PATHWAY TO DECARBONIZATION FEASIBILITY STUDY

CITY OF TEMISKAMING SHORES

WATERFRONT POOL AND FITNESS CENTRE
77 Wellington Street South, New Liskeard, ON

WalterFedy Project No: 2023-0734-10

July 21, 2025

DISCLAIMER AND LIMITATION OF LIABILITY

This document was prepared by WalterFedy for the above stated client ("Client") for the specific purpose and use by the client, as described in the report and subsequent scope of work agreement. This report was completed based on the information that was available at the time of the report preparation and completion, and is subject to all limitations, assumptions and qualifications contained herein. Any events or circumstances that have occurred since the date on which the report was prepared, are the responsibility of the client, and WalterFedy accepts no responsibility to update the report to reflect these changes.

WalterFedy agrees that this report represents its professional judgement and any estimates or opinions regarding probable costs, schedules, or technical estimates provided represent the professional judgement in light of WalterFedy's experience as well as the information available at the time of report preparation. In addition, WalterFedy accepts no responsibilities for changes in market or economic conditions, price fluctuations for labour and material costs, and therefore makes no representations, guarantees or warranties for the estimates in this report. Persons relying on such estimates or opinions do so at their own risk.

Reported utility company incentive amounts are estimated based on information that was available at the time of report preparation. Actual incentive amounts are to be determined and provided by the utility company. The utility company must be contacted prior to beginning any work for which an incentive will be applied for.

This report may not be disclosed or referred to in any public document without the prior formal written consent of WalterFedy. Any use which a third party makes of the report is at the sole responsibility and risk of the third party.

WalterFedy agrees with the Client that it will provide under this Agreement the standards of care, skill and diligence normally provided in the performance of services in respect of work similar to that contemplated by this Agreement. WalterFedy at its own expense carries professional liability insurance to the extent that it deems prudent and WalterFedy's liability under this Agreement to the Client for any claim in contract or in tort related to the services provided under this Agreement howsoever arising shall be limited to the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify WalterFedy and in any event WalterFedy's liability under this Agreement shall be limited to loss or damage directly attributable to the negligent acts of WalterFedy, its officers, servants or agents, or its failure to provide the standards of care, skill and diligence aforesaid. In no event shall WalterFedy be liable for loss or damage caused by delays beyond WalterFedy's control, or for loss of earnings or for other consequential damage howsoever caused.

The errors and omissions policies are available for inspection by the Client at all times upon request. If the Client, because of its particular circumstances or otherwise, desires to obtain further insurance to protect it against any risk beyond the coverage provided by such policies, WalterFedy will co-operate with the Client to obtain such insurance at the Client's expense.

The Client, in consideration of the provision by WalterFedy of the services set forth in this Agreement, agrees to the limitations of the liability of WalterFedy aforesaid. The Client shall have no right of set-off against any billings of WalterFedy under this Agreement.

COPYRIGHT

This project was carried out with assistance from the Green Municipal Fund, a Fund financed by the Government of Canada and administered by the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

Project Number: 2023-0734-10

July 21, 2025

Mathew Bahm
Director of Recreation
City of Temiskaming Shores
325 Farr Drive
Haileybury, ON P0J 1K0

Dear Mathew,

RE: Pathway to Decarbonization Feasibility Study

WalterFedy is pleased to submit the attached Pathway to Decarbonization Feasibility Study report to the City of Temiskaming Shores. This study covers the agreed-upon scope and provides a Pathway to Decarbonization Feasibility Study for the Waterfront Pool and Fitness Centre, which is located at 77 Wellington Street South in New Liskeard, ON. Certain parts of this report are designed to be viewed in digital/PDF format. This approach will enable the reader to zoom in on images and navigate the document using the provided hyperlinks.

The report was completed based on the information provided by the City of Temiskaming Shores, using the supplied and collected data, engineering judgment, and various analysis tools to arrive at the final recommendations.

All of which is respectfully submitted,

WALTERFEDY

Jordan Mansfield, P.Eng., M.Eng., CEM, CMVP
Energy Engineer
Energy and Carbon Solutions

jmansfield@walterfedy.com
519 576 2150 x 336

Contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

WalterFedy was engaged by the City of Temiskaming Shores to complete a Pathway to Decarbonization Feasibility Study for the Waterfront Pool and Fitness Centre. The objective of this engagement is to identify and analyze measures that reduce utility use, GHG emissions, and utility costs at the Waterfront Pool and Fitness Centre, and to analyze various GHG Reduction Pathways consisting of combinations of measures. Based on these analyses, the objective is also to recommend the preferred GHG Reduction Pathway for implementation. To achieve this objective, the following steps were taken.

1. **Facility description**. The existing conditions of the facility were reviewed through available documentation and a site survey completed on 2024-04-15 to gain an understanding of the facility and its operations. A facility description, summarizing findings, is provided in Section 2.
2. **Utility use baseline**. Metered utility data provided by the City of Temiskaming Shores was reviewed to understand historical utility use trends, and to establish the utility use baseline for the Waterfront Pool and Fitness Centre. Findings are documented in Section 3.
3. **Energy model development**. A calibrated energy model was developed from a bottom-up hourly analysis considering historical weather patterns, and the insight gained from reviewing the facility's existing conditions and historical utility use data. Findings are documented in Section 4.
4. **Measure analysis**. Measures intended to achieve the City of Temiskaming Shores's goals were identified and analyzed. Analysis includes conceptual design development and utility analysis quantifying utility use impacts, GHG emissions and utility costs for each measure. Findings are documented in Section 5.
5. **Scenario analysis**. Scenario analysis was completed to estimate the costs and benefits expected from implementing various combinations (i.e. scenarios) of the measures that were individually analyzed in Section 5, accounting for the interactive effects between measures within each scenario. Findings are documented in Section 6.

All analysis was completed using the calibrated energy model, which matches metered yearly electricity and natural gas utilities used by the Waterfront Pool and Fitness Centre by precisely capturing existing conditions of the building within the model. The model tracks each utility end use for every hour of a complete year.

Based on the analysis completed and discussions with the client, the GHG reduction pathway that is recommended for implementation is as follows.

- **Organizational goal alignment**

The recommended plan scenario composition is presented in Figure 1, which is a measure implementation timeline plot indicating which measures were assumed to be implemented in which plan scenarios and when, and the estimated project cost of each measure. The measures are also colour-coded according to measure group.

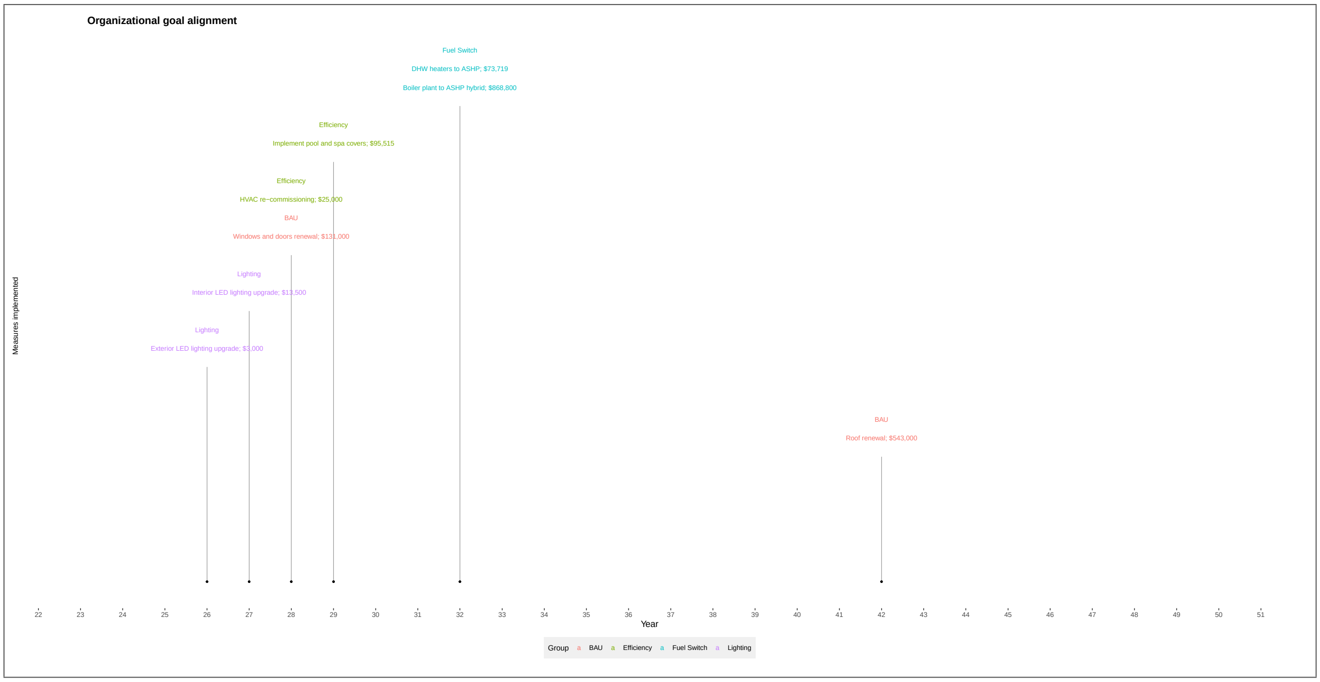


Figure 1: Recommended plan scenario composition, indicating which measures are implemented when and at what cost in each plan scenario

The following plots in Figure 2 show the results for the recommended GHG reduction pathway.

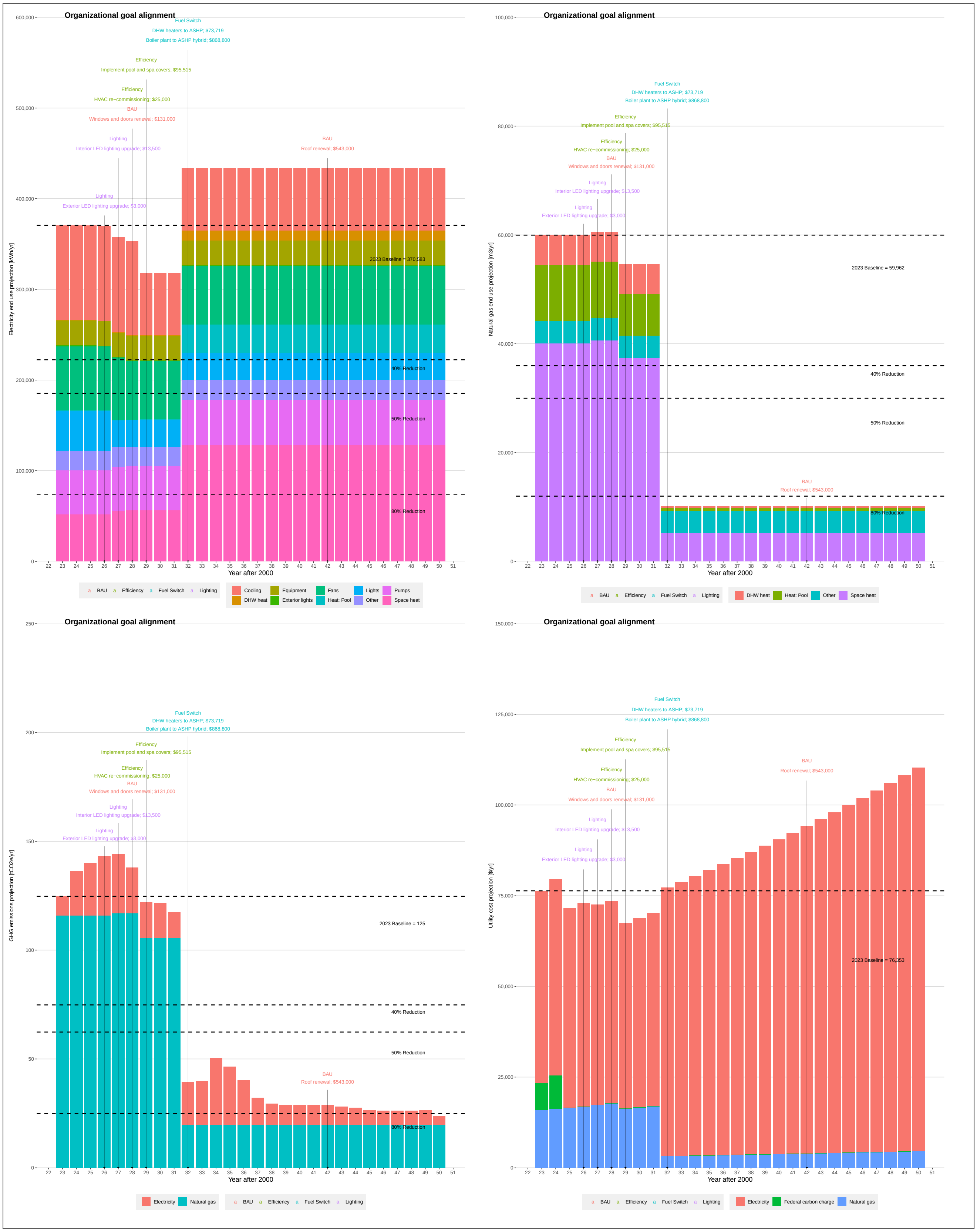


Figure 2: Recommended scenario performance

Table 1 summarizes the performance of all the plan scenarios with respect to utility use, GHG emissions, utility cost, and financial metrics. The recommended plan scenario is in **bold**. The first half of Table 1 represents the estimated performance in the final year (2050) of the evaluation period. The second half of Table 1 represents the estimated cumulative performance across the entire evaluation period (present to 2050). All final year dollar values are in the value of today's currency. All cumulative dollar values presented in Table 1 are calculated as the simple sum of expenditures over the evaluation period, except for the life cycle cost, which is discounted to present value (as illustrated in Figure 2).

Table 1: Recommended plan scenario performance summary

Section	Description	Unit	Minimum performance scenario	Aggressive deep retrofit	Comprehensive	Organizational goal alignment	Business as usual
Utility use final	Electricity use	[kWh/yr]	433,809	433,809	129,362	**433,809**	370,583
	Electricity monthly peak (av)	[kW]	80.8	80.8	68.6	**80.8**	60.0
	Electricity yearly peak (max)	[kW]	102	102	83	**102**	74
	Natural gas use	[m3/yr]	10,162	10,162	4,538	**10,162**	59,962
GHG emissions final	Electricity GHGs	[tCO2e/yr]	4.1	4.1	1.2	**4.1**	3.5
	Natural gas GHGs	[tCO2e/yr]	20	20	9	**20**	116
	Carbon offsets GHGs	[tCO2e/yr]	0.00	0.00	0.00	**0.00**	0.00
	Total GHGs	[tCO2e/yr]	24	24	10	**24**	119
Utility cost final	Electricity utility cost	[$/yr]	105,763	105,763	31,538	**105,763**	90,348
	Natural gas utility cost	[$/yr]	4,599	4,599	2,054	**4,599**	27,139
	Carbon offsets utility cost	[$/yr]	0.00	0.00	0.00	**0.00**	0.00
	Federal carbon charge	[$/yr]	0.00	0.00	0.00	**0.00**	0.00
	Total utility cost	[$/yr]	110,362	110,362	33,593	**110,362**	117,487
Utility use cumulative	Electricity use	[kWh]	11,388,999	11,760,971	8,899,412	**11,388,999**	10,376,317
	Natural gas use	[m3]	717,850	528,764	611,010	**717,850**	1,678,950
GHG emissions cumulative	Electricity GHGs	[tCO2e]	404	421	362	**404**	380
	Natural gas GHGs	[tCO2e]	1,387	1,022	1,181	**1,387**	3,244
	Carbon offsets GHGs	[tCO2e]	0.00	0.00	0.00	**0.00**	0.00
	Total GHGs	[tCO2e]	1,792	1,443	1,543	**1,792**	3,625
Utility cost cumulative	Electricity utility cost	[$]	2,177,084	2,238,194	1,615,996	**2,177,084**	1,961,272
	Natural gas utility cost	[$]	224,098	167,188	183,398	**224,098**	589,102
	Carbon offsets utility cost	[$]	0.00	0.00	0.00	**0.00**	0.00
	Federal carbon charge	[$]	16,801	16,801	16,801	**16,801**	16,801
	Total utility cost	[$]	2,417,983	2,422,183	1,816,194	**2,417,983**	2,567,175
Financial cumulative	Project cost	[$]	2,381,605	2,274,661	5,974,799	**2,381,605**	1,065,627
	Replacement cost	[$]	998,658	926,673	1,013,886	**998,658**	24,798
	Life cycle cost	[$]	2,538,564	2,749,908	2,581,330	**2,538,564**	1,662,009

1 INTRODUCTION

1.1 Overview

WalterFedy was engaged by the City of Temiskaming Shores to complete a Pathway to Decarbonization Feasibility Study for the Waterfront Pool and Fitness Centre. This engagement aims to identify a recommended Greenhouse gas (GHG) reduction pathway by examining GHG reduction measures and various scenario developments. Based on a review of the Request For Proposal Document, the City's Corporate Greenhouse Gas Reduction Plan (GHGRP), and the Federation of Canadian Municipalities (FCM) Community Buildings Retrofit (CBR) funding program, the following scenarios will be developed:

- **Business as usual**: To follow the existing capital renewal plan and replace equipment at the end of its life with like-for-like equipment, meeting minimum energy-efficiency requirements of ASHRAE 90.1.
- **Minimum performance**: To achieve a 50% reduction in operational GHG emissions within 10 years and 80% within 20 years. This scenario addresses the minimum performance scenario of FCM's CBR program.
- **Aggressive deep retrofit**: Implement the same measures as in the minimum performance scenario but achieve an 80% reduction in GHG emissions within five years. This scenario addresses the additional scenario requirement of FCM's CBR program.
- **Organizational goal alignment**: To reduce emissions by 40% GHG emissions from 2019 levels by 2033 and 80% reduction by 2050 of on-site emissions. The remaining 20% is to be addressed through carbon offsets, as noted in the City's GHGRP.
- **Comprehensive**: To understand the limit of GHG reductions possible by implementing all measures with the greatest reduction on GHG emissions that are mutually exclusive.

1.2 Background

1.2.1 Corporate Greenhouse Gas Reduction Plan

The City of Temiskaming Shores has been dedicated to taking a leading role in the battle against climate change. As a committed member of the Partners for Climate Protection (PCP) program, they achieved Milestone 3 in May 2023 by creating the City's Corporate Greenhouse Gas Reduction Plan. The plan includes ambitious targets, aiming for a 40% reduction below 2019 levels by 2033 and striving for net zero emissions operations by 2050. After conducting an inventory of its greenhouse gas (GHG) emissions in 2019, the City discovered that its buildings and facilities accounted for 813 tCO2e, representing 41.6% of its total GHG emissions inventory. A significant portion of these GHG emissions comes from natural gas, which makes up 41.7% of all energy sources for the City. To reach these sustainability goals, the City has implemented several measures, including:

- Establishing a Climate Action Committee
- Implementing a Climate Lens with regular reporting
- Utilizing a combination of EnergyCAP and ENERGY STAR Portfolio Manager to monitor and report building utility use, including electricity, natural gas, and propane
- Transitioning its fleet to biodiesel
- Initiating decarbonization studies of its buildings

This study will contribute to the decarbonization studies of its buildings. The Waterfront Pool and Fitness Centre is one of fourteen buildings being examined. Of these fourteen buildings, they represent over 77% of the buildings and facilities GHG emissions. In particular, the Waterfront Pool and Fitness Centre represented 115 tCO2e in 2019, or 5.9% of the overall inventory.

1.2.2 Asset Management Plan

The City of Temiskaming Shores released Version 1.2 of their Asset Management Plan in 2024, providing a framework for prioritizing and optimizing asset management efforts from 2024 to 2034. The building and facility assets are estimated to have a total replacement cost of $76,178,722, with City Hall alone having an estimated replacement cost of $8,613,308. The average annual financial requirements, including capital and operational expenditures, is $2,153,014. Furthermore, the 2031 budget will see a significant increase in capital needs, nearing $44 million. In 2032, this figure will exceed $25 million, and in 2033, it will be more than $5 million. Figure 2 summarizes the asset management data for the Waterfront Pool and Fitness Centre.

Table 2: Asset management summary for this facility

Group	Metric	Unit	Value
Financial	Content Value Estimated	[$]	1,836,193
	Building Land Tank	[$]	11,303,606
	Replacement Cost	[$]	13,139,799
Information	Install Date	[yr]	1988
	Age	[yrs]	37
Condition Rating	Structure Condition Score	[-]	4.1
	Final Condition Score	[-]	4.1
Risk	Probability of Failure	[-]	1
	Consequence of Failure	[-]	5
	Risk Score	[-]	1.8

1.3 Contact information

Contact information for WalterFedy (the Consultant) and City of Temiskaming Shores (the Client) is provided in Table 3.

