanical systems. Recognizing this, the Minimum Performance Pathway prioritizes cost-effective electrification of existing heating loads through measures such as the phased installation of air-source heat pumps, leveraging and optimizing the existing geothermal infrastructure, and electrifying water heaters with water-source heat pumps. Geothermal system recommissioning is a critical early step in this pathway, ensuring the geothermal field's capacity is fully assessed and optimized to maximize the efficiency and effectiveness of subsequent retrofit measures.

Financially, the Minimum Performance scenario offers a notably lower incremental lifecycle cost ($2,551,485 over 20 years) compared to the Aggressive Deep Retrofit scenario ($2,885,506), and importantly, results in a more moderate impact on operating costs—an essential consideration given the anticipated operational cost increases from transitioning heating equipment from natural gas to electricity.

Overall, the Minimum Performance Pathway effectively meets the Town's targeted 80% emissions reduction by 2045, achieves cost-effective asset renewal, and delivers significant GHG reductions without incurring unnecessary financial strain or operational disruption.

Table 13: MRC Modelled Pathway Consumption Results

Modelled Pathways Results	Electricity (kWh)	Natural Gas (m^3)	tCO_2e
Minimum Performance Scenario (Recommended)	2,950,552	7,380	66.4
Aggressive Deep Retrofit Scenario	2,925,143	0	51.8

6.3.2 Wastewater Treatment Plant

The Aggressive Deep Retrofit Pathway is recommended for implementation at the Goderich Wastewater Treatment Plant. Unlike the Maitland Recreation Centre, benchmarking indicates that the WWTP currently operates more efficiently than typical Ontario wastewater facilities, with an energy use intensity significantly below the provincial average. However, the plant's operational profile, dominated by electricity consumption, provides substantial opportunities for achieving both deep GHG reductions and notable operational cost savings through early and aggressive energy efficiency improvements and renewable energy integration.

Central to this pathway is the installation of a large-scale ground-mounted solar PV system, which substantially reduces purchased electricity and associated emissions, directly translating to reduced operational expenses. Additional measures include electrification of existing natural gas-fired heating systems through air-source heat pumps and targeted efficiency improvements to high-energy-consuming process equipment. These combined measures yield substantial operational savings of approximately $2.16 million over the 20-year study period, significantly greater than the savings ($1.1 million) projected under the Minimum Performance scenario.

Although this aggressive approach requires higher upfront capital investment, it substantially decreases annual operating expenses, resulting in a lower total lifecycle cost over 20 years ($1,706,924) compared to the Minimum Performance scenario ($2,463,747). Additionally, proactively addressing emissions reductions through comprehensive electrification and renewable generation positions the WWTP for future operational resilience and reduced exposure to volatility in energy markets.

Ultimately, the Aggressive Deep Retrofit Pathway aligns strongly with the Town's emissions reduction objectives, leverages the WWTP's operational characteristics for maximum efficiency gains, and delivers robust long-term financial and environmental benefits.

Table 14: WWTP Modelled Pathway Consumption Results

Modelled Pathways Results	Electricity (kWh)	Natural Gas (m^3)	tCO_2e
Minimum Performance Scenario	367,467	0	6.5
Aggressive Deep Retrofit Scenario (Recommended)	155,183	164	3.1

7. Demand Forecasts

7.1 Maitland Recreation Centre

The MRC electrical supply is provided via a pad mounted 3-phase transformer with a capacity of 835 MVA. The main disconnect is rated for 1600 A at 600 V, resulting in a panel capacity of 960 kW. Based on the modelled forecast of future facility peak demand there is sufficient capacity at the MRC to support the implementation of either of the proposed GHG Reduction Pathways.

Table 15: MRC Current and Future Demand Forecasts

GHG Reduction Pathway	Current Peak Demand	Future Peak Demand	Required Additional Capacity
Minimum Performance Scenario	356 kW	605 kW	None
Aggressive Deep Retrofit Scenario	356 kW	610 kW	None

7.2 Wastewater Treatment Plant

The WWTP main disconnect is rated for 400 A at 600 V, resulting in a panel capacity of 240 kW. Based on the modelled forecast of future facility peak demand there is sufficient capacity at the WWTP to support the implementation of either of the proposed GHG Reduction Pathways.

Table 16: WWTP Current and Future Demand Forecasts

GHG Reduction Pathway	Current Peak Demand	Future Peak Demand	Required Additional Capacity
Minimum Performance Scenario	145 kW	223 kW	None
Aggressive Deep Retrofit Scenario	145 kW	230 kW	None

8. Conclusion

This GHG Reduction Feasibility Study has provided the Town of Goderich with comprehensive, actionable strategies to significantly reduce emissions from the Maitland Recreation Centre and the Goderich Wastewater Treatment Plant. Guided by clear emissions reduction targets aligned with the Federation of Canadian Municipalities' Community Buildings Retrofit initiative, the study identified technically viable and financially feasible pathways tailored to the distinct operational characteristics and opportunities present at each facility.

The two main scenarios analyzed—Minimum Performance and Aggressive Deep Retrofit—each meet or exceed the targeted 80% emissions reduction by 2045. The study incorporated thorough benchmarking analyses, which showed that the MRC currently operates above median energy-use intensities for comparable recreation facilities, primarily due to its year-round arena operations. Conversely, the WWTP was found to be operating significantly more efficiently than provincial benchmarks, highlighting unique opportunities for operational savings.

For the MRC, the recommended Minimum Performance Pathway prioritizes a phased electrification approach. By strategically sequencing decarbonization measures such as geothermal system recommissioning, water-source heat pumps, and air-source heat pumps to more closely align with planned equipment renewal timelines, this pathway spreads capital investments over a longer period, effectively managing upfront costs and moderating operational impacts associated with the transition from natural gas to electric heating equipment.

At the WWTP, the recommended Aggressive Deep Retrofit Pathway maximizes operational cost savings and emissions reductions through immediate investments in renewable energy generation and efficiency improvements. The installation of a large-scale ground-mounted solar PV system, complemented by targeted efficiency measures, and electrification of heating loads, significantly reduces purchased electricity. This scenario generates approximately $2.16 million in operational cost savings over 20 years, providing both environmental and financial benefits to the Town.

Both recommended pathways underscore the importance of aligning retrofit strategies with asset lifecycle planning, operational resilience, and fiscal responsibility. By proactively securing external funding, the Town can help to offset upfront capital expenses and enhance project feasibility.

Aladaco sincerely appreciates the active participation and valuable contributions of Town staff throughout this process. Their insight, operational expertise, and collaborative spirit were instrumental in shaping realistic, implementable solutions. Additionally, we extend our thanks to the Goderich Town Council for the opportunity to present these findings and for their ongoing commitment to sustainability and climate leadership. This study provides a clear foundation for informed decision-making and effective progress toward achieving the Town's long-term climate and sustainability objectives.

Appendices

Appendix A: Design Workshop Summary Report

ALADACO | Powering Progress with Sustainable Solutions

DESIGN WORKSHOP SUMMARY REPORT

Prepared for The Town of Goderich

GHG Reduction Pathways Feasibility Study

Date: March 10, 2025

ALADACO CONSULTING INC.

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Table of Figures

1. Introduction

This Design Workshop Summary Report is intended to provide the Town of Goderich (Goderich) with a summary of the outcomes from the recently completed Design Workshop for their GHG Reduction Pathways Feasibility Study project funded through the Federation of Canadian Municipalities Green Municipal Fund. This Report will also provide a summary of the completed site investigations and energy modelling efforts completed to date.

Included within the Appendix of this document are copies of the PowerPoint presentation slides developed by Aladaco Consulting Inc. (Aladaco) to conduct the Design Workshops.

2. Project Timeline

Below is a summary of the project milestones as described within Aladaco's RFP response for the GHG Reduction Pathways Feasibility Study. To date the Site Investigations, Energy Model, and Design Workshop phases of the project have been completed. The expected completion dates for the remaining milestones are indicated in the table. For further details on specifics of each milestone, please refer to the Study Review Process slide within Appendix: PPT Presentations.

Table 1 Project Timeline

Project Milestone	Timeline for Completion
Site Investigations	Complete
Energy Modelling	Complete (see section 4 Energy Modelling)
Design Workshop	Complete
Measure Level Analysis	February to April, 2025
Scenario Development	April to May, 2025
Decision Making Workshop	May, 2025
Final GHG Reduction Pathway Feasibility Study Report and Presentation	August 2025

3. Site Investigations

On October 29th, 2024, Aladaco's site investigator, Sean Pittman, P.Eng, CEM, CMVP, CBCP, met with Town of Goderich site staff at the Maitland Recreation Centre (MRC, 190 Suncoast Dr E, Goderich) to conduct the on-site investigation portion of this project.

The investigation began with a meeting attended by Sean Pittman (Aladaco) and Goderich Staff including Jessica Clapp - Project Lead, Greg Morningstar - Recreation Facilities Supervisor, and Kyle Williams - Community Services and Operations Manager. The meeting outlined the project scope and objectives, the data and documentation received to date, facilitated discussions on on-going operational and maintenance items, as well as the facility operational parameters. Following the meeting Aladaco was provided access to all areas of the facility to document existing equipment and assess facility systems such as: the building envelope, mechanical and electrical systems, internal loads, building schedules, and potential for renewable energy systems.

Similarly, an on-site investigation was conducted at the Wastewater Treatment Plant (WWTP, 211 Sunset Dr, Goderich) on October 30, 2024. A meeting held at this location was attended by Sean Pittman (Aladaco), Jessica Clapp - Project Lead (Goderich), and Steve Johnston (Veolia Water Canada), prior to conducting the on-site documentation portion of the investigation.

In addition to the on-site portion of the Site Investigations, Aladaco has also completed a full review of all available facility drawings, operation and maintenance records, and building condition assessments provided by the Town of Goderich. We have also completed a review and analysis of facility utility data from 2021 to 2023.

4. Energy Modelling

Detailed energy models were developed for each facility to assess facility energy consumption. These models will also be used to inform measure level analysis when determining existing and retrofit case consumption. In accordance with GMF Study Guidance, the models were calibrated following ASHRAE 14 standards, and a calibration report will be provided with the Final Report.

The models captured all key building characteristics and systems impacting energy use and emissions, including:

- Building orientation and envelope components
- Hydronic, HVAC, and dehumidification systems
- Electrical systems, lighting, and plug loads
- Refrigeration plants and associated equipment
- Automation, control, and heat recovery systems
- Process equipment and renewable energy generation

For systems not accurately represented within the energy modeling software (e.g., wastewater aeration blowers), separate analyses were conducted in Excel and integrated into the results. If required, these supplementary analyses can be provided along with the energy model files.

Energy models will continue to be refined and developed throughout the study process, with finalized calibration reports and model files delivered with the Final Report.

5. Design Workshop

On February 5, 2025, Aladaco conducted Design Workshops for each of the facilities. The in-person workshops took place at the Town of Goderich offices located at 57 West St, Goderich. The intent of the Design Workshops was to gather all relevant stakeholders to review preliminary decarbonization measures and their feasibility, while also encouraging engagement and discussion on the challenges and opportunities at each facility.

Please refer to Appendix: PPT Presentations for more details.

5.1. Workshop Attendees

The following personnel attended and participated in the Design Workshops.

Table 2 Workshop Attendees

Stakeholders	Organization	Title
Jessica Clapp	Town of Goderich	Asset Management and Environmental Services Coordinator (Goderich Project Lead)
Janice Hallahan	Town of Goderich	Chief Administrative Officer
Deanna Hastie	Town of Goderich	Director of Corporate Services/Treasurer
Sean Thomas	Town of Goderich	Director of Community Services, Infrastructure, and Operations
Kyle Williams	Town of Goderich	Community Services and Operations Manager
Greg Morningstar	Town of Goderich	Recreation Facilities Supervisor
Steve Johnston	Veolia Water Canada	Assistant Project Manager
Sean Pittman	Aladaco Consulting Inc.	Conservation & Energy Management Lead (Aladaco Project Lead)
Taylor Wilson	Aladaco Consulting Inc.	Technical Lead – Energy & Carbon Management
Jeremiah Heffernan	HEMCon Energy Modeling Solutions	Founder, Principal Energy Analyst

5.2. Decarbonization Measure Selections

One of the primary goals of the Design Workshop was to form a consensus on a selection of Decarbonization or Energy Conservation Measures (ECMs) for inclusion in the Measure Level Analysis phase of this project. A selection of measures for each facility was presented to the groups and the feasibility of each was discussed. Selection of specific measures for further investigations is required to remain within the scope of the feasibility study's budget.

Below you will find summary tables of all measures which were included for consideration in the Design Workshops. Those selected for further analysis are included in the Selected ECM table, those which were not selected are in the Disqualified ECM table.

Table 3 Selected ECMs

Facility	Measure Description	Description of the Selected Measure
MRC	Recommission Geothermal System	Conduct a detailed assessment of system performance to identify inefficiencies in controls, pumping, and heat exchange. Evaluate system capacity for future additional heating integrations
MRC	Install Water-Source Heat Pumps	Install additional Water-Source Heat Pumps connected to the existing Geothermal System to provide additional heating for Domestic Hot Water and the Pool
MRC	Variable Frequency Drives - Pool	Install Variable Frequency Drives on Pool Pumps that are currently manually throttled
MRC	Variable Frequency Drives - Heating Loop	Install additional controls to dynamically adjust the speed of existing variable frequency drives on heating loop pumps based on system demand
MRC	BAS Recommissioning	Conduct Existing Building Recommissioning on Building Automation Systems. Based on system age this measure is expected to occur later in the implementation timeline

Facility	Measure Description	Description of the Selected Measure
MRC	Electrify Heating	Replace fossil fueled heating equipment with electric alternatives (heat pumps or electric resistive heaters)
MRC	Install Solar PV Panels	Install rooftop mounted Solar PV panels. Requires staging with existing capital plans to repair the roof
WWTP	Reduce Exhaust Area for Filter Press	Install plastic curtain wall to reduce the area required to be ventilated during operation of the filter press
WWTP	Replace Aerators with Low-Speed Models	Replace the existing mechanical aerators with models designed to operate at lower speeds and/or at higher oxygen delivery rates
WWTP	Upgrade Thermostats	Install new thermostats to reduce interior air temperature during unoccupied periods
WWTP	Isolate Truckway	Improve the isolation between the Truckway and the workshop area and reduce the impacts to heating load when the bay doors are opened
WWTP	Lockout Truckway Heating	Lock-out heating in the Truckway when the bay doors are open
WWTP	Electrify Heating	Replace fossil fueled heating equipment with electric alternatives (heat pumps or electric resistive heaters)
WWTP	Install Solar PV Panels	Investigate the optimal approach to installing ground-mount Solar PV panels

Table 4 Disqualified ECMs

Facility	Measure Description	Rationale for Disqualification
MRC	Improve Building Envelope	High implementation cost and limited return potential
MRC	Liquid Pool Cover	Limited return potential. The Town of Goderich intends to pursue this ECM independently from this study
MRC	Reduce Pool Make-up Water	During stakeholder engagement it was determined that make-up water is controlled automatically to maintain sufficient water levels within the pool, thus there is no opportunity to reduce the volume of make-up water.
MRC	Cold Water Ice-Resurfacing	The viability of this technology is still in question and operators are concerned that this system will not produce the quality of ice required to maintain their standards of service.
MRC	Electric Ice-Resurfacer	High capital costs and limited return potential
MRC	Install LED Lamps	Most of the facility's lighting has already been retrofitted to LED
MRC	Install High-Efficiency Pumps	The majority of the facility's pumps are already high-efficiency models. On replacement Goderich staff are selecting the highest efficiency models available
WWTP	Improve Building Envelope - Windows	Due to the limited return potential this measure is not included in future analysis, Aladaco will however include this retrofit in the energy models to reflect Goderich's intent to proceed with a window reduction

Facility	Measure Description	Rationale for Disqualification
WWTP	Improve Building Envelope - Other	High implementation cost and limited return potential
WWTP	Improve Process Related VFD Use	Many of the pumps and motors are equipped with VFDs that act dynamically to reduce energy consumption
WWTP	Replace Aerators with Aeration Blowers	A similar measure to this was previously investigated by the Town and was not selected for implementation. This measure also requires more significant disruption to WWTP operations than the aerator replacement measure
WWTP	Install High-Efficiency Pumps	The majority of the facility's pumps are already high-efficiency models. On replacement Goderich staff are selecting the highest efficiency models available
WWTP	Increase SCADA/BAS capabilities	SCADA system has been recently updated. Any additional capabilities required to implement any of the selected measures will be included within those analyses.
WWTP	Install LED Lamps	While lamp retrofit opportunities exist, the electrical load associated with lighting at this facility is small in comparison to other measures. Energy models will be updated to reflect a gradual phasing out of fluorescent lamps over the next 5 years, but this measure will not be included in additional analysis.

6. Conclusion and next steps

Aladaco would like to thank the Town of Goderich for their engagement and participation in the feasibility study process. In completing these first steps we have laid the foundation for a final report that will provide the most feasible and cost-effective decarbonization pathways available to the Town.

Our next steps in this process include completing the Measure Level Analysis and Pathways Scenario Planning prior to meeting again with stakeholders to decide on the optimal pathways to meeting the decarbonization targets. We look forward to continuing to collaborate with the Town throughout these steps.

7. Appendix: PPT Presentations

Aladaco Consulting Inc.

Maitland Recreation Centre
Town of Goderich
Design Workshop

Agenda

- Introductions
- Review of the Study Process
- Confirmation of Project Goals
- Current Emissions and Distribution
- Existing Capital Plans Review
- Decarbonization Measures
- Funding Opportunities
- Next steps and Discussion

THIS IS A LIVE DOCUMENT

Discussion and engagement are encouraged. We will build out and edit this document together today and distribute a final copy to all participants.

Introductions - Aladaco

- Aladaco Consulting Inc
  - Founded in 2007
  - Energy professionals providing services to help organizations navigate and reach energy efficiency and decarbonization goals
  - Energy management and M&V, GHG inventorying and decarbonization pathways, CDM planning
  - IESO Industrial Technical Review Services

Sean Pittman
Conservation & Energy Management Lead
P.Eng., CEM, CMVP

Taylor Wilson
Technical Lead - Energy & Carbon Management
CET, CEM, CMVP

Introductions – HEMCon Energy Modeling Solutions

HEMCon is an energy analysis and building simulation firm.

We specialize in building energy models for new and existing buildings to facilitate good design decisions.

HEMCON

Jeremiah Heffernan
Founder, Principal Energy Analyst
P.Eng, M.Eng., G.Dip Green Energy, BEMP, LEED AP BD+C

Introductions – Town of Goderich

- Jessica Clapp (Town of Goderich Project Lead)
  Asset Management and Environmental Services Coordinator
- Deanna Hastie
  Director of Corporate Services/Treasurer
- Janice Hallahan
  Chief Administrative Officer
- Greg Morningstar
  Recreation Facilities Supervisor
- Sean Thomas
  Director of Community Services, Infrastructure, and Operations
- Kyle Williams
  Community Services and Operations Manager

Design Workshop - MRC

Study Review Process

Site Investigation
- Review available documentation and reports
- Analyze utility data
- Conduct Site Visits
- Interview Facility Operators
- Identify current metering points and identify any additional metering required

Calibrated Energy Modelling
- eQuest energy model developed by Heffernan Energy Modelling
- Calibrated to utility data to ensure accuracy of simulations

Design Workshop
- Gather relevant stakeholders to review preliminary decarbonization measures and their feasibility
- Review asset management planning and equipment replacement needs
- Discuss budgetary considerations and implementation planning
- Select decarbonization measures for in-depth analysis

Measure Level Analysis
- Develop detailed project metrics for all selected decarbonization measures
- Capital cost estimates, energy savings, implementation timelines, etc.

GHG Reduction Scenario Planning
- Compile the identified measures into GHG reduction pathway scenarios for each facility
- Scenario packages will include all relevant project metrics and offer alternative pathways to achieving required outcomes

Decision Making Workshop
- Two workshops, one for each facility
- Gather relevant stakeholders to examine GHG reduction pathways developed by Aladaco
- Engage stakeholders to find consensus on the preferred scenarios for inclusion the final report

Report and Presentation
- Develop draft Pathway Feasibility Study Report
- Facilitate stakeholder review and update accordingly
- Issue Final Pathway Feasibility Study Report
- Prepare/present summary of Pathway Feasibility Study to Town Council

Project Goals and Outcomes

PROJECT GOALS

- Develop a tailored GHG Reduction Pathway Feasibility Study for the Town of Goderich
- Prioritize efficiency measures to reduce emissions and costs
- Align decarbonization strategies with facility needs and lifecycle planning
- Maintain current standards of service without significant cost increases

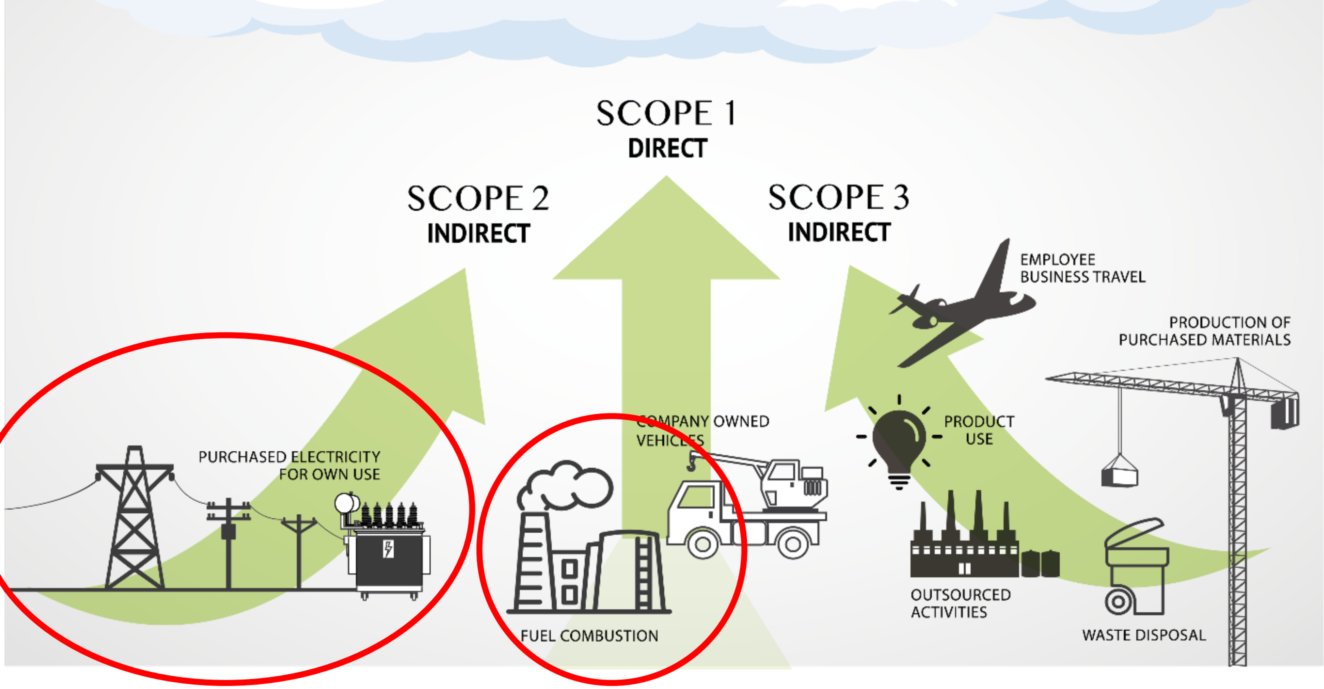
Project Goals and Outcomes

OUTCOMES

- Delivery of 3 scenarios:
  - **Minimum Performance**: 50% reduction in 10 years, 80% in 20 years
  - **Aggressive Deep Retrofit**: 50% reduction in 5 years, 80% in 20 years
  - **Business-As-Usual**: Like-for-like replacements with existing specs
- Detailed GHG reduction pathways and financial analyses
- Clear, actionable recommendations for decarbonization

GHG Emissions Calculations

$CO_2 + SF_6 + CF_4 + N_2O + HFCs + PFCs = \sum(GHGs \times GWP) = CO2e$

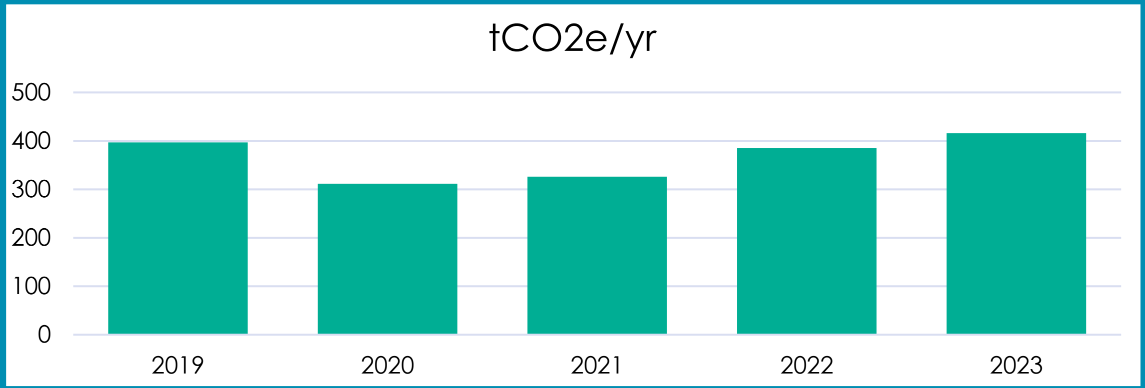


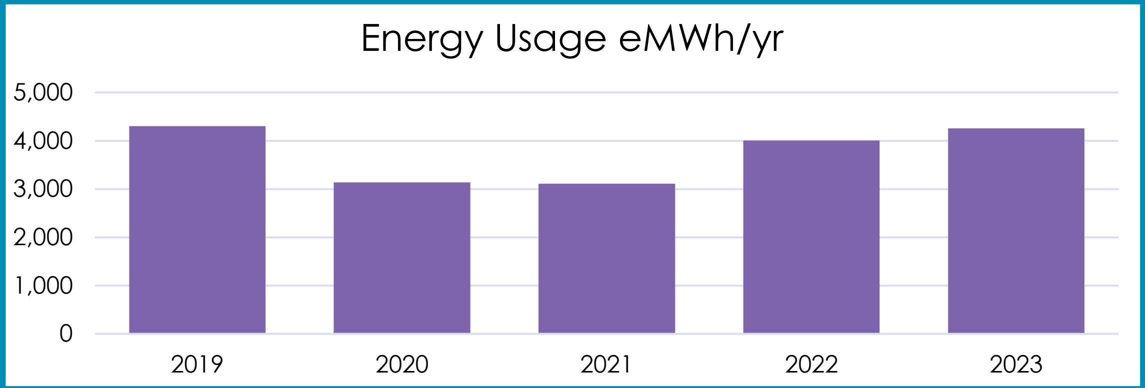
IESO Grid Emissions

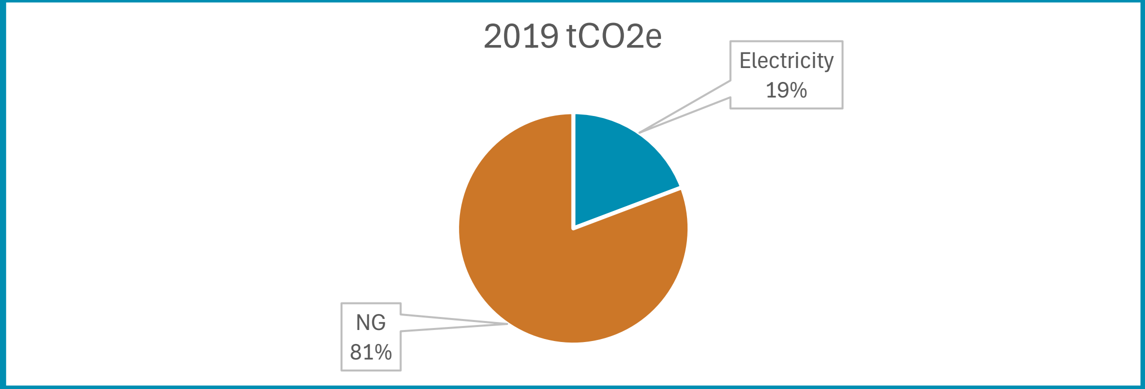
Natural Gas Combustion Emissions

Design Workshop - MRC

Current Emissions and Targets

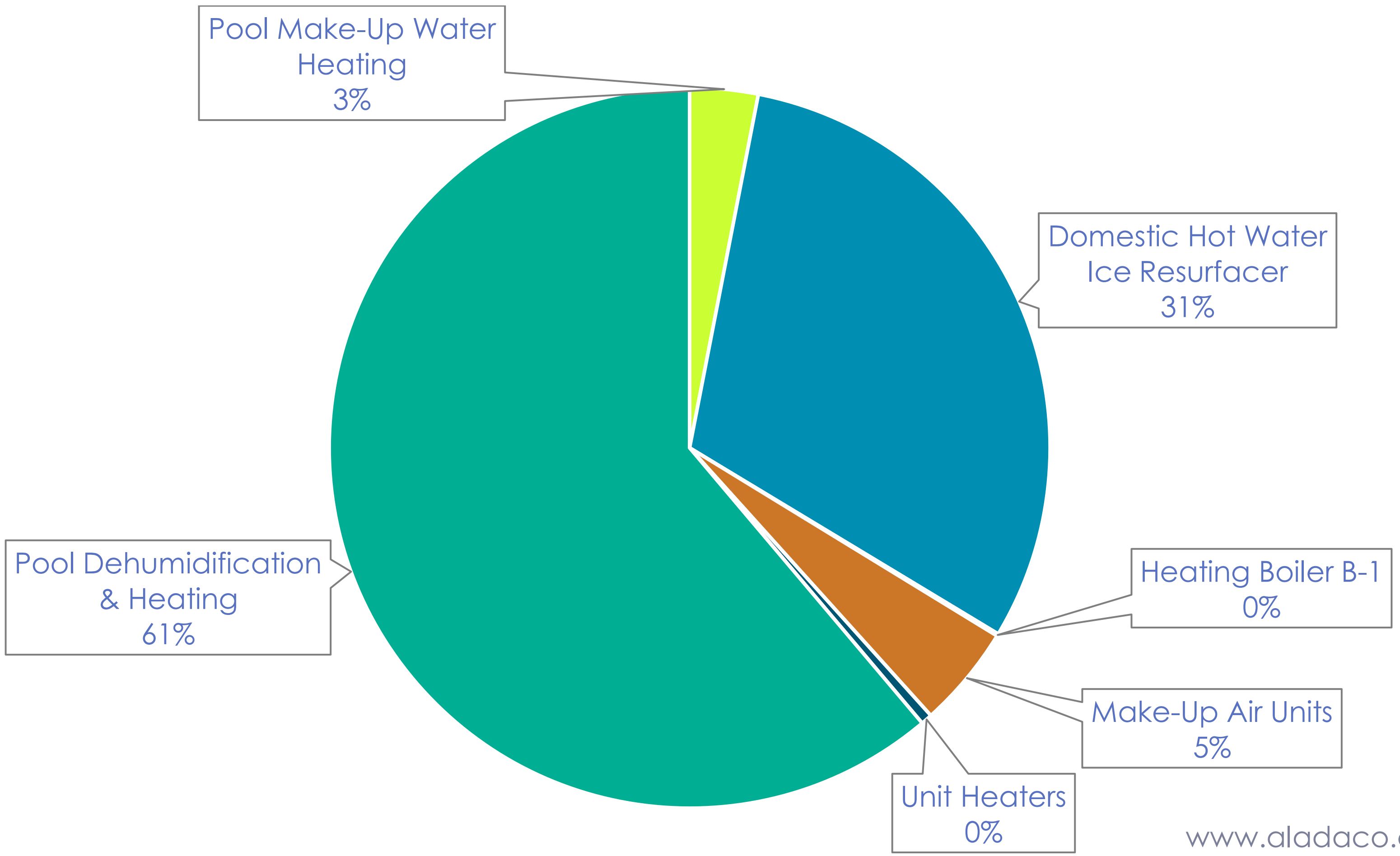






Baseline Emissions ($tCO2_e$)			Targets	
Electricity	Gas	Total	50%	80%
76.3	320.2	396.5	198.3	79.3

Natural Gas Emissions Distribution



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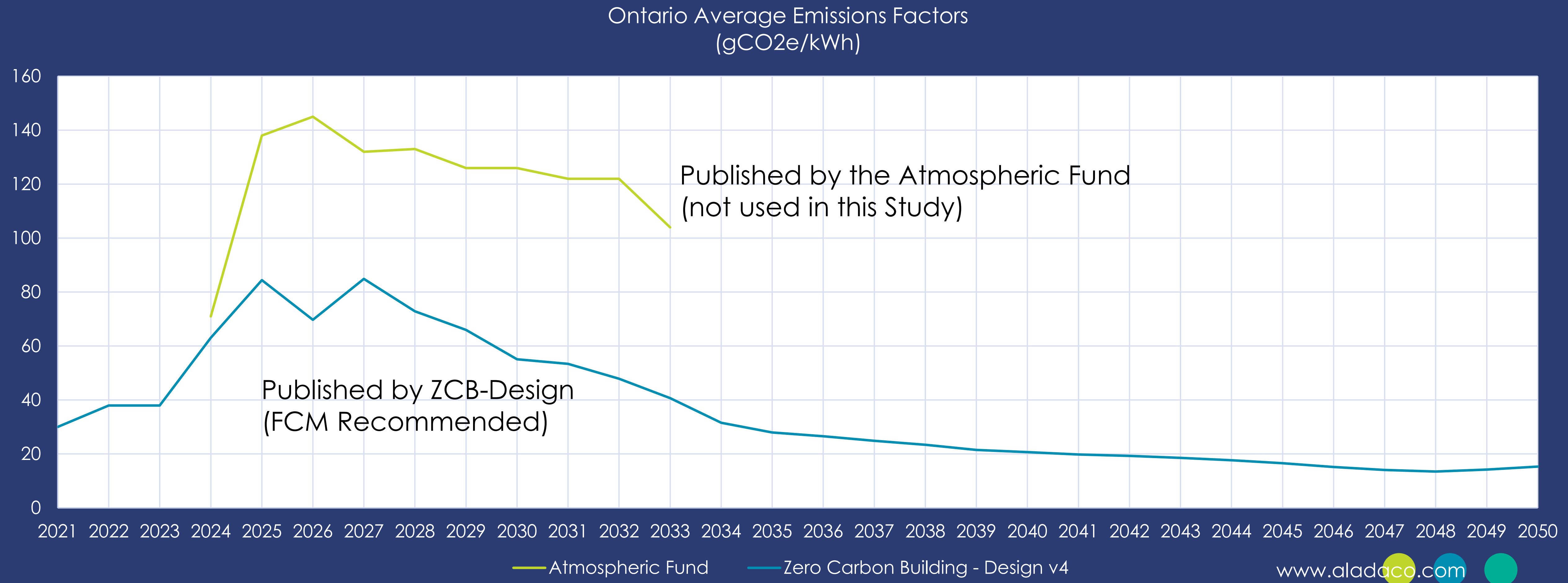
Future Grid Emissions Factors



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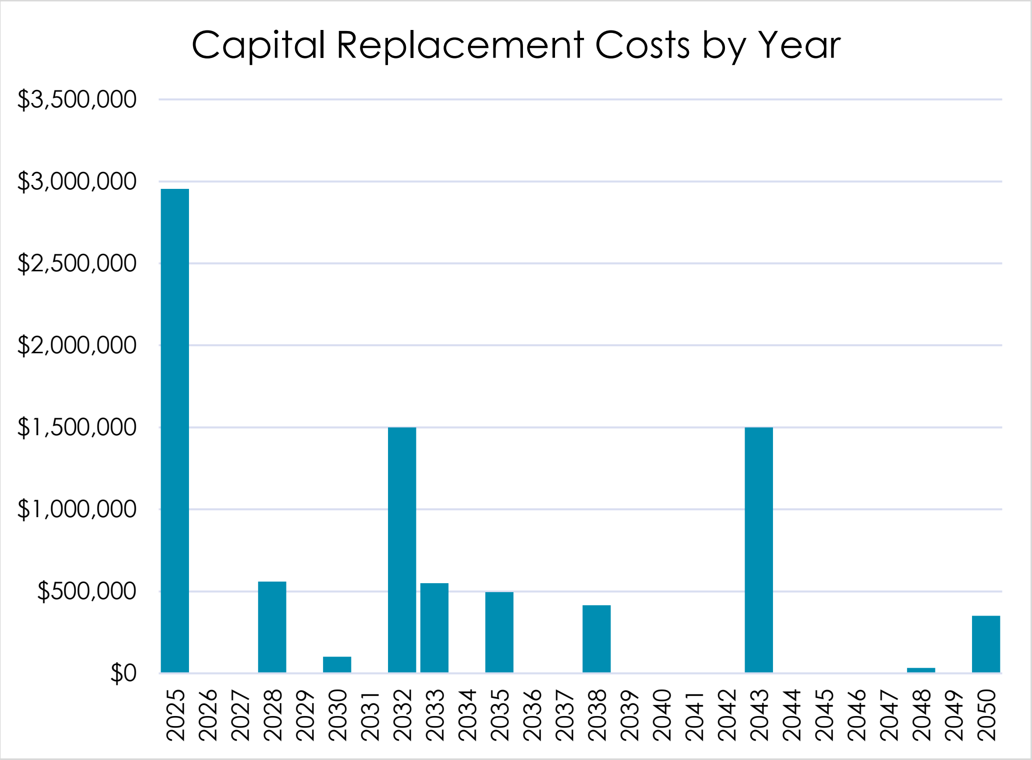
Existing Capital Replacements

Replacement Year	Equipment
2025	B-1 DHW Boiler
	Pool Water Heater
	Whirlpool Water Heater
	Roof
	Heat Pumps
	HRU-1
	HRU-2
	UH1 - UH5
	DH-1
	MUA-1
	Pool Filter Pump
	Hot Tub Filter & Jet Pump
	Pool Filter Chemical Pumps
	Filter Room Motor Starters
	Ice Resurfacer
	P110 HPLP Return Pump
	P-107 Pool Water Heating Pump
	P-108 Pool Water Heating Pump
	Boiler Room Circulation Pumps

Replacement Year	Equipment
2028	P101 HPLP Loop Pump
	P102 HPLP Loop Pump
	Ice Cube Room Heater and Pump
	CT-1
2030	Doors
	Water Feature Pump
2032	SW Corner Ground Loop
2033	Kube HPs (1 to 8)
2035	Windows
2038	DH-2
2043	Heating Loops
2050	DH-3



Based on BCA, Roof Condition Assessment Report, and Town of Goderich Capital Replacement data

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Energy Conservation Measures (ECMs)

ECMs – Geothermal System Recommissioning

PROJECT DESCRIPTION

- Conduct a detailed assessment of system performance to identify inefficiencies in controls, pumping, and heat exchange operations
- Optimize control settings for temperature setpoints, seasonal operation modes, and occupancy schedules
- Test and balance ground loop flow rates to ensure efficient heat exchange and minimize energy waste

ECM OUTCOMES

- Improve energy performance of the system (3% to 5%)
- Evaluate capacity for additional Heating opportunities
- Right size future electrification measures
- Potential to tie-in Unit Heaters

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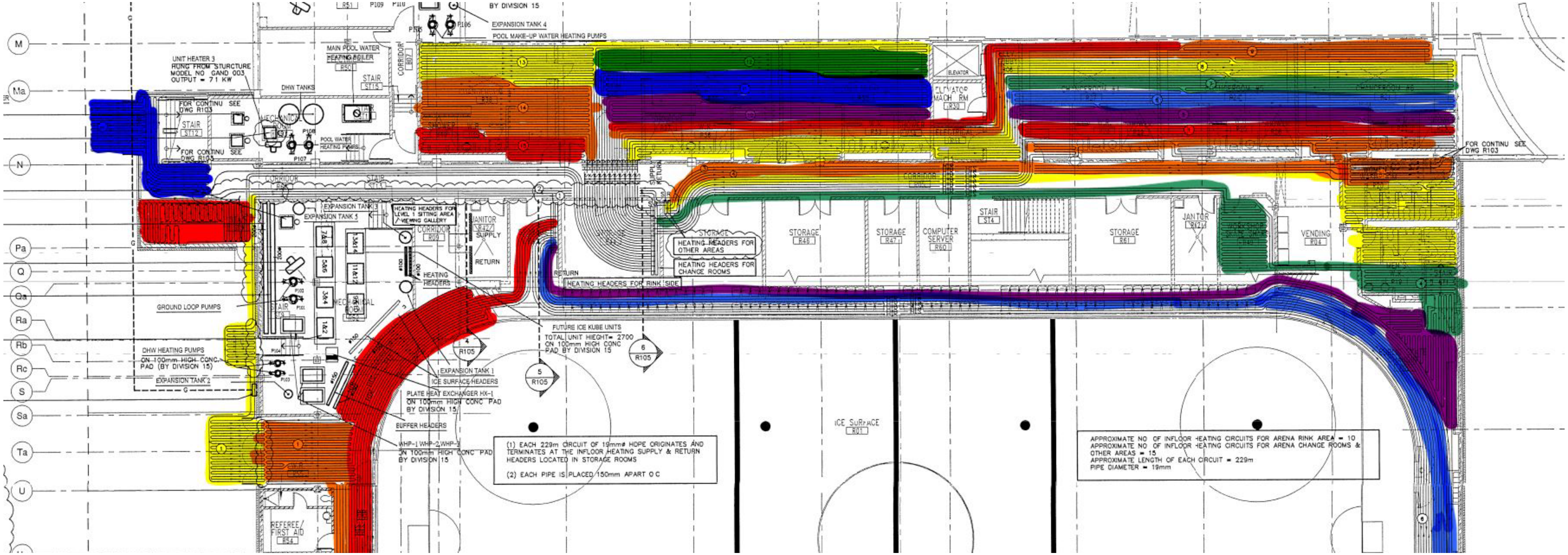
ECMs – Geothermal System Recommissioning



ECMs – Install Water-Source Heat Pumps

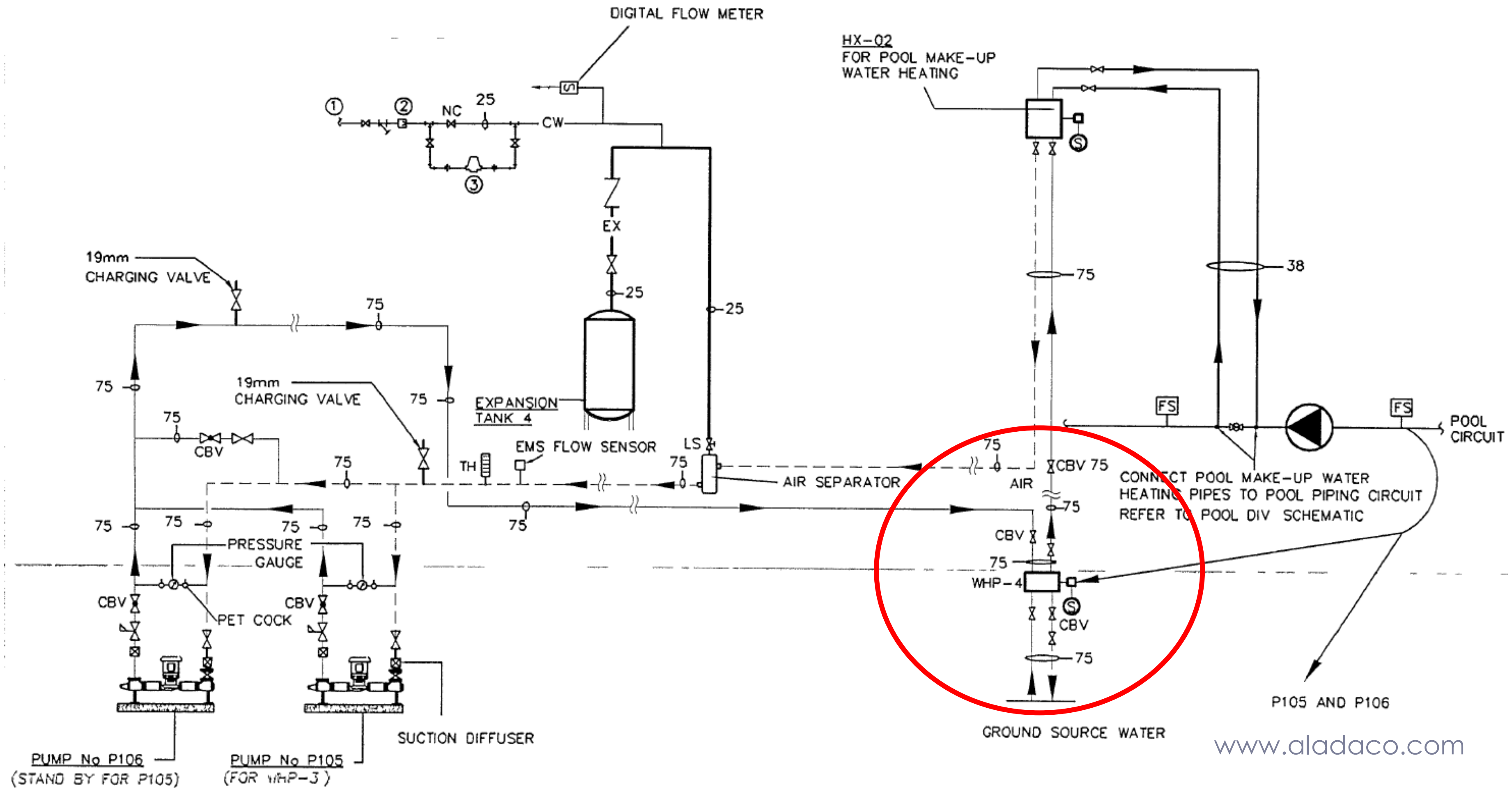
PROJECT DESCRIPTION

- Mechanical Design Drawings indicate additional Water Source Heat Pumps were originally planned to support Pool and DHW Heating
- Geothermal System Recommissioning can determine the available heating capacity

ECM OUTCOMES

- Reduce Boiler Loads
- Reduce electrification impacts and right size future electrification measures

ECMs – Install Water-Source Heat Pumps



ECMs – Building Envelope Improvements

PROJECT DESCRIPTION

- Wall Insulation Improvements
- Air Sealing
- Decrease Thermal Bridging
- Windows & Doors
- Roof

ECM OUTCOMES

- Estimates of up to 10% to 15% Energy Savings
- Improved Occupant Comfort
- Reduces Equipment Cycling and prolongs expected life

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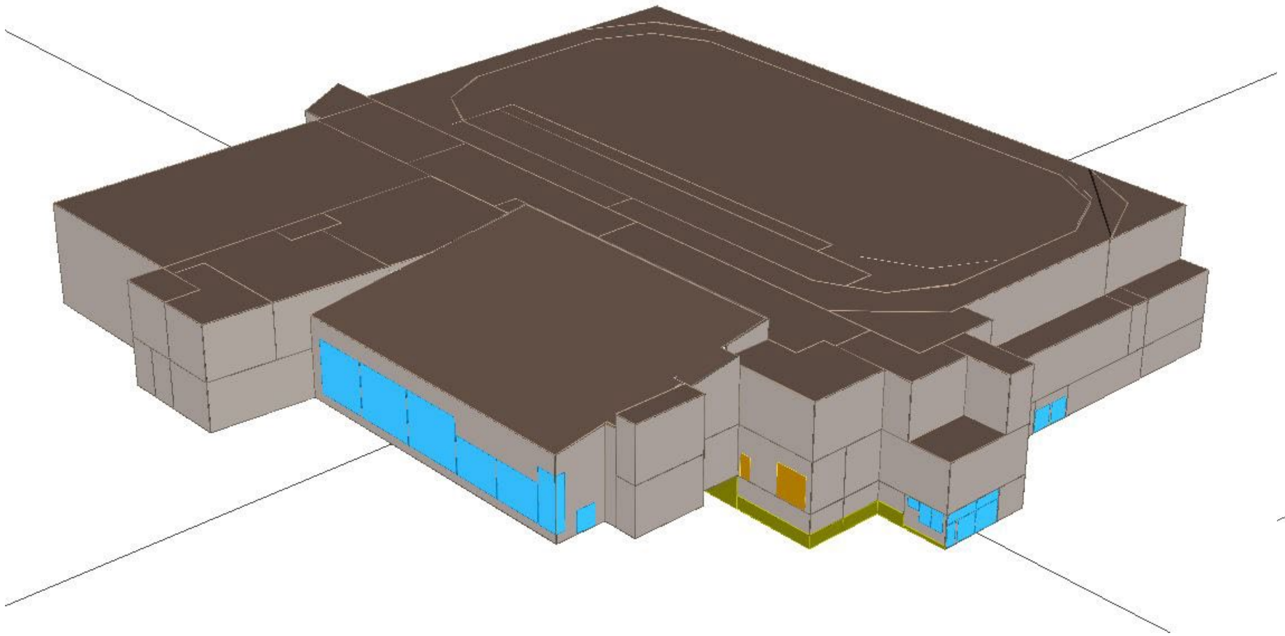
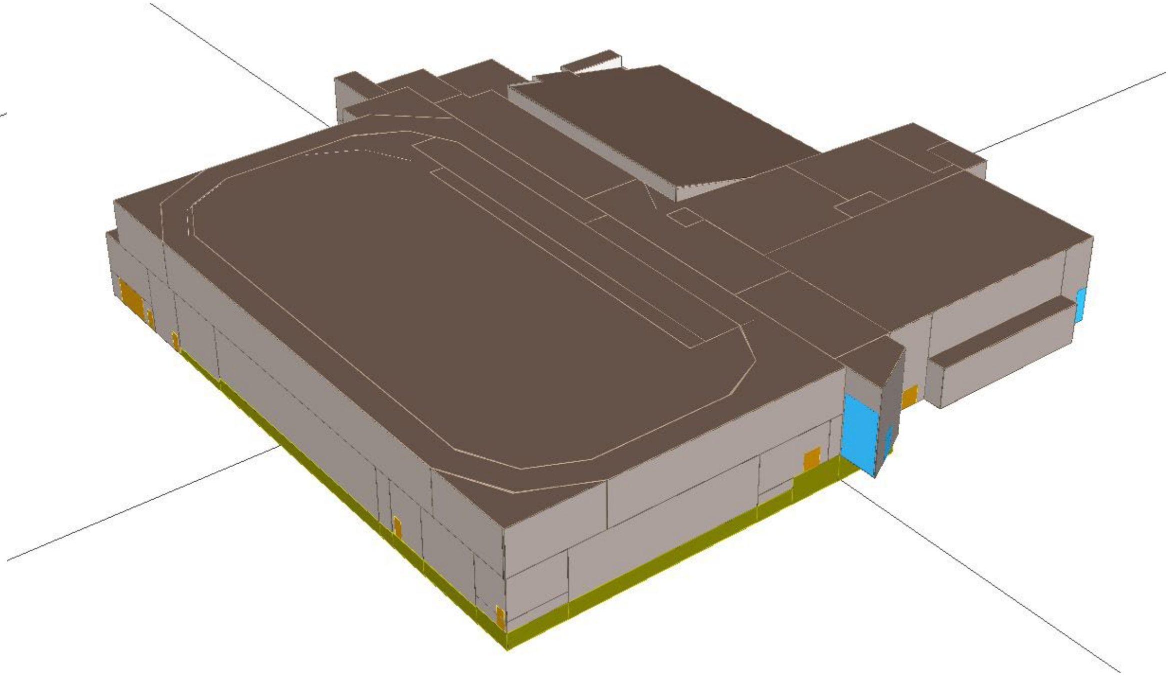
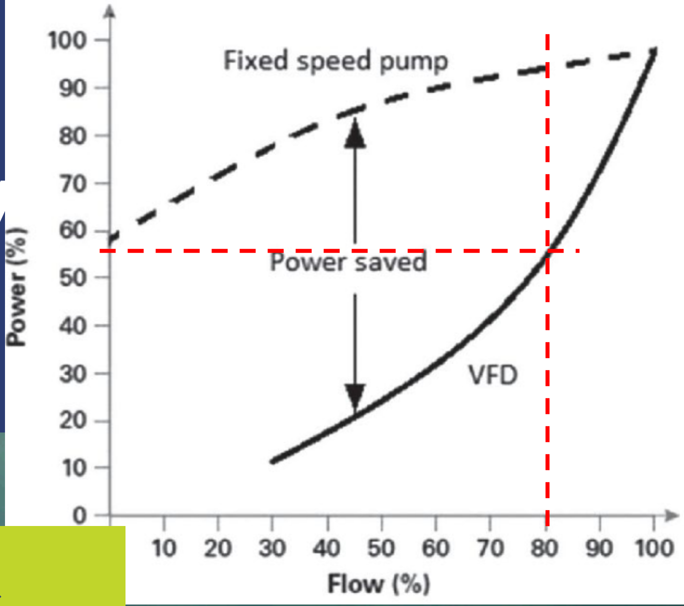
ECMs – Building Envelope Improvements





Design Workshop - MRC

ECMs – Variable Frequency Drives



PROJECT DESCRIPTION

- Variable Frequency Drives on Pool Pumps & Heat Loop
- Requires enabling/programming for Heat Loop and new VFDs for Pool Pumps

ECM OUTCOMES

- Significant energy savings
- Increased controls to match operation to requirements
- Prolongs expected life

ECMs – Other Opportunities

PROJECT DESCRIPTION

- Liquid Pool Cover
- Cold Water Ice-Resurfacing
- Electric Ice-Resurfacer
- LED Lamps

- BAS Recommissioning
- High Efficiency Pumps
- Pool Make-up Water

ECMs – Heating Electrification

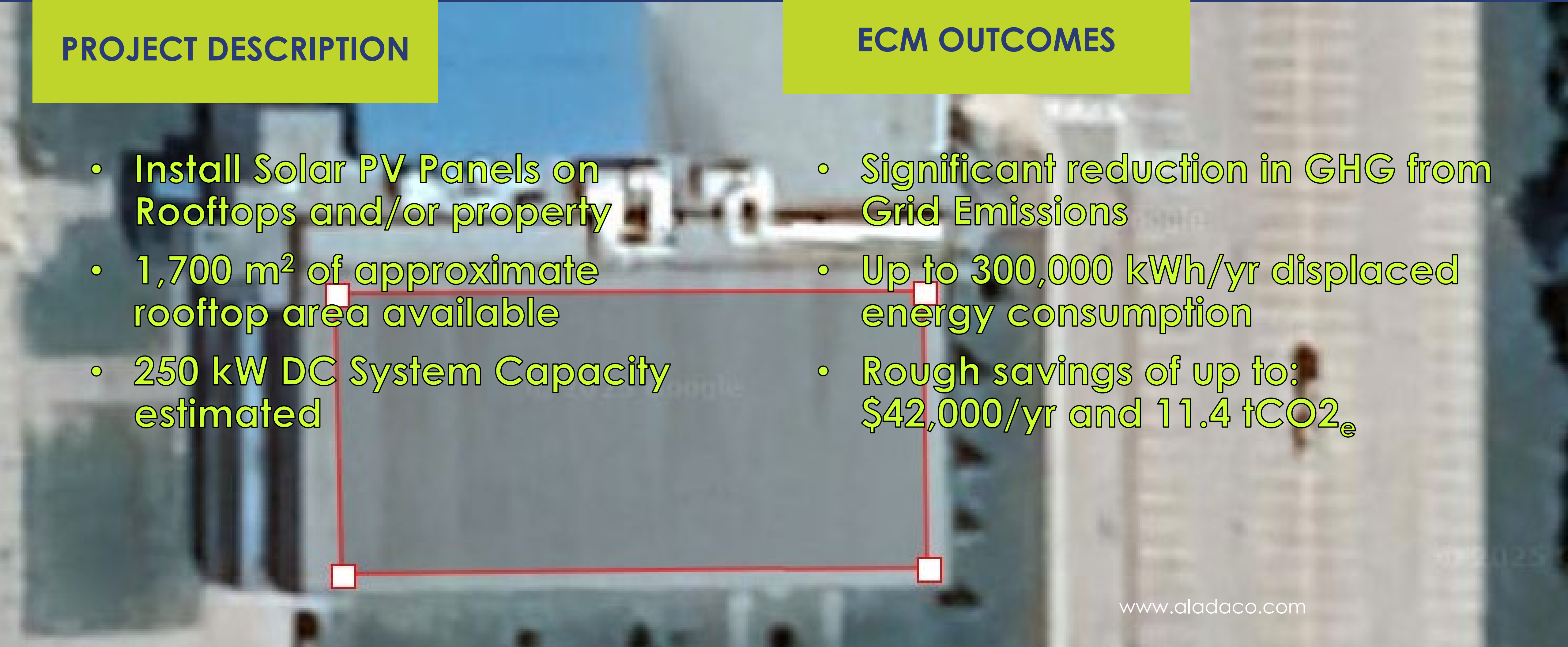
PROJECT DESCRIPTION

- Replace all Natural Gas heating sources with electric alternatives (resistance or Heat Pumps)
- Includes Pool Boilers, DHW Boilers, Unit Heaters, Rooftop Units

ECM OUTCOMES

- Significant reduction in GHG
- Increased building electrical loading

ECMs – Renewable Energy Generation



PROJECT DESCRIPTION

- Install Solar PV Panels on Rooftops and/or property
- 1,700 m^2 of approximate rooftop area available
- 250 kW DC System Capacity estimated

ECM OUTCOMES

- Significant reduction in GHG from Grid Emissions
- Up to 300,000 kWh/yr displaced energy consumption
- Rough savings of up to: $42,000/yr and 11.4 $tCO2_e$

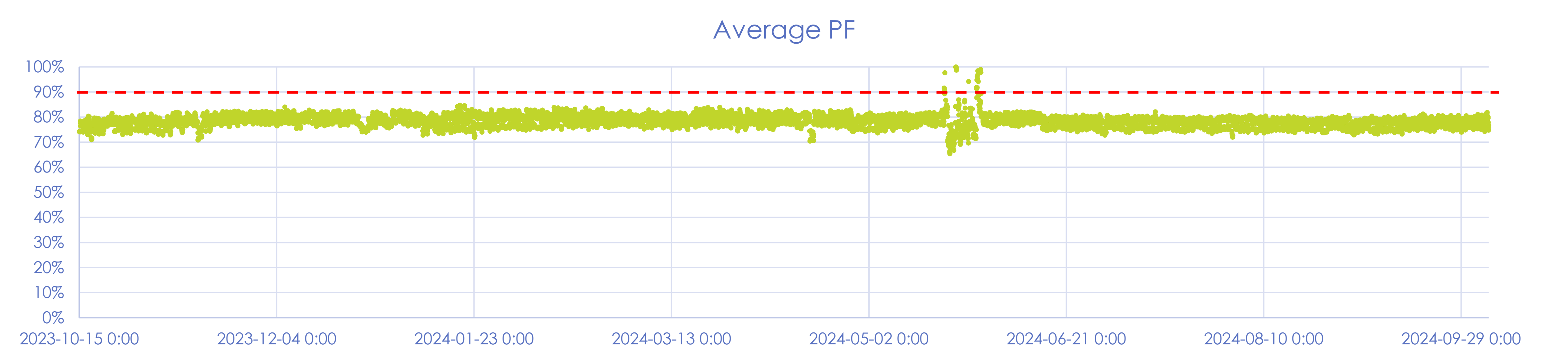
ECMs – Power Factor Correction

PROJECT DESCRIPTION

- Install capacitor banks to improve facility power factor

ECM OUTCOMES

- Reduce Power Factor penalties on utility bills
- Financial savings measure only, will not impact emissions or energy use.