Table 3: Contact information

Description	Consultant	Client
Organization	WalterFedy	City of Temiskaming Shores
Address	Suite 111, 675 Queen St South	325 Farr Drive
Location	Kitchener, ON	Haileybury, ON
Postal code	N2M 1A1	P0J 1K0
Contact name	Jordan Mansfield	Mathew Bahm
Credentials	P.Eng., M.Eng., CEM, CMVP	-
Title	Energy Engineer	Director of Recreation
Phone	519 576 2150 x 336	705 672 3363 x 4106
Email	jmansfield@walterfedy.com	mbahm@temiskamingshores.ca

2 FACILITY DESCRIPTION

2.1 Facility description methodology

The facility was reviewed and described according to the following methodology. The intent of reviewing and describing the facility is to understand the pertinent operations and systems in the facility that use utilities so that the baseline (i.e. existing) utility use can be accurately quantified.

1. **Facility document review**. Facility documents from the following list were reviewed, if available. Further information on available documentation are available in Section 2.3.
    - Building drawings.
    - Building automation system graphics and points lists.
    - Previously completed Engineering studies, including Energy Audits, Feasibility Studies, and Building Condition Assessments.
    - Historical utility use data.
    - Other documentation made available by the City of Temiskaming Shores.
2. **Site survey**. A site survey was completed on 2024-04-15 to review the energy systems applicable to the desired retrofit scenario.

2.2 Facility overview

An overview of the Waterfront Pool and Fitness Centre is provided in Table 4.

Table 4: Facility overview

Description	Unit	Value
Name	[-]	Waterfront Pool and Fitness Centre
Address	[-]	77 Wellington Street South
Location	[-]	New Liskeard, ON
Type	[-]	Community centre
Construction year	[-]	1988
Gross floor area	[m2]	1,981
Gross floor area	[ft2]	21,320

An aerial view of the Waterfront Pool and Fitness Centre is provided in Figure 3.

Figure 3: Waterfront Pool and Fitness Centre aerial view

2.3 Building information

Renovations

The following renovations are known:

Men's and Women's Changeroom renovation (2013): The non-member changerooms were renovated to be barrier free.

Dehumidification System (2014): The dehumidification system was replaced by removing HV2 and DH1, located in the pool mezzanine, and a new DH1 was installed outside. A reheat coil was installed in the pool mezzanine.

Mechanical system renovation (2018): The heating system was replaced, which included the following: replaced four boilers, replaced the heating coil in DH-1, new heat exchangers (HX1-pool heating, HX2-whirlpool heating, and HX3-DHW), P5 and P6 complete with VFDs, replaced the pre-heat and reheat coils for HV1, replaced the pump serving the preheat coil of HV1, and replaced P13 serving DH1 reheat coil. The new coils were designed for an EWT of 140F.

Roof replacement (2022): The asphalt shingle roof was replaced with a metal roof. No additional insulation was added.

Additions

There have been no additions to this building.

Energy use not within the gross floor area

The following energy use is located outside the gross floor area of this building:

- Building-mounted exterior light fixtures

Utility bill responsibility

Utility bill responsibility is as follows:

- Natural gas meter: the City
- Electricity meter: the City

Commissioning history

No commissioning history has been documented.

Previous studies

The following is a summary of known previous studies:

- Energy audits: None.
- Engineering studies: Roof inspection in 2022. The report was not provided.
- Building condition assessments: None.

Documentation availability

In conjunction with the site survey, the following documents are being used to help us better understand this facility:

- Mechanical drawings for the original building, M-1 to M-4, dated 11/08/87.
- Mechanical drawings for the 2014 new dehumidification system, M-1 to M-6, dated July 3, 2014.

- Mechanical drawings for the 2018 mechanical upgrade, M-1 to M-5, dated October 25, 2018.
- Pool drawings for the 3 re-circulation system reno, ASB1.0, dated 4/30/17.
- Architectural drawings for the 2013 washroom renovation, A1-A3, dated 2023/06/21.
- Architectural drawings for the original building, dated 11/08/87.
- Floor plans, FP-1 and FP-2, dated May 2014.
- Roof drawings, Sheets 1-7, dated 03/04/22.
- Electrical drawings for the original building, E-1 to E-3, dated July 31/87.
- Electrical drawings for the 2014 new dehumidification system, E-1, dated November 25, 2015.

2.4 Space use

Type summary

The following spaces were identified during the site survey and documentation review.

- Natatorium
- Changerooms
- Offices
- Saunas
- Viewing room
- Washrooms
- Kitchenette
- Lounge
- Fitness area
- Electrical/Mechanical room
- Storage

The crossfit and weight rooms were designed as squash courts. Furthermore, the lifeguard changeroom was designed as a sauna. It is unclear when these renovations were completed.

Occupancy scheduling

The facility operation hours are as follows:

- **Building hours**: 06:30-21:15 Monday to Friday, 08:00-19:00 Saturday, and 10:00-16:30 Sunday, per the City's website.
- **Pool hours**: Varies.

Based on the GFA, it is assumed that this building has a peak occupancy of 198 people.

Space use breakdown

A space use breakdown, which was estimated via calibrated measurements performed on available facility floor plans, is presented in Table 5.

Table 5: Space use summary

Space name	Floor area of space	HVAC System	Data source
-	[m2]	-	-
Natatorium	623.9	DH1	Drawings.
Weight training room	135.3	HV1	Drawings.
Cross fit, squash court, and weight room	277.4	HV1	Drawings.
Lobby and kitchenette	173.2	Baseboards	Drawings.
Supervisor 128 and Office 127	39.5	Baseboards	Drawings.
Meeting room 120	28.2	Baseboards	Drawings.
Lounge 117	123.4	Baseboards	Drawings.
Misc.	557.0	Unconditioned	Drawings.

Space use documentation

Space use documentation, including available drawings and photos taken during the site survey, is provided in the following images. Most drawings in this report are high-quality, embedded PDF documents, enabling the reader to review details by zooming in on the figures.

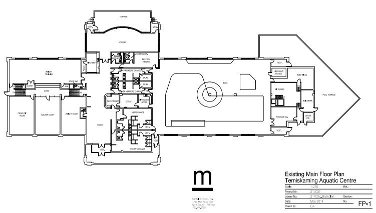


Figure 4: Main floor PFC

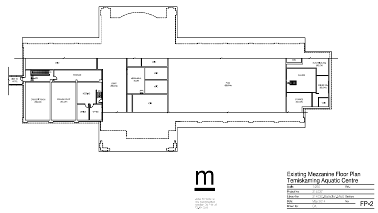


Figure 5: Mezzanine floors PFC

2.5 Building Envelope

Building envelope area data summary

Building envelope areas are summarized in Table 6.

Table 6: Building envelope summary

Area of roof	Area of exterior walls net	Area of exterior walls	Area of exterior windows	Area of exterior doors
[m2]	[m2]	[m2]	[m2]	[m2]
2,088	941	751	174	15.6

Roof

The exterior layer of the roof consisted of a metal roof that was installed in 2022. No additional insulation was added during this renovation. One typical roof assembly was noted per the drawings. It had the following composition (exterior to interior layer):

- Metal roof
- 19mm exterior grade plywood
- 125mm furring channels at 600mm O.C.
- 105mm roof insulation
- Air barrier
- 13mm fire-rated gypsum board
- Metal deck

The overall U-Value for this assembly is assumed to be 0.5162 W/m2K (R11).

The roof was in excellent condition.

Opaque Walls (above ground)

The exterior layer of the wall consisted of either metal siding or veneer brick. Two typical wall assemblies were noted per the drawings. They had the following compositions (exterior to interior layer):

W1:

- 90mm architectural concrete block
- 14mm air space
- 76mm insulation
- Air barrier
- 190mm concrete block

W2:

- Metal siding on z-girts
- 75mm insulation
- Air barrier
- 190mm concrete block

The overall U-Value for these two assemblies is assumed to be 0.3712 W/m2K (R15.3).

The walls were in poor condition. Moisture issues are present under windows around the natatorium.

Fenestration

Windows

- The facility has double glazed windows complete with aluminum frames that are original to the building. All windows were of the picture type.
- Windows appeared to be in fair condition. However, some windows are missing sealant.
- The window system's overall U-Value is assumed to be 2.27 W/m2K, with an SHGC of 0.35.

Doors

- The facility has swing doors with glazing, sliding doors with glazing and hollow metal.
- The overall fenestration-to-wall ratio is estimated to be 28%.

Overall Enclosure Tightness

It is difficult to determine a building's infiltration rate without performing a blower door test. However, an infiltration rate is required for energy modelling purposes. Based on the site survey, an infiltration rate of 0.5 Lps/m2 of the above-grade building envelope area will be assumed here.

Building Envelope documentation

Building envelope documentation, including available drawings and photos from the site survey, is provided in the following images.


Figure 6: Brick facade on the northeast corner


Figure 7: Exposed foundation insulation


Figure 8: Front entrance

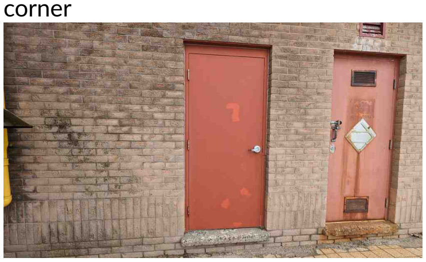


Figure 9: Hollow metal door to the filter room


Figure 10: Metal siding on the west elevation with outdoor air louvre


Figure 11: Missing caulking around partial window outside the pool area


Figure 12: Moisture damage on the south elevation


Figure 13: North elevation


Figure 14: Pedestrian bridge connecting the motel and the fitness centre

Figure 15: Pool window

Figure 16: South elevation window

Figure 17: South elevation of the lounge room

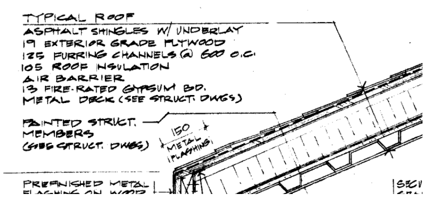


Figure 18: Original typical roof assembly before roof renovation

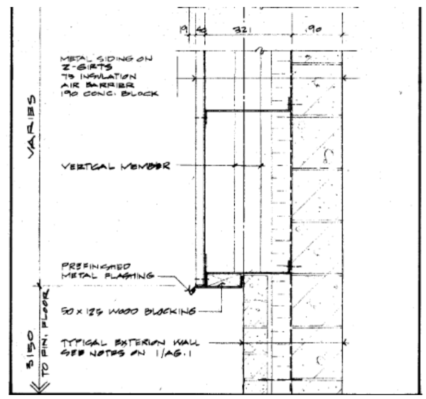


Figure 19: Typical metal siding assembly

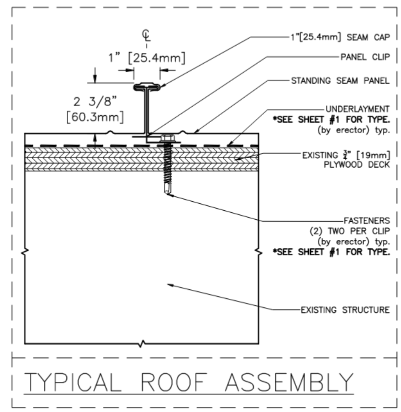


Figure 20: Typical roof assembly from the roof renovation

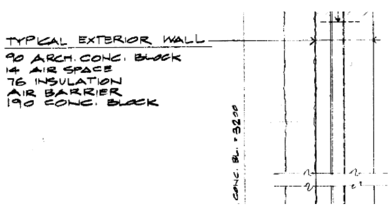


Figure 21: Typical wall assembly

2.6 HVAC

HVAC equipment summary

HVAC systems are summarized in Table 7, Table 8, Table 9, and Table 10.

Table 7: Air distribution systems summary

Tag	Make	Model	Serves	Design flow	Motor output	Data source
-	-	-	-	[cfm]	[hp]	-
DH1	Dectron	RSH-082-9	Natatorium	8,600	-	Assumption.
HV1	Markhot	MZ	Fitness centre	7,915	7.50	Nameplate.
EF1	NA	NA	Washrooms, changerooms, and kitchenette	3,811	3.00	Assumption.
EF2	NA	NA	Lounge and viewing room	-	0.50	Assumption.

Table 8: Water distribution systems summary

Tag	Serves	Flow	Head	Motor output	Data source
-	-	[gpm]	[ft]	[hp]	-
BP1	B1	38.0	21	0.40	Drawings.
BP2	B2	38.0	21	0.40	Drawings.
BP3	B3	38.0	21	0.40	Drawings.
BP4	B4	38.0	21	0.40	Drawings.
PP1	Main pool	385.0	70	10.00	Nameplate.
PP2	Slide	700.0	70	15.00	Nameplate.
PP3	Spa hydrojet	200.0	70	5.00	Nameplate.
PP4	Spa filter	225.0	40	7.50	Nameplate.
P5	Hydronic heating	237.8	102	7.50	Nameplate.
P6	Hydronic heating	237.8	102	7.50	Nameplate.
P12	DH1 heat recovery	-	-	0.40	Drawings.
P12A	DH1 heat recovery	-	-	0.40	Drawings.
P13	DH1 reheat coil	48.0	20	0.40	Drawings.
P14	HV1 preheat coil	9.4	-	0.40	Drawings.
P15	DHW recirc.	5.0	10	0.27	Drawings.

Table 9: Heating systems summary

Tag	Serves	Utility	Efficiency	Output	Data source
-	-	-	[decimal]	[btuh]	-
B1	Hydronic heating	Natural gas	0.95	380,000	Nameplate.
B2	Hydronic heating	Natural gas	0.95	380,000	Nameplate.
B3	Hydronic heating	Natural gas	0.95	380,000	Nameplate.
B4	Hydronic heating	Natural gas	0.95	380,000	Nameplate.

Table 10: Cooling systems summary

Tag	Serves	Efficiency	Output	Data source
-	-	[decimal]	[ton]	-
CU1	HV1 cold deck	5	10	Assumption.
FC1	Second office	4	2	Assumption.

System type

The facility utilizes one dehumidification unit (DH1) to serve the natatorium and a multizone system (HV1) to serve the fitness centre. There is also a cooling unit in the second-floor office. A summary of these systems is as follows:

DH1

- Contains 2-stage cooling, two blower fans, and two condenser fans. The blower fans are equipped with VFDs.
- The nameplate indicates an EWT of 82F, an air temperature of 84F, and RH 50-60%.
- DH1 has refrigerant hot-gas heat recovery via a glycol loop from DH1 to HX4, then a water loop to the pool. P12a is on the glycol side, and P12 is on the water side.
- The pool water heat recovery is sized for 42.2 kW at a water flow of 1.2 lps.
- There is a hydronic reheat coil located in the pool mezzanine room.
- DH1 is in good condition.

HV1

- The unit has one supply fan and no return fan. The fan is constant speed.
- There is a preheat coil and a reheat coil in the hot deck. Both coils are served by the hydronic system.
- There is a DX cooling coil in the cold deck. It is connected to a water-cooled condenser.
- HV1 serves six zones throughout the fitness centre.
- The filters were in good condition.
- The hot water supply and return valves for the preheat coil were closed, but the pump appeared to be ON.
- There was missing insulation on the pipe leading to the reheat coil.
- HV1 is original to the building, including the water-cooled condenser unit, and is passed its expected useful life. Unfortunately, getting a new unit into the same space would be difficult.

Exhaust fans

- Two main exhaust fans operate with HV1. EF1 is located in the mezzanine mechanical room with HV1.

Miscellaneous

- There is a cooling unit in the second floor office. Information for this unit was not available.
- There is a significant number of electric baseboards present in this facility. A takeoff of the original drawings suggests approximately 74 kW capacity.

Central Plant

- Four condensing boilers provide hot water to three heat exchangers (HX1-pool, HX2-spa, HX3-DHW), DH1 reheat coil, HV1 hot deck heating coil, and HV1 preheat coil.

Distribution system

A total of 15 pumps circulate the working fluid throughout the building. They serve the following:

- Four pumps serve the primary boiler loop. Each pump is interlocked with a corresponding boiler.
- Two pumps serve the secondary hot water loop. They are intended to operate in a lead/lag configuration.
- Four pumps serve the pool, spa, and slide.
- Two pumps serve the DH1 heat recovery loop.
- Two pumps serve heating coils.
- One pump for DHW circulation.

Note that the pump serving the reheat coil is deadheading.

HV1 uses a hot and cold deck that is combined into dedicated ductwork per zone.

Controls

HV1

- HV1, EF1, and EF2 are to operate when in occupied mode. The occupied mode is determined by a day schedule.
- The unit is equipped with optimal start with the mixing damper being in the full return position.
- HV1 and EF2 are to operate continuously with EF1 enabled.
- The outside air damper is intended to introduce 3,125 CFM when all zone dampers are open.
- During unoccupied mode, HV1 and EF2 are to cycle to respond to heating or cooling calls from individual zones. EF1 is turned off in unoccupied mode.
- Unoccupied setpoints are intended to be 28C and 18C for cooling and heating setpoints, respectively.
- P14 is enabled when the OA temperature is below 10C.
- The 3-way control valve is intended to modulate the discharge air temperature of 12.5C.
- The VVT control is based on the temperature sensors installed in the zones. Heating or cooling is determined based on zone calls. If more zones are calling for heat, then the system performs a changeover to close the cold deck and open the hot deck. The opposite happens if cooling calls are greater than heating. The reference zone is based on the zone with the greatest need.
- The hot deck temperature is intended to be 32C.
- The economizer mode is enabled when there is a call for cooling, the supply fan is on, and the outdoor air temperature is less than the exhaust temperature. The outdoor air damper is to slowly open from the minimum position. However, it is to maintain a minimum mixed air temperature of 12.8C.

Observations of HV1 are as follows:

- HV1 is scheduled to be in occupied mode continuously.
- The OAT was 3.8C. However, there was no call for heat. The EAT from EF2 was reading 23.5C. However, there are no spaces with that temperature.
- EF2 and EF3 are set to in-hand.
- The OA damper is constrained to 0%.
- The hot deck supply air temperature setpoint is 13C. However, the SOO suggests that the setpoint should be 32C.

DH1

- P12 and P12a are to be enabled by the BAS when there is a call for pool heating from DH1.
- P13 is to be enabled when the OA temperature is less than 10C.

- The Dectron SOO was not provided.

Observations of DH1 are as follows:

- The BAS is unable to get a connection to P13.
- The SOO indicates that the BAS is to enable P12 and P12a. However, these pumps are not present in the BAS.
- The pool air temperature was 21C and had an RH of 62%.

Boilers

- All four boilers are sequenced to maintain the supply water setpoint. When a boiler is enabled, its corresponding pump is also enabled.
- The boilers are to rotate lead position every two weeks.
- A review of the BAS shows that the SWT is constrained to 60C.

Hot water loop

- P5 and P6 serve the secondary loop and are equipped with VFDs. The heat exchangers are equipped with 2-way valves. However, the heating coils have three-way valves.
- PP1 and PP2 appear to be ON continuously.
- P15 appears to turn off at 22:15 and back on at 04:00.
- DHW has a setpoint of 49C.
- The spa has a setpoint of 39C.
- The pool has a setpoint of 28C.
- The OAT on the BAS is higher than the actual OAT.

Zone temperatures

- The viewing room has its damper set to 40%.
- Five of the six zones are satisfied with their heating setpoint. However, most of their dampers are 100% open.

HVAC system documentation

HVAC system documentation, including available drawings and photos from the site survey, is provided in the following images.