Funding Opportunities

Funding Entity	Program	Available Funding	Notes
IESO	Custom Retrofit	\$0.13/kWh or \$1,200/kW Peak Demand Savings	May be applicable to Heating Electrification and Heat Pump Installations
	Prescriptive Retrofit	Varies by Equipment Type	Per unit incentives for Lighting, VFDs, high-efficiency pumps, heat pumps, etc.
	Solar PV DER	\$860/kW-AC	For a 240 kW-AC system = \$206,400
Enbridge	Custom Retrofit	\$0.25/m^3, up to \$100,000	
FCM Green Municipal Fund	GHG Impact Retrofit	Maximum of \$5 million per project.	Up to 25% as a grant and the remainder as a loan. Combined loan and grant for up to 80% of eligible project costs. 30% GHG reduction required
Canadian Infrastructure Bank	Green Infrastructure Program	Varies based on project	Provides financing to reduce investment barriers and decarbonize buildings.

ECM Summary

ECM	Energy Savings Potential	GHG Savings Potential	Implementation Cost	Life-Cycle Cost	Selected for Study
Geothermal System Recommissioning	Low	Low	$$	Positive	X
Installing Water-Source Heat Pumps	Medium	High	$$$	Negative	X
Building Envelope Improvements	Low	Low	$$$$	Negative	
Variable Frequency Drives - Pool	Low	Low	$$	Positive	X
Variable Frequency Drives - Heating Loop	Medium	Low	$	Positive	X
Liquid Pool Cover	Low	Low	$	Positive	
Reduce Pool Make-up Water	Low	Low	$	Positive	
Cold Water Ice-Resurfacing	Low	Medium	$	Positive	
Electric Ice-Resurfacer	None	Medium	$$$	Negative	
LED Lamps	Low	Low	$	Positive	
BAS Recommissioning	Low	Low	$$	Positive	X
High-Efficiency Pumps	Low	Low	$	Positive	
Electrification of Heating	Medium	High	$$$$	Negative	X
Solar PV Panels	None	Medium	$$$	Positive	X

Next Steps

- Finalization of PPT and measures selected for analysis
- Delivery of Summary Report
- Begin Measure Level Analysis phase
- Decision Making Workshop April/May


Thank You
Questions?
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Aladaco Consulting Inc.

Wastewater Treatment Plant
Town of Goderich
Design Workshop

Agenda

- Introductions
- Review of the Study Process
- Confirmation of Project Goals
- Current Emissions and Trends
- Existing Capital Plans Review
- Decarbonization Measures
- Funding Opportunities
- Next steps and Discussion

THIS IS A LIVE DOCUMENT

Discussion and engagement are encouraged. We will build out and edit this document together today and distribute a final copy to all participants.

Introductions - Aladaco

- Aladaco Consulting Inc
  - Founded in 2007
  - Energy professionals providing services to help organizations navigate and reach energy efficiency and decarbonization goals
  - Energy management and M&V, GHG inventorying and decarbonization pathways, CDM planning
  - IESO Industrial Technical Review Services

Sean Pittman
Conservation & Energy Management Lead
P.Eng., CEM, CMVP

Taylor Wilson
Technical Lead - Energy & Carbon Management
CET, CEM, CMVP

Introductions – HEMCon Energy Modeling Solutions

HEMCon is an energy analysis and building simulation firm.

We specialize in building energy models for new and existing buildings to facilitate good design decisions.

HEMCON

Jeremiah Heffernan
Founder, Principal Energy Analyst
P.Eng, M.Eng., G.Dip Green Energy, BEMP, LEED AP BD+C

Design Workshop – WWTP

Introductions – Town of Goderich

- Jessica Clapp (Town of Goderich Project Lead)
  Asset Management and Environmental Services Coordinator
- Deanna Hastie
  Director of Corporate Services/Treasurer
- Janice Hallahan
  Chief Administrative Officer
- Sean Thomas
  Director of Community Services, Infrastructure, and Operations
- Steven Walmsley
  Veolia Water Canada
- Steve Johnston
  Veolia Water Canada

Design Workshop - WWTP

Study Review Process

Site Investigation

- Review available documentation and reports
- Analyze utility data
- Conduct Site Visits
- Interview Facility Operators
- Identify current metering points and identify any additional metering required

Calibrated Energy Modelling

- eQuest energy model developed by Heffernan Energy Modelling
- Calibrated to utility data to ensure accuracy of simulations

Design Workshop

- Gather relevant stakeholders to review preliminary decarbonization measures and their feasibility
- Review asset management planning and equipment replacement needs
- Discuss budgetary considerations and implementation planning
- Select decarbonization measures for in-depth analysis

Measure Level Analysis

- Develop detailed project metrics for all selected decarbonization measures
- Capital cost estimates, energy savings, implementation timelines, etc.

GHG Reduction Scenario Planning

- Compile the identified measures into GHG reduction pathway scenarios for each facility
- Scenario packages will include all relevant project metrics and offer alternative pathways to achieving required outcomes

Decision Making Workshop

- Two workshops, one for each facility
- Gather relevant stakeholders to examine GHG reduction pathways developed by Aladaco
- Engage stakeholders to find consensus on the preferred scenarios for inclusion the final report

Report and Presentation

- Develop draft Pathway Feasibility Study Report
- Facilitate stakeholder review and update accordingly
- Issue Final Pathway Feasibility Study Report
- Prepare/present summary of Pathway Feasibility Study to Town Council

Project Goals and Outcomes

PROJECT GOALS

- Develop a tailored GHG Reduction Pathway Feasibility Study for the Town of Goderich
- Prioritize efficiency measures to reduce emissions and costs
- Align decarbonization strategies with facility needs and lifecycle planning
- Maintain current standards of service without significant cost increases

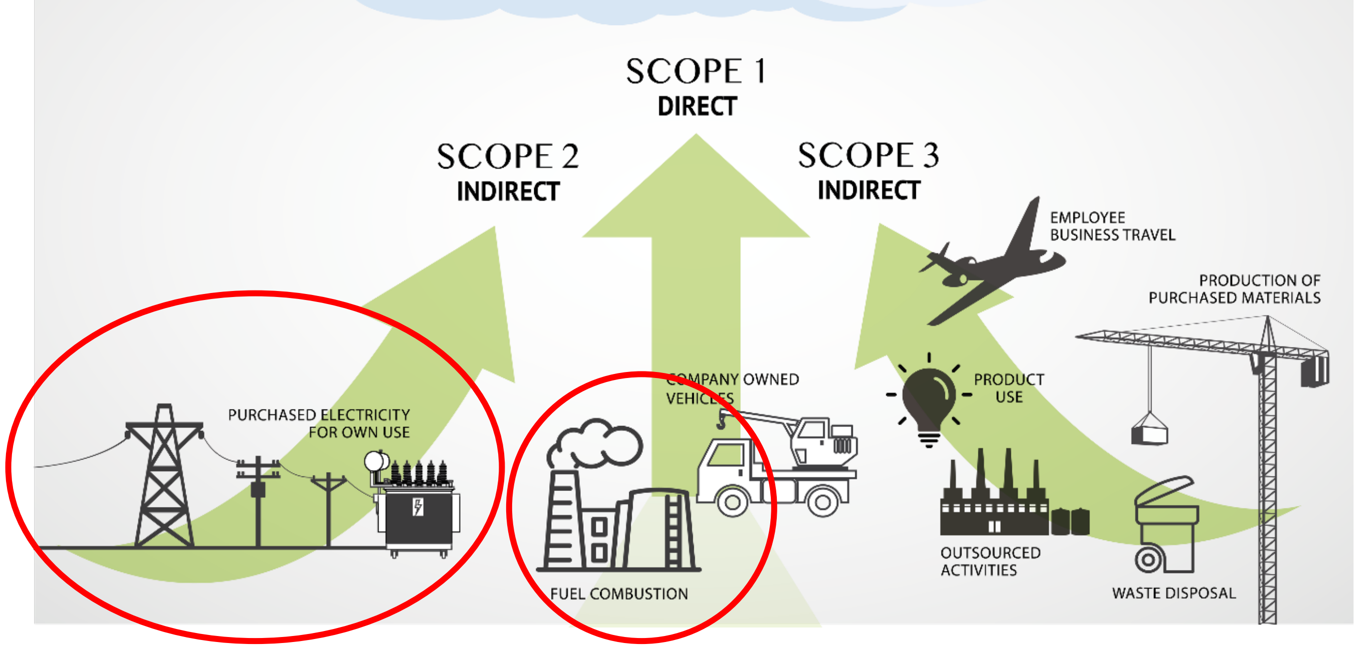
Project Goals and Outcomes

OUTCOMES

- Delivery of 3 scenarios:
  - **Minimum Performance**: 50% reduction in 10 years, 80% in 20 years
  - **Aggressive Deep Retrofit**: 50% reduction in 5 years, 80% in 20 years
  - **Business-As-Usual**: Like-for-like replacements with existing specs
- Detailed GHG reduction pathways and financial analyses
- Clear, actionable recommendations for decarbonization

GHG Emissions Calculations

$CO_2 + SF_6 + CF_4 + N_2O + HFCs + PFCs = \sum(GHGs \times GWP) = CO2e$

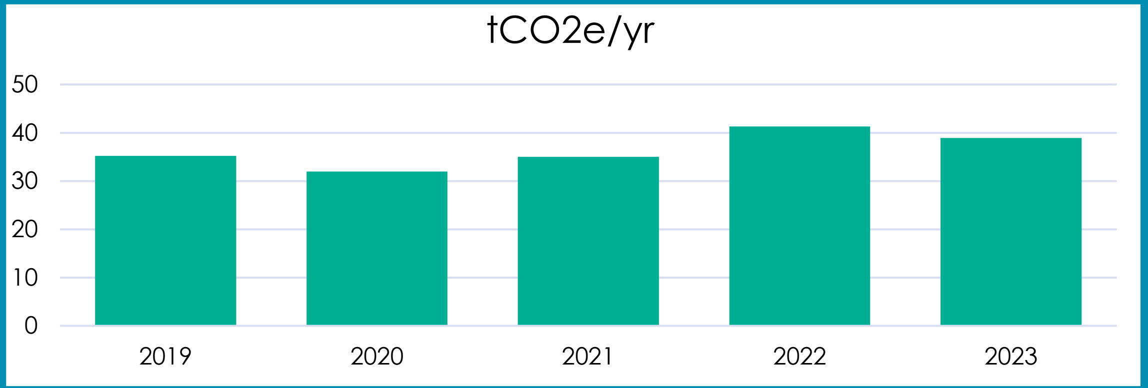


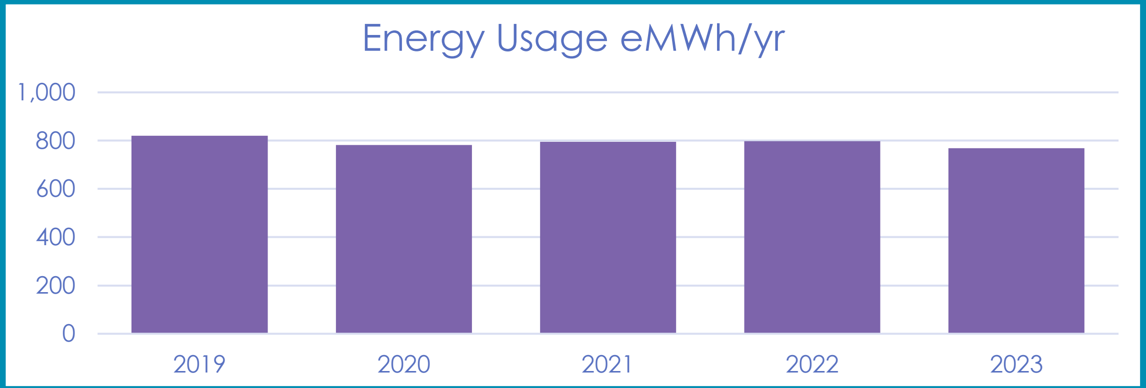
IESO Grid Emissions

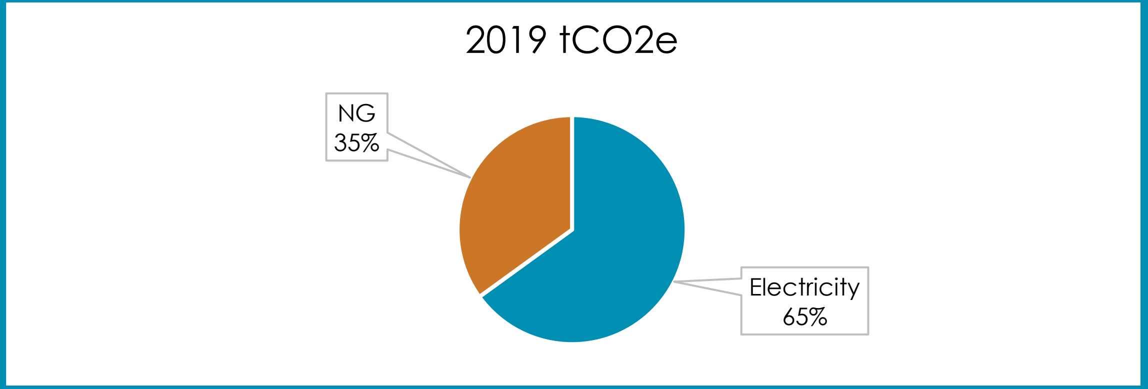
Natural Gas Combustion Emissions

Design Workshop - WWTP

Current Emissions and Targets



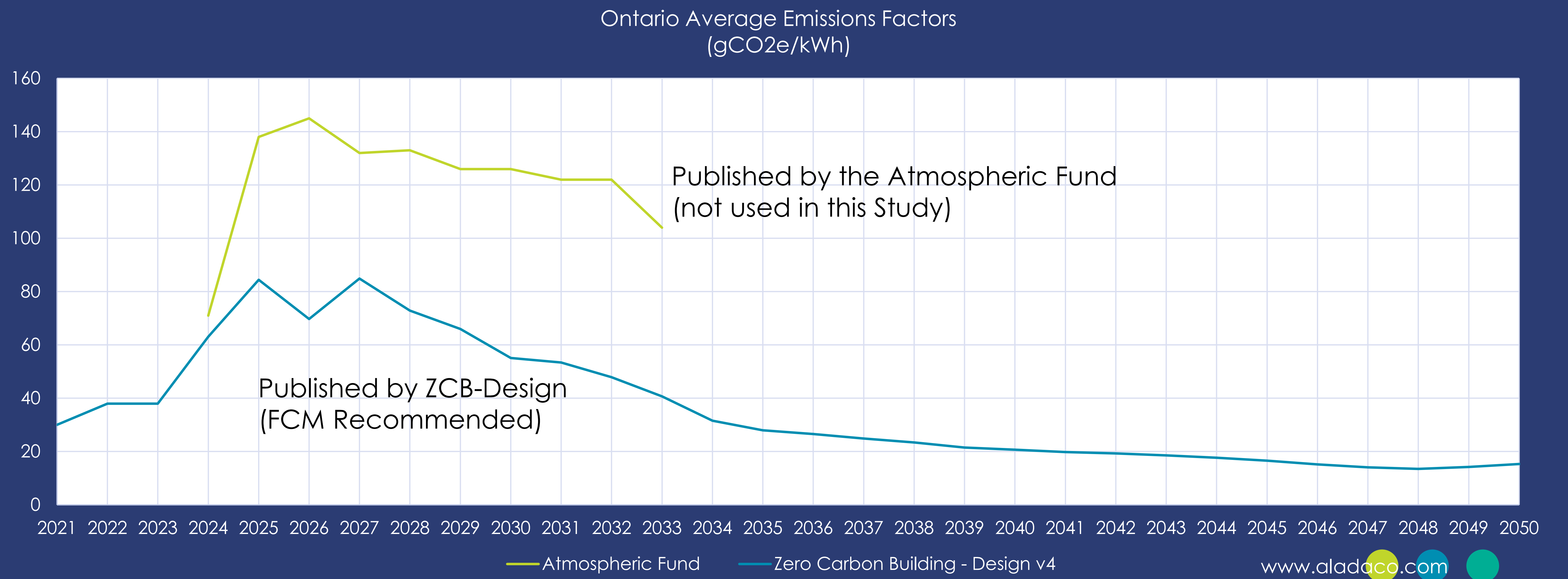




Baseline Emissions ($tCO2_e$)			Targets	
Electricity	Gas	Total	50%	80%
22.9	12.3	35.2	17.6	7.0

Design Workshop - WWTP

Future Grid Emissions Factors



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Existing Capital Replacements

Replacement Year	Equipment
2025	Primary Clarifier 1, 2, 3, & 4
	Final Clarifier 1, 2, & 3
	WAS Pump 1
	Aerator 3 & 4
	RPU2 Chemical Pumps
	UV Banks 1 & 2
	KM04 Pumps
	Pumphouse Electric Unit Heaters
	CSO Return Pumps
	ACA Exhaust Unit
	MUA-1

Replacement Year	Equipment
2028	Final Clarifier 4
	RAS Pumps 1, 2, 3, 4, 5, & 6
	WAS Pump 2
	Aerator 7
	Booster Pump
	Filtrate Pump
	Raw Water Pump
	Radiant Tube Heaters
2031	Belt Filter Press
	Grit Screener
	Aerator 5, 6, & 8
	Aeration Blower
2034	Admin Building Roof
2038	Domestic Hot Water Heater
2046	Wasting Pump
2048	Belt Filter Air Compressor

2024 Capital Work

- SCADA Improvements
- MCC/HVAC Upgrades
- Sludge Pump Replacements
- Lighting Upgrade
- WAS Pump Replacement

Energy Conservation Measures (ECMs)

ECMs – Reduce Exhaust Area for Filter Press

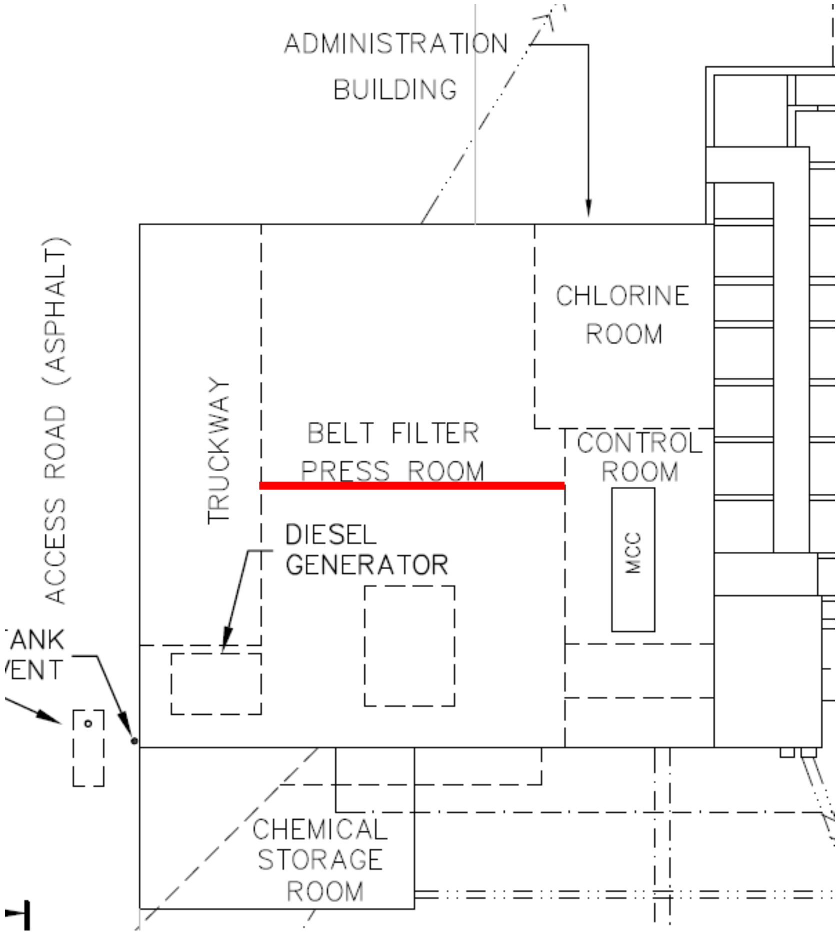
PROJECT DESCRIPTION

- Investigate methods of reducing the overall quantity of air exhausted and replaced during Belt Filter Press operation
- Options to include traditional interior walls, or plastic curtain walls.

ECM OUTCOMES

- Reduces natural gas consumption required to heat make-up air
- Reduces run-time of the make-up air unit fan

ECMs – Reduce Exhaust Area for Filter Press



ECMs – Building Envelope Improvements

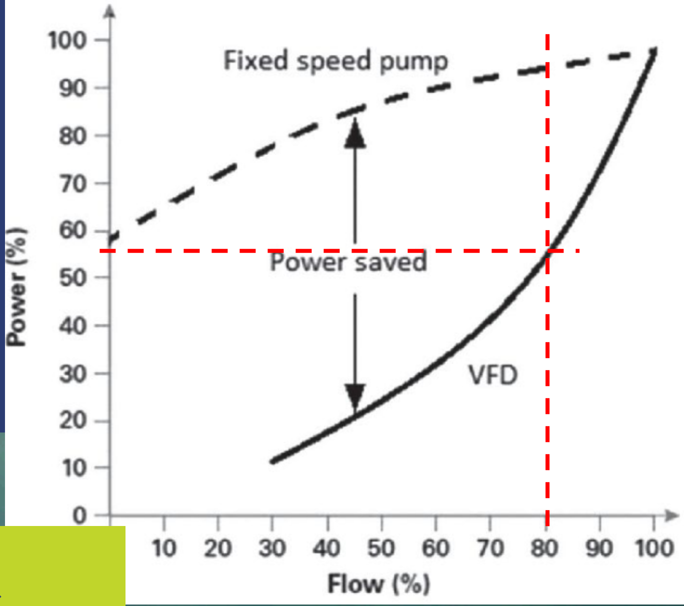
PROJECT DESCRIPTION

- Walls Insulation Improvements
- Windows & Doors
- Window Area Reduction

ECM OUTCOMES

- Low quantity of GHG reductions
- Improved Occupant Comfort
- Reduces Equipment Cycling and prolongs expected life

ECMs – Process Related VFD Improvements



PROJECT DESCRIPTION

- Optimize the use of VFDs to reduce pumping energy
- Integrate VFD controls with SCADA to better match energy use to process requirements

ECM OUTCOMES

- Significant energy savings
- Increased controls to match operation to requirements
- Prolongs expected life

ECMs – Replace Mechanical Aerators with Aeration Blowers

PROJECT DESCRIPTION

- Replace the mechanical aerators with a diffuse aeration system
- Requires Engineering Study to determine feasibility

ECM OUTCOMES

- Reduces electrical consumption related to the treatment of wastewater

ECMs – Replace Mechanical Aerators with Low-Speed Models

PROJECT DESCRIPTION

- Replace the mechanical aerators with a diffuse aeration system
- Requires Engineering Study to determine feasibility

ECM OUTCOMES

- Reduces electrical consumption related to the treatment of wastewater

ECMs – Other Opportunities

PROJECT DESCRIPTION

- High-Efficiency Pumps
- Thermostat Upgrades
- LED Lamps
- Increase SCADA/BAS capabilities

- Isolate Truckway from other interior areas
- Lock-out heating in garage when bay doors are open

ECMs – Electrify Heating

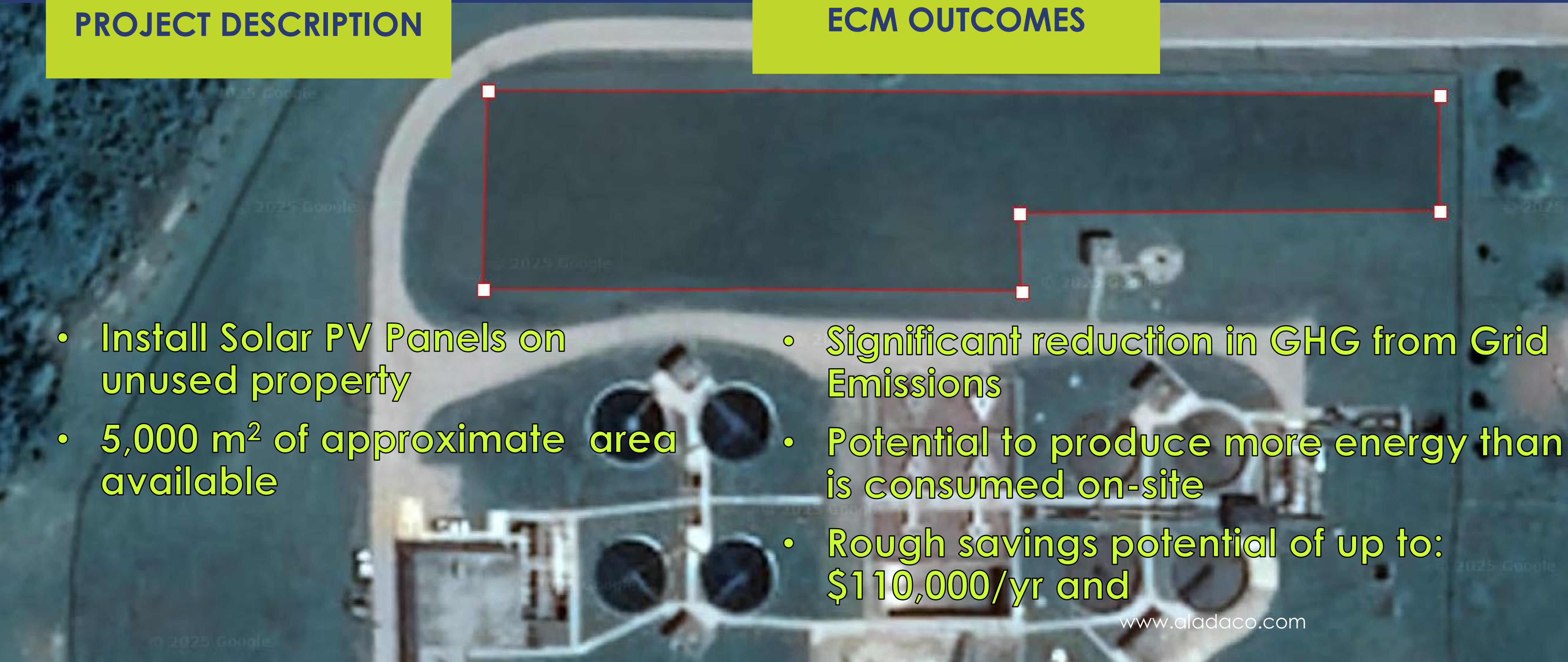
PROJECT DESCRIPTION

- Replace MAU Natural Gas heating with electric alternative (resistance or Heat Pumps)
- Replace Radiant Tube Heaters with Heat Pumps
- Replace Electric Resistive Unit Heaters with Heat Pumps

ECM OUTCOMES

- Significant reduction in GHG
- Increased building electrical loading

ECMs – Renewable Energy Generation



PROJECT DESCRIPTION

- Install Solar PV Panels on unused property
- 5,000 m^2 of approximate area available

ECM OUTCOMES

- Significant reduction in GHG from Grid Emissions
- Potential to produce more energy than is consumed on-site
- Rough savings potential of up to: $110,000/yr and

Design Workshop - WWTP

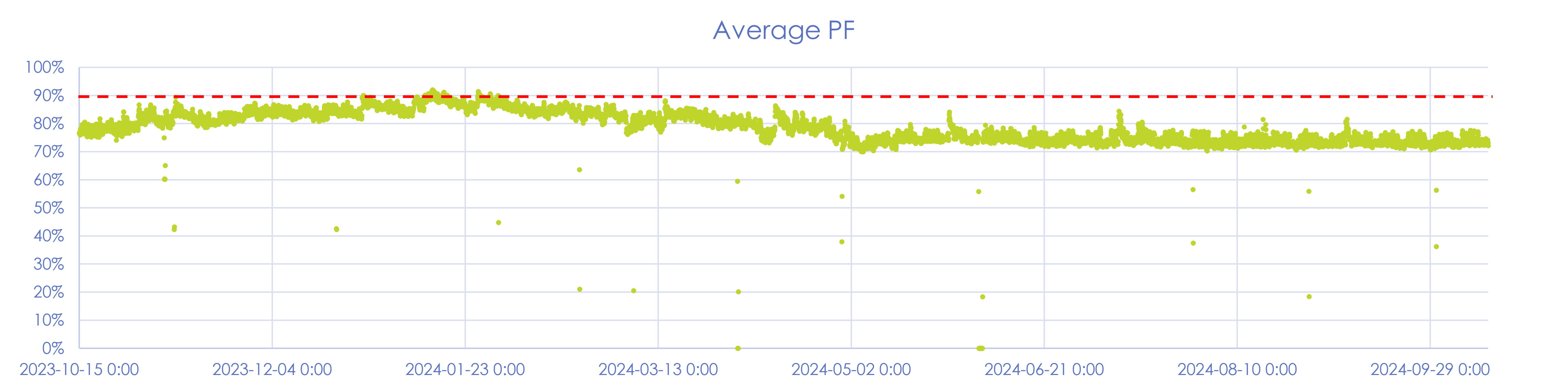
ECMs – Power Factor Correction

PROJECT DESCRIPTION

- Install capacitor banks to reduce inductive loads and improve facility power factor

ECM OUTCOMES

- Reduce Power Factor penalties on utility bills
- Financial savings measure only, will not impact emissions or energy use.



Funding Opportunities

Funding Entity	Program	Available Funding	Notes
IESO	Custom Retrofit	$0.13/kWh or $1,200/kW Peak Demand Savings	Applies to process related improvements. May be applicable to Heating Electrification and Heat Pump Installations
	Prescriptive Retrofit	Varies by Equipment Type	Per unit incentives for Lighting, VFDs, high-efficiency pumps, heat pumps, etc.
	Solar PV DER	$860/kW-AC	For a 60 kW-AC system = $51,600
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FCM Green Municipal Fund	GHG Impact Retrofit	Maximum of $5 million per project.	Up to 25% as a grant and the remainder as a loan. Combined loan and grant for up to 80% of eligible project costs. 30% GHG reduction required
Canadian Infrastructure Bank	Green Infrastructure Program	Varies based on project	Provides financing to reduce investment barriers and decarbonize buildings.