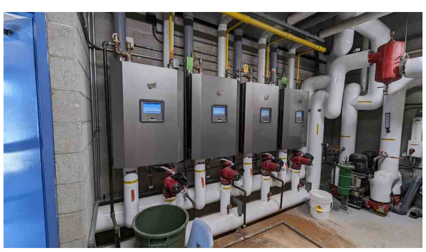


Figure 22: B1 to B4 and BP1 to BP4

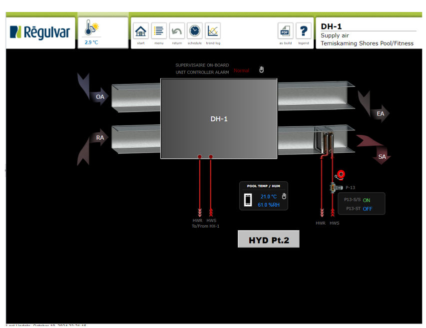


Figure 23: BAS - DH1

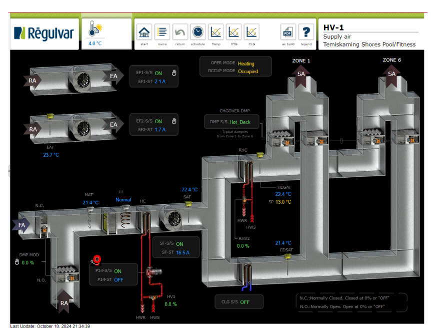


Figure 24: BAS - HV1

Figure 25: BAS - Lounge

Figure 26: BAS - Zone 3

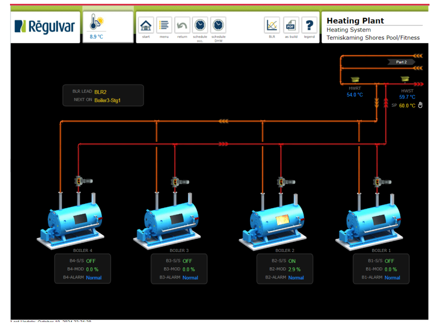


Figure 27: BAS - Boilers

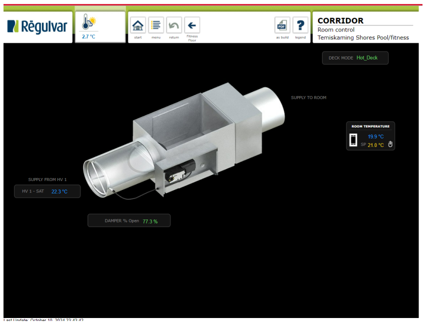


Figure 28: BAS - Corridor


Figure 29: BAS - DHW trend

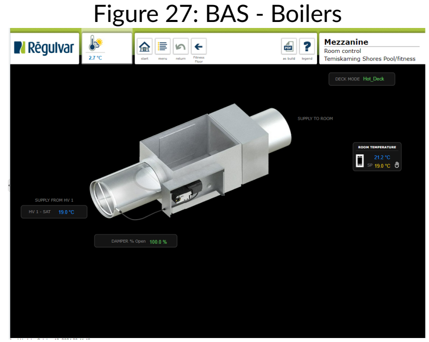


Figure 30: BAS - Mezzanine

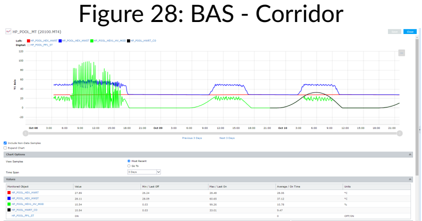


Figure 31: BAS - Pool trends

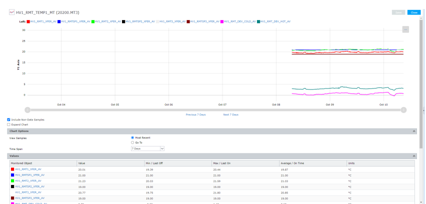


Figure 32: BAS - HV1 - Trends

Figure 33: BAS - Viewing room

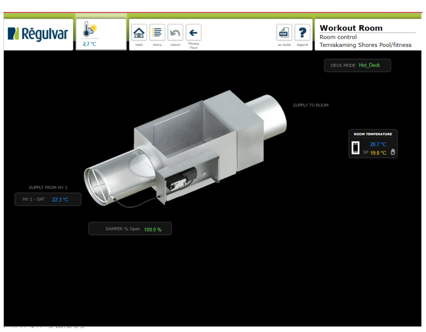


Figure 34: BAS - Workout room

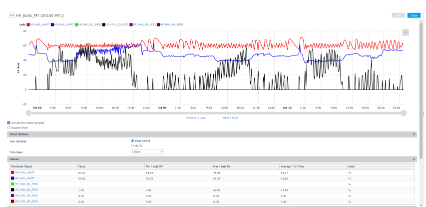


Figure 35: BAS - Boiler trends

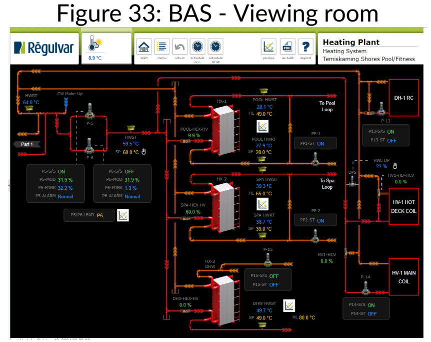


Figure 36: BAS - Hot water loop

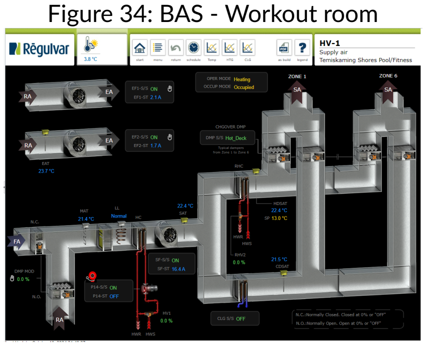


Figure 37: BAS - HV1 - Schedule

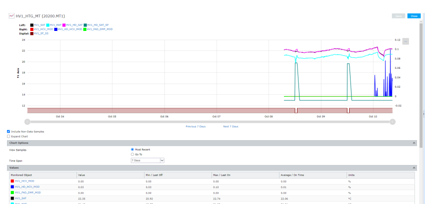


Figure 38: BAS - HV1 - Trends 2

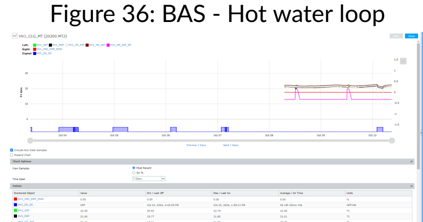


Figure 39: BAS - HV1 - Trends 3

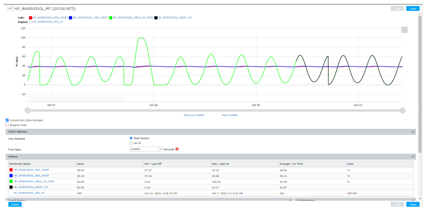


Figure 40: BAS - Whirlpool trend

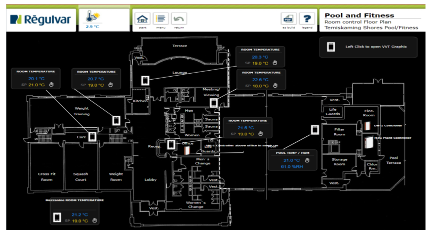


Figure 41: BAS - Zone temperatures

Figure 42: Boiler exhaust ports

Figure 43: Boiler room exhaust port

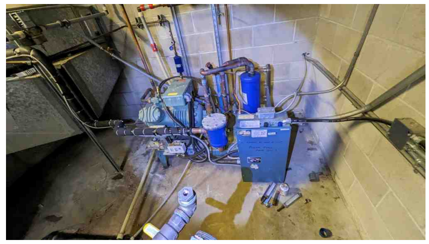


Figure 44: CU1

Figure 45: CU1 was turned off during the site visit

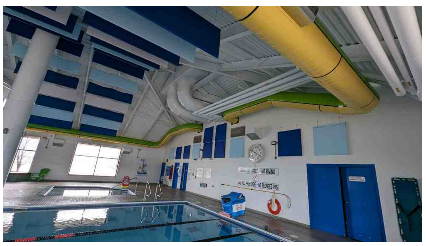


Figure 46: DH1 ductwork

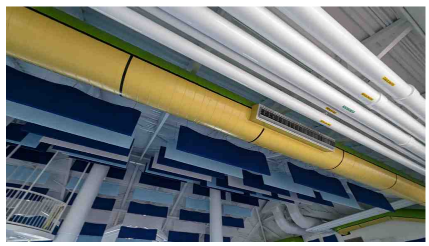


Figure 47: DH1 supply ductwork

Figure 48: DH1

Figure 49: DH1 reheat coil

Figure 50: Electric heater in vestibule to natatorium

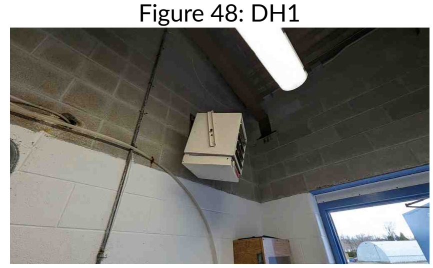


Figure 51: Electric unit heater in the pool mechanical room

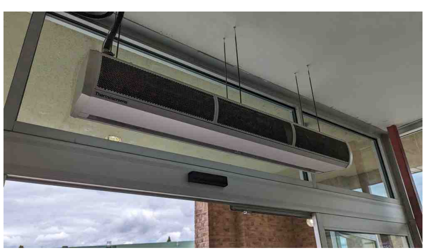


Figure 52: Front entrance electric air curtain

Figure 53: Front entrance electric air curtain controls

Figure 54: HV1 - Hot and cold deck

Figure 55: HV1 - Zone 3 thermostat

Figure 56: HV1 - Zone 5 thermostat

Figure 57: HV1 filters are in good condition

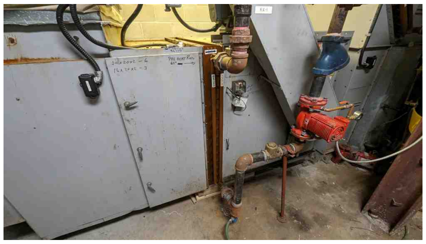


Figure 58: HV1 preheat coil

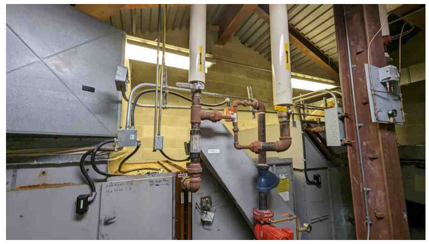


Figure 59: HV1 preheat valves are closed

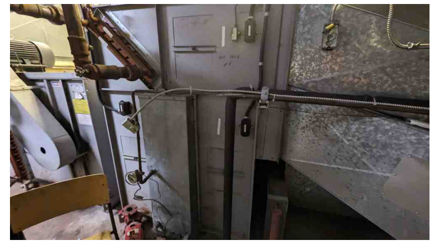


Figure 60: HV1 reheat and cooling coils


Figure 61: HV1 reheat shut off valves are open


Figure 62: HV1 return


Figure 63: HX1, HX2, and HX3


Figure 64: HV2 was removed but disconnect still present


Figure 65: Heating supply valve is closed


Figure 66: PP1


Figure 67: PP2


Figure 68: PP3


Figure 69: PP4


Figure 70: P5 and P6

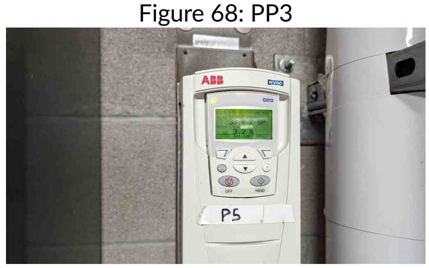


Figure 71: P5 VFD

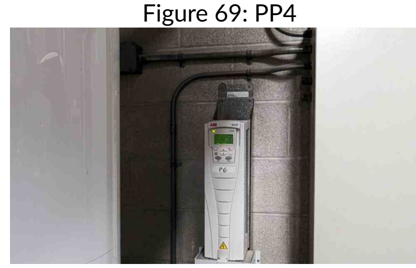


Figure 72: P6 VFD

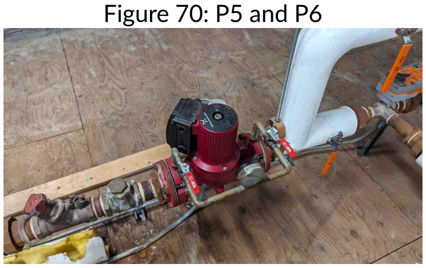


Figure 73: P13


Figure 74: P13 switch is OFF


Figure 75: P14

Figure 76: P15


Figure 77: Thermostat in the Men's Changeroom


Figure 78: Type F - Electric heater

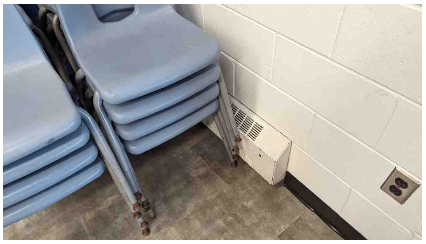


Figure 79: Type F - Electric baseboard heating in the meeting viewing room

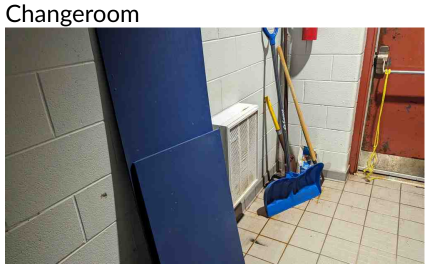


Figure 80: Type H - Electric heater


Figure 81: Type H - Electric heater control


Figure 82: Unit heater in the boiler room

2.7 Domestic hot water

Overview

DHW is provided via HX3 from the hot water loop. There is no storage tanks on site, and P15 is used as a circulation pump. The system has a setpoint of 49C.

Domestic Hot Water documentation

Domestic Hot Water documentation, including available drawings and photos from the site survey, is provided in the following images.

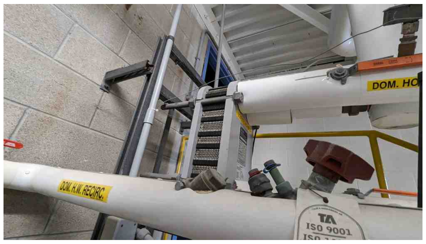


Figure 83: DHW HX3

Figure 84: DHW tank disconnect - not longer installed

2.8 Lighting

Lighting system summary

Lighting systems are summarized in Table 11.

Table 11: Lighting systems summary

Space name	Floor area of space	Light power density	Light power input	Data source
-	[m2]	[W/m2]	[W]	-
Natatorium	623.9	0.86	540	Assumption.
Weight training room	135.3	10.22	1,384	Assumption.
Cross fit, squash court, and weight room	277.4	9.33	2,588	Assumption.
Lobby and kitchenette	173.2	6.07	1,051	Assumption.
Supervisor 128 and Office 127	39.5	14.25	563	Assumption.
Meeting room 120	28.2	13.06	368	Assumption.
Lounge 117	123.4	5.11	630	Assumption.
Misc.	557.0	4.72	2,628	Assumption.

Interior lighting

Fixtures

The following interior light fixtures were observed during the site survey:

- Type B: 1'x4' recessed, 2 lamp, 120V, fluorescent.
- Type D: 1'x4' suspended or recessed, 2 lamp, 120V, fluorescent.
- Type H: recessed pot light, 120V, CFL.
- Type K: wall-mounted fixtures with an LED corn lamp.
- Type P: LED flood light.
- Type Q: 1'x4' recessed, LED fixture.

Controls

Interior lighting is controlled by switches. There are two low-voltage lighting control panels, which appear original to the building. However, it is unclear what is controlling them.

Exterior lighting

Fixtures

The following exterior light fixtures were observed during the site survey:

- Type H2: recessed pot light, 120V, CFL
- Type O: LED wall pack

Controls

A photocell controls the Type O fixture. A timer is assumed to control the remaining fixtures.

Lighting system documentation

Lighting system documentation, including available drawings and photos taken during the site survey, is provided in the following images.

Figure 85: Kitchenette lamps


Figure 86: Lighting in pool mezz has been replaced with LED


Figure 87: T12 fluorescent lamps in the kitchenette


Figure 88: Typce C - Men's Members' Changeroom

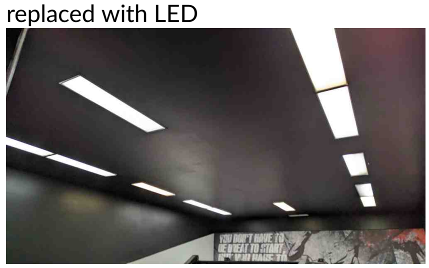


Figure 89: Type B - Squash court lighting


Figure 90: Type D - Office

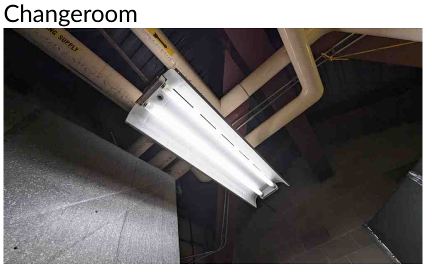


Figure 91: Type D - F12 lamps in the mechanical room


Figure 92: Type D - Lighting specs in the mechanical room


Figure 93: Type H2 - Exterior pot light

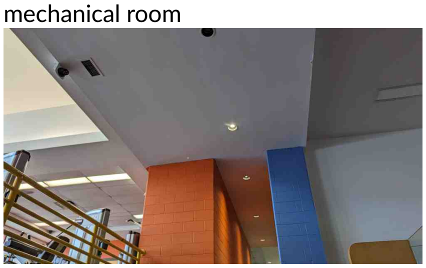


Figure 94: Type H

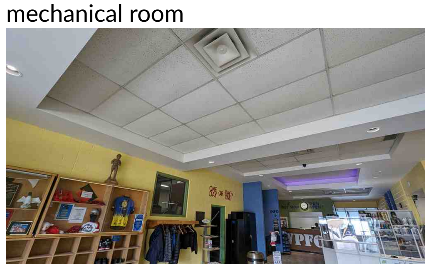


Figure 95: Type H - Lobby


Figure 96: Type H - Entrance vestibule

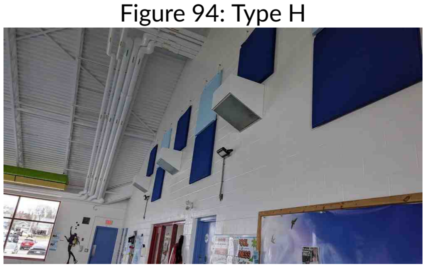


Figure 97: Type K - Nataorium fixtures that appear to be retrofitted with LED corn lamps


Figure 98: Type O - With integrated photocell


Figure 99: Type P - Flood light in the natatorium

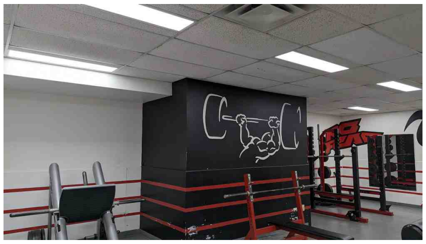


Figure 100: Weight room lighting has been converted to LED

2.9 Process and plug loads

Process

General

Various process loads are present at the facility, including:

- Men's and Women's sauna
- IT equipment
- Hand dryers

Spa

The spa characteristics are summarized as follows:

- Spa capacity is 2,581 USG, and has a rated flow rate of 200 gpm.
- PP3 and PP4 serve the spa filter and the spa hydrojets, respectively.
- There is no heat recovery present on the drain per schematic drawings.
- The flow rate path is the following: the main drains or the skimmers, filters, sample line, make-up water, a heat exchanger (HX2), acid and chlorine feeds, quick fill, and return to wall inlets. The spa pump returns directly to 15 hydrojets.
- DCW is metered and provided to the spa based on the water level controller. The controller is connected to a water sensor in a 2 inch stilling pipe in the spa wall per drawings.
- There is no noted heat recovery on the drains.

Pool

The pool characteristics are summarized as follows:

- The pool capacity is 140,000 USG, with a rated flow rate of 385 gpm.
- PP1 serves the pool filter, and PP2 serves the slide.
- The flow rate path is the following: the main drains or the skimmers, filter tank (make up water added here), PP1, sample line, quick fill line, HX4 (DH1 heat recovery), HX1 (heating loop), flow meter, sample line return, acid and chlorine feed, and return via wall outlets.
- DCW is metered and provided to the pool based on the water level controller.
- There is no noted heat recovery on the drains.

Plug loads

Various plug loads are present at the facility, including:

- Office equipment (photocopier, plot printer, etc.)
- Personal computers
- Appliances (e.g., dishwasher, kettle, etc.)

Process and plug loads documentation

Process and plug loads documentation, including available drawings and photos from the site survey, is provided in the following images.


Figure 101: Chemical controllers


Figure 102: Exterior speaker


Figure 103: Fitness equipment


Figure 104: Hand dryer in the Men's Changeroom


Figure 105: Natatorium


Figure 106: Pool filtration tank


Figure 107: Refrigerator

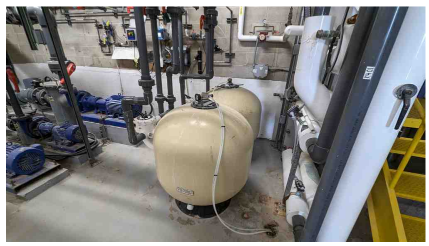


Figure 108: Spa filters

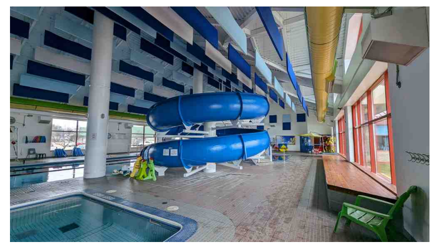


Figure 109: Water slide


Figure 110: Water softener


Figure 111: Whirlpool

2.10 Water fixtures

Water fixture summary

Water fixtures at Waterfront Pool and Fitness Centre are summarized in Table 12.

Table 12: Water fixture summary

Serves	Unit count	Flow	Volume	Data source
-	-	[gpm]	[gpc]	-
Kitchen faucets	2	2.2	-	Assumption.
Washroom faucets	11	1.5	-	Assumption.
Showers	6	1.5	-	Assumption.
Toilets	10	-	1.60	Assumption.
Urinals	3	-	0.50	Assumption.