ECM Summary

ECM	Energy Savings Potential	GHG Savings Potential	Implementation Cost	Life-Cycle Cost	Selected for Study
Reduce Exhaust Area for Filter Press	Low	Low	$	Positive	X
Building Envelope Improvements - Windows	Low	Low	$$	Negative	
Building Envelope Improvements - Other	Low	Low	$$$$	Negative	
Process Related VFD Improvements	Medium	Low	$$	Positive	
Replace Aerators with Aeration Blowers	Medium	Low	$$$	Positive	
Replace Aerators with Low-Speed Models	Medium	Low	$$$	Positive	X
High-Efficiency Pumps	Low	Low	$	Positive	
Thermostat Upgrades	Low	Low	$	Positive	X
LED Lamps	Low	Low	$	Positive	
Increase SCADA/BAS capabilities	Low	Low	$$$	Negative	
Truckway Isolation	Low	Low	$$	Negative	X
Lockout Garage Heating	Low	Low	$	Negative	X
Electrification of Heating	Medium	High	$$$	Negative*	X
Solar PV Panels	None	High	$$$	Positive	X

Next Steps

- Finalization of PPT and measures selected for analysis
- Delivery of Summary Report
- Begin Measure Level Analysis phase
- Decision Making Workshop April/May


Thank You
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Appendix B: Calculations

Grid Emission Factors:

Emission Factors (CO_2e) - ZCB ref		
Year	**Electricity (g/kWh)**	**Natural Gas (g/m3)**
2019	30.5	1,921
2020	28.0	1,921
2021	30.0	1,921
2022	38.0	1,921
2023	38.0	1,921
2024	63.1	1,921
2025	84.4	1,921
2026	69.7	1,921
2027	84.9	1,921
2028	72.9	1,921
2029	66.0	1,921
2030	55.1	1,921
2031	53.4	1,921
2032	47.9	1,921
2033	40.7	1,921
2034	31.6	1,921
2035	28.0	1,921
2036	26.6	1,921
2037	24.9	1,921
2038	23.4	1,921
2039	21.5	1,921
2040	20.7	1,921
2041	19.8	1,921
2042	19.3	1,921
2043	18.6	1,921
2044	17.7	1,921

Financial Metrics

Financial Metrics	
Inflation (Capital)	2%
Inflation (Elec Cost)	2%
Inflation (NG Cost)	2%
Inflation (Labor)	2%
Discount Rate	4%

Utility Rates		
	MRC	**WWTP**
Electricity (kWh)	$0.15	$0.16
Demand (kW)	$9.95	$9.73
Natural Gas (m3)	$0.38	$0.72

ECM Calculations

Equipment	Quantity	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
		kWh	m3	kWh	m3	kWh	kW	m3						
Recommissioning of the Geothermal Systems	1	1,366,294	0	1,332,137	0	34,157	0	0	$21,500	$0	$0	$21,500	$972	Vendor

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	NPV
Recommissioning of the Geothermal Systems	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035				**$21,705.82**
Project Cost	-$21,500														
Elec Savings	$5,465	$5,574	$5,686	$5,800	$5,916	$6,034	$6,155	$6,278	$6,403	$6,531	$6,662				
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0				
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0				
Maintenance Cost	-$972	-$992	-$1,012	-$1,032	-$1,052	-$1,073	-$1,095	-$1,117	-$1,139	-$1,162	-$1,185				
Emissions Savings	2.88	2.38	2.90	2.49	2.25	1.88	1.82	1.64	1.39	1.08	0.96				
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0				
Residual Value															
Net Cash Flow	$4,493	$4,583	$4,674	$4,768	$4,863	$4,961	$5,060	$5,161	$5,264	$5,369	$5,477				

Equipment	Quantity	Baseline			Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
		BTUh Heating	kWh	m3	kWh	m3	kWh	kW	m3						
Pool Boiler B1	1	688,500	0	24,029	78,567	0	-78,567	-66	24,029	$777,430	$116,614	$77,743	$971,787	$1,600	Vendor
Domestic B1	1	1,062,500	0	45,726	151,971	0	-151,971	-88	45,726	$919,155	$137,873	$91,915	$1,148,944	$2,900	Vendor
Whirlpool Water Heater	1	323,190	0	4,024	13,273	0	-13,273	-44	4,024	$480,555	$72,083	$48,055	$600,694	$400	Vendor

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Install Water-Source Heat Pump Boilers	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$2,721,424															
Elec Savings	-$39,010	-$39,790	-$40,586	-$41,397	-$42,225	-$43,070	-$43,931	-$44,810	-$45,706	-$46,620	-$47,553	-$48,504	-$49,474	-$50,463	-$51,473	-$52,502
Demand Savings	-$1,927	-$1,965	-$2,004	-$2,044	-$2,085	-$2,127	-$2,170	-$2,213	-$2,257	-$2,302	-$2,348	-$2,395	-$2,443	-$2,492	-$2,542	-$2,593
NG Savings	$52,834	$53,890	$54,968	$56,067	$57,189	$58,333	$59,499	$60,689	$61,903	$63,141	$64,404	$65,692	$67,006	$68,346	$69,713	$71,107
Maintenance Cost	-$4,900	-$4,998	-$5,098	-$5,200	-$5,304	-$5,410	-$5,518	-$5,629	-$5,741	-$5,856	-$5,973	-$6,093	-$6,214	-$6,339	-$6,465	-$6,595
Emissions Savings	121.15	124.74	121.03	123.96	125.64	128.30	128.71	130.05	131.81	134.03	134.90	135.25	135.66	136.03	136.49	136.68
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$6,997	$7,137	$7,280	$7,426	$7,574	$7,726	$7,880	$8,038	$8,198	$8,362	$8,530	$8,700	$8,874	$9,052	$9,233	$9,417
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Install Water-Source Heat Pump Boilers	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$2,582,731.84**	
Project Cost																
Elec Savings	-$53,552	-$54,623	-$55,716	-$56,830	-$57,966	-$59,126	-$60,308	-$61,514	-$62,745	-$64,000						
Demand Savings	-$2,645	-$2,698	-$2,752	-$2,807	-$2,863	-$2,920	-$2,978	-$3,038	-$3,099	-$3,161						
NG Savings	$72,529	$73,980	$75,459	$76,969	$78,508	$80,078	$81,680	$83,313	$84,980	$86,679						
Maintenance Cost	-$6,727	-$6,861	-$6,998	-$7,138	-$7,281	-$7,427	-$7,575	-$7,727	-$7,881	-$8,039						
Emissions Savings	136.90	137.03	137.20	137.42	137.68	138.02	138.29	138.44	138.27	138.00						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$198,724												
Net Cash Flow	$9,606	$9,798	$9,994	$10,194	$10,398	$10,606	$10,818	$11,034	$11,255	$11,480						

Equipment	Quantity	Pump Size (HP)	Pump Flow (GPM)	Pump Speed (RPM)	Discharge Pressure (psig)	Discharge Head (Ft)	Valve Position	Cv	Pressure Drop	Adjusted Head	Adjusted Speed (RPM)	Operating Hours	kWh Savings	kW Savings	Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
Install Variable Frequency drives on Pool Pumps	1	20	600	1,800	34	78.7	70% Closed	380	1.6	75.0	1,758	8,760	1,270	0.20	$9,065	$1,360	$906	$11,331	$0	RSMeans

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Install Variable Frequency drives on Pool Pumps	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$11,331															
Elec Savings	$203	$207	$211	$216	$220	$224	$229	$233	$238	$243	$248	$253	$258	$263	$268	$273
Demand Savings	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$2	$3	$3	$3
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Emissions Savings	0.11	0.09	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$205	$209	$213	$218	$222	$226	$231	$236	$240	$245	$250	$255	$260	$265	$271	$276

NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV
Install Variable Frequency drives on Pool Pumps															**-$8,591.43**
Project Cost															
Elec Savings															
Demand Savings															
NG Savings															
Maintenance Cost															
Emissions Savings															
Carbon Tax Savings															
Residual Value															
Net Cash Flow															

Equipment	Area	Type	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
			kWh	m3	kWh	m3	kWh	kW	m3						
Upgrade to High Efficiency Windows	Pool	Triple Pane HE	2,471,575	162,471	2,471,104	162,452	471	0	20	$400,000	$60,000	$40,000	$500,000	$0	Vendor (Fisher Glass)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Upgrade to High Efficiency Windows	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$500,000															
Elec Savings	$75	$77	$78	$80	$82	$83	$85	$87	$88	$90	$92	$94	$96	$97	$99	$101
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG Savings	$14	$14	$15	$15	$15	$16	$16	$16	$17	$17	$17	$18	$18	$18	$19	$19
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Emissions Savings	0.08	0.07	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$89	$91	$93	$95	$97	$99	$101	$103	$105	$107	$109	$111	$114	$116	$118	$120
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Upgrade to High Efficiency Windows	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	**-$498,024.28**	
Project Cost																
Elec Savings	$103	$106	$108	$110	$112	$114	$117	$119	$121	$124	$126	$129	$131	$134		
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
NG Savings	$19	$20	$20	$21	$21	$21	$22	$22	$23	$23	$24	$24	$25	$25		
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Emissions Savings	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05		
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Residual Value				$78,238												
Net Cash Flow	$123	$125	$128	$130	$133	$136	$138	$141	$144	$147	$150	$153	$156	$159		

Equipment	Quantity	Baseline		Retrofit		Savings		Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
		kWh	m3	kWh	m3	kWh	m3						
Recommissioning of the BAS and Related Systems	1	1,471,503	159,276	1,434,715	155,295	36,788	3,982	$0	$18,060	$0	$18,060	$1,944	Vendor

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	NPV
Recommissioning of the BAS and Related Systems	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035				**$47,263.91**
Project Cost	-$18,060														
Elec Savings	$5,886	$6,004	$6,124	$6,246	$6,371	$6,499	$6,629	$6,761	$6,896	$7,034	$7,175				
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0				
NG Savings	$2,851	$2,908	$2,967	$3,026	$3,086	$3,148	$3,211	$3,275	$3,341	$3,408	$3,476				
Maintenance Cost	-$1,944	-$1,983	-$2,023	-$2,063	-$2,105	-$2,147	-$2,190	-$2,234	-$2,278	-$2,324	-$2,370				
Emissions Savings	10.75	10.21	10.77	10.33	10.08	9.68	9.61	9.41	9.15	8.81	8.68				
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0				
Residual Value															
Net Cash Flow	$6,793	$6,929	$7,067	$7,209	$7,353	$7,500	$7,650	$7,803	$7,959	$8,118	$8,281				

Equipment	Quantity	Tons Cooling	BTUh Heating	HP Size	COP	Balance Point (Deg C)	BTUh	Backup Electric COP	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
									kWh	m3	kWh	m3	kWh	kW	m3						
MAU-1	1	4	200,000	48,000	3	2	200,000	1	3,363	5,217	23,918	0	-20,555	-0.1	5,225						
HRV-1	1	22	800,000	264,000	3	2	800,000	1	139,652	19,588	233,230	0	-93,578	-3	19,588	$455,780	$79,762	$68,367	$603,909	$4,300	RSMeans
HRV-2	1	22	800,000	264,000	3	2	800,000	1	58,386	9,915	117,297	0	-58,911	-4	9,915						

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electrification of HRU's and MAU	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$603,909															
Elec Savings	-$27,687	-$28,241	-$28,806	-$29,382	-$29,969	-$30,569	-$31,180	-$31,804	-$32,440	-$33,089	-$33,750	-$34,425	-$35,114	-$35,816	-$36,532	-$37,263
Demand Savings	-$60	-$62	-$63	-$64	-$65	-$67	-$68	-$69	-$71	-$72	-$74	-$75	-$77	-$78	-$80	-$81
NG Savings	$24,869	$25,366	$25,874	$26,391	$26,919	$27,457	$28,006	$28,567	$29,138	$29,721	$30,315	$30,921	$31,540	$32,171	$32,814	$33,470
Maintenance Cost	-$4,300	-$4,386	-$4,474	-$4,563	-$4,654	-$4,748	-$4,842	-$4,939	-$5,038	-$5,139	-$5,242	-$5,347	-$5,453	-$5,563	-$5,674	-$5,787
Emissions Savings	52.11	54.65	52.02	54.10	55.29	57.18	57.47	58.42	59.67	61.24	61.87	62.11	62.40	62.66	62.99	63.13
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	-$7,178	-$7,322	-$7,468	-$7,618	-$7,770	-$7,926	-$8,084	-$8,246	-$8,411	-$8,579	-$8,750	-$8,925	-$9,104	-$9,286	-$9,472	-$9,661
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Electrification of HRU's and MAU	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$746,191.07**	
Project Cost																
Elec Savings	-$38,008	-$38,769	-$39,544	-$40,335	-$41,141	-$41,964	-$42,804	-$43,660	-$44,533	-$45,424						
Demand Savings	-$83	-$84	-$86	-$88	-$90	-$91	-$93	-$95	-$97	-$99						
NG Savings	$34,140	$34,823	$35,519	$36,229	$36,954	$37,693	$38,447	$39,216	$40,000	$40,800						
Maintenance Cost	-$5,903	-$6,021	-$6,141	-$6,264	-$6,390	-$6,517	-$6,648	-$6,781	-$6,916	-$7,055						
Emissions Savings	63.29	63.37	63.49	63.65	63.84	64.08	64.27	64.38	64.26	64.07						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$41,602												
Net Cash Flow	-$9,854	-$10,052	-$10,253	-$10,458	-$10,667	-$10,880	-$11,098	-$11,320	-$11,546	-$11,777						

Equipment	Quantity	Tons Cooling	BTUh Heating	HP Size	COP	Balance Point (Deg C)	BTUh	Backup Electric COP	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
									kWh	m3	kWh	m3	kWh	kW	m3						
Electrification of DH3	1	80	1,100,000	960,000	3	2	1,100,000	1	261,817	50,828	645,479	0	-383,662	-45	50,828	$783,328	$137,082	$117,499	$1,037,910	$2,600	Vendor

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electrification of DH3	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$1,037,910															
Elec Savings	-$61,386	-$62,614	-$63,866	-$65,143	-$66,446	-$67,775	-$69,131	-$70,513	-$71,923	-$73,362	-$74,829	-$76,326	-$77,852	-$79,409	-$80,997	-$82,617
Demand Savings	-$439	-$448	-$457	-$466	-$475	-$484	-$494	-$504	-$514	-$524	-$535	-$546	-$557	-$568	-$579	-$591
NG Savings	$36,398	$37,126	$37,868	$38,626	$39,398	$40,186	$40,990	$41,810	$42,646	$43,499	$44,369	$45,256	$46,161	$47,084	$48,026	$48,987
Maintenance Cost	-$2,600	-$2,652	-$2,705	-$2,759	-$2,814	-$2,871	-$2,928	-$2,987	-$3,046	-$3,107	-$3,169	-$3,233	-$3,297	-$3,363	-$3,431	-$3,499
Emissions Savings	65.26	70.90	65.07	69.67	72.32	76.50	77.15	79.26	82.02	85.52	86.90	87.43	88.09	88.66	89.39	89.70
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	-$28,027	-$28,588	-$29,159	-$29,743	-$30,337	-$30,944	-$31,563	-$32,194	-$32,838	-$33,495	-$34,165	-$34,848	-$35,545	-$36,256	-$36,981	-$37,721
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Electrification of DH3	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$1,593,428.53**	
Project Cost																
Elec Savings	-$84,270	-$85,955	-$87,674	-$89,428	-$91,216	-$93,041	-$94,901	-$96,799	-$98,735	-$100,710						
Demand Savings	-$602	-$614	-$627	-$639	-$652	-$665	-$678	-$692	-$706	-$720						
NG Savings	$49,966	$50,966	$51,985	$53,025	$54,085	$55,167	$56,270	$57,396	$58,543	$59,714						
Maintenance Cost	-$3,569	-$3,641	-$3,713	-$3,788	-$3,863	-$3,941	-$4,020	-$4,100	-$4,182	-$4,266						
Emissions Savings	90.04	90.24	90.50	90.85	91.27	91.81	92.23	92.46	92.19	91.77						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$71,500												
Net Cash Flow	-$38,475	-$39,245	-$40,030	-$40,830	-$41,647	-$42,480	-$43,329	-$44,196	-$45,080	-$45,981						

Equipment	Quantity	Tons Cooling	BTUh Heating	HP Size	COP	Balance Point (Deg C)	BTUh	Backup Electric COP	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
									kWh	m3	kWh	m3	kWh	kW	m3						
Electrification of Unit Heaters	5	-	250,000	-	-	-	250,000	1	0	3,195	22,969	0	-22,969	0.1	3,195	$17,907	$2,686	$403	$20,996	$0	RSMeans

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electrification of Unit Heaters	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$20,996															
Elec Savings	-$3,675	-$3,749	-$3,824	-$3,900	-$3,978	-$4,058	-$4,139	-$4,221	-$4,306	-$4,392	-$4,480	-$4,569	-$4,661	-$4,754	-$4,849	-$4,946
Demand Savings	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1	$1
NG Savings	$2,288	$2,334	$2,380	$2,428	$2,477	$2,526	$2,577	$2,628	$2,681	$2,734	$2,789	$2,845	$2,902	$2,960	$3,019	$3,079
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Emissions Savings	4.20	4.54	4.19	4.46	4.62	4.87	4.91	5.04	5.20	5.41	5.49	5.53	5.57	5.60	5.64	5.66
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	-$1,386	-$1,414	-$1,442	-$1,471	-$1,500	-$1,530	-$1,561	-$1,592	-$1,624	-$1,656	-$1,690	-$1,723	-$1,758	-$1,793	-$1,829	-$1,865
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Electrification of Unit Heaters	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$48,469.62**	
Project Cost																
Elec Savings	-$5,045	-$5,146	-$5,249	-$5,354	-$5,461	-$5,570	-$5,682	-$5,795	-$5,911	-$6,029						
Demand Savings	$1	$1	$1	$1	$1	$1	$2	$2	$2	$2						
NG Savings	$3,141	$3,204	$3,268	$3,333	$3,400	$3,468	$3,537	$3,608	$3,680	$3,754						
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Emissions Savings	5.68	5.69	5.71	5.73	5.76	5.79	5.81	5.83	5.81	5.79						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$1,635												
Net Cash Flow	-$1,903	-$1,941	-$1,980	-$2,019	-$2,060	-$2,101	-$2,143	-$2,186	-$2,229	-$2,274						

Equipment	Quantity	Capacity DC (kW)	Capacity AC (kW)	Operating Hours	Baseline			Retrofit			Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
					kWh	kW	m3	kWh	kW	m3	kWh	kW	m3						
Install Rooftop Solar PV System	1	341	250	1,600	0	0	0	-400,000	0	0	400,000	0	0	$582,250	$115,750	$58,225	$756,225	$5,115	Vendor (Delta Energy Solutions)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Install Rooftop Solar PV System	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$756,225															
Elec Savings	$64,000	$65,280	$66,586	$67,917	$69,276	$70,661	$72,074	$73,516	$74,986	$76,486	$78,016	$79,576	$81,167	$82,791	$84,447	$86,136
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	-$5,115	-$5,217	-$5,322	-$5,428	-$5,537	-$5,647	-$5,760	-$5,876	-$5,993	-$6,113	-$6,235	-$6,360	-$6,487	-$6,617	-$6,749	-$6,884
Emissions Savings	33.76	27.88	33.96	29.16	26.40	22.04	21.36	19.16	16.28	12.64	11.20	10.64	9.96	9.36	8.60	8.28
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$58,885	$60,063	$61,264	$62,489	$63,739	$65,014	$66,314	$67,640	$68,993	$70,373	$71,780	$73,216	$74,680	$76,174	$77,698	$79,251
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Install Rooftop Solar PV System	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**$410,923.11**	
Project Cost																
Elec Savings	$87,858	$89,615	$91,408	$93,236	$95,101	$97,003	$98,943	$100,922	$102,940	$104,999						
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Maintenance Cost	-$7,022	-$7,162	-$7,305	-$7,452	-$7,601	-$7,753	-$7,908	-$8,066	-$8,227	-$8,392						
Emissions Savings	7.92	7.72	7.44	7.08	6.64	6.08	5.64	5.40	5.68	6.12						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$53,146												
Net Cash Flow	$80,836	$82,453	$84,102	$85,784	$87,500	$89,250	$91,035	$92,856	$94,713	$96,607						

Equipment	Quantity	Baseline			Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
		BTUh Heating	kWh	m3	kWh	m3	kWh	kW	m3						
Pool Boiler B1	1	688,500	0	24,029	196,540	0	-196,540	-210	24,029	$313,649	$78,412	$62,730	$454,790	$3,750	RSMeans/Vendor (Electro Industries)
Domestic B1	1	1,062,500	0	45,726	380,054	0	-380,054	-300	45,726						
Whirlpool Water Heater	1	323,190	0	4,024	33,304	0	-33,304	-120	4,024						

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electrification of Pool and DHW Boilers	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$454,790															
Elec Savings	-$97,584	-$99,535	-$101,526	-$103,557	-$105,628	-$107,740	-$109,895	-$112,093	-$114,335	-$116,622	-$118,954	-$121,333	-$123,760	-$126,235	-$128,760	-$131,335
Demand Savings	-$6,130	-$6,252	-$6,378	-$6,505	-$6,635	-$6,768	-$6,903	-$7,041	-$7,182	-$7,326	-$7,472	-$7,622	-$7,774	-$7,930	-$8,088	-$8,250
NG Savings	$52,834	$53,890	$54,968	$56,067	$57,189	$58,333	$59,499	$60,689	$61,903	$63,141	$64,404	$65,692	$67,006	$68,346	$69,713	$71,107
Maintenance Cost	-$3,750	-$3,825	-$3,902	-$3,980	-$4,059	-$4,140	-$4,223	-$4,308	-$4,394	-$4,482	-$4,571	-$4,663	-$4,756	-$4,851	-$4,948	-$5,047
Emissions Savings	90.26	99.22	89.95	97.27	101.48	108.13	109.16	112.52	116.91	122.46	124.65	125.51	126.54	127.46	128.62	129.11
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	-$54,630	-$55,723	-$56,837	-$57,974	-$59,133	-$60,316	-$61,522	-$62,753	-$64,008	-$65,288	-$66,594	-$67,925	-$69,284	-$70,670	-$72,083	-$73,525
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Electrification of Pool and DHW Boilers	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$1,537,600.28**	
Project Cost																
Elec Savings	-$133,961	-$136,641	-$139,374	-$142,161	-$145,004	-$147,904	-$150,862	-$153,880	-$156,957	-$160,096						
Demand Savings	-$8,415	-$8,583	-$8,755	-$8,930	-$9,109	-$9,291	-$9,477	-$9,666	-$9,860	-$10,057						
NG Savings	$72,529	$73,980	$75,459	$76,969	$78,508	$80,078	$81,680	$83,313	$84,980	$86,679						
Maintenance Cost	-$5,148	-$5,251	-$5,356	-$5,463	-$5,572	-$5,684	-$5,797	-$5,913	-$6,032	-$6,152						
Emissions Savings	129.65	129.96	130.39	130.94	131.61	132.46	133.13	133.50	133.07	132.40						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$28,629												
Net Cash Flow	-$74,995	-$76,495	-$78,025	-$79,586	-$81,177	-$82,801	-$84,457	-$86,146	-$87,869	-$89,626						

Equipment	Existing Volume (ft^3)	Retrofit Volume (ft^3)	Baseline			Retrofit			Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
			kWh	kW	m3	kWh	kW	m3	kWh	kW	m3						
Reduce Exhaust Area for Filter Press	40,147	14,650	35,661	15.1	186	28,638	5.4	186	7,023	9.7	0	$2,135	$320	$213	$2,668	$1,020	Vendor (ULine)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Reduce Exhaust Area for Filter Press	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$2,668	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$1,124	$1,146	$1,169	$1,192	$1,216	$1,241	$1,265	$1,291	$1,317	$1,343	$1,370	$1,397	$1,425	$1,454	$1,483	$1,512
Demand Savings	$94	$96	$98	$100	$102	$104	$106	$108	$111	$113	$115	$117	$120	$122	$124	$127
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	-$1,020	-$1,040	-$1,061	-$1,082	-$1,104	-$1,126	-$1,149	-$1,172	-$1,195	-$1,219	-$1,243	-$1,268	-$1,294	-$1,319	-$1,346	-$1,373
Emissions Savings	0.59	0.49	0.60	0.51	0.46	0.39	0.38	0.34	0.29	0.22	0.20	0.19	0.17	0.16	0.15	0.15
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$198	$202	$206	$210	$214	$219	$223	$227	$232	$237	$241	$246	$251	$256	$261	$266
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Reduce Exhaust Area for Filter Press	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**$1,256.19**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	$1,543	$1,573	$1,605	$1,637	$1,670	$1,703	$1,737	$1,772	$1,807	$1,843						
Demand Savings	$129	$132	$135	$137	$140	$143	$146	$149	$152	$155						
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Maintenance Cost	-$1,400	-$1,428	-$1,457	-$1,486	-$1,516	-$1,546	-$1,577	-$1,608	-$1,641	-$1,673						
Emissions Savings	0.14	0.14	0.13	0.12	0.12	0.11	0.10	0.09	0.10	0.11						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$195												
Net Cash Flow	$272	$277	$283	$288	$294	$300	$306	$312	$318	$325						

Equipment	Quantity	Capacity DC (kW)	Capacity AC (kW)	Operating Hours	Baseline		Retrofit		Savings		Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
					kWh	m3	kWh	m3	kWh	m3						
Install Ground Mount Solar PV System 510 kW DC	1	510	429	1,400	0	0	-600,000	0	600,000	0	$975,375	$193,125	$97,538	$1,266,038	$7,650	Vendor (Delta Energy Solutions)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Install Ground Mount Solar PV System 510 kW DC	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$1,266,038	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$96,000	$97,920	$99,878	$101,876	$103,913	$105,992	$108,112	$110,274	$112,479	$114,729	$117,023	$119,364	$121,751	$124,186	$126,670	$129,203
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	-$7,650	-$7,803	-$7,959	-$8,118	-$8,281	-$8,446	-$8,615	-$8,787	-$8,963	-$9,142	-$9,325	-$9,512	-$9,702	-$9,896	-$10,094	-$10,296
Emissions Savings	50.64	41.82	50.94	43.74	39.60	33.06	32.04	28.74	24.42	18.96	16.80	15.96	14.94	14.04	12.90	12.42
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$88,350	$90,117	$91,919	$93,758	$95,633	$97,546	$99,496	$101,486	$103,516	$105,586	$107,698	$109,852	$112,049	$114,290	$116,576	$118,907
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Install Ground Mount Solar PV System 510 kW DC	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**$485,130.64**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	$131,787	$134,423	$137,112	$139,854	$142,651	$145,504	$148,414	$151,382	$154,410	$157,498						
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Maintenance Cost	-$10,502	-$10,712	-$10,926	-$11,145	-$11,367	-$11,595	-$11,827	-$12,063	-$12,305	-$12,551						
Emissions Savings	11.88	11.58	11.16	10.62	9.96	9.12	8.46	8.10	8.52	9.18						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$89,030												
Net Cash Flow	$121,286	$123,711	$126,186	$128,709	$131,283	$133,909	$136,587	$139,319	$142,105	$144,948						

Equipment	Qty	Flowrate (Nm3/hr)	Transfer Rate (Nm3/kWh)	Power (kW)	Underground Piping (m)	Diffuser Tubes (m)	Operating Hours	Existing Mechanical Aerators (Metered)		Baseline		Retrofit		Savings		Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
								Low Speed Annual (kWh)	High Speed Annual (kWh)	kWh	kW	kWh	kW	kWh	kW						
Install Aeration Blower	1	1800	65.21	27.6	100	150	8,760	252,723	77,989	330,712	37.8	241,776	27.6	88,936	10.2	$212,749	$31,912	$21,275	$265,936	$3,400	RSMeans/Vendor (ENV Treatment Systems)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Install Aeration Blower	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$265,936	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$14,230	$14,514	$14,805	$15,101	$15,403	$15,711	$16,025	$16,346	$16,672	$17,006	$17,346	$17,693	$18,047	$18,408	$18,776	$19,151
Demand Savings	$100	$102	$104	$106	$108	$110	$112	$114	$117	$119	$121	$124	$126	$129	$131	$134
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	-$3,400	-$3,468	-$3,537	-$3,608	-$3,680	-$3,754	-$3,829	-$3,906	-$3,984	-$4,063	-$4,145	-$4,227	-$4,312	-$4,398	-$4,486	-$4,576
Emissions Savings	7.51	6.20	7.55	6.48	5.87	4.90	4.75	4.26	3.62	2.81	2.49	2.37	2.21	2.08	1.91	1.84
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$10,929	$11,148	$11,371	$11,598	$11,830	$12,067	$12,308	$12,554	$12,806	$13,062	$13,323	$13,589	$13,861	$14,138	$14,421	$14,710
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Install Aeration Blower	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$49,306.59**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	$19,534	$19,925	$20,324	$20,730	$21,145	$21,568	$21,999	$22,439	$22,888	$23,345						
Demand Savings	$137	$139	$142	$145	$148	$151	$154	$157	$160	$163						
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Maintenance Cost	-$4,667	-$4,761	-$4,856	-$4,953	-$5,052	-$5,153	-$5,256	-$5,361	-$5,469	-$5,578						
Emissions Savings	1.76	1.72	1.65	1.57	1.48	1.35	1.25	1.20	1.26	1.36						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$19,419												
Net Cash Flow	$15,004	$15,304	$15,610	$15,922	$16,241	$16,565	$16,897	$17,235	$17,579	$17,931						

Equipment	Quantity	Baseline		Retrofit		Savings		Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
		kWh	m3	kWh	m3	kWh	m3						
Thermostat Upgrades	13	36,754	6,387	16,383	3,790	20,371	2,597	$3,900	$0	$0	$4,290	$510	Internal