Overview

A summary of water fixtures is as follows:

- Eleven handwashing faucets. They are manually operated and high-flow.
- Two kitchen sinks.
- Six showers.
- Ten toilets.
- Three urinals.

Water fixture documentation

Water fixture documentation, including available drawings and photos taken during the site survey, is provided in the following images.


Figure 112: Exterior water spout

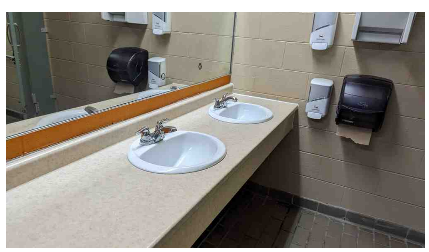


Figure 113: Faucets in Men's Changeroom


Figure 114: High flow faucets in the Men's Members' changeroom


Figure 115: Kitchen faucet


Figure 116: Men's Members' changeroom faucets


Figure 117: Natatorium water fountain

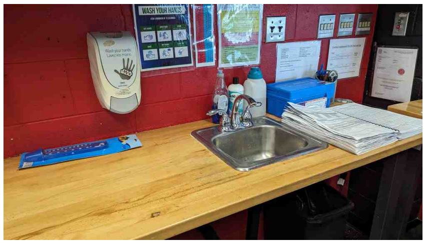


Figure 118: Room 128 sink

Figure 119: Shower in the Men's Changeroom

Figure 120: Toilet

Figure 121: Urinal

Figure 122: Water fountain in the lobby

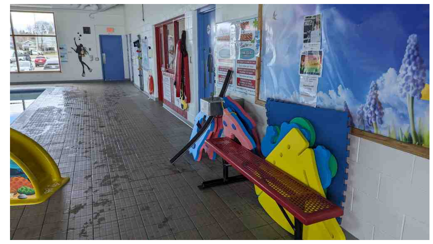


Figure 123: Water fountain in the natatorium

2.11 Utility services

Utility services summary

Overview

The building utilizes electricity from Hydro One Networks Inc. and natural gas from Enbridge.

The one electricity meter operates on a General Service Demand rate structure.

There is one natural gas meter at this facility.

Utility services documentation

Utility services documentation, including available drawings and photos from the site survey, is provided in the following images.

Figure 124: Electricity meter

Figure 125: Natural gas meter

2.12 Onsite energy sources

Overview

There are no onsite energy sources.

2.13 Electrical infrastructure

Overview

The building is fed from a pad-mounted transformer in the northwest section of the property. The feed travels underground to the electrical room via two parallel runs of 4-500 MCM, entering the main 120V/208V switchgear with an 800A main disconnect. The existing system is 800A at 208 V - 3Ph service running at a maximum load of 95.68 kW, which is approximately 41% of the full load of 332.55 kW of the building. There is about 50% of available physical space available on the main incoming switchboard. There are five panels throughout the building.

Panel summary

The five panels at this site are summarized below:

- Panel LP-A, 200A, 120/208V, three ph, 4 W. Serves lights and receptacles.
- Panel LP-B, 200A, 120/208V, three ph, 4 W. Serves automatic front doors, heaters, receptacles, subpanel for reception, AC in the office, fitness equipment, and hair dryers.
- Panel LP-C, 200A, 120/208V, three ph, 4 W. Serves UV spa light, pool and spa water level, low voltage lighting control, exterior lights, receptacles, flow meters, P13, EF3, and P15.
- Panel LP-D, 200A, 120/208V, three ph, 4 W. Serves electric heaters, men's sauna, P12, P12A, receptacle, hand dryers, basketball lights, and PML 2/3.
- Panel F, 100A, 120/208V, 3 ph, 4 W. Serves the boilers, boiler room exhaust, P5 and P6.

Electrical infrastructure documentation

Electrical infrastructure documentation, including available drawings and photos from the site survey, is provided in the following images.

Figure 126: 25 kW heater is shown as OFF

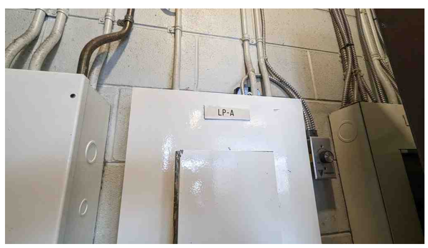


Figure 127: LP-A

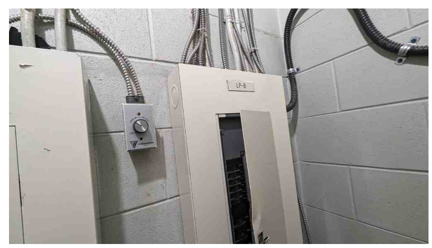


Figure 128: LP-B

Figure 129: LP-C

Figure 130: LP-D

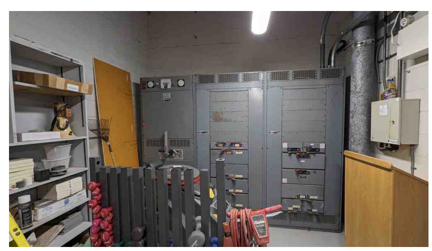


Figure 131: Main switchboard

3 UTILITY USE ANALYSIS

3.1 Utility analysis methodology

The utility use analysis was completed according to the following methodology. Note that the results achieved from applying this methodology are presented in the same order in Sections 3.2 through 3.8.

1. **Utility analysis assumptions**. Assumptions applied in the utility use analysis were identified and summarized in Section 3.2.
2. **Metered utility use**. Metered utility use data, as available, were analyzed and summarized in a subsection corresponding to the utility. Metered utility use data were available for the following utilities for Waterfront Pool and Fitness Centre.
    - Electricity; see Section 3.3.
    - Natural gas; see Section 3.4.
3. **Utility use baseline**. The utility use baseline was summarized in Section 3.5, and includes the following.
    - Baseline year: A baseline year was determined as the most recent year with the fewest anomalies in facility operations and utility metering. The baseline year was used to establish the historical weather data used for the energy model development, as explained in Section 4.1. If valid metered utility data was available for the baseline year, then the metered utility use data for the baseline year was used to establish baseline performance and for energy model calibration.
    - Baseline performance: Yearly utility use, GHG emissions and utility costs. For each utility, the baseline performance was derived from the metered utility use for the baseline year if available for that utility, or from the energy model described in Section 4 if metered data were unavailable or invalid for that utility. Table 13 summarizes the data source of the baseline performance for each utility.

Table 13: Baseline performance data source for each utility

Utility	Source
Electricity	Meter
Natural gas	Meter

4. **Benchmarking analysis**. The yearly baseline energy use and GHG emissions of Waterfront Pool and Fitness Centre was compared with those of similar facilities in Section 3.6. Data for similar facilities were obtained from the Government of Ontario's website, made available for the Broader Public Sector (BPS) through O. Reg. 25/23. The list below includes all municipalities considered for the benchmarking process. If this building is the only one presented, it indicates that similar buildings are not being reported to the database.
    - City of Greater Sudbury
    - City of North Bay
    - City of Temiskaming Shores
    - City of Timmins
    - Municipality of Temagami
    - Municipality of West Nipissing
    - Town of Iroquois Falls
    - Town of Kirkland Lake
    - Township of Armstrong
    - Township of Black River-Matheson
    - Township of Brethour
    - Township of Casey

- Township of Chamberlain
- Township of Gauthier
- Township of Harley
- Township of Harris
- Township of Hilliard
- Township of Hudson
- Township of James
- Township of Kerns
- Township of Larder Lake
- Township of Matachewan
- Township of McGarry

5. **Portfolio benchmarking analysis**. A portfolio benchmarking analysis was also performed, where Energy Star Portfolio Manager was used to benchmark the energy analysis of Waterfront Pool and Fitness Centre.
6. **Utility use analysis discussion**. Results of the utility use analysis were studied and discussed in Section 3.8.

3.2 Utility analysis assumptions

Assumptions applied throughout the methodology are summarized as follows.

- GHG emissions factors were assumed as per Table 14.

Table 14: GHG emissions factor assumptions

Utility	Unit	Value	Source
Electricity	[tCO2e/kWh]	0.0000239	Environment and Climate Change Canada Data Catalogue, Electricity Grid Intensities-1
Natural gas	[tCO2e/m3]	0.0019324	National Inventory Report, 1990-2023, Table 1-1, Table A61.1-1 and Table A61.1-3

- Utility cost rates for the baseline year of 2023 were assumed as per Table 15. Electricity utility cost rates were assumed based on typical wholesale rates for the General Service Energy billing structure. Throughout this document, the Federal Carbon Charge ("FCC") was treated separately with respect to applicable fuels, rather than being blended into the utility cost rate for those fuels. As such, all other utility cost rates exclude the federal carbon charge. The Federal Carbon Charge was removed on April 1, 2025, as such, this document has been updated to have the FCC set to $0/tCO2e for 2025 and onward.

Table 15: Utility cost rate assumptions for the baseline year (2023)

Utility	Line item	Unit	Value
Electricity	Electricity consumption - Class B	[$/kWh]	0.0200
Electricity	Global adjustment - Class B	[$/kWh]	0.0735
Electricity	Regulatory	[$/kWh]	0.0057
Natural gas	Natural gas (blended)	[$/m3]	0.2600
GHG emissions	Federal carbon charge	[$/tCO2e]	50.0000

3.3 Electricity metered utility use

Hourly electricity use is plotted in Figure 132.

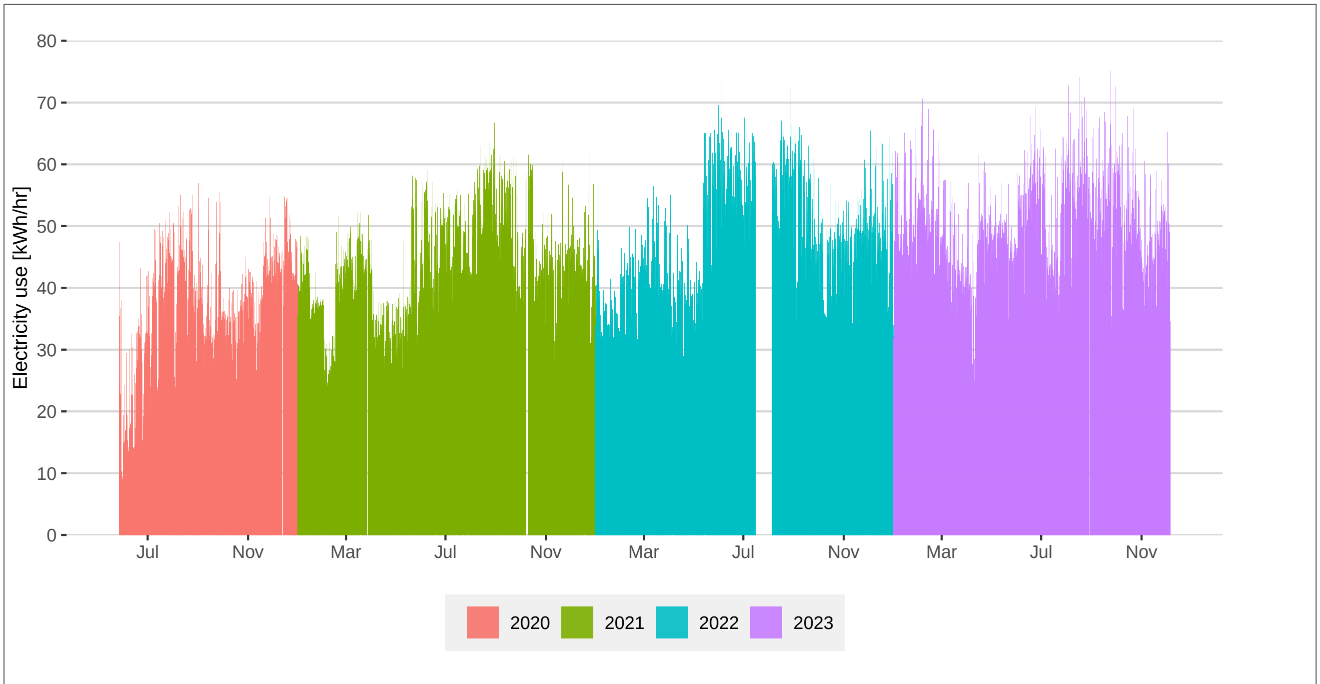


Figure 132: Hourly electricity use

The same hourly electricity use data is plotted in Figure 133, which highlights how electricity use is influenced by year, season, day of week and hour of day. The vertical axis on Figure 133 may be rescaled relative to in Figure 132 for greater resolution.

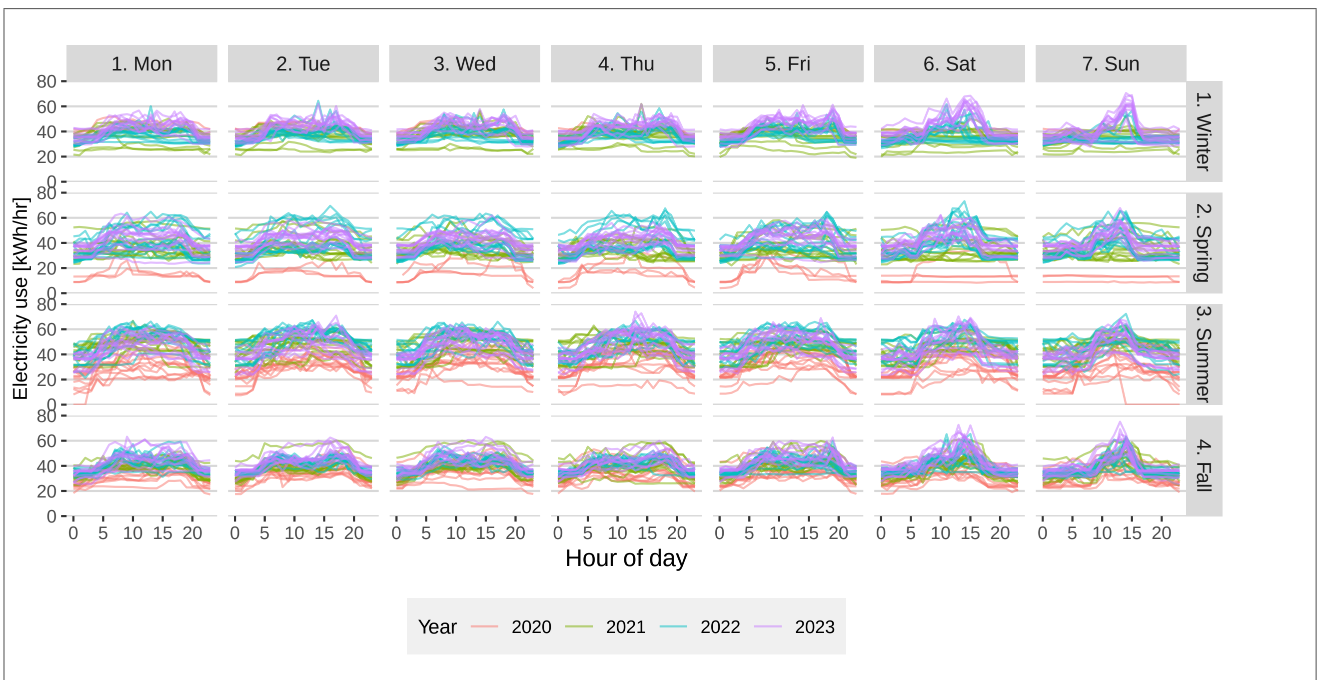


Figure 133: Hourly electricity use hairball plot

Monthly electricity use is plotted in Figure 134.

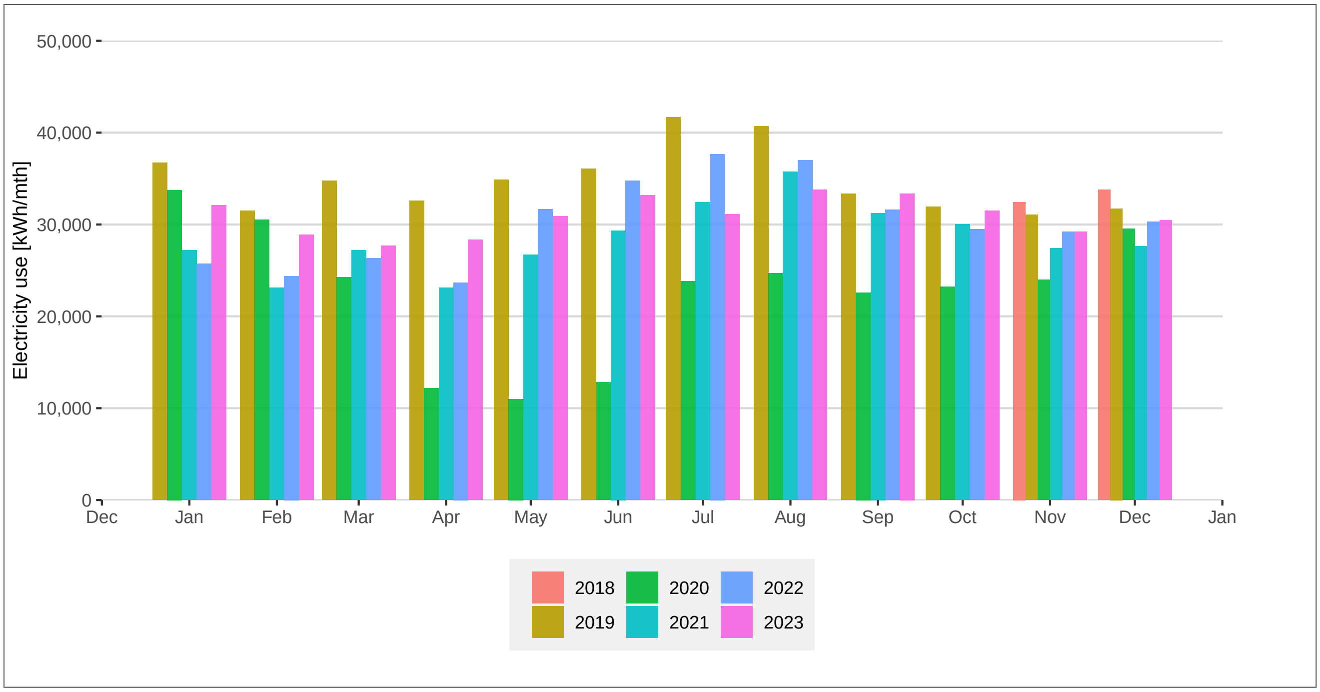


Figure 134: Monthly electricity use

3.4 Natural gas metered utility use

Monthly natural gas use is plotted in Figure 135.

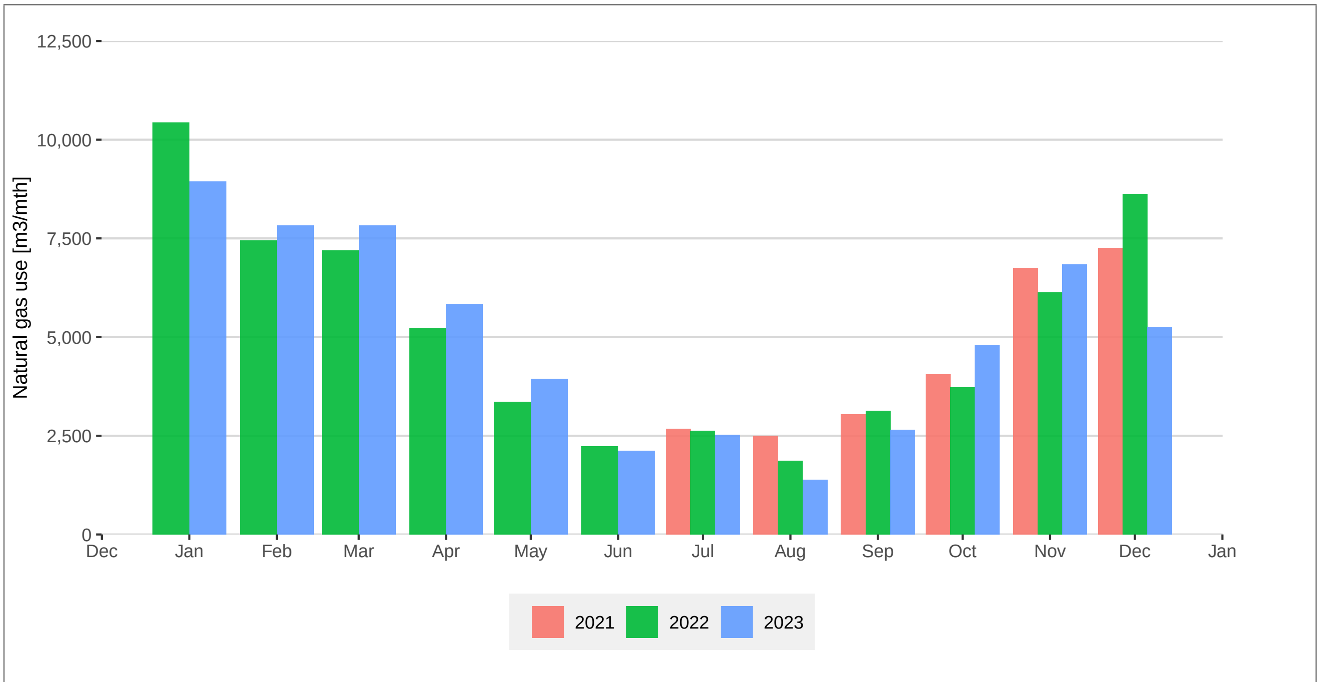


Figure 135: Monthly natural gas use

3.5 Utility use baseline

Baseline year

The baseline year for Waterfront Pool and Fitness Centre, which is used to establish the baseline performance through the metered utility use data from that year, is as follows.

- **Baseline year**: 2023.

Baseline performance

Baseline utility use performance for the baseline year of 2023 is summarized in Table 16.

Table 16: Baseline utility use performace

Category	Utility	Unit	Value
Utility use	Electricity use	[kWh/yr]	370,583
	Natural gas use	[m3/yr]	59,962
	Carbon offset use	[tCO2e/yr]	0
Equivalent energy use	Electricity energy	[kWh/yr]	370,583
	Natural gas energy	[kWh/yr]	633,007
	Total energy	[kWh/yr]	1,003,590
GHG emissions	Electricity GHGs	[tCO2e/yr]	9
	Natural gas GHGs	[tCO2e/yr]	116
	Carbon offsets GHGs	[tCO2e/yr]	0
	Total GHGs	[tCO2e/yr]	125
Utility cost	Electricity utility cost	[$/yr]	36,762
	Natural gas utility cost	[$/yr]	15,590
	Carbon offsets utility cost	[$/yr]	0
	Federal carbon charge	[$/yr]	5,793
	Total utility cost	[$/yr]	58,146

3.6 Benchmarking analysis

Benchmarking analysis results are presented in the following figures.

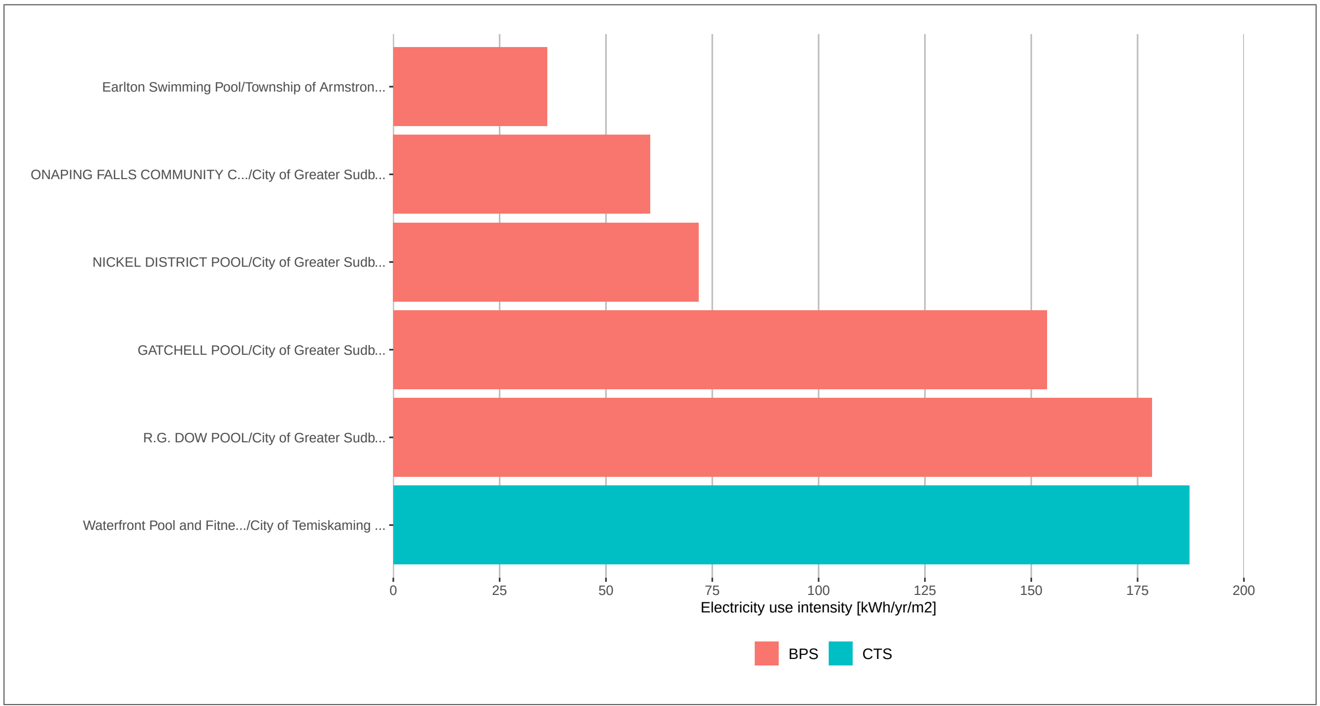


Figure 136: Electricity use intensity benchmarking analysis comparison

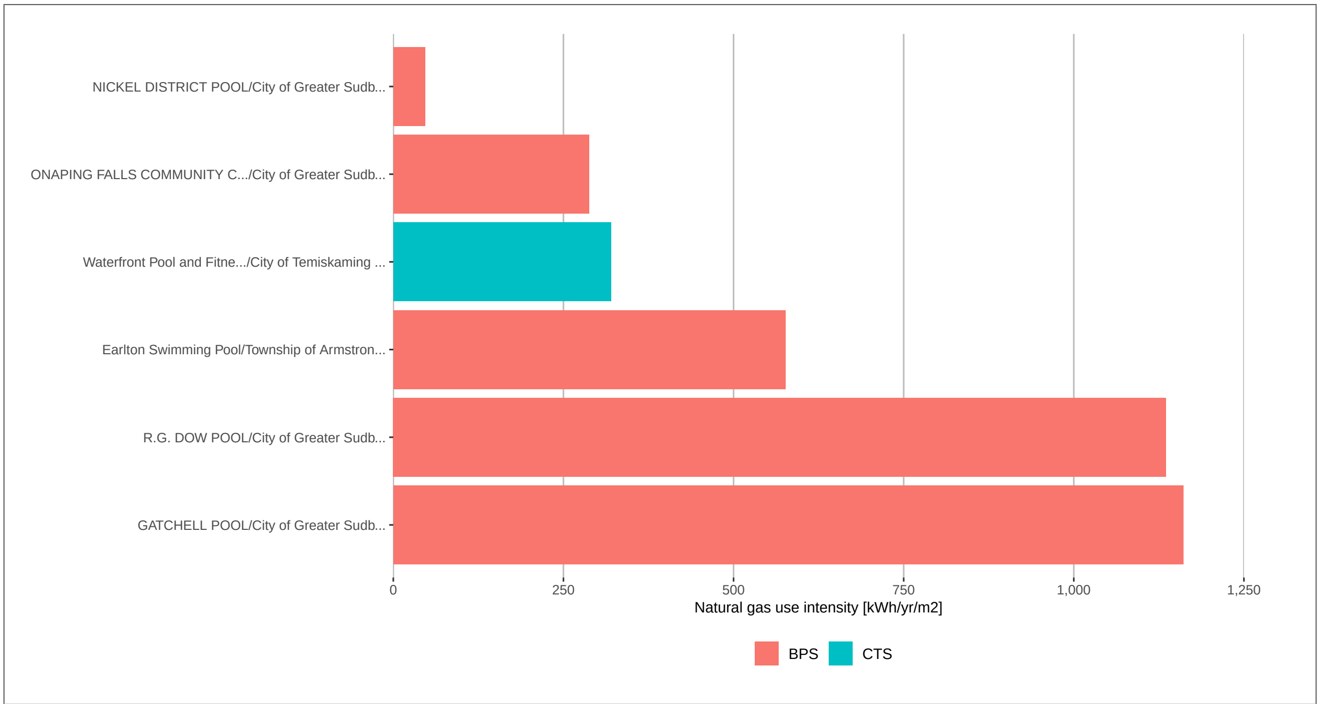


Figure 137: Natural gas use intensity benchmarking analysis comparison

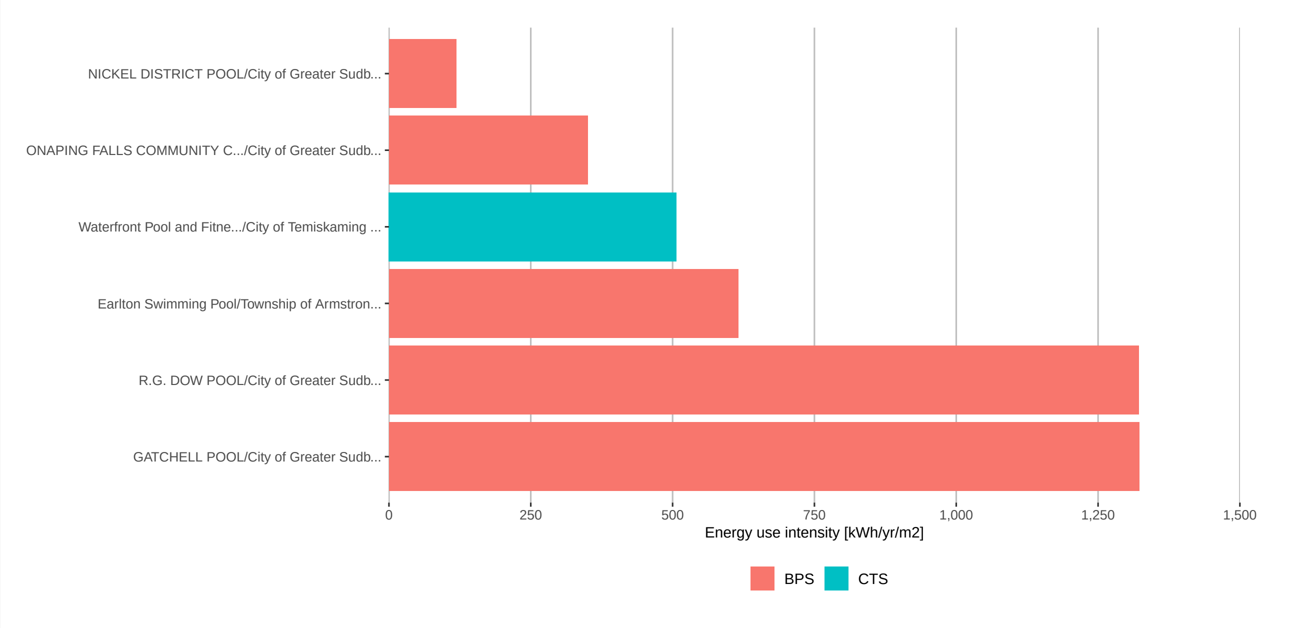


Figure 138: Total energy use intensity benchmarking analysis comparison

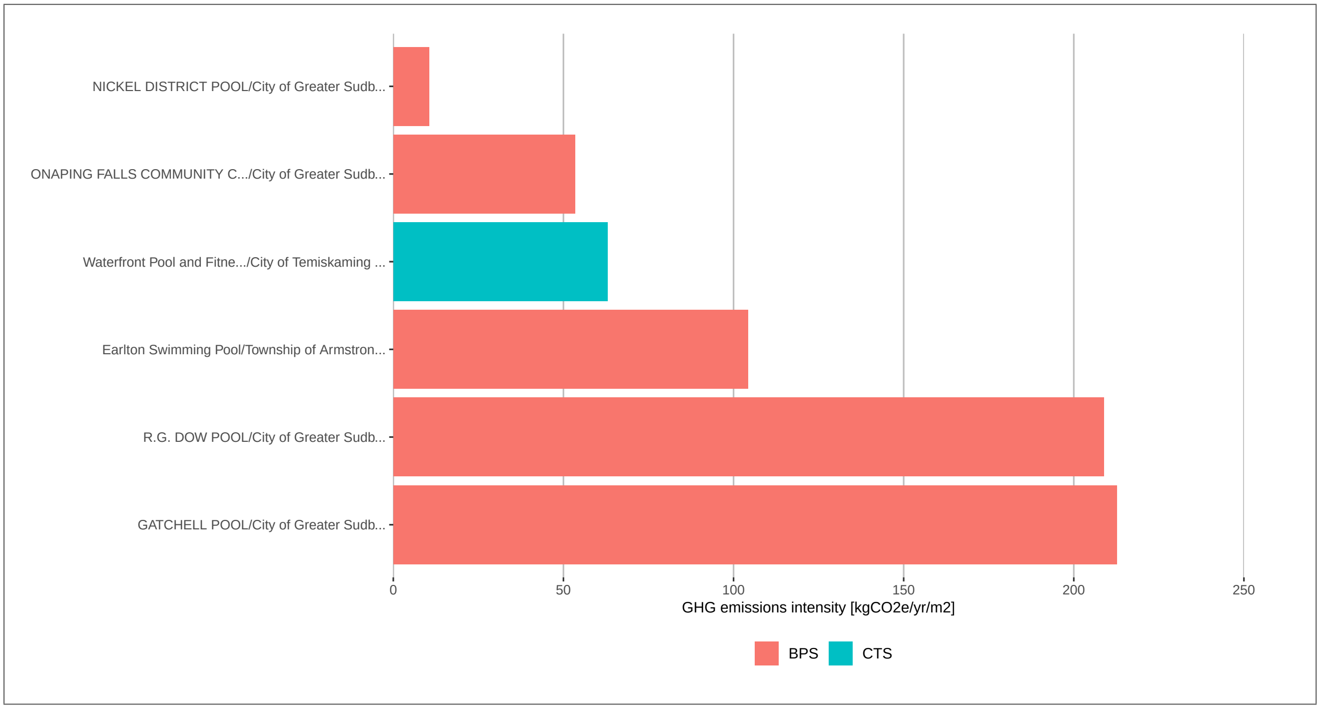


Figure 139: GHG emissions intensity benchmarking analysis comparison

3.7 ENERGY STAR Portfolio Manager benchmarking analysis

The scorecard is shown in Figure 140.

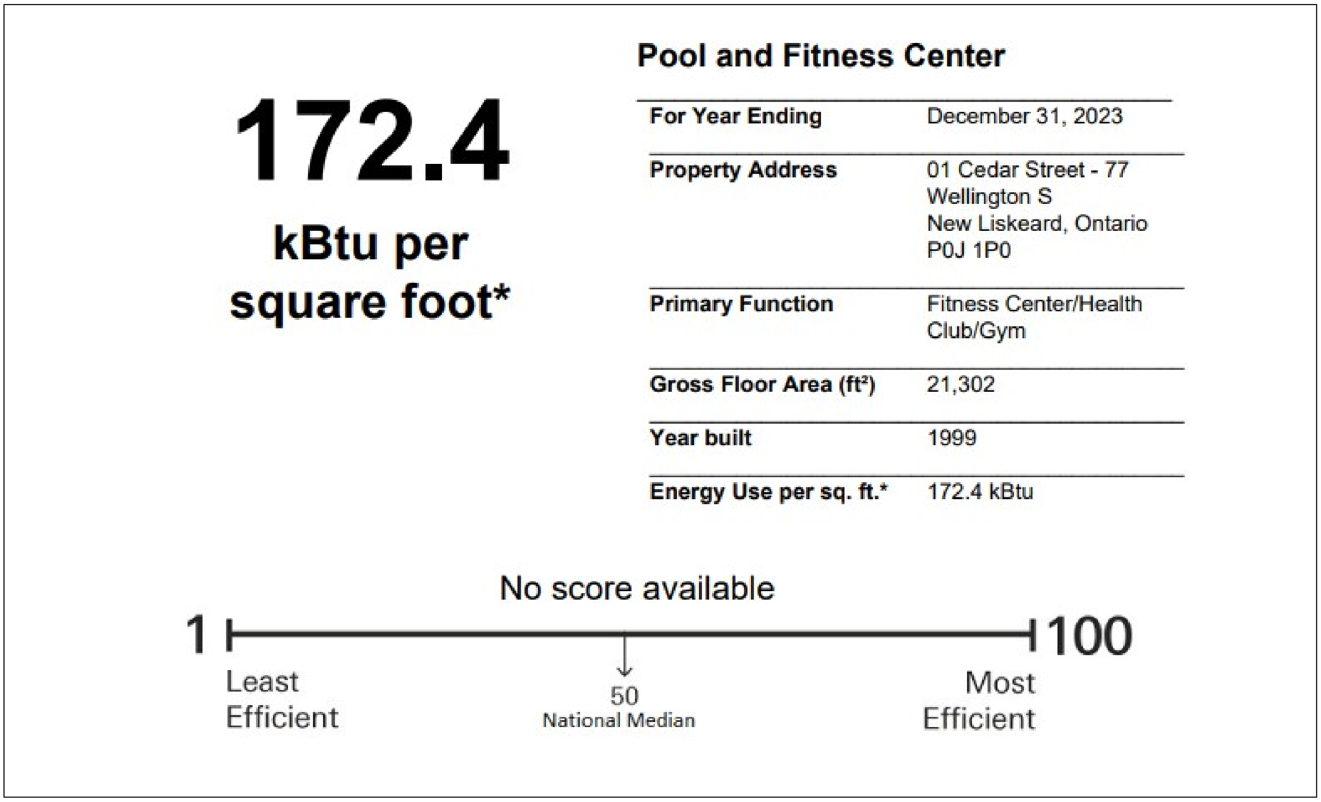


Figure 140: Energy Star energy performance scorecard.

3.8 Utility use analysis discussion

General

The following discussion seeks to explain utility use trends observed in the metered data, based on the understanding of the building systems and their operations presented in Section 2.

Electricity - Hourly

- Hourly electricity consumption typically peaks during the summer and winter, most likely due to space cooling and heating, as well as dehumidification for the pool space.
- Hourly consumption is typically under 70 kWh and above 30 kWh.
- Seasonal peaks suggest heating in the winter and cooling in the summer.
- There appears to be a gap in the dataset in July and August. Monthly consumption for July and August 2022 is consistent with the average consumption during these months, so this is thought to be due to an issue with the hourly metered data, and does not appear to be reflected in the monthly consumption data.

Electricity - Monthly

- **2018**: The dataset provided started in November 2018 and did not allow for a full year of comparison.
- **2019**: Monthly consumption is overall high compared to future years.
- **2020**: There was a noticeable dip in consumption from April through June, and it remained lower than the seasonal average from July through November. This observation is consistent with other similar buildings due to the pandemic.
- **2021**: Consumption is highest during the summer months, likely due to space cooling.
- **2022**: Monthly consumption is similar to 2021.
- **2023**: Monthly consumption is similar to 2021 and 2022.

Natural gas

- Natural gas consumption has maintained a consistent profile year over year. It is highest during the heating season and low during the cooling season.
- Natural gas is consumed by the boilers, and is used for space heating, domestic hot water use, and process heating (for instance, heating the pool water).
- Natural gas consumption in the summer is likely due to DHW, heating makeup water for the pools, and reheat for the dehumidification coils.
- Of the thirty data points available for monthly natural gas consumption, only 13 were actual readings, not estimates. This observation can lead to calibration issues, as the model may not pass ASHRAE Guideline 14.

4 ENERGY MODEL DEVELOPMENT

4.1 Energy model development methodology

The utility use profile was developed from an hourly analysis, spanning one year, of the following energy systems. The analysis reflects the existing conditions of the facility as documented in Section 2.

The energy model was created in eQUEST v3.65, build 7175, using the DOE2.3 engine. The inputs were established to match the existing conditions as closely as possible. The following sources were used as background information to inform energy model inputs:

- Observations from site survey and conversations with facility staff.
- Schedules and setpoints from the BAS. As-built drawings provided by the City of Temiskaming Shores.
- References from the Ontario Building Code (OBC) SB-12, ASHRAE90.1, and NECB where the above data was not available.

1. **Hourly utility use profiles**. An hourly utility use profile for each utility was developed according to the following methodology. Results were presented in Section 4.2.
   (a) *Utilities and end uses*. Hourly utility use profiles developed through this analysis were assigned to both utilities and end uses. The utilities and end uses that were modelled are summarized in Table 17.

Table 17: Utility and end use summary and definitions

Utility	End use	Definition of end use
Electricity	Cooling	Cooling energy use.
	DHW heat	Domestic hot water heating energy use.
	Equipment	Equipment energy use.
	Exterior lights	Exterior lighting energy use.
	Fans	Fan motor energy use.
	Heat: Pool	Heating energy use for pool heating.
	Lights	Lighting energy use.
	Other	Metered use less modelled use.
	Pumps	Pump motor energy use.
	Space heat	Space heating energy use.
Natural gas	DHW heat	Domestic hot water heating energy use.
	Heat: Pool	Heating energy use for pool heating.
	Other	Metered use less modelled use.
	Space heat	Space heating energy use.