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Thermostat Upgrades	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$4,290	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$3,259	$3,325	$3,391	$3,459	$3,528	$3,599	$3,671	$3,744	$3,819	$3,895	$3,973	$4,053	$4,134	$4,216	$4,301	$4,387
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG Savings	$1,860	$1,897	$1,935	$1,974	$2,013	$2,053	$2,095	$2,136	$2,179	$2,223	$2,267	$2,313	$2,359	$2,406	$2,454	$2,503
Maintenance Cost	-$510	-$520	-$531	-$541	-$552	-$563	-$574	-$586	-$598	-$609	-$622	-$634	-$647	-$660	-$673	-$686
Emissions Savings	6.71	6.41	6.72	6.47	6.33	6.11	6.08	5.97	5.82	5.63	5.56	5.53	5.50	5.47	5.43	5.41
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$4,609	$4,701	$4,795	$4,891	$4,989	$5,089	$5,191	$5,295	$5,400	$5,508	$5,619	$5,731	$5,846	$5,963	$6,082	$6,203
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Thermostat Upgrades	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	**$97,464.13**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Elec Savings	$4,474	$4,564	$4,655	$4,748	$4,843	$4,940	$5,039	$5,140	$5,242	$5,347	$5,454	$5,563	$5,675	$5,788		
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
NG Savings	$2,553	$2,604	$2,656	$2,709	$2,764	$2,819	$2,875	$2,933	$2,991	$3,051	$3,112	$3,175	$3,238	$3,303		
Maintenance Cost	-$700	-$714	-$728	-$743	-$758	-$773	-$788	-$804	-$820	-$837	-$853	-$871	-$888	-$906		
Emissions Savings	5.39	5.38	5.37	5.35	5.33	5.30	5.28	5.26	5.28	5.30	5.30	5.30	5.30	5.30		
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Residual Value				$763												
Net Cash Flow	$6,327	$6,454	$6,583	$6,715	$6,849	$6,986	$7,126	$7,268	$7,414	$7,562	$7,713	$7,867	$8,025	$8,185		

Equipment	Location	Existing Windowed Area (ft2)	Retrofit Windowed Area (ft2)	Type	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
					kWh	m3	kWh	m3	kWh	kW	m3						
Reduce Windowed Area in the Control Room	Control Room	10.2	6.5	Triple Pane HE	0	1,633	0	1,390	0	0	243	$14,563	$2,184	$2,184	$18,932	$0	RSMeans

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Reduce Windowed Area in the Control Room	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$18,932	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG Savings	$174	$177	$181	$184	$188	$192	$196	$199	$203	$208	$212	$216	$220	$225	$229	$234
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Emissions Savings	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$174	$177	$181	$184	$188	$192	$196	$199	$203	$208	$212	$216	$220	$225	$229	$234

NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV
Reduce Windowed Area in the Control Room	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	**-$15,097.77**
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Elec Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
NG Savings	$238	$243	$248	$253	$258	$263	$268	$274	$279	$285	$291	$296	$302	$308	
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Emissions Savings	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Residual Value				$2,848											
Net Cash Flow	$238	$243	$248	$253	$258	$263	$268	$274	$279	$285	$291	$296	$302	$308	

Equipment	Quantity	Airflow	BTUh Heating	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
				kWh	m3	kWh	m3	kWh	kW	m3						
Electrification of the MAU	1	4,000	12,000	1,096	186	2,631	0	-1,535	-3.5	186	$29,344	$4,402	$2,934	$36,681	$1,500	RSMeans

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electrification of the MAU	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$36,681	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	-$246	-$251	-$256	-$261	-$266	-$271	-$277	-$282	-$288	-$294	-$299	-$305	-$311	-$318	-$324	-$331
Demand Savings	-$34	-$35	-$36	-$36	-$37	-$38	-$39	-$39	-$40	-$41	-$42	-$43	-$43	-$44	-$45	-$46
NG Savings	$133	$136	$139	$141	$144	$147	$150	$153	$156	$159	$162	$166	$169	$172	$176	$179
Maintenance Cost	-$1,500	-$1,530	-$1,561	-$1,592	-$1,624	-$1,656	-$1,689	-$1,723	-$1,757	-$1,793	-$1,828	-$1,865	-$1,902	-$1,940	-$1,979	-$2,019
Emissions Savings	0.23	0.25	0.23	0.25	0.26	0.27	0.28	0.28	0.30	0.31	0.31	0.32	0.32	0.32	0.32	0.33
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	-$1,647	-$1,679	-$1,713	-$1,747	-$1,782	-$1,818	-$1,854	-$1,891	-$1,929	-$1,968	-$2,007	-$2,047	-$2,088	-$2,130	-$2,173	-$2,216
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Electrification of the MAU	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$69,316.10**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	-$337	-$344	-$351	-$358	-$365	-$372	-$380	-$387	-$395	-$403						
Demand Savings	-$47	-$48	-$49	-$50	-$51	-$52	-$53	-$54	-$55	-$56						
NG Savings	$183	$187	$190	$194	$198	$202	$206	$210	$214	$219						
Maintenance Cost	-$2,059	-$2,100	-$2,142	-$2,185	-$2,229	-$2,273	-$2,319	-$2,365	-$2,413	-$2,461						
Emissions Savings	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.34	0.34	0.33						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$2,678												
Net Cash Flow	-$2,260	-$2,306	-$2,352	-$2,399	-$2,447	-$2,496	-$2,546	-$2,596	-$2,648	-$2,701						

Equipment	Existing Quantity	Existing Capacity (BTUh)	Retrofit Quantity	Retrofit Capacity (BTUh)	Retrofit COP	Baseline		Retrofit		Savings			Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
						kWh	m3	kWh	m3	kWh	kW	m3						
Truck Bay Tube Heater	1	80,000	2	49,000	3	0	1,238	6,126	0	-6,126	-7	1,238	$124,476	$18,671	$12,448	$155,595	$0	RSMeans/ Vendor (Senville)
Workshop Tube Heater	1	80,000	2	49,000	3	0	1,376	9,458	0	-9,458	-30	1,376						
Belt Filter Press Tube Heater	1	80,000	2	49,000	3	0	1,404	9,608	0	-9,608	-30	1,404						
Chlorine Tube Heater	1	80,000	1	49,000	3	0	623	2,775	0	-2,775	-6	623						
Control Tube Heater	2	40,000	2	49,000	3	0	1,633	7,661	0	-7,661	-18	1,633						
Locker Tube Heater	1	40,000	1	49,000	3	0	113	650	0	-650	-3	113						

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Electrification of Tube Heaters	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$155,595	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	-$5,804	-$5,921	-$6,039	-$6,160	-$6,283	-$6,409	-$6,537	-$6,668	-$6,801	-$6,937	-$7,076	-$7,217	-$7,361	-$7,509	-$7,659	-$7,812
Demand Savings	-$506	-$516	-$526	-$537	-$548	-$559	-$570	-$581	-$593	-$605	-$617	-$629	-$642	-$655	-$668	-$681
NG Savings	$4,574	$4,665	$4,759	$4,854	$4,951	$5,050	$5,151	$5,254	$5,359	$5,466	$5,576	$5,687	$5,801	$5,917	$6,035	$6,156
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Emissions Savings	9.21	9.74	9.19	9.63	9.88	10.27	10.33	10.53	10.79	11.12	11.25	11.31	11.37	11.42	11.49	11.52
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	-$1,736	-$1,771	-$1,807	-$1,843	-$1,880	-$1,917	-$1,956	-$1,995	-$2,035	-$2,075	-$2,117	-$2,159	-$2,202	-$2,246	-$2,291	-$2,337
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Electrification of Tube Heaters	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$190,013.87**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	-$7,968	-$8,128	-$8,290	-$8,456	-$8,625	-$8,798	-$8,974	-$9,153	-$9,336	-$9,523						
Demand Savings	-$695	-$708	-$723	-$737	-$752	-$767	-$782	-$798	-$814	-$830						
NG Savings	$6,279	$6,405	$6,533	$6,663	$6,797	$6,933	$7,071	$7,213	$7,357	$7,504						
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Emissions Savings	11.55	11.57	11.60	11.63	11.67	11.72	11.76	11.78	11.75	11.71						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$11,362												
Net Cash Flow	-$2,384	-$2,432	-$2,480	-$2,530	-$2,580	-$2,632	-$2,685	-$2,738	-$2,793	-$2,849						

Equipment	Quantity	Heating Capacity (kW, ea)	HP Size (BTUh, ea)	COP	Baseline	Retrofit	Savings		Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
					kWh	kWh	kWh	kW						
Replace Electric Unit Heaters with Heat Pumps	12	3	12,000	3	37,978	21,778	16,200	7.7	$55,377	$8,307	$5,538	$69,221	$0	RSMeans/Vendor (Senville)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Replace Electric Unit Heaters with Heat Pumps	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$69,221	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$2,592	$2,644	$2,697	$2,751	$2,806	$2,862	$2,919	$2,977	$3,037	$3,098	$3,160	$3,223	$3,287	$3,353	$3,420	$3,488
Demand Savings	$74	$76	$77	$79	$81	$82	$84	$86	$87	$89	$91	$93	$94	$96	$98	$100
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Emissions Savings	1.37	1.13	1.38	1.18	1.07	0.89	0.87	0.78	0.66	0.51	0.45	0.43	0.40	0.38	0.35	0.34
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$2,666	$2,720	$2,774	$2,830	$2,886	$2,944	$3,003	$3,063	$3,124	$3,187	$3,250	$3,315	$3,382	$3,449	$3,518	$3,589
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Replace Electric Unit Heaters with Heat Pumps	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**-$16,370.37**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	$3,558	$3,629	$3,702	$3,776	$3,852	$3,929	$4,007	$4,087	$4,169	$4,252						
Demand Savings	$102	$104	$106	$108	$111	$113	$115	$117	$120	$122						
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Maintenance Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Emissions Savings	0.32	0.31	0.30	0.29	0.27	0.25	0.23	0.22	0.23	0.25						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$5,055												
Net Cash Flow	$3,660	$3,734	$3,808	$3,884	$3,962	$4,041	$4,122	$4,205	$4,289	$4,375						

Equipment	Quantity	Capacity DC (kW)	Capacity AC (kW)	Operating Hours	Baseline		Retrofit		Savings		Materials & Labour	Engineering	Contingency	Total Capital	O&M	Pricing
					kWh	m3	kWh	m3	kWh	m3						
Install Ground Mount Solar PV System 260 kW DC	1	260	214	1,400	0	0	-300,000	0	300,000	0	$497,250	$98,750	$49,725	$645,725	$3,900	Vendor (Delta Energy Solutions)

NPV Calculations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Install Ground Mount Solar PV System 260 kW DC	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Project Cost	-$645,725	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Elec Savings	$48,000	$48,960	$49,939	$50,938	$51,957	$52,996	$54,056	$55,137	$56,240	$57,364	$58,512	$59,682	$60,876	$62,093	$63,335	$64,602
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Maintenance Cost	-$3,900	-$3,978	-$4,058	-$4,139	-$4,221	-$4,306	-$4,392	-$4,480	-$4,569	-$4,661	-$4,754	-$4,849	-$4,946	-$5,045	-$5,146	-$5,249
Emissions Savings	25.32	20.91	25.47	21.87	19.80	16.53	16.02	14.37	12.21	9.48	8.40	7.98	7.47	7.02	6.45	6.21
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Residual Value																
Net Cash Flow	$44,100	$44,982	$45,882	$46,799	$47,735	$48,690	$49,664	$50,657	$51,670	$52,704	$53,758	$54,833	$55,929	$57,048	$58,189	$59,353
NPV Calculations	17	18	19	20	21	22	23	24	25	26	27	28	29	30	NPV	
Install Ground Mount Solar PV System 260 kW DC	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050					**$228,372.51**	
Project Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Elec Savings	$65,894	$67,212	$68,556	$69,927	$71,325	$72,752	$74,207	$75,691	$77,205	$78,749						
Demand Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
NG Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Maintenance Cost	-$5,354	-$5,461	-$5,570	-$5,682	-$5,795	-$5,911	-$6,029	-$6,150	-$6,273	-$6,398						
Emissions Savings	5.94	5.79	5.58	5.31	4.98	4.56	4.23	4.05	4.26	4.59						
Carbon Tax Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0						
Residual Value				$45,388												
Net Cash Flow	$60,540	$61,751	$62,986	$64,245	$65,530	$66,841	$68,178	$69,541	$70,932	$72,351						

Appendix C: Disqualified ECMs

The following ECMs were identified for analysis through the Design Workshops but were disqualified from inclusion in the decarbonization pathways due to limited potential for GHG reductions and poor financial returns.

MRC ECM – Install Variable Frequency drives on Pool Pumps (MRC)

Utility Savings	
Electricity (kWh)	1,270
Demand (kW)	0.2
Natural Gas (m^3)	0
GHG (tCO_2e)	0.1
GHG Baseline Reduction	0%
EUI Reduction ($ekWh/m^2$)	0.18
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$9,065
Engineering & PM	$1,360
Contingency	$906
Total Capital Cost	$11,331
Utility Savings	$214
Annual O&M	$-
Simple Payback	52.9
Net-Present Value	-$8,591

<u>Existing Conditions:</u>

The primary pool circulation pump has its output flow restricted by a butterfly valve. This is likely to aid in balancing the systems' overall flow and improve system performance. This type of flow control, however, represents an inefficiency in energy usage, as the amount of pumping energy used is higher than required by the system.

Figure 23: Pool Circulation Pump Control Valve

Proposed Measure:

To improve flow control and reduce energy usage, it is recommended to install a VFD to reduce the flow of water in the pool's circulation system. This type of flow control can significantly decrease energy consumed by pumps and motors while also increasing the level of operational control.

Implementation and Non-Financial Considerations:

Several other VFDs are already installed at this facility and site staff are familiar with their operation. The system can be tied into the existing BAS, allowing for a seamless integration with current systems. Implementation of the measure would result in a brief interruption of pool circulation with little to no impact on pool operations.

Measurement and Verification:

M&V for this measure is recommended to follow IPMVP Option A – Retrofit Isolation due to the quantity of saving, the availability of spot meter data, as well as BAS trend data.

MRC ECM – Electrification of Pool and DHW Boilers - MRC

Utility Savings	
Electricity (kWh)	-609,898
Demand (kW)	-630
Natural Gas (m^3)	73,780
GHG (tCO_2e)	90.3
GHG Baseline Reduction	23%
EUI Reduction ($ekWh/m^2$)	25.51
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$313,649
Engineering & PM	$78,412
Contingency	$62,730
Total Capital Cost	$454,790
Utility Savings	-$138,958
Annual O&M	$3,750
Simple Payback	-3.3
Net-Present Value	-$1,537,600

Existing Conditions:

The MRC currently relies on natural gas-fired boilers to provide hot water for the pool, whirlpool, and domestic hot water systems. These boilers are a significant source of fossil fuel consumption at the facility and contribute directly to its operational greenhouse gas emissions. The equipment is aging and represents an opportunity for both emissions reduction and operational efficiency improvement through electrification.

Existing Equipment	Heating Capacity (BTUh)
Pool Boiler B1	688,500
Domestic Hot Water Boiler B1	1,062,500
Whirlpool Water Heater	323,190

Proposed Measure:

The measure proposes replacing the existing boilers with new equivalent capacity electric models to significantly reduce GHG emissions.

Proposed Equipment	Electric Boiler Capacity (kW)
Pool Boiler B1	210
Domestic Hot Water Boiler B1	300
Whirlpool Water Heater	120

Implementation and Non-Financial Considerations:

The measure is not expected to have any impact on occupant comfort or facility operations. Implementation of this measure is also not expected to impact operations.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A or B is recommended, based on the availability of BAS data and energy meter data.

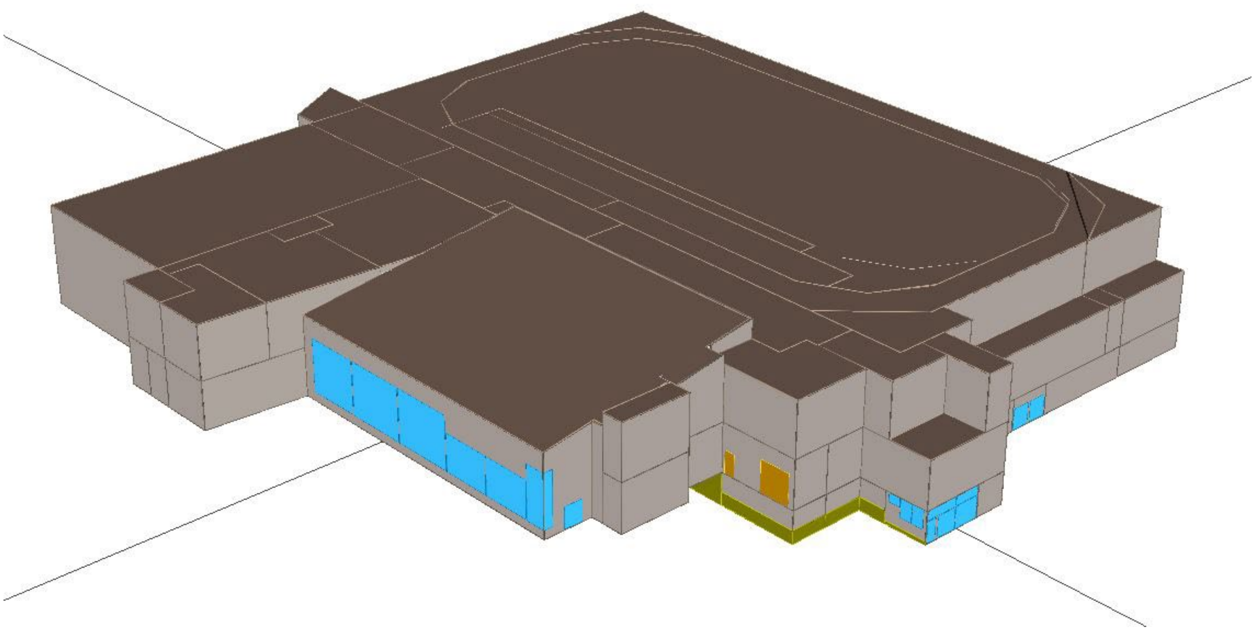
MRC ECM – Upgrade to High Efficiency Windows

Utility Savings	
Electricity (kWh)	471
Demand (kW)	0.0
Natural Gas (m^3)	20
GHG (tCO_2e)	0.1
GHG Baseline Reduction	0%
EUI Reduction ($ekWh/m^2$)	0.10
TEDI Reduction	0.17%

Financial Analysis	
Materials & Labour	$400,000
Engineering & PM	$60,000
Contingency	$40,000
Total Capital Cost	$500,000
Utility Savings	$78
Annual O&M	$-
Simple Payback	6,404
Net-Present Value	-$498,024

Existing Conditions:

The MRC currently has double-pane windows on its exterior. The majority of these windows are in the pool area, as pictured below. The existing windows will reach their end-of-life within the study period.



Proposed Measure:

The measure proposes replacing the pool area windows with triple-pane high efficiency windows. This measure will increase the insulating properties of this exterior wall and increase occupant comfort, while still maintaining natural lighting in the pool.

Implementation and Non-Financial Considerations:

Replacing the windows will require significant impacts to pool operations, including some shutdown of services. With proper planning, the severity of these impacts can be minimized by scheduling during low-occupancy periods. Overall, impacts from the project on occupants are expected to be positive due to increased comfort resulting from the improved thermal performance of the windows.

Measurement and Verification:

To measure the electrical energy and carbon savings IPMVP Option A or B is recommended, based on the scope of the project and the size of the estimated savings.

WWTP ECM – Replace Electric Unit Heaters with Heat Pumps

Utility Savings	
Electricity (kWh)	16,200
Demand (kW)	7.7
Natural Gas (m^3)	0
GHG (tCO_2e)	1.4
GHG Baseline Reduction	4%
EUI Reduction ($ekWh/m^2$)	0.48
TEDI Reduction	0%

Financial Analysis	
Materials & Labour	$55,377
Engineering & PM	$8,307
Contingency	$5,538
Total Capital Cost	$69,221
Utility Savings	$3,039
Annual O&M	$-
Simple Payback	22.8
Net-Present Value	-$16,370

Existing Conditions:

The Pumphouse, Office, and Chlorine Room are heated via electric unit heaters. While these units do not produce significant carbon emissions, their operation can be improved through installing heat pumps.

Location	Electric Unit Heater Capacity (BTUh)
Pumphouses	110,000
Office & Chlorine Room	20,000

Proposed Measure:

The measure proposes replacing the existing electric unit heaters with mini-split heat pumps with electric backup heating. The mini-split heat pumps will operate at outdoor air temperatures above 2° C and the electric heating will supply heat at lower temperatures, ensuring the interior temperature is consistently maintained.

Location	Heat Pump Capacity (BTUh)	Supplementary Electric Capacity (BTUh)
Pumphouses	108,000	108,000
Office & Chlorine Room	24,000	24,000

Implementation and Non-Financial Considerations:

Installation costs include penetration to the building envelope to accommodate the new systems. The actual placement of the interior fan coil units will differ from the current heating system as the interior fan coil units will be limited in the distance away from the exterior units they can be located.

Measurement and Verification:

To measure the change in energy consumption IPMVP Option A is recommended to keep M&V costs in line with savings estimates.

WWTP ECM – Reduce Windowed Area in the Control Room

Utility Savings	
Electricity (kWh)	0
Demand (kW)	0.0
Natural Gas (m^3)	243
GHG (tCO_2e)	0.5
GHG Baseline Reduction	1%
EUI Reduction ($ekWh/m^2$)	0.08
TEDI Reduction	1.05%

Financial Analysis	
Materials & Labour	$14,563
Engineering & PM	$2,184
Contingency	$2,184
Total Capital Cost	$18,932
Utility Savings	$174
Annual O&M	$-
Simple Payback	109.0
Net-Present Value	-$15,098

Existing Conditions:

The Control Room's exterior curtain wall is aged and uses older double pane insulated glass. Site staff have communicated that the windows are oversized and unnecessary for the space, often leading to overheating in the summer and increasing the heating requirements in the winter due to their age and construction.

Figure 24: WWTP Control Room Curtain Wall

Proposed Measure:

The measure proposes reducing the total windowed area by approximately 30% and installing modern triple pane insulted windows in place of the curtain wall. This measure will increase the insulating properties of this exterior wall and increase occupant comfort, while still maintaining natural lighting and visibility of the WWTP from the Control Room.

Implementation and Non-Financial Considerations:

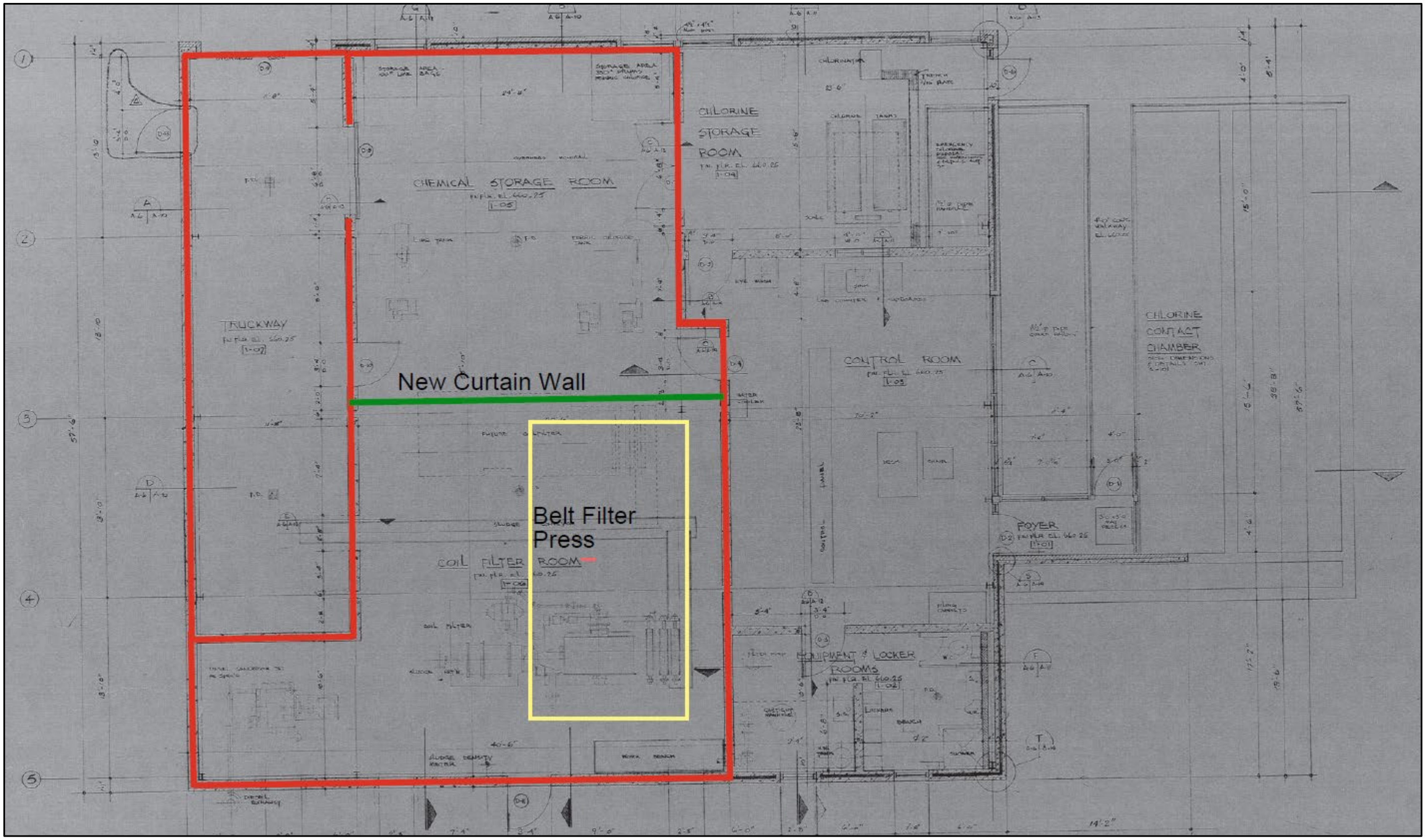
Replacing the windows will require some impacts to plant operations during implementation. It is anticipated that 1 to 2 days of restricted access for the site staff will be required to complete the installation. With proper planning, the severity of these impacts can be minimized by scheduling much of the construction to weekends or other low-occupancy periods.

Measurement and Verification:

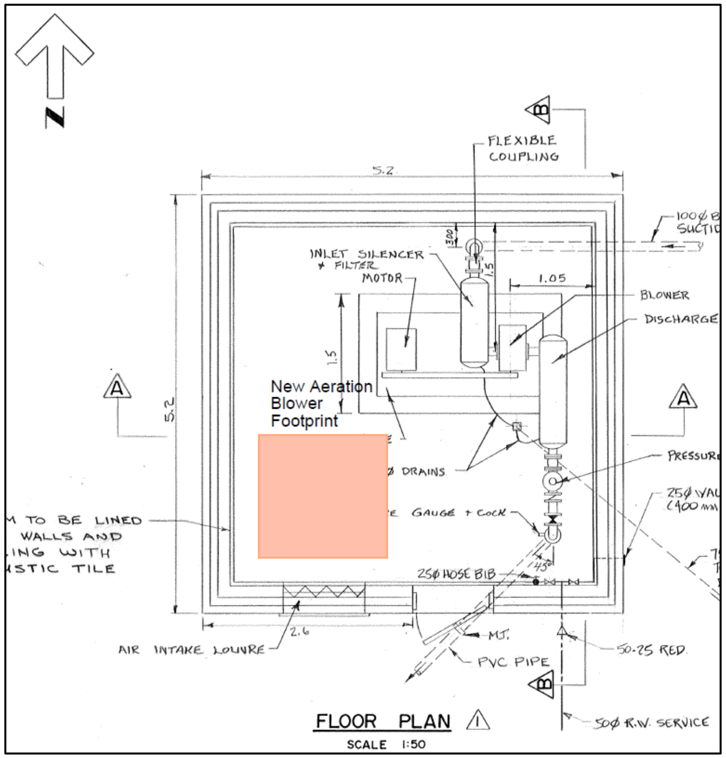
To measure the change in energy consumption IPMVP Option A or B is recommended, based on the scope of the project and the size of the estimated savings.

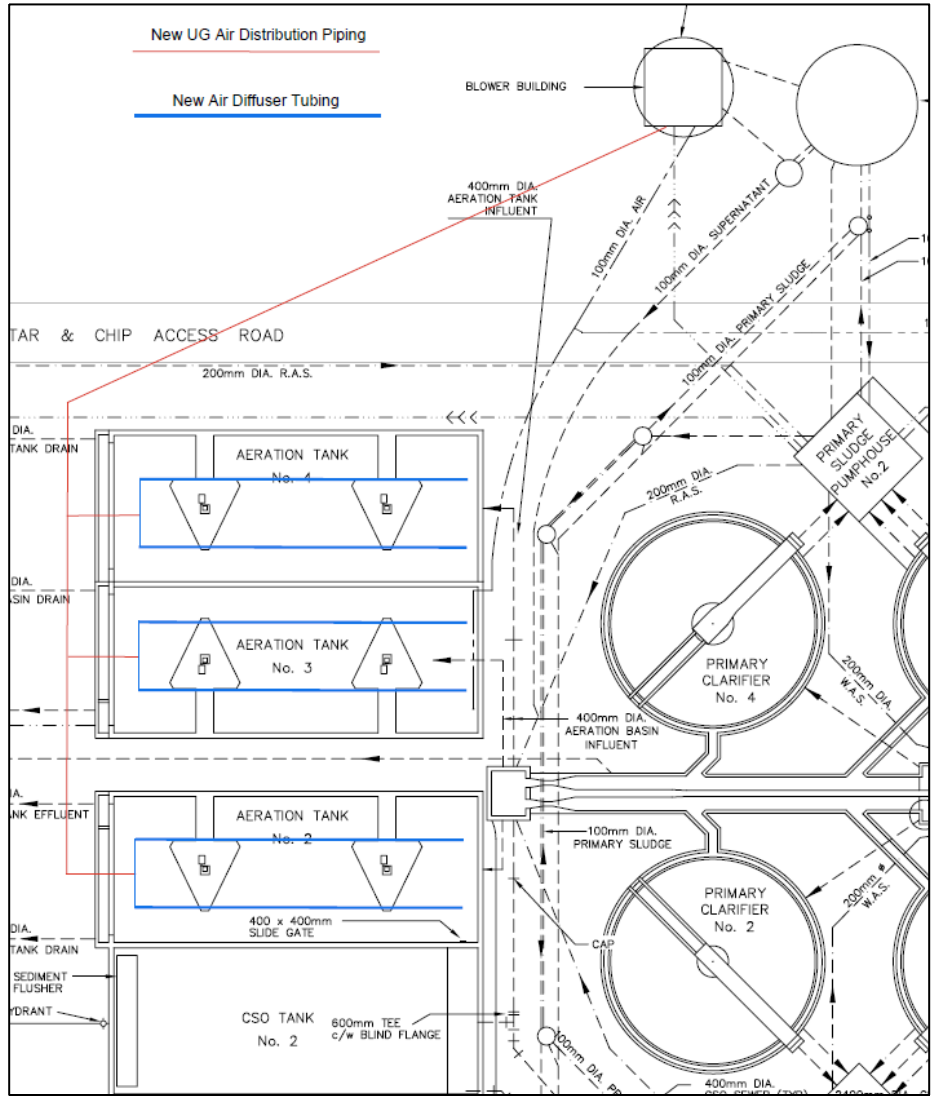
Appendix D: Schematics

ECM – Reduce Exhaust Area for Filter Press



ECM – Install Aeration Blower





Appendix E: Decision Making Workshop

Aladaco Consulting Inc.