   (b) *Weather data*. Hourly weather data was obtained from the Earlton-Cimate weather station, ID 712130S.
   (c) *Facility spaces*. Facility spaces were grouped according to activities in the spaces and HVAC systems serving them. The thermal characteristics of the exterior building envelope components for each space were assumed based on findings documented in Section 2.7. Thermal loads within each space were calculated based on assumed space temperature and humidity setpoints, hourly weather data, and activities in the space that affect thermal conditions (e.g. lighting or equipment that generates heat).
   (d) *Primary systems*. Primary systems are defined as systems whose utility use can be predicted independent from other systems; examples include lighting, equipment (e.g. office and process equipment), pumps, etc. The hourly utility demand of primary systems was modelled based on assumed time-of-day operating schedules, peak power input and average loads relative to the peak power input. Peak power input was estimated from findings documented throughout Section 2, including lighting power or power density, nameplate horsepower of motors, etc.
   (e) *HVAC systems*. HVAC system energy use was modelled based on hourly weather data and space condition setpoints defined for the various spaces. The analysis also accounted for system-specific

ventilation controls and activities and primary systems that have thermal influences on spaces (e.g. occupancy, lighting, equipment, processes that add heat to spaces). The analysis quantified hourly energy use of fans, heating (e.g. sensible, humidification, reheat) and cooling (e.g. sensible, dehumidification).

(f) *Generators*. The utility use and generation of on-site systems that generate energy or utilities was modelled based on the assumed capacities and operations of those systems according to findings documented in Section 2; examples include solar PV, CHP, etc. Utilities generated on site were treated as negative utility consumption relative to utilities consumed on site so that the consumption, generation and the aggregate use of utilities could be tracked accordingly.

(g) *Other*. For each utility having valid metered utility use data available for the baseline year, the Other end use was modelled from the top down to reconcile results of the above utility-consuming systems that were modelled from the bottom up with metered utility use data for the baseline year. This end use was called Other.

2. **Monthly utility use profiles**. A monthly utility use profile for each utility was developed by grouping and summing up the hourly utility use profiles by end use and by month. Results were presented in Section 4.3.
3. *Calibration analysis*. After explicitly modeling the above systems, the model was calibrated for each of the following utilities (utilities for which valid metered data for the baseline year was available) through the Other end use, which was calculated as the difference of metered and modeled utility use. The above modeling steps were iterated as required to achieve reasonable calibration.
   - Electricity
   - Natural gas
4. **End use analysis**. An end use analysis of each utility was completed. Since the hourly utility use profiles already track the hourly utility use by each end use, the end use analysis involved summarizing data from the hourly utility use profiles to obtain yearly utility use by each end use. Results were presented in Section 4.5.

4.2 Hourly utility use profiles

The hourly utility use profiles are presented graphically in this Section 4.2 in a format called a stacked bar plot. For each hour of the year, the utility use for all end uses active during that hour is presented in a single bar pertaining to that hour. The end uses are identified by colour, and all end uses are "stacked" on top of each other within each hour-specific bar such that the total height of each bar represents the total utility use of all end uses combined in that hour.

Electricity

The hourly electricity utility use profile by end use made by the energy model is plotted in Figure 141. See Table 17 for end use definitions.

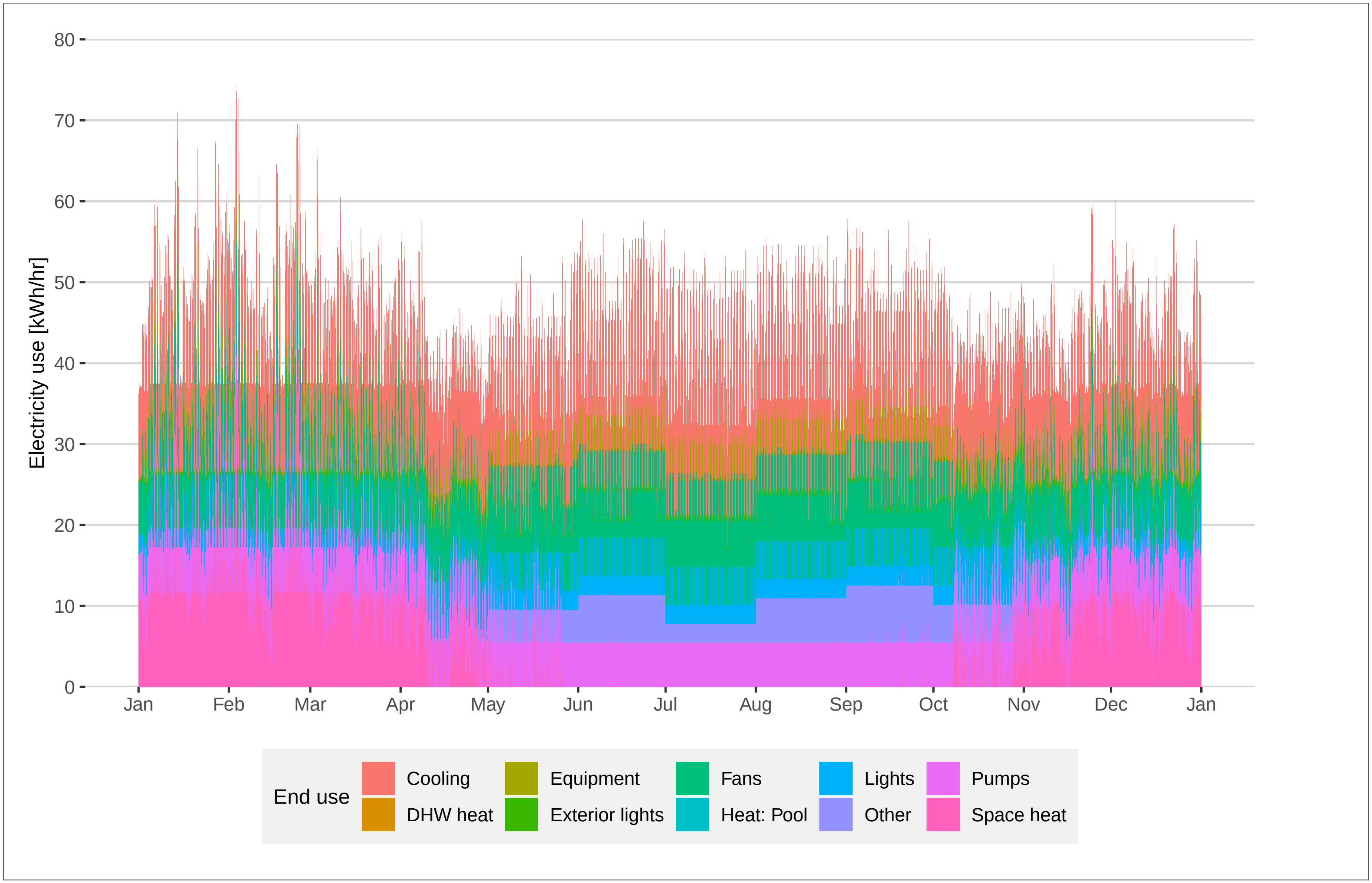


Figure 141: Hourly electricity utility use by end use (made by calibrated energy model)

Natural gas

The hourly natural gas utility use profile by end use made by the energy model is plotted in Figure 142. See Table 17 for end use definitions.

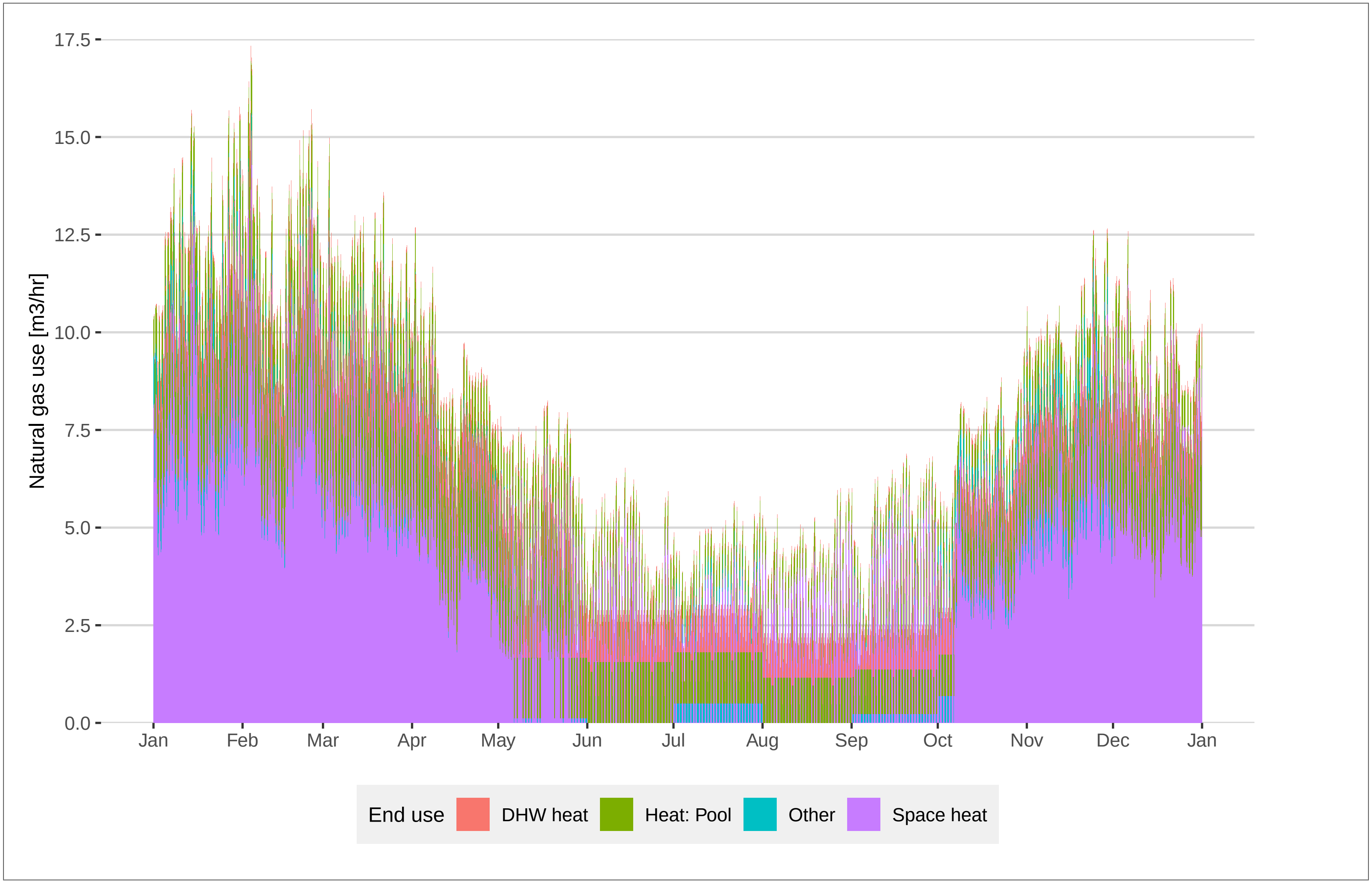


Figure 142: Hourly natural gas utility use by end use (made by calibrated energy model)

4.3 Monthly utility use profiles

Monthly utility use profiles for each modelled utility are presented in Figure 143.

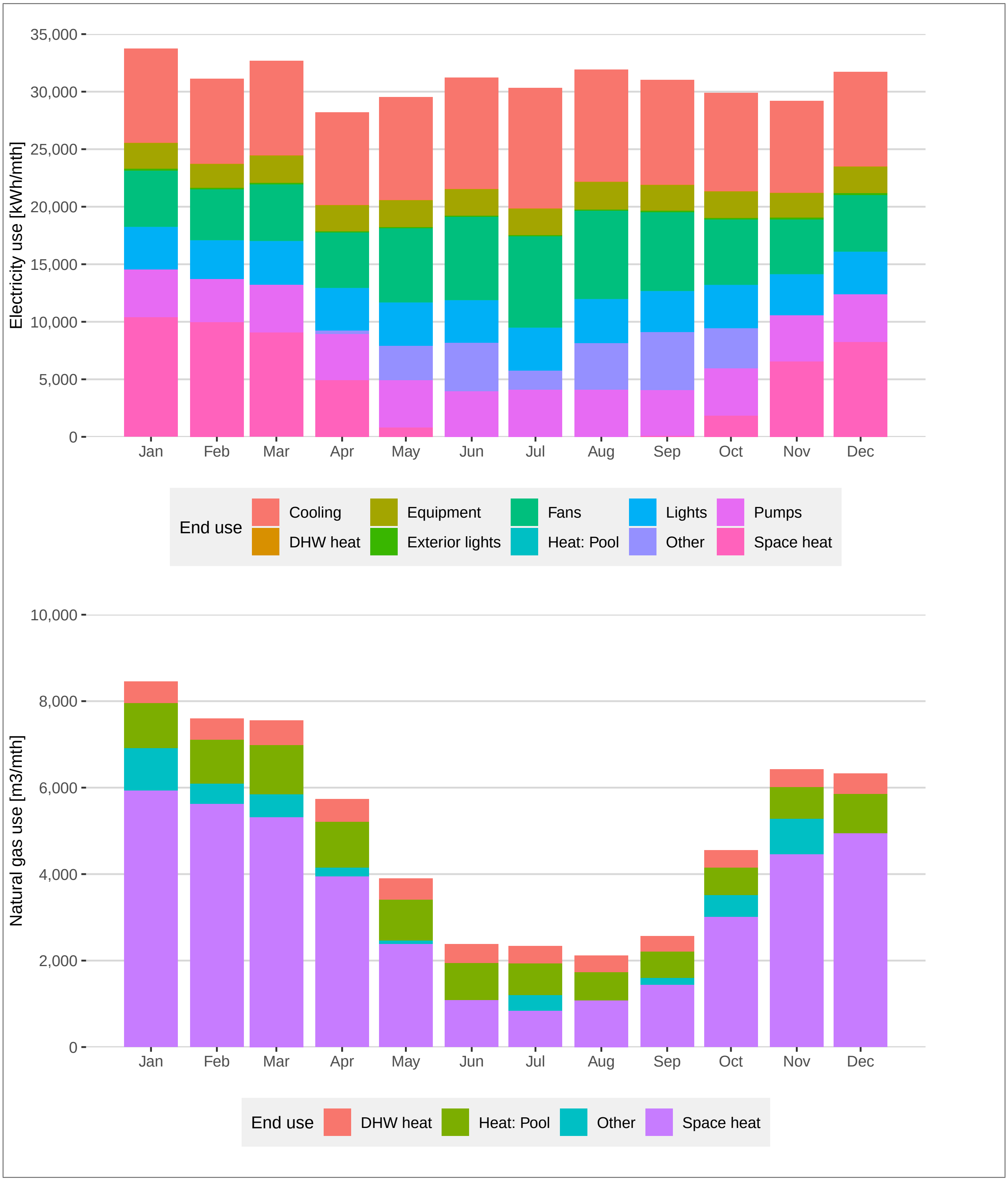


Figure 143: Monthly utility use profiles for each modelled utility

4.4 Calibration analysis

Electricity

Figure 144 compares the metered utility use with the modelled use to check how well the model is calibrated.

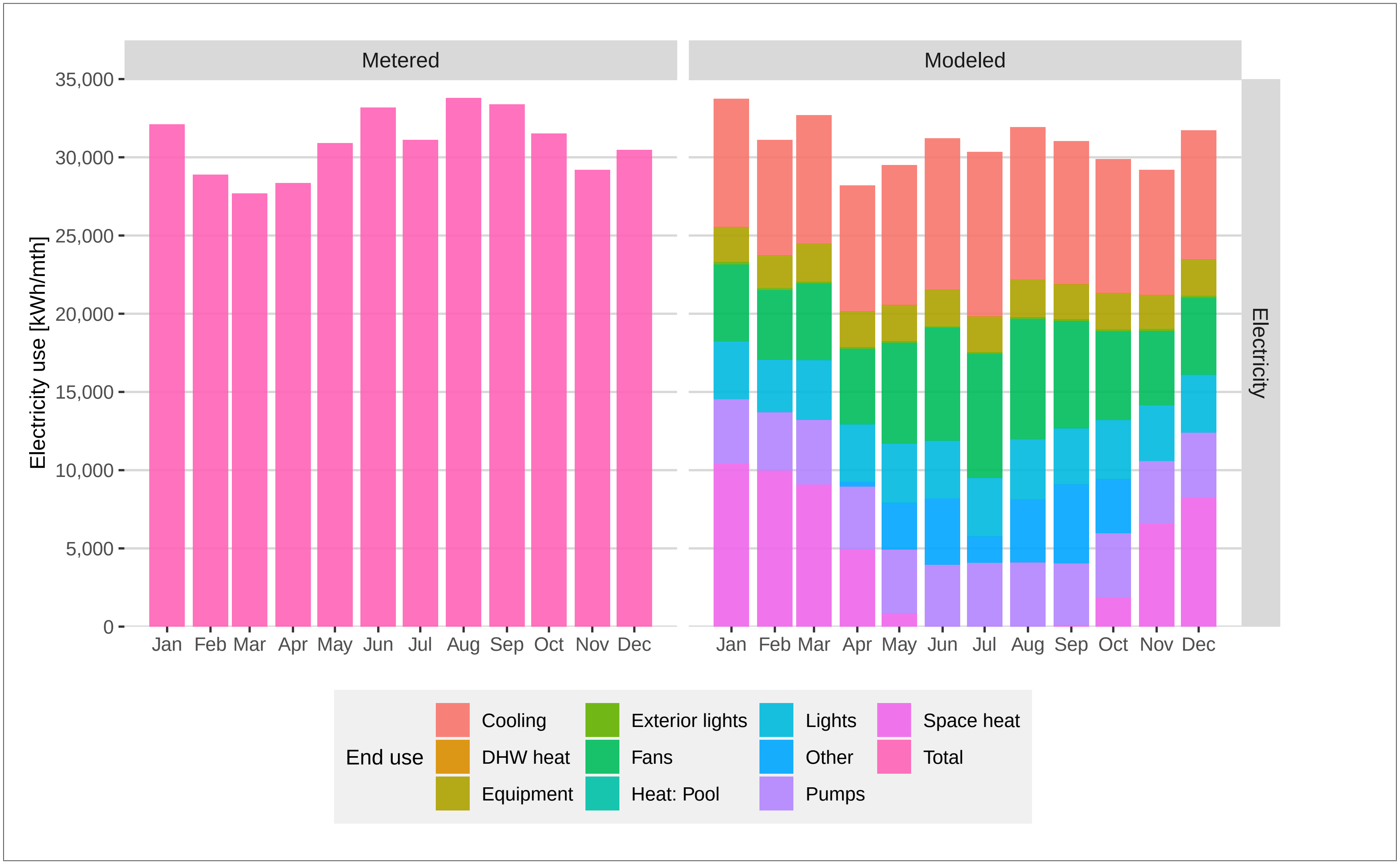


Figure 144: Electricity calibration analysis (metered vs modelled utility use)

Natural gas

Figure 145 compares the metered utility use with the modelled use to check how well the model is calibrated.