Town of Goderich
MRC Decision Making Workshop

Decision Making Workshop

Agenda

- Introductions
- Review of the required GHG Reduction Pathways
- Decarbonization Measures Analyzed
- Pathways Development
- Next steps and Discussion

Introductions - Aladaco

- Aladaco Consulting Inc
  - Founded in 2007
  - Energy professionals providing services to help organizations navigate and reach energy efficiency and decarbonization goals
  - Energy management and M&V, GHG inventorying and decarbonization pathways, CDM planning
  - IESO Industrial Technical Review Services

Sean Pittman
Conservation & Energy Management Lead
P.Eng., CEM, CMVP

Taylor Wilson
Technical Lead - Energy & Carbon Management
CET, CEM, CMVP

Introductions – HEMCon Energy Modeling Solutions

HEMCon is an energy analysis and building simulation firm.

We specialize in building energy models for new and existing buildings to facilitate good design decisions.

HEMCON

Jeremiah Heffernan
Founder, Principal Energy Analyst
P.Eng, M.Eng., G.Dip Green Energy, BEMP, LEED AP BD+C

Decision Making Workshop

Introductions – Town of Goderich

- Jessica Clapp (Town of Goderich Project Lead)
  Asset Management and Environmental Services Coordinator
- Deanna Hastie
  Director of Corporate Services/Treasurer
- Kyle Williams
  Community Services and Operations Manager
- Greg Morningstar
  Recreation Facilities Supervisor
- Sean Thomas
  Director of Community Services, Infrastructure, and Operations

Study Review Process

Site Investigation	Calibrated Energy Modelling	Design Workshop	Measure Level Analysis	GHG Reduction Scenario Planning	Decision Making Workshop	Report and Presentation
• Review available documentation and reports • Analyze utility data • Conduct Site Visits • Interview Facility Operators • Identify current metering points and identify any additional metering required	• eQuest energy model developed by Heffernan Energy Modelling • Calibrated to utility data to ensure accuracy of simulations	• Gather relevant stakeholders to review preliminary decarbonization measures and their feasibility • Review asset management planning and equipment replacement needs • Discuss budgetary considerations and implementation planning • Select decarbonization measures for in-depth analysis	• Develop detailed project metrics for all selected decarbonization measures • Capital cost estimates, energy savings, implementation timelines, etc.	• Compile the identified measures into GHG reduction pathway scenarios for each facility • Scenario packages will include all relevant project metrics and offer alternative pathways to achieving required outcomes	• Gather relevant stakeholders to examine GHG reduction pathways developed by Aladaco • Engage stakeholders to find consensus on the preferred scenarios for inclusion the final report	• Develop draft Pathway Feasibility Study Report • Facilitate stakeholder review and update accordingly • Issue Final Pathway Feasibility Study Report • Prepare/present summary of Pathway Feasibility Study to Town Council

GHG Reduction Pathways

- **Minimum Performance**: 50% reduction in 10 years, 80% in 20 years
- **Aggressive Deep Retrofit**: 50% reduction in 5 years, 80% in 20 years
- **Business-As-Usual**: Like-for-like replacements with existing specs

ECM Summary

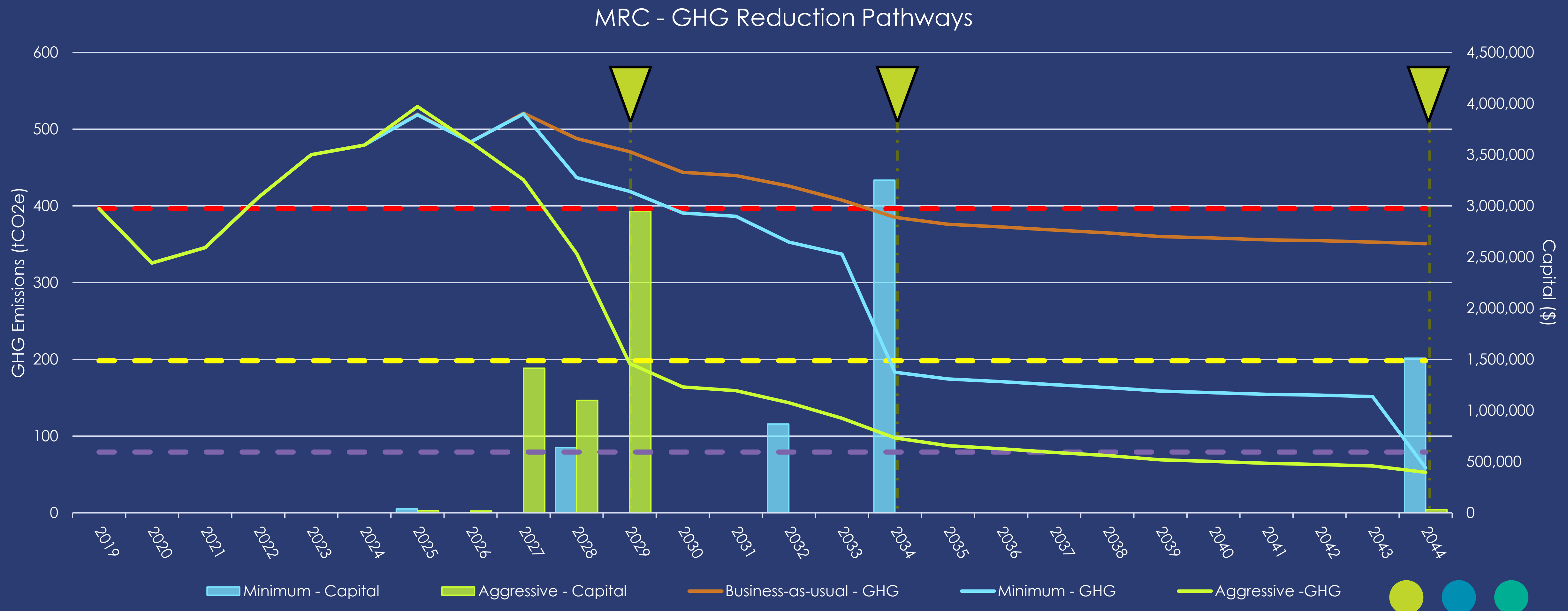
ECM	Energy Savings Potential	GHG Savings Potential	Implementation Cost	Life-Cycle Cost	Selected for Study
Geothermal System Recommissioning	Low	Low	$$	Positive	X
Installing Water-Source Heat Pumps	Medium	High	$$$	Negative	X
Building Envelope Improvements	Low	Low	$$$$	Negative	
Variable Frequency Drives - Pool	Low	Low	$$	Positive	X
Variable Frequency Drives - Heating Loop	Medium	Low	$	Positive	X
Liquid Pool Cover	Low	Low	$	Positive	
Reduce Pool Make-up Water	Low	Low	$	Positive	
Cold Water Ice-Resurfacing	Low	Medium	$	Positive	
Electric Ice-Resurfacer	None	Medium	$$$	Negative	
LED Lamps	Low	Low	$	Positive	
BAS Recommissioning	Low	Low	$$	Positive	X
High-Efficiency Pumps	Low	Low	$	Positive	
Electrification of Heating	Medium	High	$$$$	Negative	X
Solar PV Panels	None	Medium	$$$	Positive	X

Decarbonization Measures Analyzed

ECM	Annual Utility Savings	GHG Savings ($tCO2_e$)	Implementation Cost	NPV	SPP
Geothermal System Recommissioning	$5,124	2.9	$21,500	$21,705	4.4
Variable Frequency Drive – Pool	$214	0.1	$11,331	-$8,591	52.9
Window Replacement – Pool	$78	0.1	$500,000	-$498,024	6,404
BAS Recommissioning	$7,016	10.8	$18,060	$47,264	2.9
ASHP HRUs & MUA	-$13,265	52.1	$603,909	-$746,191	-45.8
ASHP Dehumidifier (DH-3)	-$41,125	65.3	$1,037,910	-$1,593,429	-25.3
WSHP Boilers	-$32,464	121.2	$2,721,424	-$2,582,732	-84.0
Electrification of Boilers	-$138,958	90.3	$454,790	-$1,537,600	-3.3
Electrification of Unit Heaters	-$2,238	4.2	$20,996	-$48,470	-9.4
Solar PV Panels	$60,000	33.8	$756,225	$410,923	12.7

Decision Making Workshop

GHG Reduction Pathways



Decision Making Workshop

GHG Reduction Pathways

Metric	Minimum Performance	Aggressive Deep Retrofit	BAU (Baseline)
Capital Cost	$6,313,490	$5,532,788	$2,208,394
External Funding	$1,294,266	$1,383,197	-
BAU Avoided Costs	$2,208,394	$2,208,394	
Residual Value at Study End	$1,757,764	$707,148	$397,994
Incremental Costs	$2,810,831	$1,941,196	-
Operating Costs	$11,352,974	$11,545,804	$10,472,299
5-year GHG Reduction (tCO2e)	-23 (-5.7%)	**202 (50.9%)**	-
10-year GHG Reduction (tCO2e)	**213 (53.8%)**	299 (75.3%)	-
20-year GHG Reduction (tCO2e)	**338 (85.2%)**	**344 (86.7%)**	-
Incremental LC Cost (20-year)	$2,331,735	$2,705,546	-
Cost per tonne CO2e abated ($ILCC/tCO2e)	$345	$394	-

ECM Description	Min Performance Year	Aggressive Deep Retrofit Year
Geothermal Recommissioning	2025	2025
Water-Source Heat Pump Boilers	2034	2029
VFDs - Pool		
Window Replacement		
BAS Recommissioning	2025	2026
Air-source Heat Pump HRUs & MAU	2028	2027
Air-source Heat Pump DH3	2044	2028
Electrify UHs		2044
Solar PV Panels	2032	2027

Next Steps

- Finalization of PPT and timeline of measure implementations
- Delivery of Feasibility Study Report Draft (Mid July)
- Final Study Report and Council Presentation (August)

Thank You

Questions?

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ECMs – Geothermal System Recommissioning

PROJECT DESCRIPTION

- Conduct a detailed assessment of system performance to identify inefficiencies in controls, pumping, and heat exchange operations
- Optimize control settings for temperature setpoints, seasonal operation modes, and occupancy schedules
- Test and balance ground loop flow rates to ensure efficient heat exchange and minimize energy waste

ECM OUTCOMES

- Improve energy performance of the system (3% to 5%)
- Evaluate capacity for additional Heating opportunities
- Right size future electrification measures
- Potential to tie-in Unit Heaters

ECMs – Install Water-Source Heat Pumps

PROJECT DESCRIPTION

- Mechanical Design Drawings indicate additional Water Source Heat Pumps were originally planned to support Pool and DHW Heating
- Geothermal System Recommissioning can determine the available heating capacity

ECM OUTCOMES

- Reduce Boiler Loads
- Reduce electrification impacts and right size future electrification measures

ECMs – Building Envelope Improvements

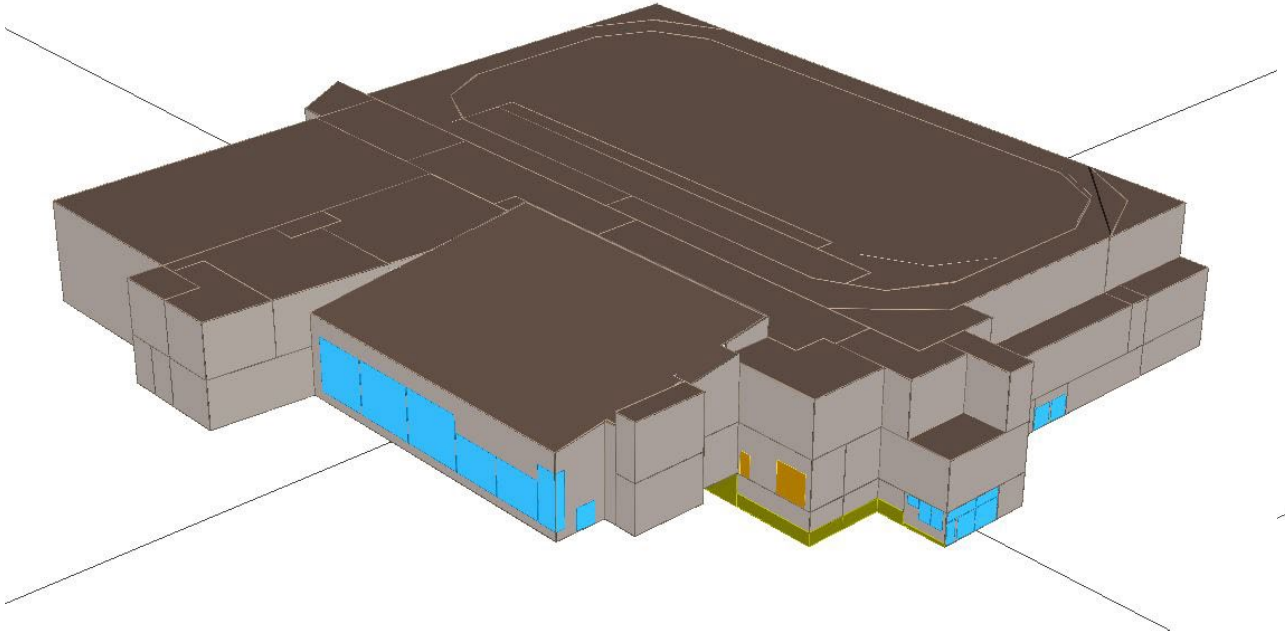
PROJECT DESCRIPTION

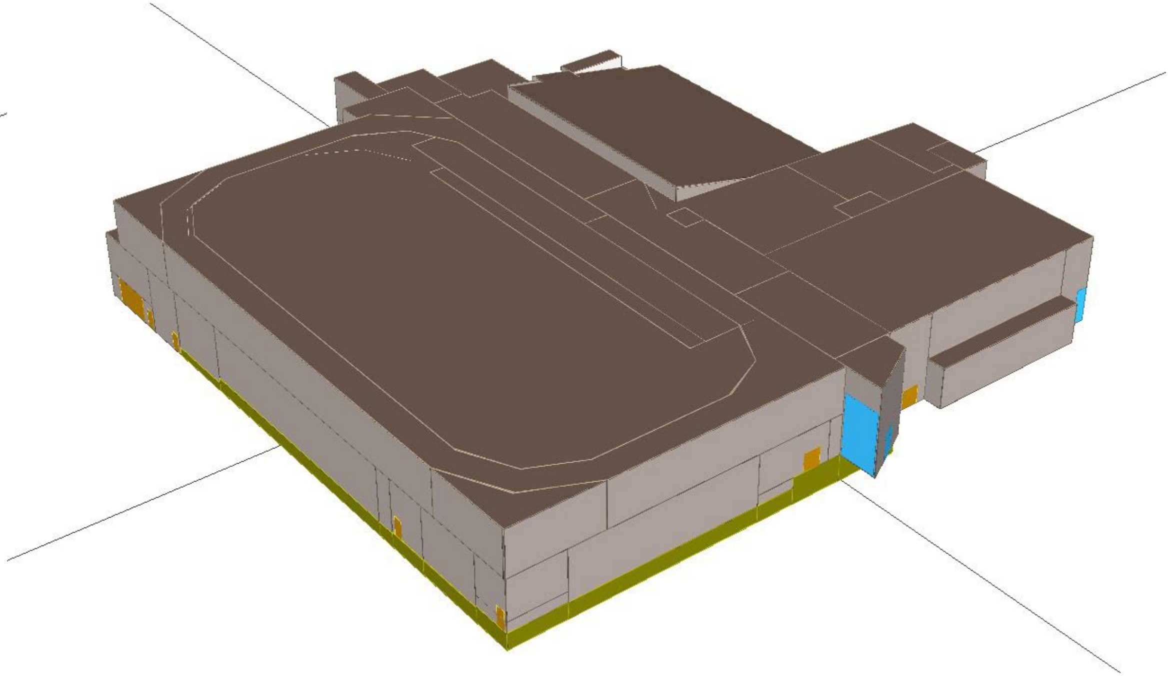
- Wall Insulation Improvements
- Air Sealing
- Decrease Thermal Bridging
- Windows & Doors
- Roof

ECM OUTCOMES

- Estimates of up to 10% to 15% Energy Savings
- Improved Occupant Comfort
- Reduces Equipment Cycling and prolongs expected life

ECMs – Building Envelope Improvements





ECMs – Heating Electrification

PROJECT DESCRIPTION

- Replace all Natural Gas heating sources with electric alternatives (resistance or Heat Pumps)
- Includes Pool Boilers, DHW Boilers, Unit Heaters, Rooftop Units

ECM OUTCOMES

- Significant reduction in GHG
- Increased building electrical loading

ECMs – Renewable Energy Generation

PROJECT DESCRIPTION

- Install Solar PV Panels on Rooftops and/or property
- 1,700 m^2 of approximate rooftop area available
- 250 kW DC System Capacity estimated

ECM OUTCOMES

- Significant reduction in GHG from Grid Emissions
- Up to 300,000 kWh/yr displaced energy consumption
- Rough savings of up to: $42,000/yr and 11.4 $tCO2_e$

Funding Opportunities

Funding Entity	Program	Available Funding	Notes
IESO	Custom Retrofit	$0.13/kWh or $1,200/kW Peak Demand Savings	May be applicable to Heating Electrification and Heat Pump Installations
	Prescriptive Retrofit	Varies by Equipment Type	Per unit incentives for Lighting, VFDs, high-efficiency pumps, heat pumps, etc.
	Solar PV DER	$860/kW-AC	For a 240 kW-AC system = $206,400
Enbridge	Custom Retrofit	$0.25/m^3, up to $100,000	
FCM Green Municipal Fund	GHG Impact Retrofit	Maximum of $5 million per project.	Up to 25% as a grant and the remainder as a loan. Combined loan and grant for up to 80% of eligible project costs. 30% GHG reduction required
Canadian Infrastructure Bank	Green Infrastructure Program	Varies based on project	Provides financing to reduce investment barriers and decarbonize buildings.

Aladaco Consulting Inc.

Town of Goderich
WWTP Decision Making Workshop

Agenda

- Introductions
- Review of the required GHG Reduction Pathways
- Decarbonization Measures Analyzed
- Pathways Development
- Next steps and Discussion

Introductions - Aladaco

- Aladaco Consulting Inc
  - Founded in 2007
  - Energy professionals providing services to help organizations navigate and reach energy efficiency and decarbonization goals
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- Deanna Hastie
  Director of Corporate Services/Treasurer
- Sean Thomas
  Director of Community Services, Infrastructure, and Operations
- Scott Gowan
  Veolia Water Canada
- Steve Johnston
  Veolia Water Canada

Decision Making Workshop

Study Review Process

Site Investigation
- Review available documentation and reports
- Analyze utility data
- Conduct Site Visits
- Interview Facility Operators
- Identify current metering points and identify any additional metering required

Calibrated Energy Modelling
- eQuest energy model developed by Heffernan Energy Modelling
- Calibrated to utility data to ensure accuracy of simulations

Design Workshop
- Gather relevant stakeholders to review preliminary decarbonization measures and their feasibility
- Review asset management planning and equipment replacement needs
- Discuss budgetary considerations and implementation planning
- Select decarbonization measures for in-depth analysis

Measure Level Analysis
- Develop detailed project metrics for all selected decarbonization measures
- Capital cost estimates, energy savings, implementation timelines, etc.

GHG Reduction Scenario Planning
- Compile the identified measures into GHG reduction pathway scenarios for each facility
- Scenario packages will include all relevant project metrics and offer alternative pathways to achieving required outcomes

Decision Making Workshop
- Gather relevant stakeholders to examine GHG reduction pathways developed by Aladaco
- Engage stakeholders to find consensus on the preferred scenarios for inclusion the final report

Report and Presentation
- Develop draft Pathway Feasibility Study Report
- Facilitate stakeholder review and update accordingly
- Issue Final Pathway Feasibility Study Report
- Prepare/present summary of Pathway Feasibility Study to Town Council

GHG Reduction Pathways

- **Minimum Performance**: 50% reduction in 10 years, 80% in 20 years
- **Aggressive Deep Retrofit**: 50% reduction in 5 years, 80% in 20 years
- **Business-As-Usual**: Like-for-like replacements with existing specs

ECM Summary

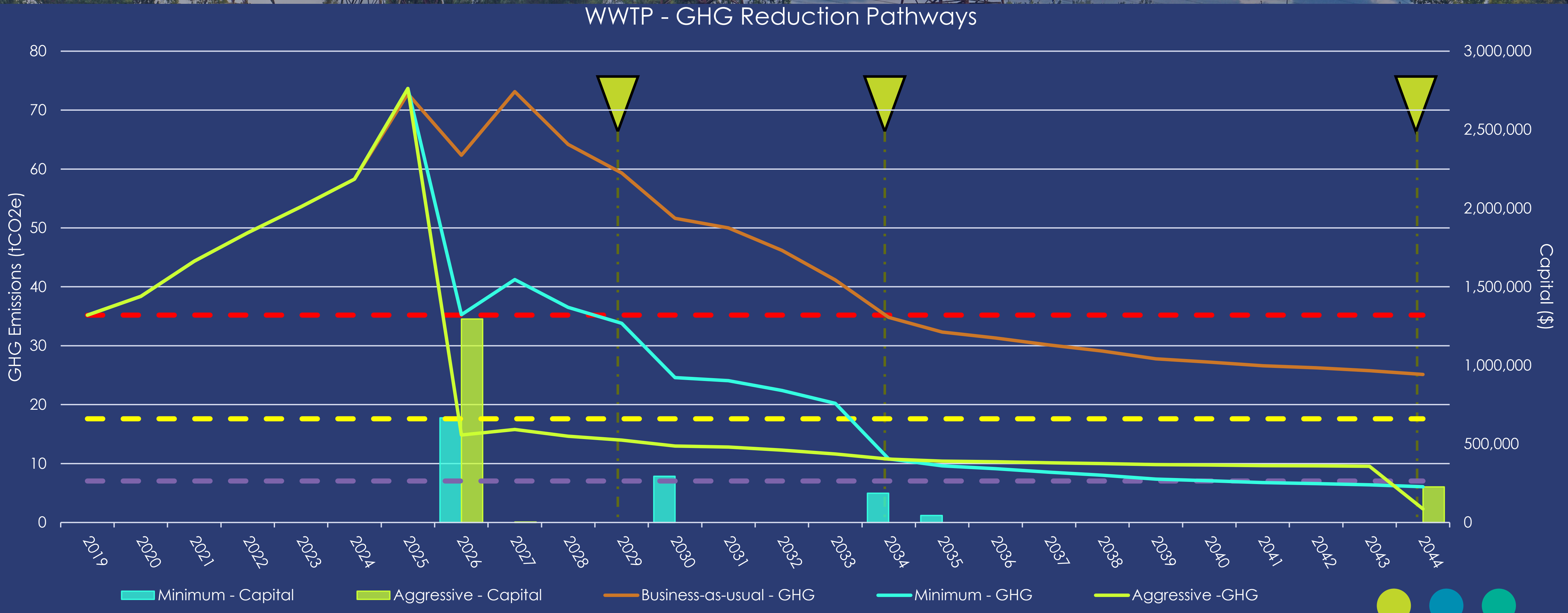
ECM	Energy Savings Potential	GHG Savings Potential	Implementation Cost	Life-Cycle Cost	Selected for Study
Reduce Exhaust Area for Filter Press	Low	Low	$	Positive	X
Building Envelope Improvements - Windows	Low	Low	$$	Negative	
Building Envelope Improvements - Other	Low	Low	$$$$	Negative	
Process Related VFD Improvements	Medium	Low	$$	Positive	
Replace Aerators with Aeration Blowers	Medium	Low	$$$	Positive	X
Replace Aerators with Low-Speed Models	Medium	Low	$$$	Positive	X
High-Efficiency Pumps	Low	Low	$	Positive	
Thermostat Upgrades	Low	Low	$	Positive	X
LED Lamps	Low	Low	$	Positive	
Increase SCADA/BAS capabilities	Low	Low	$$$	Negative	
Truckway Isolation	Low	Low	$$	Negative	X
Lockout Garage Heating	Low	Low	$	Negative	X
Electrification of Heating	Medium	High	$$$	Negative*	X
Solar PV Panels	None	High	$$$	Positive	X

Decarbonization Measures Analyzed

ECM	Annual Utility Savings	GHG Savings ($tCO2_e$)	Implementation Cost	NPV	SPP
Reduce Exhaust Area for Filter Press	$1,218	0.6	$2,668	$1,256	3.0
Replace Aerators with Aeration Blowers	$15,425	7.5	$265,936	-$49,307	17.5
Thermostat Upgrades	$5,119	6.7	$4,290	$97,464	0.9
Window Area Reduction in Control Room	$174	0.5	$18,932	-$15,098	109
Electrification of MUA	-$523	0.2	$36,681	-$69,316	-73.0
Electrification of Tube Heaters	-$3,254	9.2	$155,595	-$190,014	-47.8
Electric Unit Heaters to HPs	$3,039	1.4	$69,221	-$16,370	22.8
Solar PV Panels 260 kW DC	$48,000	25.3	$645,725	$228,373	13.5
Solar PV Panels 510 kW DC	$96,000	50.6	$1,266,038	$485,131	13.3

Decision Making Workshop

GHG Reduction Pathways



GHG Reduction Pathways

Metric	Minimum Performance	Aggressive Deep Retrofit	BAU (Baseline)
Capital Cost	$1,190,016	$1,525,183	-
External Funding	$297,504	$381,296	-
Residual Value at Study End	$162,161	$116,042	-
Operating Costs	$1,641,359	$585,699	$2,836,827
20-Year Operational Cost Savings	$1,195,468	$2,251,128	-
20-Year LCC	$2,371,710	$1,613,544	-
5-year GHG Reduction (tCO2e)	1 (4%)	**21 (60.2%)**	-
10-year GHG Reduction (tCO2e)	**24 (69.4%)**	24 (69.4%)	-
20-year GHG Reduction (tCO2e)	**29 (82.8%)**	**33 (93.5%)**	-

ECM Description	Min Performance Year	Aggressive Deep Retrofit Year
WWTP MUA Area Reduction	2026	2027
Solar PV 510 kW DC	-	2026
Aeration Blower	2030	-
Thermostat Upgrades	2026	2026
Window Area Reduction	-	-
Electrification of MUA	2035	-
Electrification of Tube Heaters	2034	2044
Electric Unit Heaters to HPs	-	-
Solar PV 260 kW DC	2026	-

Next Steps

- Finalization of PPT and timeline of measure implementations
- Delivery of Feasibility Study Report Draft (Mid July)
- Final Study Report and Council Presentation (August)


Thank You
Questions?
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ECMs – Reduce Exhaust Area for Filter Press

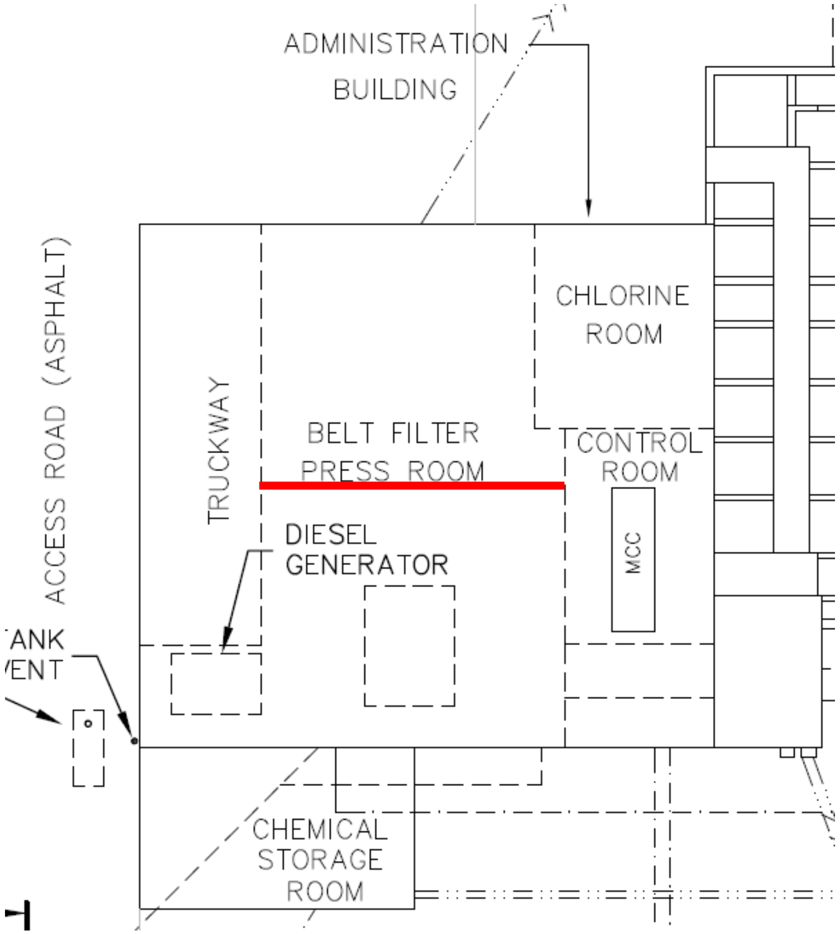
PROJECT DESCRIPTION

- Investigate methods of reducing the overall quantity of air exhausted and replaced during Belt Filter Press operation
- Options to include traditional interior walls, or plastic curtain walls.