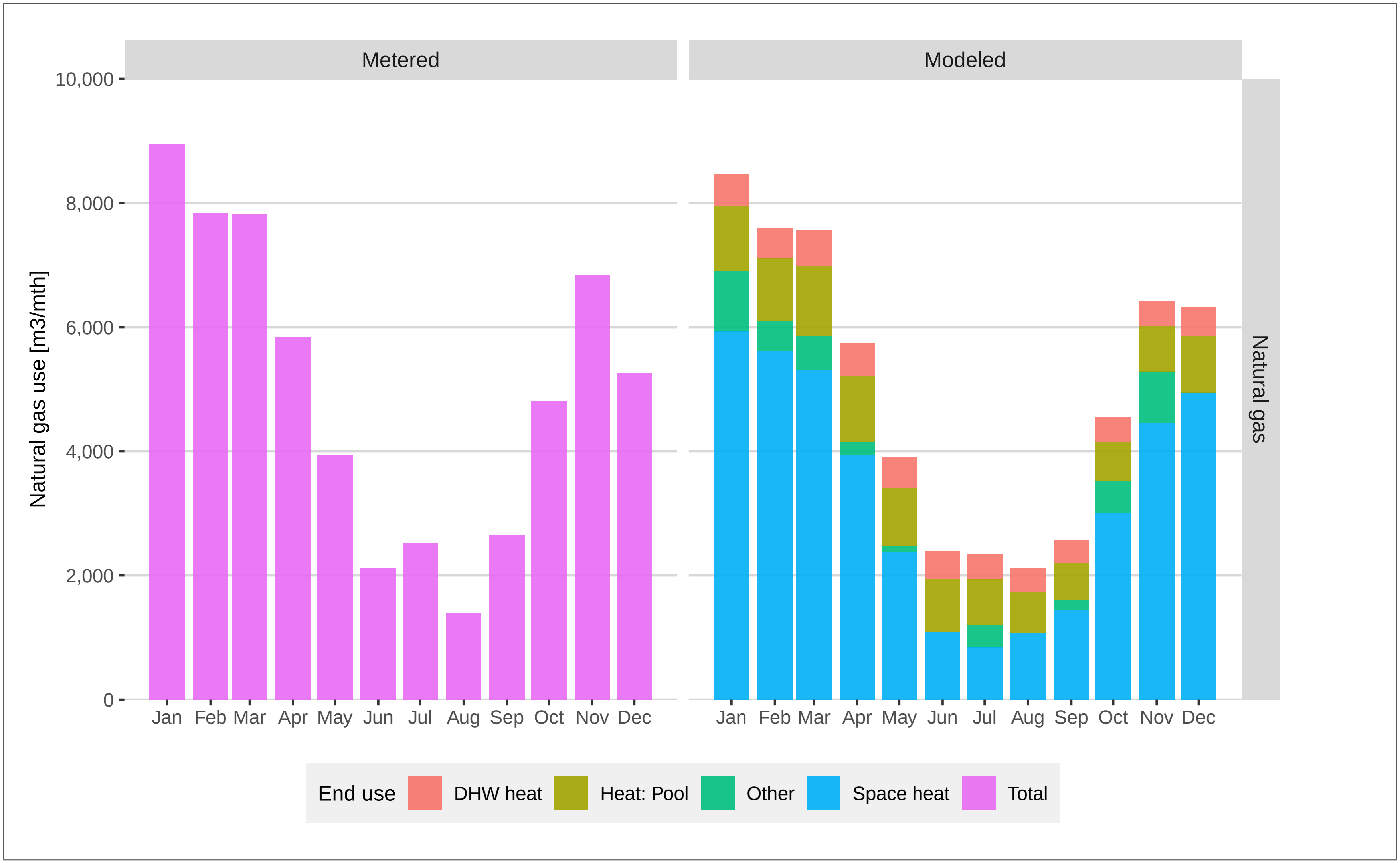


Figure 145: Natural gas calibration analysis (metered vs modelled utility use)

Statistical calibration analysis

ASHRAE Guideline 14 suggests maximum allowable values for the mean bias error, and the root mean bias error, which are defined as follows with respect to energy model calibration.

- **Mean bias error (MBE)**. The average monthly error between modelled and metered utility use as a percentage of the mean monthly metered utility use. This metric indicates the ability of the model to accurately predict yearly utility use, despite month-to-month errors, by capturing the direction of all month-to-month errors.
- **Root mean square error (RMBE)**. The square root of the sum of all squared monthly errors as a percentage of the mean monthly metered utility use. This metric indicates the ability of the model to accurately predict month-specific utility use.

Statistical calibration analysis results were calculated and are summarized in Table 18.

Table 18: Statistical calibration analysis summary

Utility	Description	Unit	ASHRAE 14	Model	Pass/Fail
Electricity	Mean bias error	[%]	< +/- 5	0.0	Pass
	Root mean square error	[%]	< 15	7.1	Pass
Natural gas	Mean bias error	[%]	< +/- 5	-0.0	Pass
	Root mean square error	[%]	< 15	9.3	Pass

It should be noted that the root mean square error test suggested by ASHRAE Guideline 14 places undue emphasis on months that have relatively little utility use (e.g. natural gas or steam use in the summer). This is because the root mean square error test is calculated based on relative errors between monthly metered and modelled utility use. Because of this, a small absolute error between metered and modelled utility use for a certain month may also be a large relative error, causing a significant increase in the root mean square error. Practically, though, the ability of the energy model to accurately quantify utility use overall has little dependence on its ability to quantify utility use in months with relatively little metered use, because overall utility use is more heavily influenced by those months with greater utility use. Therefore, it may not always be suitable for the model to pass the root mean square error test, provided that it reasonably captures utility use in the months of greater use.

A discussion of the energy model calibration analysis is as follows.

- Figures 144 and 145 both demonstrate a strong agreement between monthly trends observed in the metered utility use data and the monthly utility use predicted by the calibrated energy model.
- Electricity and natural gas use were successfully calibrated according to the standards of ASHRAE Guideline 14. Note that the mean bias error is zero for electricity and natural gas because the Other end-use ensures that the yearly modelled utility use matches the yearly metered utility use. This process also maintains consistency between the baseline utility use derived from the metered utility data and all measure and scenario analyses.
- The successful energy model calibration is largely due to the methodology used in developing the calibrated energy model. Under this methodology, the major systems affecting utility use were studied in detail (see Section 2), including their operations and control sequences from analyzing the building automation system (BAS), so that these systems could be explicitly modelled one-to-one, precisely reflecting the unique operations associated with each system. Examples of such major systems include HV1, DH1, and the boiler plant. The methodology also integrates the Other end-use category, which reflects the exact difference between metered and modelled utility use in a top-down calculation after all systems have been modelled from the bottom-up.
- Therefore, there can be confidence that the utility use impacts quantified in the various measure and scenario analyses under this report are reasonable.

Electricity

- Figure 144 indicates strong agreement between modelled and metered data.
- The peak and trough hourly consumption align with the metered interval data.
- Note that the "Cooling" end use for electricity also includes energy used for dehumidification.

Natural gas

- Figure 145 indicates good agreement between modelled and metered data.
- The annual amount of natural gas consumption in the model is very close to the annual amount of the metered data. However, there are variances within several months. That being said, there are several estimated readings for this particular dataset, and only 5 of 12 of the readings are actual readings.

4.5 End use analysis

Electricity

The yearly electricity end use breakdown calculated by the energy model is plotted in Figure 146. See Table 17 for end use definitions.

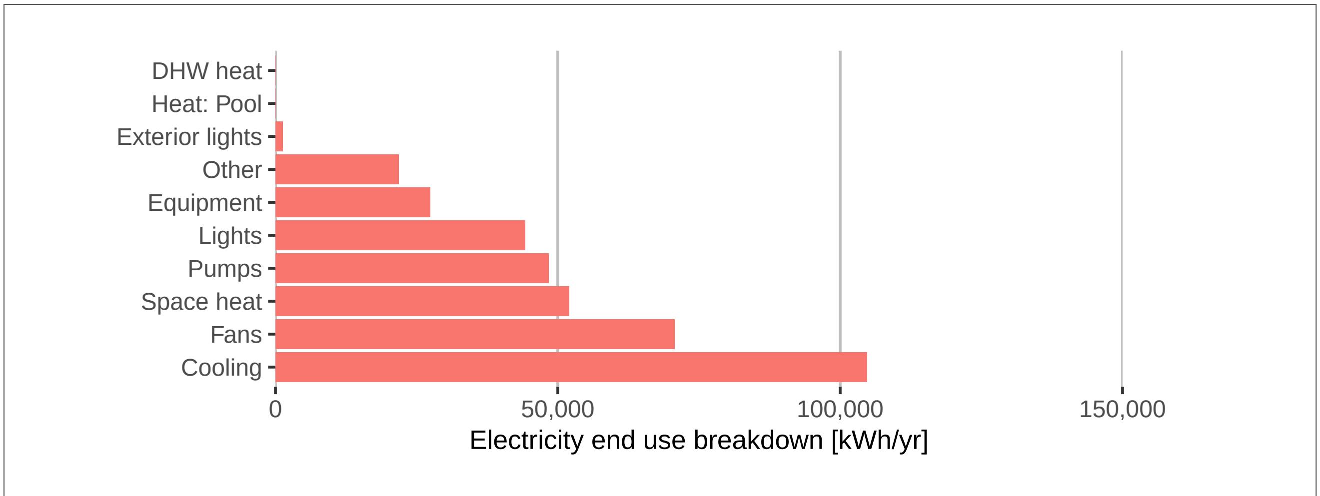


Figure 146: Electricity end use breakdown (calculated by calibrated energy model)

Natural gas

The yearly natural gas end use breakdown calculated by the energy model is plotted in Figure 147. See Table 17 for end use definitions.

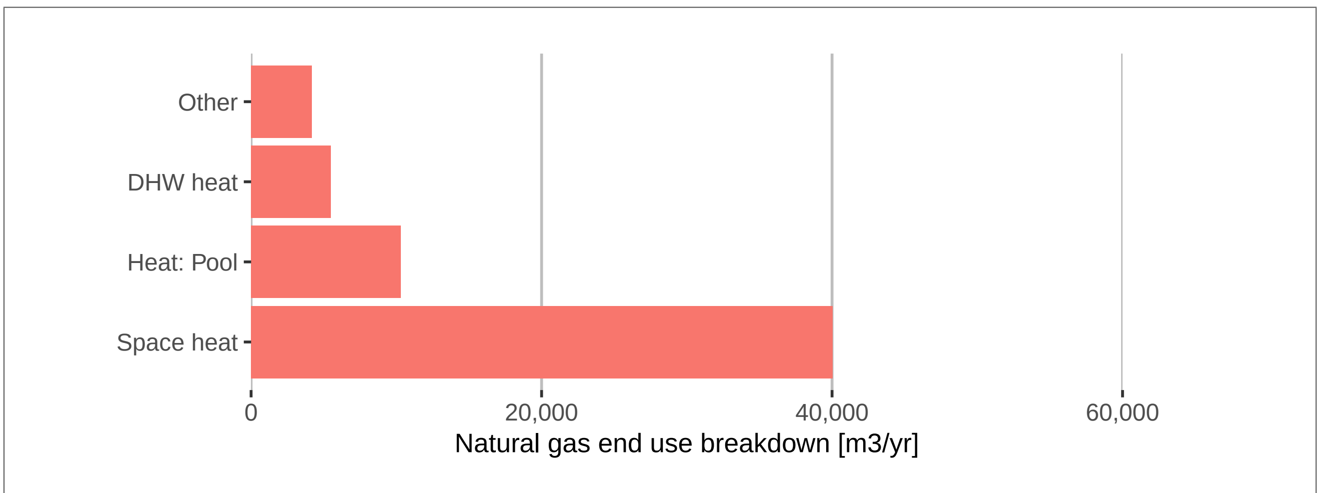


Figure 147: Natural gas end use breakdown (calculated by calibrated energy model)

5 MEASURE ANALYSIS

5.1 Measure analysis methodology

The measure analysis was completed according to the following methodology.

1. **Measure identification and triaging**. Measures that could be implemented to help achieve City of Temiskaming Shores's goals were identified based on the findings documented in Sections 2 and 3. Identified measures were triaged by labeling each one as either 'Analyzed' or 'Not analyzed'. The intent of triaging was to focus efforts on analyzing measures for which analysis was considered most valuable (typically for measures that are more complex or more impactful). Results are summarized in Section 5.3.
2. **Measure analysis.** For each 'Analyzed' measure, the analysis completed for that measure was summarized in a dedicated sub-section named after that measure (see Sections 5.4 through 5.16). In each sub-section, the following was documented.
   - *Measure description*. The relevant existing condition was summarized, an opportunity for improving the stated existing condition was described, and the intended utility-savings mechanism associated with the opportunity was described.
   - *Design description*. A conceptual design description was provided, including a written description of the proposed design concept and the associated project cost estimate.
   - *Utility analysis*. A utility analysis was completed using the energy model introduced in Section 4. Measure-specific assumptions applied in calculating the impacts on utility use were provided for each measure. For each measure, the expected GHG emissions, utility costs and financial incentives associated with implementing the measure were calculated based on utility use, using the assumptions outlined in Section 5.2. A life cycle cost analysis was completed, applying the assumptions summarized in Tables 15 and 21 according to the following methodology.
     (a) The life cycle cost for each measure was calculated based on the assumed implementation year of 2026 for each measure. The life cycle cost for each measure was calculated as the sum of the following future financial cost expenditures, discounted back to present value using the discount rate from Table 21, over the evaluation period of present to 2050.
     (b) Project costs: The future value of project costs was calculated based on the project cost estimate of each measure, inflated to future value associated with the assumed implementation year using the general inflation rate from Table 21. In the life cycle cost calculation, the project cost was amortized over the expected life of the measure such that the yearly present value is constant over every year of the expected life of the measure. This results in the net present value of the project cost being equal to what it would be if the owner was to pay for it via lump sum in the implementation year for that measure.
     (c) Replacement costs: The future value of replacement costs was calculated assuming that a financial cost was incurred to replace equipment associated with each measure at the end of the expected life of that measure equal to 50% of the initial project cost, inflated to future value associated with the estimated time of replacement using the general inflation rate from Table 21. The same amortization approach as for project costs was used.
     (d) Utility costs: The future value of yearly utility costs of the entire facility was accounted for in the life cycle cost calculation for each measure. The future value of yearly utility costs was calculated by applying the future utility cost rates from Table 19 to the utility use of the entire facility for that year as predicted by the calibrated energy model for each measure and scenario.
3. **Measure risk analysis**. A risk analysis of each individual measure was completed to test how the performance of that measure might be affected by changes to certain risk parameters. In this risk analysis, each of the risk parameters defined in Table 22 was tested under each risk case also defined in Table 22 for that risk parameter. For each risk case of each risk parameter, the expected performance of each measure was quantified, and the results were summarized using box and whisker plots indicating the range over

which performance might be expected to vary. Findings from the risk analysis were summarized in Section 5.17.

4. **Measure analysis summary**. Measure analysis results for all measures were summarized in table format in Section 5.18.

5.2 Measure analysis assumptions

Assumptions general to all measures are as follows.

- GHG emissions factor assumptions are summarized in Table 14, in Section 3.2.
- Utility cost rate assumptions applied to quantify yearly utility cost impacts relative to the baseline are summarized in Table 15, in Section 3.2. Utility cost rate future assumptions applied in the life cycle analysis for each measure are summarized in Table 19. Note that throughout this Pathway to Decarbonization Feasibility Study the Federal Carbon Charge is treated separately (if applicable) with respect to associated fuels (rather than being accounted for within the rates of the applicable fuels, the federal carbon charge line item is calculated separately based on the estimated yearly GHG emissions for that fuel). As such, all other utility cost rates exclude the federal carbon charge.

Table 19: Utility cost rate future assumptions

Year	Natural gas	Federal carbon charge	Carbon offsets	Class B HOEP	Class B GA	Class B regulatory
-	[$/m3]	[$/tCO2e]	[$/tCO2e]	[$/kWh]	[$/kWh]	[$/kWh]
2023	0.2652	65	30	0.0204	0.075	0.0058
2024	0.2705	80	30.6	0.0208	0.0765	0.0059
2025	0.2759	0	31.21	0.0212	0.078	0.006
2026	0.2814	0	31.84	0.0216	0.0796	0.0061
2027	0.287	0	32.47	0.022	0.0812	0.0062
2028	0.2927	0	33.12	0.0224	0.0828	0.0063
2029	0.2986	0	33.78	0.0228	0.0845	0.0064
2030	0.3046	0	34.46	0.0233	0.0862	0.0065
2031	0.3107	0	35.15	0.0238	0.0879	0.0066
2032	0.3169	0	35.85	0.0243	0.0897	0.0067
2033	0.3232	0	36.57	0.0248	0.0915	0.0068
2034	0.3297	0	37.3	0.0253	0.0933	0.0069
2035	0.3363	0	38.05	0.0258	0.0952	0.007
2036	0.343	0	38.81	0.0263	0.0971	0.0071
2037	0.3499	0	39.58	0.0268	0.099	0.0072
2038	0.3569	0	40.38	0.0273	0.101	0.0073
2039	0.364	0	41.18	0.0278	0.103	0.0074
2040	0.3713	0	42.01	0.0284	0.1051	0.0075
2041	0.3787	0	42.85	0.029	0.1072	0.0077
2042	0.3863	0	43.7	0.0296	0.1093	0.0079
2043	0.394	0	44.58	0.0302	0.1115	0.0081
2044	0.4019	0	45.47	0.0308	0.1137	0.0083
2045	0.4099	0	46.38	0.0314	0.116	0.0085
2046	0.4181	0	47.31	0.032	0.1183	0.0087
2047	0.4265	0	48.25	0.0326	0.1207	0.0089
2048	0.435	0	49.22	0.0333	0.1231	0.0091
2049	0.4437	0	50.2	0.034	0.1256	0.0093
2050	0.4526	0	51.21	0.0347	0.1281	0.0095

- Financial incentive assumptions are summarized in Table 20.

Table 20: Financial incentive assumptions

Incentive program	Incentive calculation rules
Enbridge custom	0.25 $/m3/yr of natural gas reduction
	Up to a maximum of 50% of eligible project costs Up to a maximum of $100,000
FCM CBR GHG reduction pathway grant	Up to 80% of project costs (grant + loan)
	Up to $5 million (grant + loan) Up to 25% of funding can be grant

- Life cycle cost analysis assumptions are summarized in Table 21.

Table 21: Life cycle cost analysis assumptions

Description	Unit	Value
General cost inflation	[%]	2
Discount rate	[%]	5

- Risk analysis assumptions, including risk parameters and risk cases that were tested in the measure risk analysis are summarized in Table 22.

Table 22: Risk parameter and case definitions

Parameter	Description	Methodology	Case	X	Unit
Project cost	Project cost may differ from the estimated values.	The case project cost = x TIMES the initial project cost estimate.	Very low|Low|High|Very high	0.75|.9|1.1|1.25	[decimal]
Replacement cost	Replacement cost may differ from the estimated values.	The case replacement cost = x TIMES the initial replacement cost estimate.	Very low|Low|High|Very high	0.75|.9|1.1|1.25	[decimal]
Utility use change	Changes to utility use and thermal energy demand in a measure or scenario may differ from reality.	The case utility use profile is the baseline profile plus x TIMES the difference between the initial proposed profile and the baseline profile.	Very low|Low|High|Very high	0.75|.9|1.1|1.25	[decimal]
Electricity GHG factor	Future GHG factors for electricity may differ than those assumed.	For each year for which the GHG factor is projected, the case GHG factor for that year = the current year factor PLUS (x TIMES the difference between the initial value for that year, and the factor for the current year).	Very low|Low|High|Very high	0.75|.9|1.1|1.25	[decimal]
Incentive rates	Actual incentives may be different from estimated ones. While project cost and utility use affects incentive amounts, this risk parameter seeks to identify the risk in changes to the financial rates used in incentive amount calculations (e.g.\ if saveon energy provides incentives at 0.05 \$/kWh rather than 0.04 $/kWh, etc).	For each financial rate used in incentive amount calculations, the case rate is x TIMES the initial rate.	Very low|Low|High|Very high	0.75|.9|1.1|1.25	[decimal]
Federal carbon charge	Future federal carbon charge rates may differ than those assumed.	The default federal carbon charge increases to 170 $/tCO2e by 2030 and to 300 $/tCO2e by 2050. The case federal carbon charge follows the default trend but limited to a maximum value of x.	Very low|Low|High|Very high	0|100|240|300	[$/tCO2e]
Utility cost inflation	Future utility cost rates may differ than what was assumed.	The case utility cost inflation rate for all utilities is x (as a decimal) compounded yearly.	Very low|Low|High|Very high	0.01|0.015|0.025|0.03	[decimal]
General cost inflation	General cost inflation may differ from what was assumed. Note that general cost inflation is applied ONLY to project costs, replacement costs, and maintenance costs (future utility cost rates are handled separately).	The case general cost inflation rate is x.	Very low|Low|High|Very high	0.01|0.015|0.025|0.03	[decimal]
Discount rate	It is worth testing the sensitivity of the discount rate on life cycle cost / net present value calculations.	The case discount rate is x.	Very low|Low|High|Very high	0.05|0.06|0.08|0.09	[decimal]

- This building has not undergone a building condition assessment, and therefore, business as usual (BAU) measures were not available. WalterFedy utilized previous reports to gauge the potential costing of BAU renewal measures. These measures are provided for reference only and are not intended for use in budgetary requirements. It’s recommended that the City of Temiskaming Shores undertake a Building Condition Assessment of this building.

5.3 Measure identification

Results of the measure identification and triaging process are summarized in Table 23.