ECM OUTCOMES

- Reduces natural gas consumption required to heat make-up air
- Reduces run-time of the make-up air unit fan

ECMs – Reduce Exhaust Area for Filter Press



ECMs – Building Envelope Improvements

PROJECT DESCRIPTION

- Walls Insulation Improvements
- Windows & Doors
- Window Area Reduction

ECM OUTCOMES

- Low quantity of GHG reductions
- Improved Occupant Comfort
- Reduces Equipment Cycling and prolongs expected life

ECMs – Replace Mechanical Aerators with Aeration Blowers

PROJECT DESCRIPTION

- Replace the mechanical aerators with a diffuse aeration system
- Requires Engineering Study to determine feasibility

ECM OUTCOMES

- Reduces electrical consumption related to the treatment of wastewater

ECMs – Replace Mechanical Aerators with Low-Speed Models

PROJECT DESCRIPTION

- Replace the mechanical aerators with a diffuse aeration system
- Requires Engineering Study to determine feasibility

ECM OUTCOMES

- Reduces electrical consumption related to the treatment of wastewater

ECMs – Other Opportunities

PROJECT DESCRIPTION

- High-Efficiency Pumps
- Thermostat Upgrades
- LED Lamps
- Increase SCADA/BAS capabilities

- Isolate Truckway from other interior areas
- Lock-out heating in garage when bay doors are open

ECMs – Electrify Heating

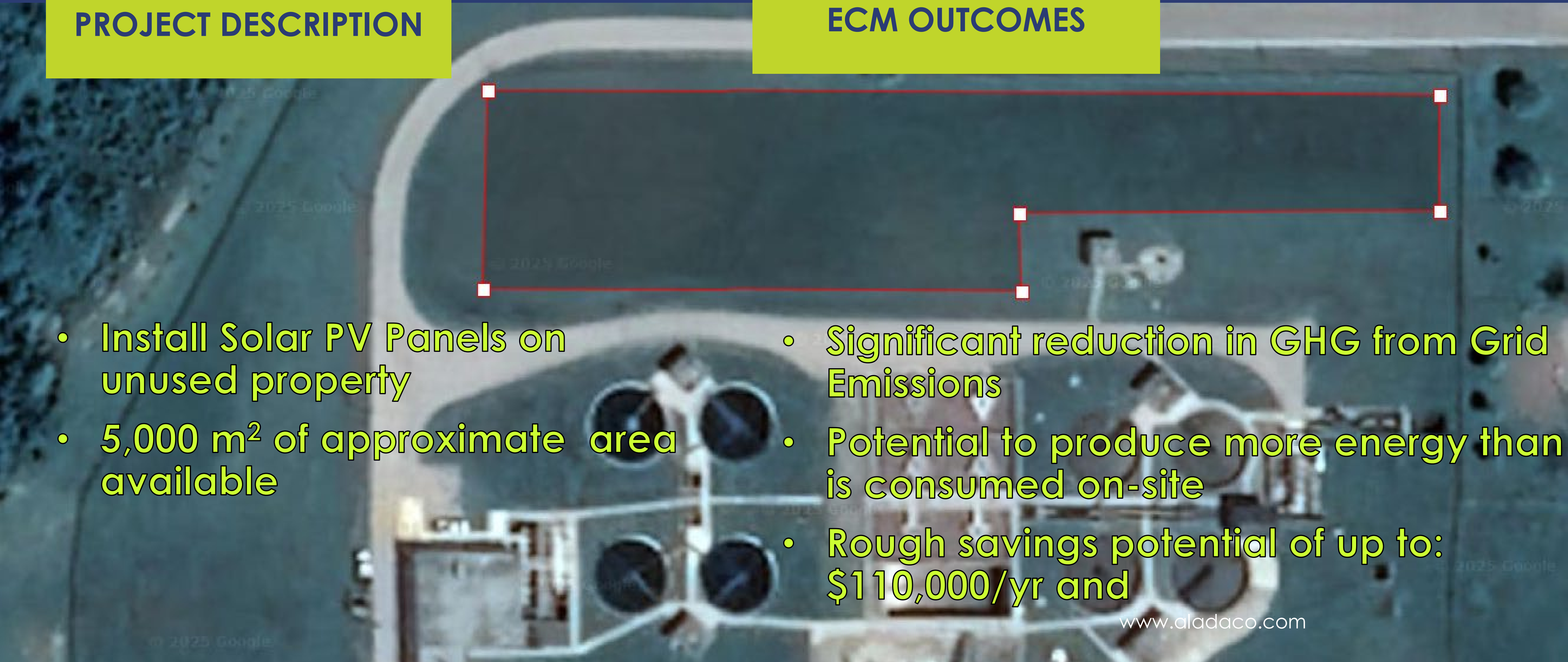
PROJECT DESCRIPTION

- Replace MAU Natural Gas heating with electric alternative (resistance or Heat Pumps)
- Replace Radiant Tube Heaters with Heat Pumps
- Replace Electric Resistive Unit Heaters with Heat Pumps

ECM OUTCOMES

- Significant reduction in GHG
- Increased building electrical loading

ECMs – Renewable Energy Generation



PROJECT DESCRIPTION

- Install Solar PV Panels on unused property
- 5,000 m^2 of approximate area available

ECM OUTCOMES

- Significant reduction in GHG from Grid Emissions
- Potential to produce more energy than is consumed on-site
- Rough savings potential of up to: $110,000/yr and

Funding Opportunities

Funding Entity	Program	Available Funding	Notes
IESO	Custom Retrofit	\$0.13/kWh or \$1,200/kW Peak Demand Savings	Applies to process related improvements. May be applicable to Heating Electrification and Heat Pump Installations
	Prescriptive Retrofit	Varies by Equipment Type	Per unit incentives for Lighting, VFDs, high-efficiency pumps, heat pumps, etc.
	Solar PV DER	\$860/kW-AC	For a 60 kW-AC system = \$51,600
Enbridge	Custom Retrofit	\$0.25/m^3, up to \$100,000	
FCM Green Municipal Fund	GHG Impact Retrofit	Maximum of \$5 million per project.	Up to 25% as a grant and the remainder as a loan. Combined loan and grant for up to 80% of eligible project costs. 30% GHG reduction required
Canadian Infrastructure Bank	Green Infrastructure Program	Varies based on project	Provides financing to reduce investment barriers and decarbonize buildings.

Appendix F: Sensitivity Analysis

Aladaco's GHG Reduction Pathways analysis relies on several key assumptions that can significantly influence projected outcomes. This section highlights the sensitivity of results to changes in select variables, offering additional insight into how pathway performance may vary. Specifically, it examines the effects of future weather patterns, carbon pricing, and projected grid emission factors.

Future Weather Analysis

The energy models used in this study are based on historical weather data specific to Goderich, Ontario. However, as climate conditions shift, changes in temperature and seasonal patterns will affect facility energy use. To assess this, energy models were updated using projected weather data for 25-year and 50-year time horizons. The analysis indicates a reduction in heating demand and an increase in cooling demand. As a result, the WWTP is expected to use less electricity and natural gas, reflecting its predominantly heating-driven loads. In contrast, the MRC will likely see a slight increase in electricity use due to higher cooling requirements, though natural gas use is expected to decrease. In all scenarios project facility GHG emissions are lower than what has been calculated in the selected GHG Reduction Pathways using 2025 weather data.

MRC Energy Model Results (2050 Weather)	Electricity (kWh)	Natural Gas (m3)	tCO2e	Facility Peak Demand
Minimum Performance Scenario	3,028,685	2,806	53.61	610 kW
Aggressive Deep Retrofit Scenario	3,008,052	0	53.24	620 kW

MRC Energy Model Results (2075 Weather)	Electricity (kWh)	Natural Gas (m3)	tCO2e	Facility Peak Demand
Minimum Performance Scenario	3,093,013	2,380	54.75	624 kW
Aggressive Deep Retrofit Scenario	3,075,840	0	54.44	624 kW

WWTP Energy Model Results (2050 Weather)	Electricity (kWh)	Natural Gas (m3)	tCO2e	Facility Peak Demand
Minimum Performance Scenario	350,117	0	6.20	222 kW
Aggressive Deep Retrofit Scenario	138,097	141	2.72	229 kW

WWTP Energy Model Results (2075 Weather)	Electricity (kWh)	Natural Gas (m3)	tCO2e	Facility Peak Demand
Minimum Performance Scenario	338,424	0	5.99	216 kW
Aggressive Deep Retrofit Scenario	126,550	124	2.48	222 kW

Carbon Pricing Analysis

At the time of this study, the federal carbon tax had been removed from consumer energy pricing. Accordingly, the primary GHG Reduction Pathways and Measures Analysis use a carbon price of $0. To help the Town of Goderich understand the financial implications should the tax be reinstated, a sensitivity analysis was completed using the federal carbon pricing schedule. This scenario assumes a carbon price of $95 per tonne in 2025, increasing by $15 annually to $170 per tonne in 2030, and remaining at that level through the remainder of the study period. The results demonstrate the added cost burden of continued fossil fuel use and highlight the increased financial value of electrification and emissions reduction strategies in a future with carbon pricing. Relevant changes in each pathway's metrics are highlighted below.

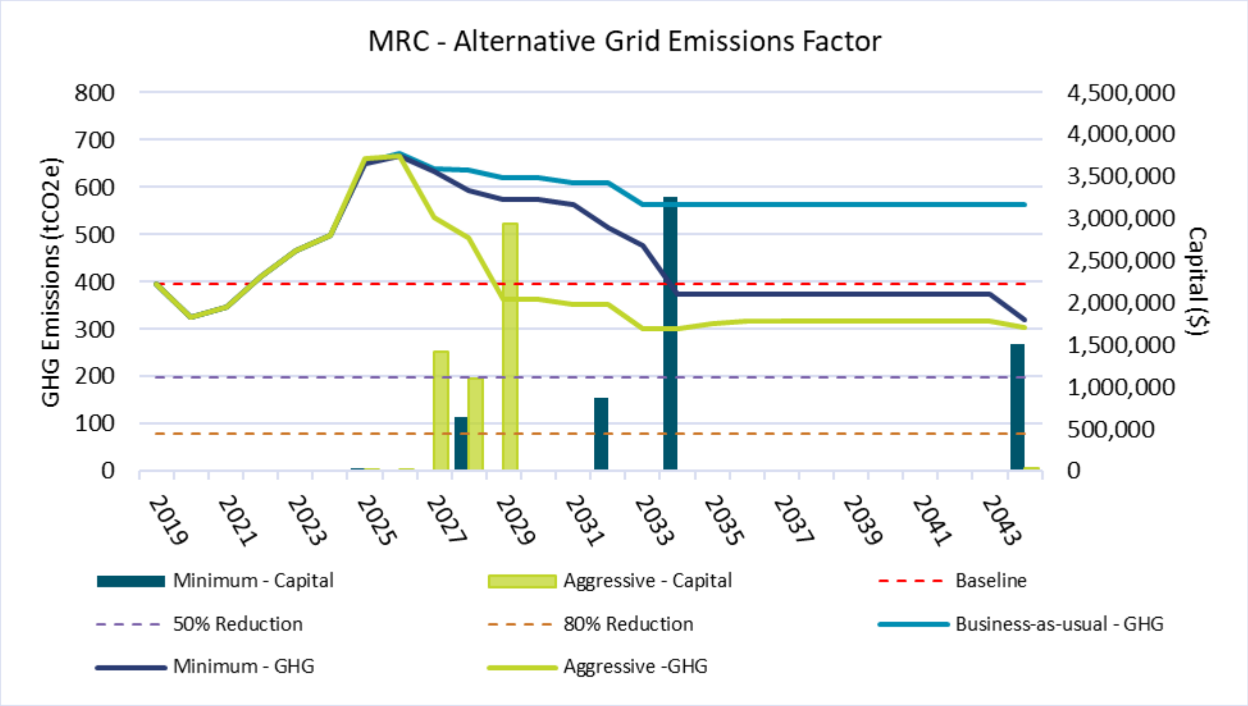
MRC Pathways Metrics with Carbon Pricing	Minimum Performance	Aggressive Deep Retrofit	BAU (Baseline)
Capital Cost	$6,313,490	$5,532,788	$2,208,394
External Funding	$1,294,266	$1,383,197	-
BAU Avoided Costs	$2,208,394	$2,208,394	
Residual Value at Study End	$1,757,764	$707,148	$397,994
Incremental Costs	$2,810,831	$1,941,196	-
Operating Costs	$12,420,649 **(+7%)**	$12,573,689 **(+7%)**	$11,753,111 **(+12%)**
5-year GHG Reduction (tCO2e)	-23 (-5.7%)	202 (50.9%)	
10-year GHG Reduction (tCO2e)	203 (51.3%)	299 (75.3%)	
20-year GHG Reduction (tCO2e)	330 (83.3%)	345 (86.9%)	
Incremental LC Cost (20-year)	$2,118,599	$2,452,620	-
Cost per tonne CO2e abated ($ILCC/tCO2e)	$321 **(-17%)**	$356 **(-15%)**	-

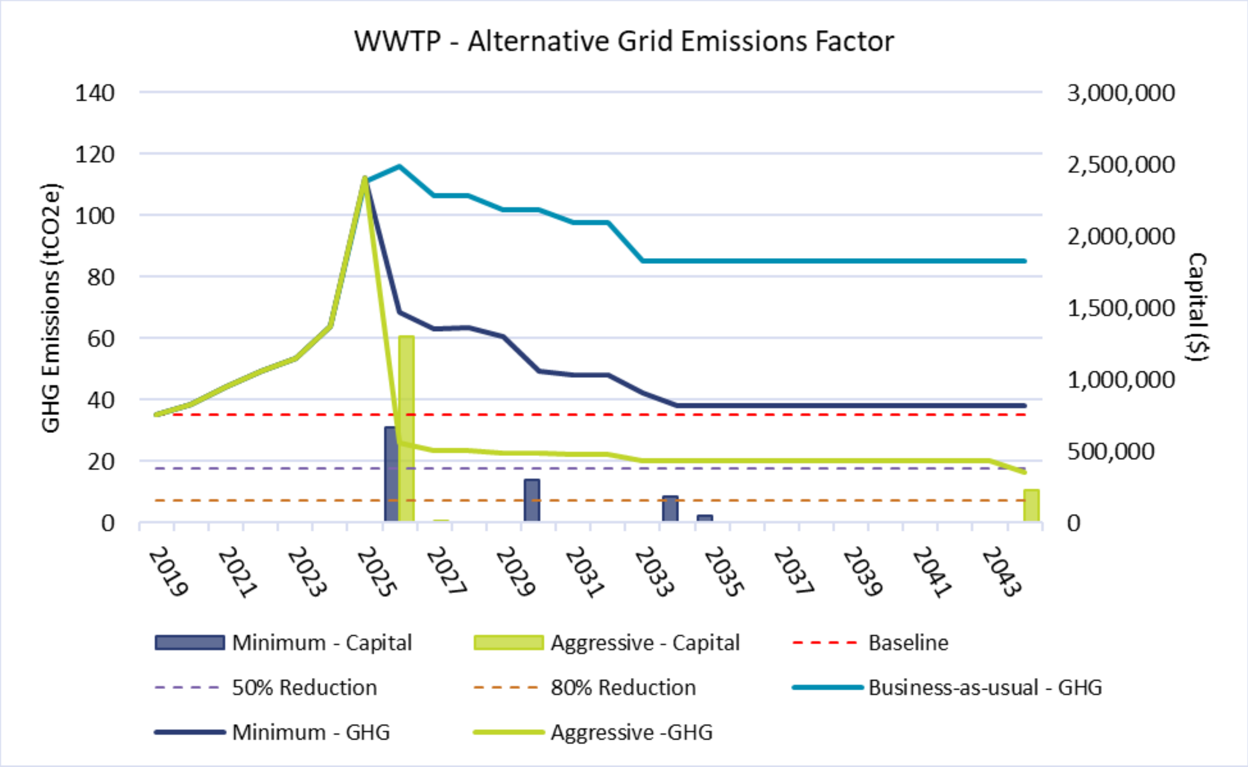
WWTP Pathways Metrics with Carbon Pricing	Minimum Performance	Aggressive Deep Retrofit	BAU (Baseline)
Capital Cost	$1,190,016	$1,525,183	-
External Funding	$297,504	$381,296	-
Residual Value at Study End	$162,161	$116,042	-
Operating Costs	$1,792,823 **(+3%)**	$738,507 **(+9%)**	$2,963,843 **(4%)**
20-Year Operational Cost Savings	$1,171,021 **(+6%)**	$2,225,337 **(+3%)**	**-**
20-Year LCC	$2,523,174 **(+2%)**	$1,766,352 **(+3%)**	**-**
5-year GHG Reduction (tCO2e)	0 (-0.6%)	20 (55.5%)	-
10-year GHG Reduction (tCO2e)	24 (67.1%)	24 (67.2%)	-
20-year GHG Reduction (tCO2e)	29 (81.5%)	32 (91.3%)	-

Grid Emission Factor Analysis

Projected grid emission factors have a major impact on the results of the GHG Reduction Pathways. As the Town of Goderich reduces its reliance on fossil fuels, the emissions associated with electricity use will become increasingly significant. The primary analysis in this study uses future grid emissions forecasts from the Green Building Council's Zero Carbon Building Workbook, in line with FCM guidance. To test sensitivity, an alternative forecast from the Posterity Group was also applied. Since this source only projects values to 2033, the 2033 factor was held constant for all subsequent years in the analysis.

The results of this comparison show that if future grid emissions are significantly higher than those projected in the Zero Carbon Buildings reference, several of the selected GHG pathways may fall short of their target reductions. This underscores the critical importance of maintaining a clean electricity grid in Ontario, especially as facilities transition carbon-intensive systems to electric alternatives. Without a decarbonized grid, these efforts risk becoming ineffective.


MRC - Alternative Grid Emissions Factor
GHG Emissions (tCO2e)
Capital ($)
800
700
600
500
400
300
200
100
0
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
Minimum - Capital
Aggressive - Capital
Baseline
50% Reduction
80% Reduction
Business-as-usual - GHG
Minimum - GHG
Aggressive -GHG


WWTP - Alternative Grid Emissions Factor
GHG Emissions (tCO2e)
Capital ($)
140
120
100
80
60
40
20
0
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
2019
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
Minimum - Capital
Aggressive - Capital
Baseline
50% Reduction
80% Reduction
Business-as-usual - GHG
Minimum - GHG
Aggressive -GHG

Appendix G: Energy Model Documentation

Simulation Inputs – Maitland Recreation Center:

General Parameters

Location	190 Suncoast Dr E, Goderich, Ontario
Weather File	CWEC 2020 Goderich Weather Data, Modified CWEC 2020 Goderich Weather Data (2050 HDD & CDD Estimate), Modified CWEC 2020 Goderich Weather Data (2075 HDD & CDD Estimate) Custom Goderich 2023 Weather Data
HDD and Climate Zone	4000 (NECB 2020), Climate Zone 6 3734 (CWEC 2020), Climate Zone 5 2971 (CWEC 2050 Estimate), Climate Zone 4 2504 (CWEC 2075 Estimate), Climate Zone 4
Building Type	Recreational
Site Orientation	True North is Project North
Modeled GFA	7,750 m²
Building Storeys	3 with 1 partially below ground
Occupancy Schedules	Based on: • 5:30 AM – 11:30 PM Monday – Friday, 7:30 AM – 10:00 PM Saturday - Sunday (Modified from NECB Schedule C for retail spaces) for the Arena • 6:00 AM – 10:00 PM Monday – Friday, 8:00 AM – 6:00 PM Saturday, 8:00 AM – 4:00 PM Sunday (Modified from NECB Schedule C for retail spaces) for the Gymnasium and Fitness • Various Times for the Canteen
Fan Schedules	Based on: • Occupancy Schedules previously defined (Modified from NECB Schedule C for retail spaces)
Thermostat Setpoints	Based on: • 24C for cooling (no night setback) for the general recreational, gymnasium and fitness spaces • 21C for heating (no night setback) for the general recreational, gymnasium and fitness spaces • 13.3C for heating and cooling (no night setback) for the Arena and Seating Areas

	• 27.7C for heating and cooling (no night setback) for the Pool Area

HVAC Plant

	Baseline Design
Cooling Plant	• Ground Source Heat Pump Ground Loop • Icekube Ice-making equipment
Heating Plant	• 1x Condensing Hot Water Boilers – General Heating Makeup – Not Functional • 1x Condensing Hot Water Boiler – Domestic Hot Water Heating (assumed 80% seasonal efficiency) • 1x Condensing Hot Water Boiler – Pool and Whirlpool Heating (assumed 80% seasonal efficiency) • Common Circulation Pump – Constant Volume 7.5 HP (Assumed 6.0 BHP)
Domestic Hot Water Heating - Load	• Domestic hot water load estimated based on the monthly facility natural gas use, measured water use, the average monthly ground temperature and an assumed seasonal efficiency
Pool and Whirlpool Heating - Load	• Pool and Whirlpool hot water estimate is based on the facility natural gas use, measured water use, the average monthly ground temperature, pool and whirlpool setpoints and an assumed seasonal efficiency • 1.5 and 5.0 kW Pool Pumps for heating and circulation
Ice Making Equipment	• 8x IceKube Heat Pumps – Assumed 4.0 COP • 16x 2.25kW Pumps providing circulation
Ground Source Heat Pump	• Based on on-site observations and interviews with the staff, it was determined that the ground loop appears to be operating strictly as a heat rejection device, no additional heat was injected into the loop, and the return temperature to the ground was observed to be 88-90°F at -30°C.

	• The ground loop itself was not modelled and instead replaced with a heat rejection device on a water loop heat pump loop. • 1x 30kW pump providing circulation year round to the ground loop

HVAC Systems

	Baseline Design
MUA	**Cantine Make Up Air Unit** • Heating: Furnace (80% Efficient) • Cooling: DX (EER 10 assumed) • Airflow: 2,000 cfm • Fan Power: 2" Static Pressure (assumed) • Controls: fans run according to Cantine schedule • Heat Recovery: Not Installed
HRV1 & 2	**Dedicated Outdoor Air Units with Heat Recovery** • Heating: Furnace (80% Efficient) • Cooling: DX (EER10 assumed) • Airflow: 13,200 and 5,500 (estimated from the drawings) • Fan Power: 1.5" Static Pressure on Supply and Return • Controls: runs during operating hours to deliver outdoor air • Heat Recovery: 60% heat recovery (estimated)
Pool and Whirlpool	**Dehumidification Unit** • Heating: Furnace (80% Efficient) • Cooling: DX (EER 10) • Airflow: 3000 cfm • Fan Power: 2.0" Static Pressure • Controls: runs as required to maintain humidity
Gymnasium, Locker Rooms, Workout, etc.	**Water Loop Heat Pump** • Heating: Heat Pump (3.0 COP) • Cooling: Heat Pump (3.0 COP) • Airflow: cfm varies (sized by software) • Fan Power: 0.5" Static Pressure (assumed) • Controls: runs as required to maintain thermostat setpoint

Arena Seating, Change Rooms	**In Floor Radiant Heating** • Heating: Hot Water • Cooling: N/A • Airflow: N/A • Controls: runs as required to maintain thermostat setpoint

Envelope

	Baseline Design
Underground Floors and Walls	**Walls** • 50mm Polystyrene **Floors** • 50mm Polystyrene
Exterior Walls	**Typical Brick** • 90mm Brick, 50mm Rigid Insulation, 190mm Concrete Block • R 9.0 ft² °F/Btu (nominal) • R 6.5 ft² °F/Btu (effective including window perimeters, slab edge) **Typical Metal Siding** • Metal siding, 125mm Semi Rigid Insulation between Studs, 52mm Rigid Insulation, Structural Studs, Interior metal panel • R 28.0 ft² °F/Btu (nominal) • R 12.5 ft² °F/Btu (effective including window perimeters, penetrations)
Exterior Roof	**Flat Roof (Estimated)** • Built up roofing, 4" Rigid Insulation, 6" Concrete Deck • R 20.0 ft² °F/Btu (nominal) • R 17.5 ft² °F/Btu (effective including parapets, penetrations

Glazing	• Double glazed, clear, 13mm Air gap, aluminum frame with standard spacer
	  ○ USI 2.8 W/ m² °C (effective)
	  ○ SHGC 0.70
	  ○ Total WWR 6.9%

Infiltration	• 0.25 L/s/m² of wall and roof area

Electrical and Other Loads

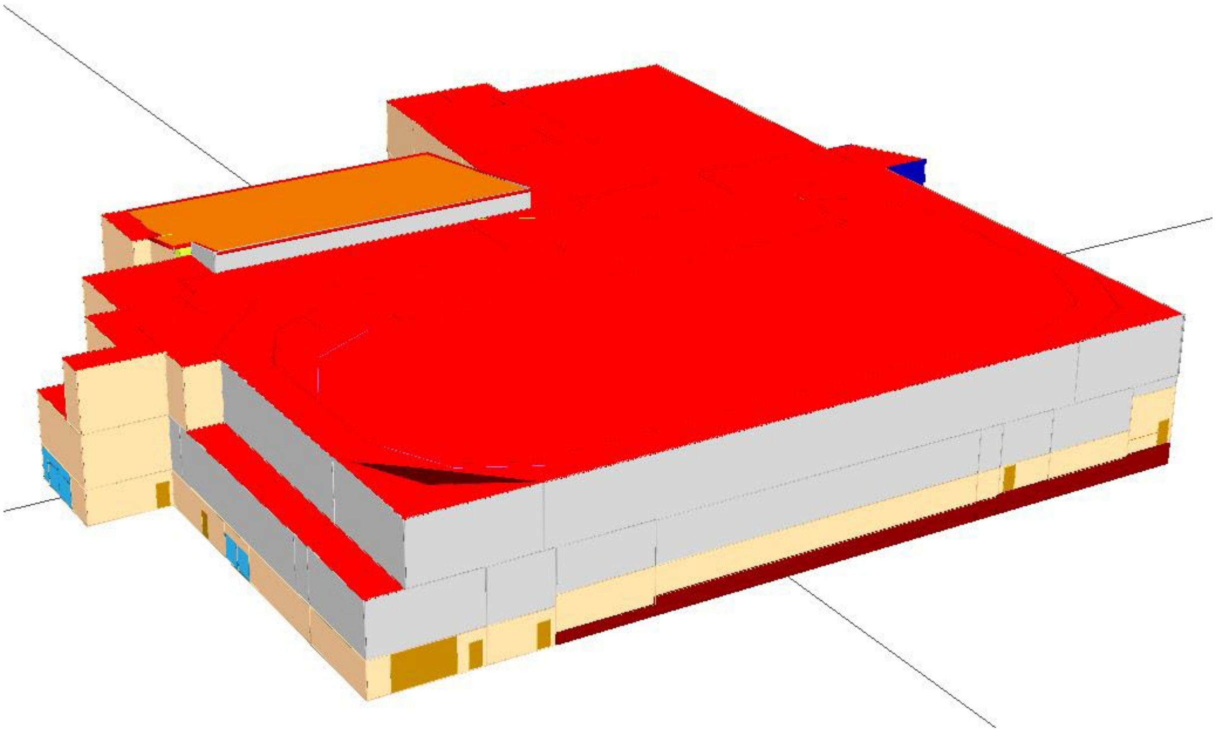
	Baseline Design

Lighting	**Interior Lighting**
	• Building average lighting power density is 9.9 W/m²
	  o Arena: 13.8 W/m²
	  o Stairways, locker room, change room, corridors, electrical/mechanical, storage: 5.4 W/m²
	  o Gymnasium and Fitness: 10.8 W/m²
	  o Pool: 20.4 W/m²
	
	Lighting scheduled to be on 90% of peak during normal working hours following the facility schedule. Lighting scheduled to be on at 5% of peak for emergency for all other hours.

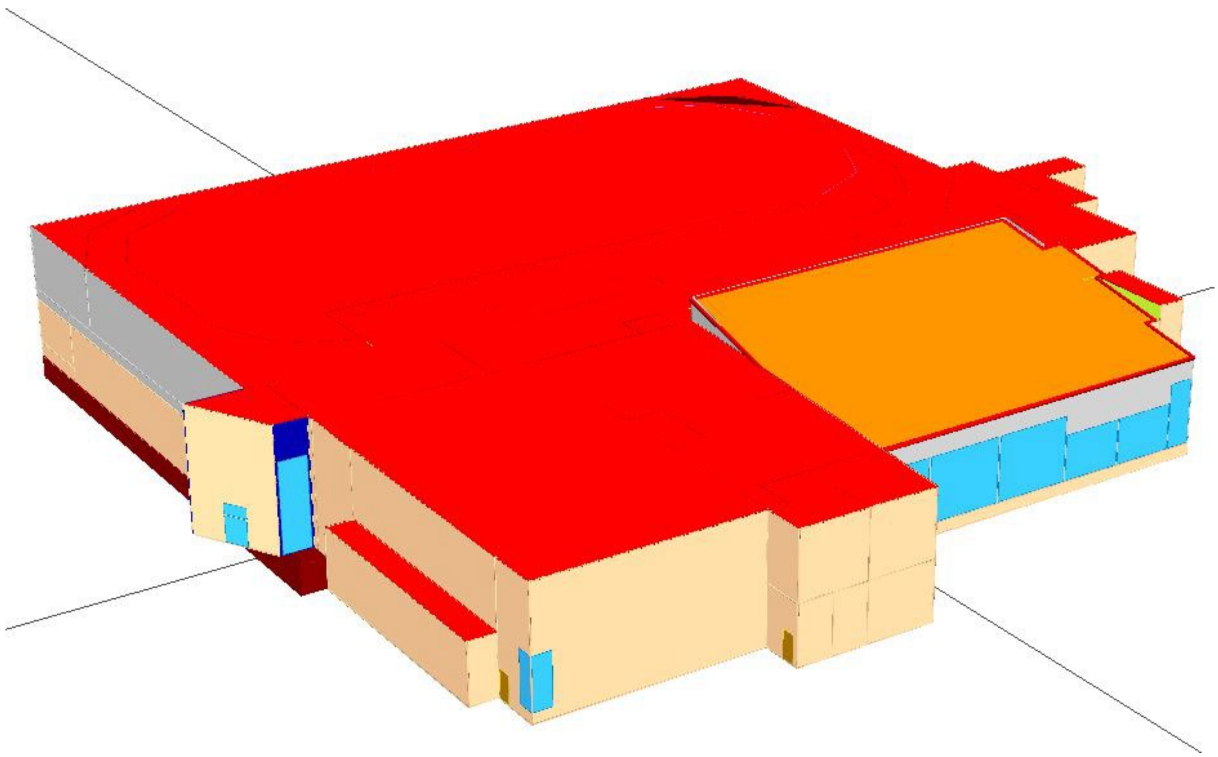
Other Electrical Loads	**Receptacle Loads**
	• Building average receptacle power density is 7.3 W/m²
	  o Office, lounge: 10.8 W/m²
	  o Fitness: 53.8 W/m²
	  o Locker room, change room: 5.4 W/m²
	  o Server: 107.6 W/m²
	  o Electrical/mechanical: 16.1 W/m²
	  o Office, lounge: 10.8 W/m²
	Elevator Load
	• Modelled as a 14.76 kW load based on the Savings by Design Elevator Schedule
	
	Pool Latent Load Assumption
	• Modelled as a 35.5kW load based on the methodology presented in "eQuest Pool Modelling Guide for SCA Energy Models 01/02/2023"

Other Natural Gas Loads	• N/A

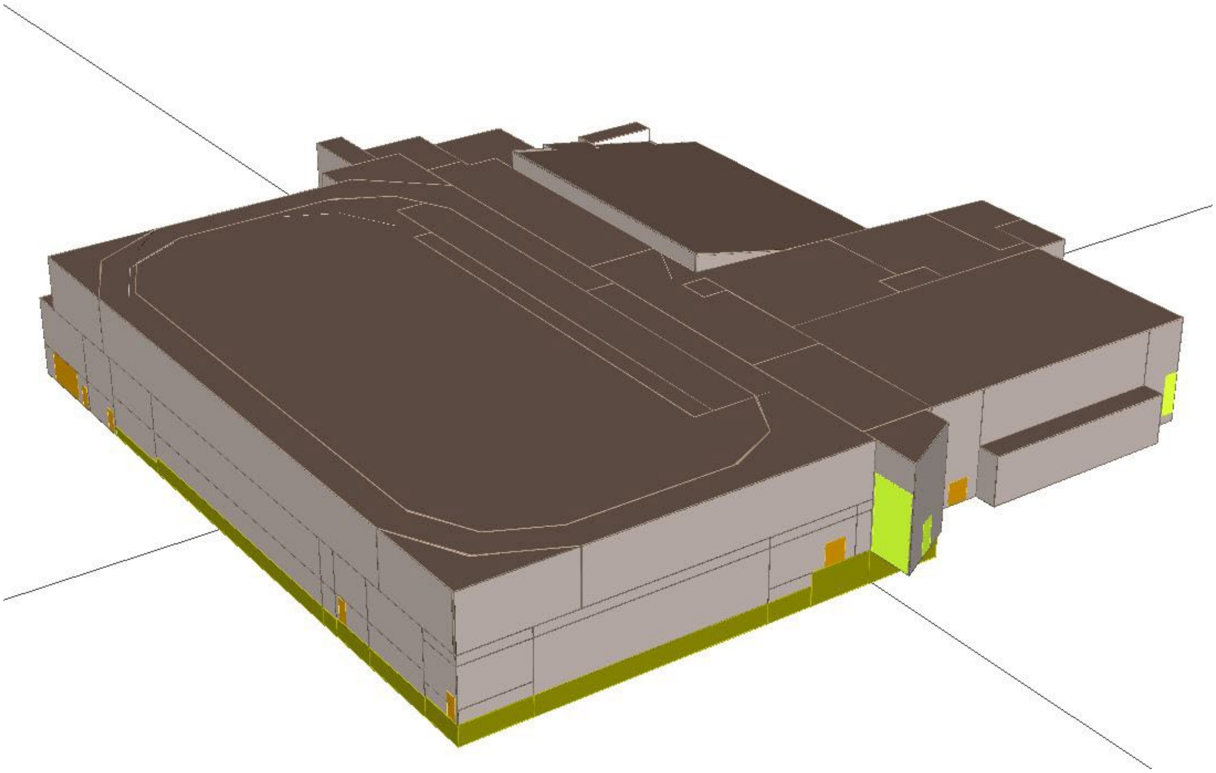
South West View (Showing Varied Opaque Constructions)



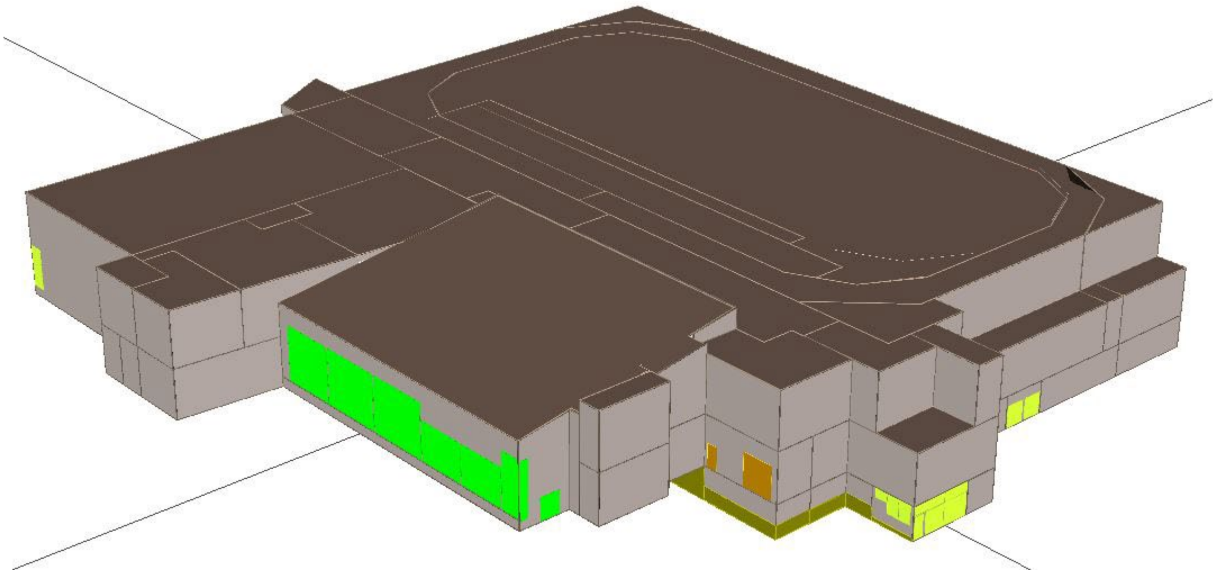
North East View (Showing Varied Opaque Constructions)



South East View (Showing Varied Window Constructions)



North West View (Showing Varied Window Constructions)



ECM Summary:

#	ECM	Change Location	Change Details
1	ASHP MUA	Canteen MUA Unit	Replace 80% efficient natural gas furnace with air source heat pump (COP 3.0)
2	ASHP HRV1	HRV 1	Replace 80% efficient natural gas furnace with air source heat pump (COP 3.0)
3	ASHP HRV2	HRV 2	Replace 80% efficient natural gas furnace with air source heat pump (COP 3.0)
4	ASHP Pool Dehumidifier	Pool Dehumidifier	Replace 80% efficient natural gas furnace with air source heat pump (COP 3.0)
5	Electric Unit Heaters	Unit Heaters	Replace 80% efficient natural gas furnace unit heaters with electric unit heaters)
6	VFD Pool Pumps	Pool Pumps	Add VFD to pool pumps
7	Triple Glazed Pool Windows	Glazing	Triple glazed, low-e (0.1) (surface 2 an 5), 13mm Ar gap, vinyl or fiberglass frame with insulating spacer o USI 1.15 W/ m² °C (effective) o SHGC 0.48
8	Electric Domestic Hot Water Boiler	DHW Boiler	Replace 80% seasonal efficient natural gas boiler with an electric boiler
9	Heat Pump Domestic Hot Water Boiler	DHW Boiler	Replace 80% seasonal efficient natural gas boiler with a water loop heat pump boiler (seasonal COP 2.5)
10	Electric Pool Boiler	Pool Boiler	Replace 80% seasonal efficient natural gas boiler with an electric boiler
11	Heat Pump Pool Boiler	Pool Boiler	Replace 80% seasonal efficient natural gas boiler with a water loop heat pump boiler (seasonal COP 2.5)
12	Electric Whirlpool Boiler	Whirlpool Boiler	Replace 80% seasonal efficient natural gas boiler with an electric boiler
13	Heat Pump Whirlpool Boiler	Whirlpool Boiler	Replace 80% seasonal efficient natural gas boiler with a water loop heat pump boiler (seasonal COP 2.5)
14	2025 – Minimum Performance	Misc	ECMs 01, 02, 03, 04, 09, 11, 13 Combined CWEC 2020 Weather File
15	2050 – Minimum Performance	Misc	ECMs 01, 02, 03, 04, 09, 11, 13 Combined Modified CWEC 2050 Weather File

16	2075 – Minimum Performance	Misc	ECMs 01, 02, 03, 04, 09, 11, 13 Combined Modified CWEC 2075 Weather File
17	2025 – Aggressive	Misc	ECMs 01, 02, 03, 04, 05, 09, 11, 13 Combined CWEC 2020 Weather File
18	2050 – Aggressive	Misc	ECMs 01, 02, 03, 04, 05, 09, 11, 13 Combined Modified CWEC 2050 Weather File
19	2075 – Aggressive	Misc	ECMs 01, 02, 03, 04, 05, 09, 11, 13 Combined Modified CWEC 2075 Weather File

Results Summary:

#	ECM	Electrical Use (kWh)	Natural Gas Use (ekWh)	Total Energy (ekWh)	Total CO2 (kg)	Energy Savings	CO2 Savings
	Baseline	1,941,348	1,688,490	3,629,838	400,755	0.0%	0.0%
1	ASHP MUA	1,961,630	1,634,267	3,595,897	392,017	0.9%	2.2%
2	ASHP HRV1	2,034,524	1,484,991	3,519,515	368,813	3.0%	8.0%
3	ASHP HRV2	2,000,026	1,585,524	3,585,551	385,170	1.2%	3.9%
4	ASHP Pool Dehumidifier	2,324,957	1,160,324	3,485,281	324,941	4.0%	18.9%
5	Electric Unit Heaters	1,963,887	1,655,370	3,619,257	395,925	0.3%	1.2%
6	VFD Pool Pumps	1,939,677	1,688,490	3,628,168	400,672	0.0%	0.0%
7	Triple Glazed Pool Windows	1,940,469	1,644,994	3,585,463	392,888	1.2%	2.0%
8	Electric Domestic Hot Water Boiler	2,321,499	1,213,375	3,534,874	334,310	2.6%	16.6%
9	Heat Pump Domestic Hot Water Boiler	2,093,437	1,213,375	3,306,813	322,907	8.9%	19.4%
10	Electric Pool Boiler	2,138,047	1,438,828	3,576,875	365,686	1.5%	8.8%
11	Heat Pump Pool Boiler	2,020,016	1,438,828	3,458,844	359,785	4.7%	10.2%
12	Electric Whirlpool Boiler	1,974,732	1,646,753	3,621,485	394,918	0.2%	1.5%

13	Heat Pump Whirlpool Boiler	1,954,713	1,646,753	3,601,466	393,917	0.8%	1.7%
14	2025 – Minimum Performance	2,807,488	35,319	2,842,806	146,727	21.7%	63.4%
15	2050 – Minimum Performance	2,870,680	29,163	2,899,843	148,779	20.1%	62.9%
16	2075 – Minimum Performance	2,923,878	24,738	2,948,615	150,643	18.8%	62.4%
17	2025 – Aggressive	2,782,076	-	2,782,076	139,104	23.4%	65.3%
18	2050 – Aggressive	2,850,046	-	2,850,046	142,502	21.5%	64.4%
19	2075 – Aggressive	2,906,702	-	2,906,702	145,335	19.9%	63.7%

Simulation Inputs – Wastewater Treatment Plant:

General Parameters

Location	211 Sunset Dr, Goderich, Ontario
Weather File	CWEC 2020 Goderich Weather Data, Modified CWEC 2020 Goderich Weather Data (2050 HDD & CDD Estimate), Modified CWEC 2020 Goderich Weather Data (2075 HDD & CDD Estimate) Custom Goderich 2023 Weather Data
HDD and Climate Zone	4000 (NECB 2020), Climate Zone 6 3734 (CWEC 2020), Climate Zone 5 2971 (CWEC 2050 Estimate), Climate Zone 4 2504 (CWEC 2075 Estimate), Climate Zone 4
Building Type	Industrial
Site Orientation	True North is Project North
Modeled GFA	657 m²
Building Storeys	1, with pump houses partially below ground
Occupancy Schedules	Based on:

	• 7:00 AM – 3:30PM Monday – Friday (Modified from NECB Schedule A for office spaces)
Fan Schedules	Based on: • 7:00 AM – 3:30PM Monday – Friday (Modified from NECB Schedule A for office spaces)
Thermostat Setpoints	Based on: • 15C for heating (no night setback) for pumphouses and non-regularly occupied admin spaces • 20C for heating (no night setback) for office and control room admin spaces • 24C for cooling (no night setback) for chemical room admin space.

HVAC Plant

	Baseline Design
Cooling Plant	• N/A
Heating Plant	• N/A
Domestic Hot Water Heating - Load	• 30 Watts per Occupant (Based on NECB default modified by utility analysis) • 2 Occupants • DHW based on NECB Schedule A for office
Domestic Hot Water Heating - Equipment	• 1x Hot Water Boilers – Electric

HVAC Systems

	Baseline Design
Ventilation	**Filter Make Up Air Unit** • Heating: Furnace (80% Efficient) • Cooling: N/A • Airflow: 4,000 cfm • Fan Power: 7.5 HP, Variable Volume (assumed 6.0 bhp) • Controls: fans and operation interlocked with filter press roo equipment (approximately 2 hours a day) • Heat Recovery: Not Installed

Pump Houses	**Electric Unit Heater** • Heating: Electric • Cooling: N/A • Airflow: 350-800 cfm (sized by software) • Fan Power: 0.1" Static Pressure • Controls: runs as required to maintain thermostat setpoint
Admin Building	**Radiant Tube Heaters** • Heating: Furnace (90% Efficient) • Cooling: Window AC in chemical room (EER 10) • Airflow: N/A • Fan Power: N/A • Controls: runs as required to maintain thermostat setpoint

Envelope

	Baseline Design
Underground Floors and Walls	**Walls** • 1" insulated board, 6" concrete **Floors** • No Insulation
Exterior Walls	**Typical Brick** • 4" Brick, 1.5" Insulated Board, 6" Concrete block • R 11.6 ft² °F/Btu (nominal)
Exterior Roof	**Flat Roof (Estimated)** • Built up roofing, 2" Rigid Insulation, 6" Concrete Deck • R 9.5 ft² °F/Btu (nominal)

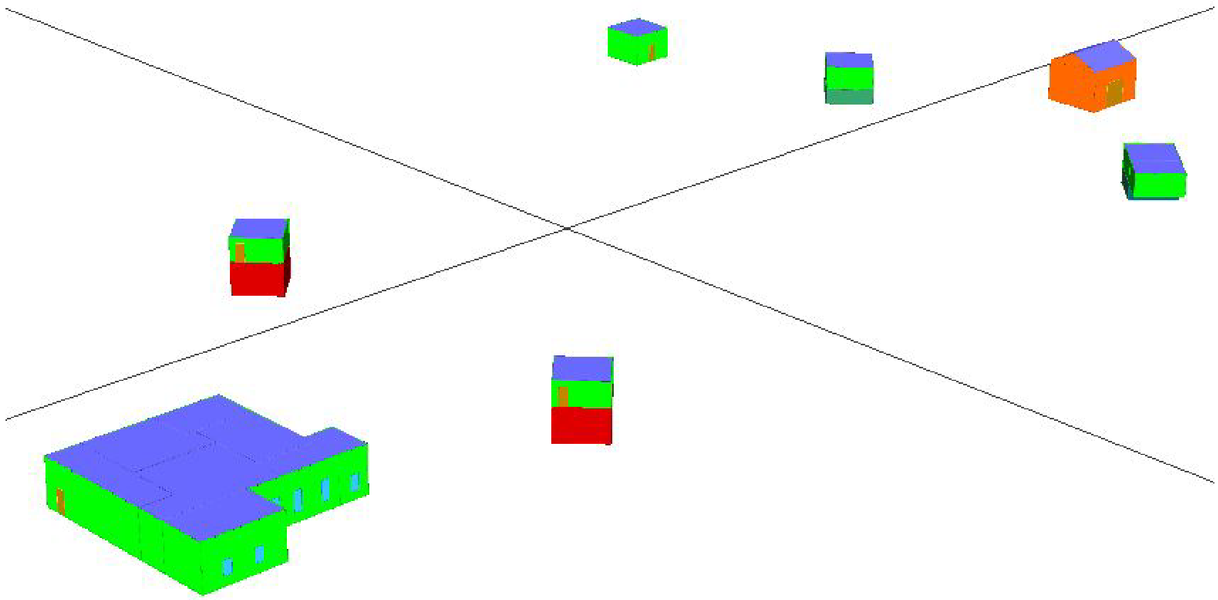
Glazing	• Double glazed, clear, 13mm Air gap, aluminum frame with standard spacer
	  o USI 2.8 W/ m² °C (effective)
	  o SHGC 0.66

Infiltration	• 0.38 L/s/m² of wall and roof area (estimated)

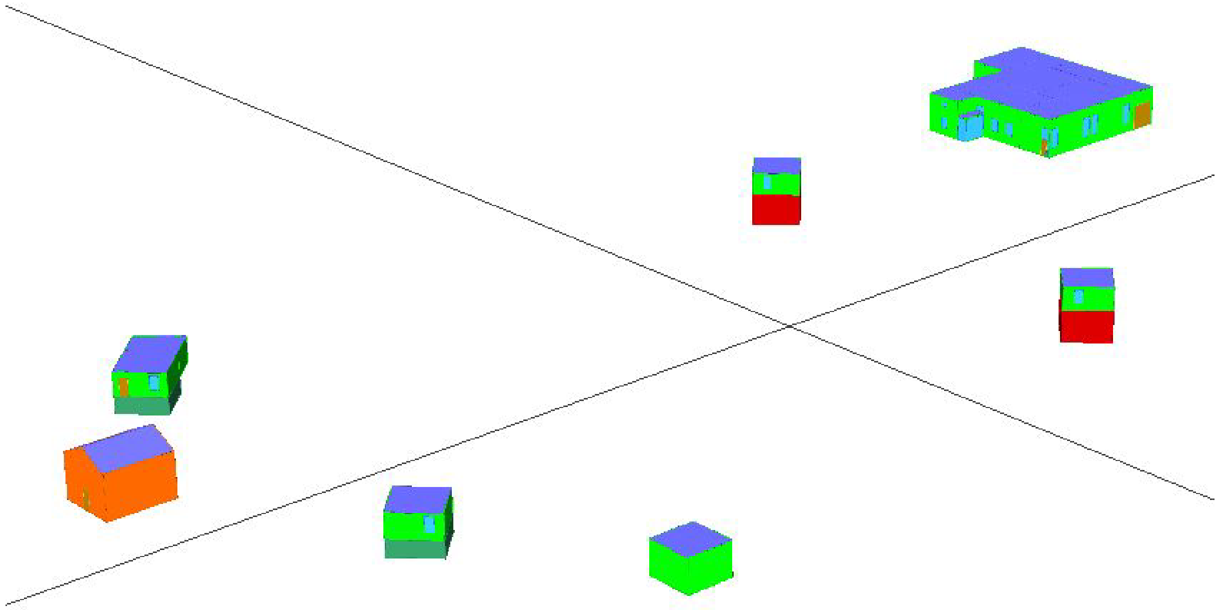
Electrical and Other Loads

	Baseline Design
Lighting	**Interior Lighting** • Admin building average lighting power density is 8.1 W/m² • Pump house building average lighting power density is 5.4 W/m² Lighting scheduled to be on 90% of peak during normal working hours (6am to 4pm) Monday to Friday. Lighting scheduled to be on at 5% of peak for emergency for all other hours.
Other Electrical Loads	**Receptacle Loads** • Building average receptacle power density is 2.7 W/m² **WWTP Process Equipment Load** • Calculated as 675,000 kWh. Modelled as 154 kW load 12 hours a day
Other Natural Gas Loads	• N/A

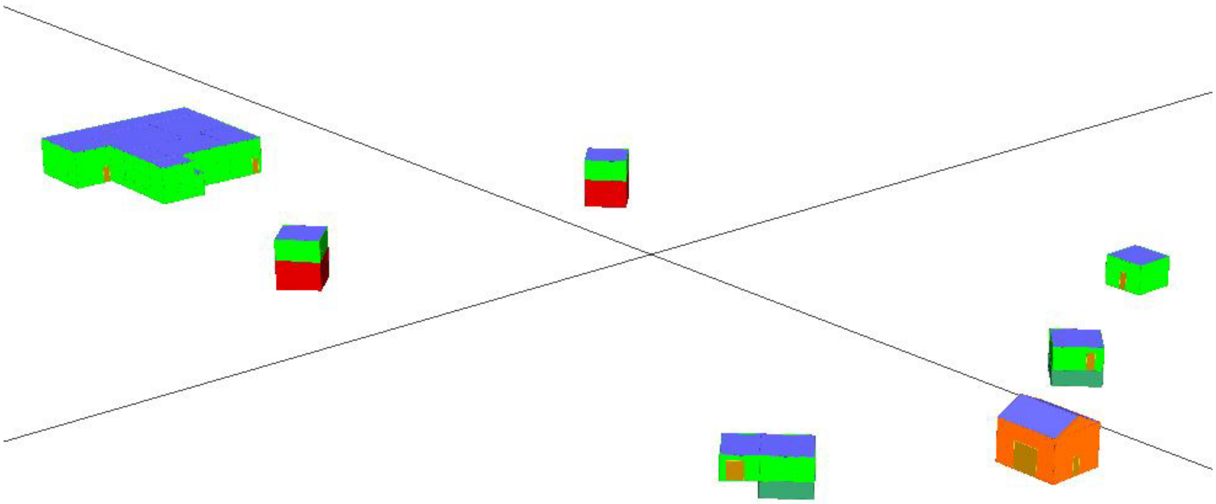
South West View (Showing Varied Opaque Constructions)



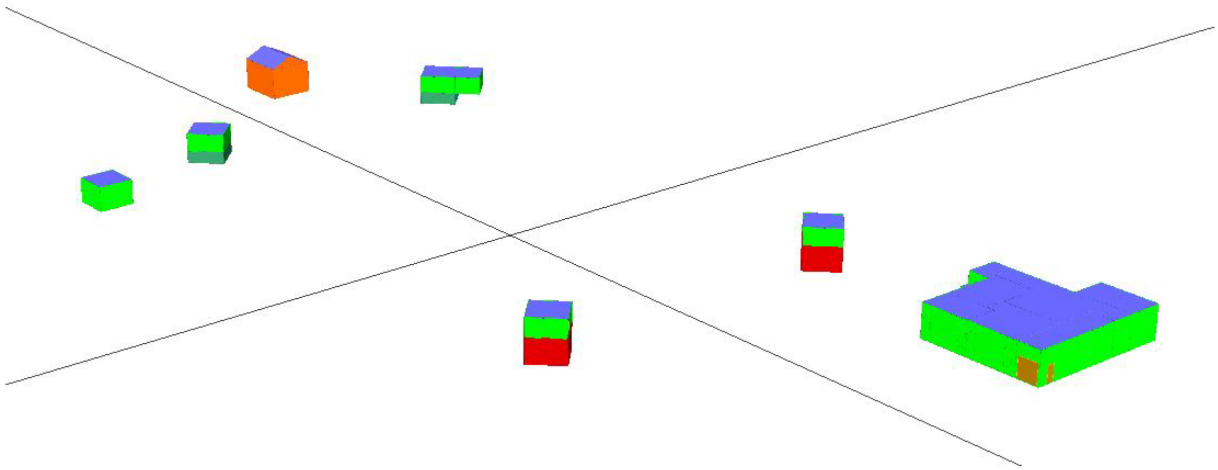
North East View (Showing Varied Opaque Constructions)



South East View (Showing Varied Opaque Constructions)



North West View (Showing Varied Opaque Constructions)



ECM Summary:

#	ECM	Change Location	Change Details
1	Electric MUA Unit	Belt MUA	Replace 80% efficient natural gas furnace with air source heat pump (COP 3.0)
2	Pump House ASHP	Pump Houses	Replace electric unit heaters with air source heat pump (COP 3.0)
3	ASHP Truck Bay	Admin Building	Replace 90% efficient radiant tube heaters with heating only air source heat pump (COP 3.0)
4	ASHP Belt Room	Admin Building	Replace 90% efficient radiant tube heaters with heating only air source heat pump (COP 3.0)
5	ASHP Chemical Room	Admin Building	Replace 90% efficient radiant tube heaters with heating only air source heat pump (COP 3.0)
6	ASHP Locker Room	Admin Building	Replace electric heater with air source heat pump (COP 3.0)
7	ASHP Office	Admin Building	Replace electric heater with air source heat pump (COP 3.0)
8	ASHP Control Room	Admin Building	Replace 90% efficient radiant tube heaters with air source heat pump (COP 3.0)
9	ASHP Chlorine Room	Admin Building	Replace 90% efficient radiant tube heaters and window air conditioner with air source heat pump (COP 3.0)
10	ASHP Workshop	Admin Building	Replace 90% efficient radiant tube heaters with heating only air source heat pump (COP 3.0)
11	ASHP All Admin Rooms	Admin Building	Replace all heating elements in the Admin Building to air source heat pump (COP 3.0). Cooling in the Office, Control Room and Chemical Room.
12	Reduce Filter Press Area	Filter Press Room	Reduce area of filter press room, reducing process energy by 7,000 kWh per year
13	Replace Process Aerators	Process Equipment	Replace mechanical agitators with blowers. Replace 80% seasonal efficient natural gas boiler with a water loop heat pump boiler (seasonal COP 2.5)
14	Adjust Occupancy Schedule	Pump Houses and Admin Building	Thermostats changed to occupancy based. Pumphouses and most Admin building spaces: 17C for 2 hours per day, 11C for all other times. Control room, office: 21C from 7:00-3:30 M-F, 15C for all other times.

15	Reduce Control Room Windows	Control Room	Reduce control room windows by 65% by replacing curtainwall with 2 punched windows 5.5'x3.25'
16	2025 – Minimum Performance	Misc	ECMs 01, 11, 12, 13, 14 Combined CWEC 2020 Weather File
17	2050 – Minimum Performance	Misc	ECMs 01, 11, 12, 13, 14 Combined Modified CWEC 2050 Weather File
18	2075 – Minimum Performance	Misc	ECMs 01, 11, 12, 13, 14 Combined Modified CWEC 2075 Weather File
19	2025 – Aggressive	Misc	ECMs 11, 12, 14 Combined CWEC 2020 Weather File
20	2050 – Aggressive	Misc	ECMs 11, 12, 14 Combined Modified CWEC 2050 Weather File
21	2075 – Aggressive	Misc	ECMs 11, 12, 14 Combined Modified CWEC 2075 Weather File

Results Summary:

#	ECM	Electrical Use (kWh)	Natural Gas Use (ekWh)	Total Energy (ekWh)	Total CO2 (kg)	Energy Savings	CO2 Savings
	Baseline	725,188	68,029	793,217	48,495	0.0%	0.0%
1	Electric MUA Unit	726,595	66,094	792,689	48,217	0.1%	0.6%
2	Pump House ASHP	714,109	68,029	782,137	47,941	1.4%	1.1%
3	ASHP Truck Bay	731,314	55,337	786,651	46,519	0.8%	4.1%
4	ASHP Belt Room	734,772	53,784	788,556	46,412	0.6%	4.3%
5	ASHP Chemical Room	722,579	68,263	790,842	48,407	0.3%	0.2%
6	ASHP Locker Room	725,862	67,149	793,011	48,370	0.0%	0.3%
7	ASHP Office	722,697	68,380	791,077	48,434	0.3%	0.1%
8	ASHP Control Room	732,867	51,498	784,365	45,906	1.1%	5.3%
9	ASHP Chlorine Room	727,972	61,844	789,817	47,522	0.4%	2.0%
10	ASHP Workshop	734,655	54,048	788,703	46,454	0.6%	4.2%

11	ASHP All Admin Rooms	759,832	1,934	761,767	38,340	4.0%	20.9%
12	Reduce Filter Press Area	718,154	68,322	786,475	48,196	0.8%	0.6%
13	Replace Process Aerators	636,086	68,322	704,407	44,092	11.2%	9.1%
14	Adjust Occupancy Schedule	704,818	41,327	746,145	42,674	5.9%	12.0%
15	Reduce and Replace Control Room Windows	725,217	65,801	791,018	48,096	0.3%	0.8%
16	2025 – Minimum Performance	667,535	-	667,535	33,377	15.8%	31.2%
17	2050 – Minimum Performance	650,184	-	650,184	32,509	18.0%	33.0%
18	2075 – Minimum Performance	638,489	-	638,489	31,924	19.5%	34.2%
19	2025 – Aggressive	755,260	1,700	756,960	38,069	4.6%	21.5%
20	2050 – Aggressive	738,172	1,466	739,638	37,172	6.8%	23.3%
21	2075 – Aggressive	726,624	1,290	727,914	36,563	8.2%	24.6%

Appendix H: References

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