Table 23: Measure identification and triaging summary

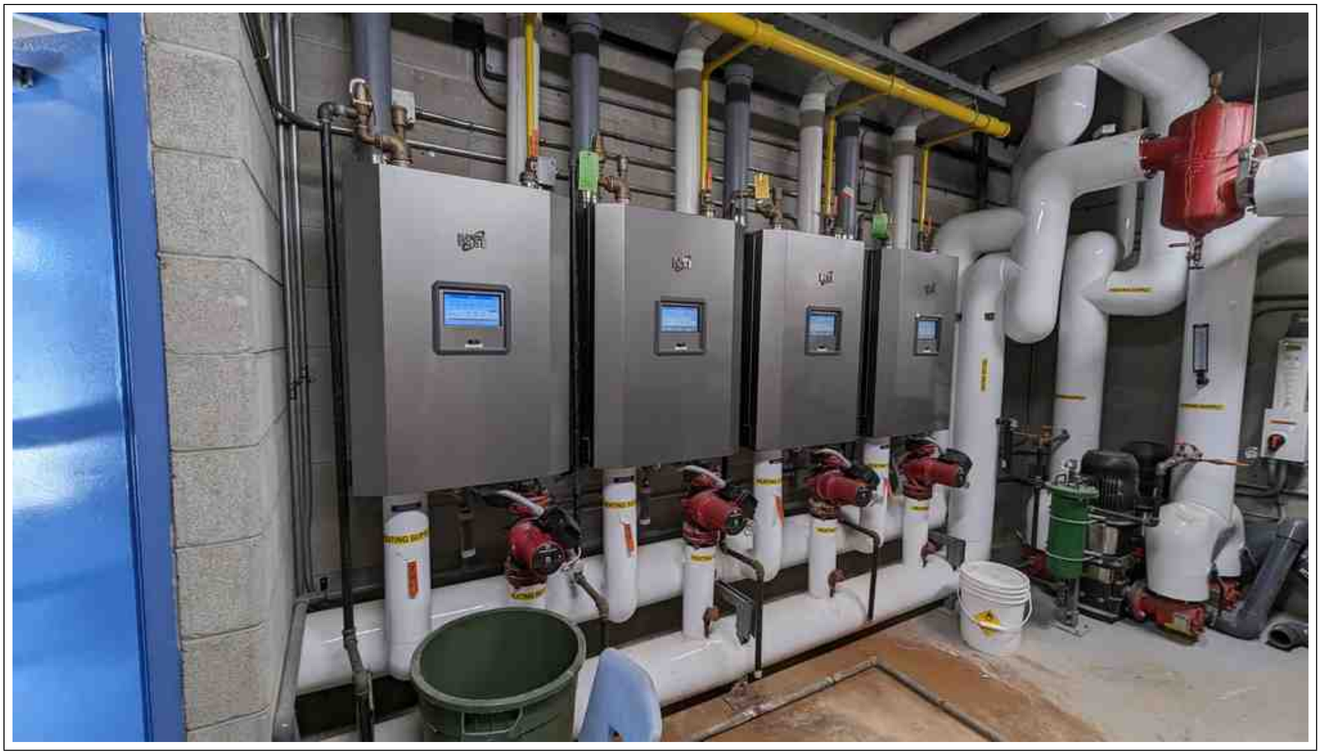
Measure name	Triage for analysis
Baseline	
Boiler plant to ASHP hybrid	Analyzed.
Carbon offsets 20	Analyzed.
DHW heaters to ASHP	Analyzed.
Exterior LED lighting upgrade	Analyzed.
Geothermal implementation	Analyzed.
HVAC re-commissioning	Analyzed.
Implement pool and spa covers	Analyzed.
Interior LED lighting upgrade	Analyzed.
Roof upgrade to high performance	Analyzed.
Solar PV canopy	Analyzed.
Solar PV rooftop	Analyzed.
Wall upgrade to high performance	Analyzed.
Windows and doors to high performance	Analyzed.
Boiler renewal	Business as usual.
DHW renewal	Business as usual.
Exterior lighting renewal	Business as usual.
Exterior walls renewal	Business as usual.
Interior lighting renewal	Business as usual.
Roof renewal	Business as usual.
Windows and doors renewal	Business as usual.
HV1 ERV	Not analyzed: there will be anticipated difficulties getting the equipment into the mechanical room.

5.4 Boiler plant to ASHP hybrid

Measure description

Existing condition

Four condensing boilers provide hot water to three heat exchangers (HX1-pool, HX2-spa, HX3-DHW), DH1 reheat coil, HV1 hot deck heating coil, and HV1 preheat coil.



Opportunity

Convert the boiler plant to a hybrid ASHP and natural gas-fired boiler plant, in which ASHP is the primary heat source, and natural gas is the backup. This option is considered a potentially more cost-efficient option for GHG abatement than complete conversion to ASHP.

Utility-savings mechanism

The primary intent of this measure is to reduce GHG emissions by converting the fuel used for heating from natural gas to electricity due to electricity having a lower GHG intensity than natural gas. Reduced natural gas use and increased electricity use would be expected as a result.

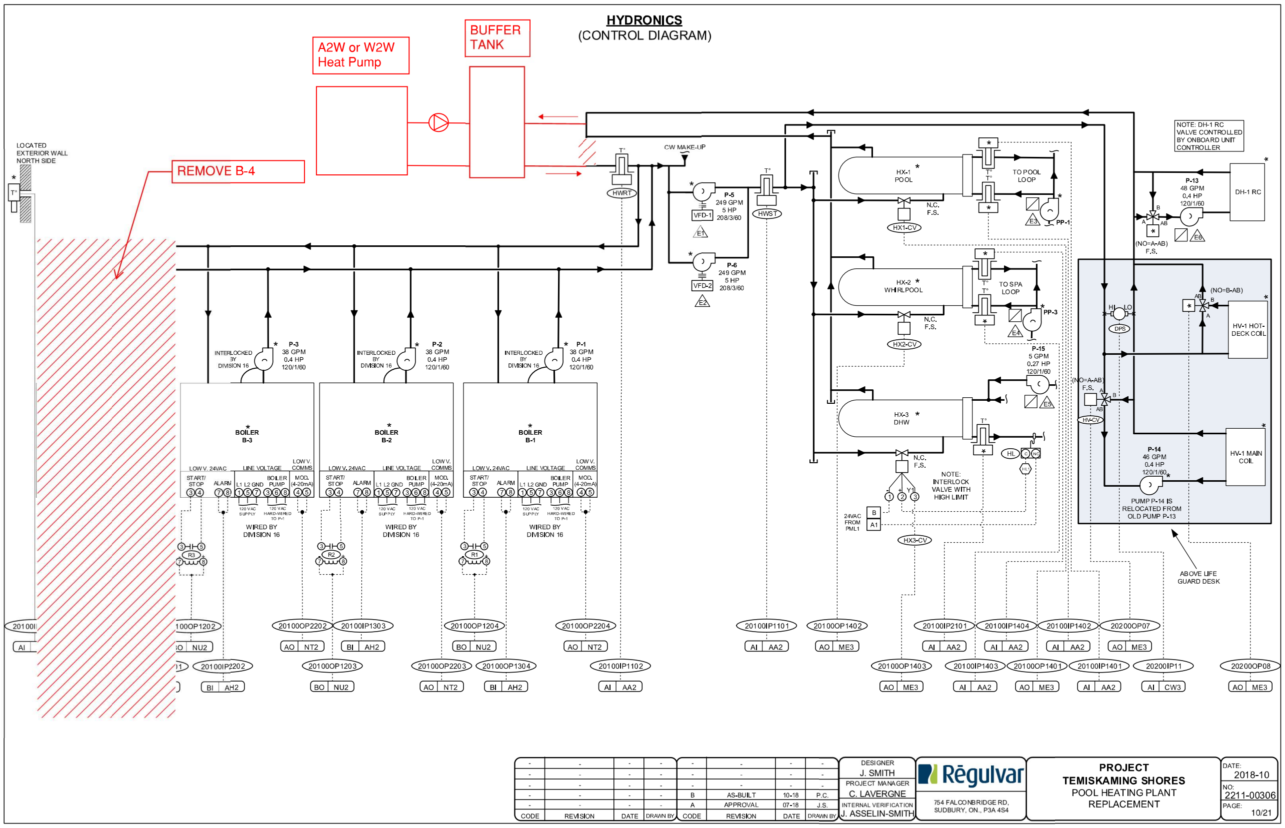
Design description

Overview

Upgrade the boiler plant to include an air source heat pump to act as the base load for heating in the building. The remaining boilers will provide backup heating.

Supply one (1) 30 ton air-to-water air-source heat pump, remove one boiler, supply one plate and frame exchanger complete with circulation pump, piping to boiler room for heating and piping to HV1 mechanical room for cooling coil, replace HV1 cooling coil suitable for hydronic, and supply electrical out to new unit.

Refer to the marked up schematic:



Electrical

The ASHP will add approximately 45 kW of power to the existing system, which will put the system at 140.68 kW, which is approximately 61% of the full load of the electrical capacity of the building. This can be powered from the existing main switchboard.

Project cost estimate

Table 24: Project cost estimate (Boiler plant to ASHP hybrid)

Category	Line item	Unit	Value
Construction	Supply	[$]	200,000
	Install	[$]	100,000
	Circulating Pumps and controls	[$]	80,000
	Piping and Architectural Considerations	[$]	120,000
	Electrical	[$]	50,000
	General requirements (25%)	[$]	137,500
Contingency	Subtotal after Construction	[$]	687,500
	Design Contingency (25%)	[$]	171,900
	Construction Contingency (10%)	[$]	68,800
Design, Contractors, PM	Subtotal after Contingency	[$]	928,200
	Engineering Design and Field Review (10%)	[$]	92,800
	Contractor Fee (7%)	[$]	65,000
Total	Total	[$]	1,086,000

Utility analysis

Utility analysis methodology

The following assumptions were applied to the energy model to estimate utility use impacts.

- **Baseline**. The boilers have a thermal efficiency of 95%.
- **Proposed**. Most boilers are replaced by air-source heat pumps with an average heating COP of 3. Backup heating is provided through natural gas when the outdoor air temperature is below -15 C or as needed to meet heating requirements.

Utility analysis results

Table 25: Boiler plant to ASHP hybrid analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	497,507	-126,924	-34.2
	Natural gas use	[m3/yr]	59,962	15,793	44,169	73.7
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	497,507	-126,924	-34.2
	Natural gas energy	[kWh/yr]	633,007	166,725	466,282	73.7
	Total energy	[kWh/yr]	1,003,590	664,232	339,358	33.8
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	11.9	-3.0	-34.2
	Natural gas GHGs	[tCO2e/yr]	116	30.5	85.4	73.7
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	42.4	82.3	66.0
Utility cost	Electricity utility cost	[$/yr]	36,762	49,353	-12,591	-34.2
	Natural gas utility cost	[$/yr]	15,590	4,106	11,484	73.7
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	1,526	4,268	73.7
	Total utility cost	[$/yr]	58,146	54,985	3,161	5.4
Financial	Assumed life	[yrs]	15	15	–	–
	Project cost	[$]	0	1,086,000	–	–
	Incentive amount	[$]	0	217,200	–	–
	Incremental project cost	[$]	0	868,800	–	–
	Life cycle cost	[$]	1,482,726	2,671,411	–	–
	Net present value	[$]	0	-1,188,685	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	10,554	–	–
	Simple payback period	[yr]	–	>20	–	–

5.5 Carbon offsets 20

Measure description

Existing condition

The facility is currently purchasing no carbon offsets.

Opportunity

After implementing other measures, purchase carbon offsets to offset 20% of the remaining GHG emissions.

Utility-savings mechanism

Energy use is not affected by purchasing carbon offsets. Yearly GHG emissions accounted against the facility will be reduced by the same quantity as those purchased for that year.

Design description

Net zero definition

The Canadian Green Building Council (CAGBC) defines net carbon emissions for a facility as in the following formula.

Net emissions = Embodied carbon + Operational carbon - Avoided emissions

The terms of this formula are defined as follows.

- **Embodied carbon**. GHG emissions associated with the construction, maintenance and final end-of-life disposal of the facility.
- **Operational carbon**. GHG emissions associated with the use of energy of the facility while in operation.
- **Avoided emissions**. GHG emissions avoided through activities such as exporting green power to local grids, or the purchase of carbon offsets.

Net Zero emissions as achieved when the Net emissions from this formula is zero or less.

This measure focuses on the on-going use of avoided emissions (as defined above) to offset operational carbon associated with ongoing energy use at the facility. Note that embodied carbon emissions tend to be a one-time event, in contrast to the on-going emissions associated with operations, which must also be accounted for through avoided emissions.

Renewable energy certificates

As defined above, emission avoidance activities recognized by the CaGBC definition of Net-Zero include exporting green power, or the purchase of carbon offsets. Green power exports include the exporting of on-site renewable energy, as well as the injection of renewable energy into local grids through off-site renewable energy generation facilities. The latter approach is typically accomplished through the purchase of Renewable Energy Certificates (RECs). RECs are utility-specific and are purchased by unit energy of the utility in question (e.g. kWh for electricity, or m^3 for natural gas), and can only be used to offset GHG emissions associated with the specific utility in question. For example, electricity RECs can be purchased to offset up to 100% of electricity used by the building, but cannot be used to offset natural gas used by the building (and vice versa). RECs are typically considered best practise because they facilitate an immediate injection of renewable energy into grids. RECs can be purchased through REC providers such as Bullfrog Power.

Carbon offsets

The purchase of carbon offsets is the second approach for avoided emissions recognized by CaGBC. Carbon offsets are purchased per tonne of GHG emissions, and can be used to offset either direct (e.g. natural gas combustion on-site) or indirect (e.g. electricity use on-site, which is generated offsite) GHG emissions. Carbon offsets must be certified as stipulated within the CaGBCs Zero Carbon Building Standard, which is required to uphold quality standards of the carbon offsets. Carbon offsets can be purchased through certified providers such as Less Emissions Inc.

Cost rates

Cost rates for RECs and carbon offsets are summarized as follows.

- Electricity REC cost rate (Bullfrog Power): 0.025 $/kWh.
- Natural gas REC cost rate (Bullfrog Power): 0.186 $/m3.
- Carbon offset cost rate (Less Emissions Inc.): 30 $/mtCO2e.

Utility analysis

Utility analysis methodology

Energy use is not affected by purchasing carbon offsets. Yearly GHG emissions accounted against the facility will be reduced by the same quantity as those purchased for that year.

Baseline. It is assumed that no carbon offsets are purchased.

Proposed. Carbon offsets are assumed to be purchased in the quantity equal to 20% of remaining GHG emissions. Note that as an individual measure, the analysis indicates the impact of offsetting baseline GHG emissions with carbon offsets. When considered as part of the scenario analyses in Section 6, this measure will cause 20% of remaining GHG emissions to be offset.

Utility analysis results

Table 26: Carbon offsets 20 analysis results summary

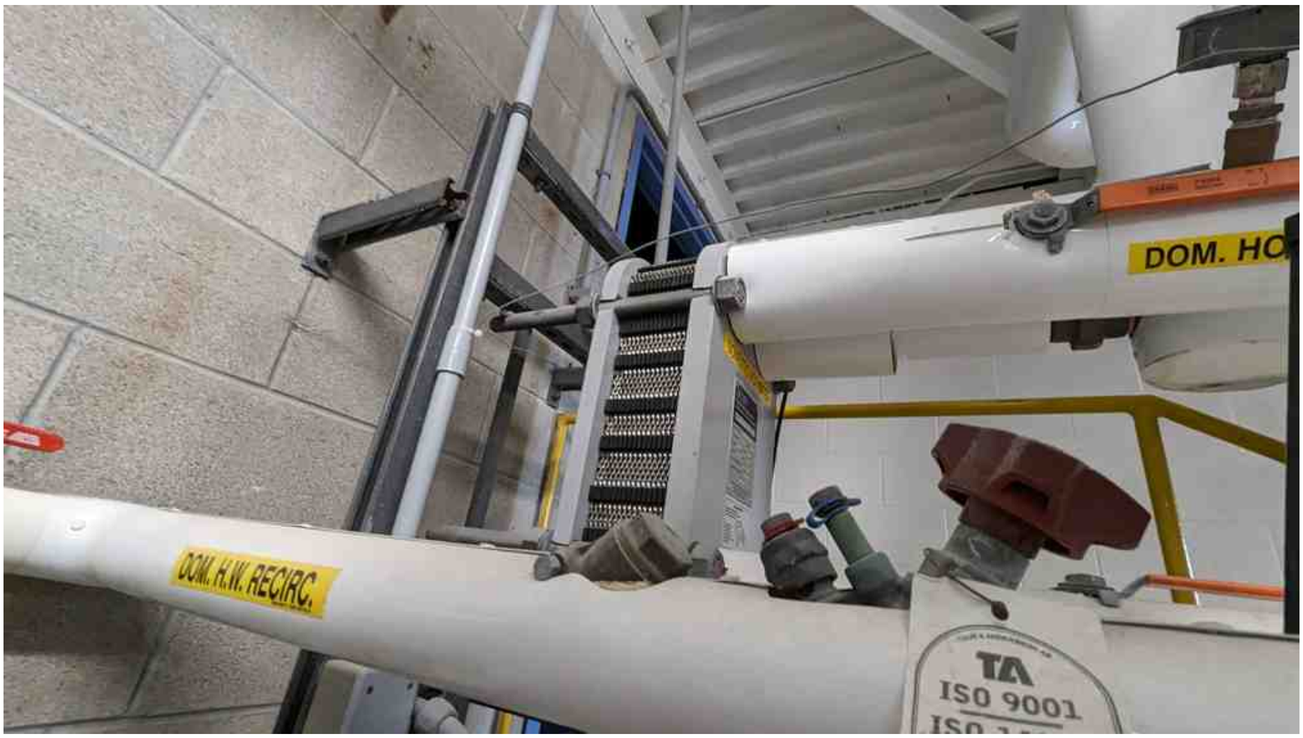
Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	370,583	0	0
	Natural gas use	[m3/yr]	59,962	59,962	0	0
	Carbon offset use	[tCO2e/yr]	0	24.9	-24.9	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	370,583	0	0
	Natural gas energy	[kWh/yr]	633,007	633,007	0	0
	Total energy	[kWh/yr]	1,003,590	1,003,590	0	0
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.9	0	0
	Natural gas GHGs	[tCO2e/yr]	116	116	0	0
	Carbon offsets GHGs	[tCO2e/yr]	0	-24.9	24.9	–
	Total GHGs	[tCO2e/yr]	125	99.8	24.9	20.0
Utility cost	Electricity utility cost	[$/yr]	36,762	36,762	0	0
	Natural gas utility cost	[$/yr]	15,590	15,590	0	0
	Carbon offsets utility cost	[$/yr]	0	748	-748	–
	Federal carbon charge	[$/yr]	5,793	5,793	0	0
	Total utility cost	[$/yr]	58,146	58,894	-748	-1.3
Financial	Assumed life	[yrs]	15	20	–	–
	Project cost	[$]	0	–	–	–
	Incentive amount	[$]	0	0	–	–
	Incremental project cost	[$]	0	–	–	–
	Life cycle cost	[$]	1,482,726	1,496,373	–	–
	Net present value	[$]	0	-13,647	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	–	–	–
	Simple payback period	[yr]	–	–	–	–

5.6 DHW heaters to ASHP

Measure description

Existing condition

DHW is provided via HX3 from the hot water loop. There is no storage tanks on site, and P15 is used as a circulation pump. The system has a setpoint of 49C.



Opportunity

Replace the gas-fired DHW heaters with ASHP (air source heat pump) equivalents.

Utility-savings mechanism

This measure will convert the heat fuel from natural gas to electricity. This will result in an overall energy reduction due to the higher efficiency of the heat pump compared to that of the natural gas DHW tanks and a reduction in GHG intensity.

Design description

Design concept

The domestic hot water is currently supplied by the boiler plant. This measure installs a single ASHP hot water heater to provide base load DHW with the existing boiler plant HX to operate as a pre-heat (or backup) system. This will allow the boiler plant to operate at a lower temperature and enable it to utilize heat pump technology.

Electrical

The ASHP will add approximately 5 kW of power to the existing system, which will put the system at 100.68 kW, which is approximately 44% of the full load of the electrical capacity of the building.

Project cost estimate

Table 27: Project cost estimate (DHW heaters to ASHP)

Category	Line item	Unit	Value
Materials and labour	AO Smith CAHP-120 (Qty 1)	[$]	18,000
	Design	[$]	20,000
	Electrical work	[$]	12,000
Contingency	Subtotal after Materials and labour	[$]	50,000
	General Contingency (50%)	[$]	25,000
Total	Total	[$]	75,000

Utility analysis

Utility analysis methodology

The following assumptions were applied to the energy model to estimate utility use impacts.

- **Baseline**. DHW heating is provided via HX3 from the hot water loop.
- **Proposed**. DHW heating is provided by an ASHP at a COP of 3. HX3 remains in place as a backup solution to assist with high demand periods.

Utility analysis results

Table 28: DHW heaters to ASHP analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	383,037	-12,454	-3.4
	Natural gas use	[m3/yr]	59,962	54,837	5,125	8.5
	Carbon offset use	[tCO2e/yr]	0	0	0	—
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	383,037	-12,454	-3.4
	Natural gas energy	[kWh/yr]	633,007	578,904	54,103	8.5
	Total energy	[kWh/yr]	1,003,590	961,941	41,649	4.2
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	9.2	-0.30	-3.4
	Natural gas GHGs	[tCO2e/yr]	116	106	9.9	8.5
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	—
	Total GHGs	[tCO2e/yr]	125	115	9.6	7.7
Utility cost	Electricity utility cost	[$/yr]	36,762	37,997	-1,235	-3.4
	Natural gas utility cost	[$/yr]	15,590	14,258	1,332	8.5
	Carbon offsets utility cost	[$/yr]	0	0	0	—
	Federal carbon charge	[$/yr]	5,793	5,298	495	8.5
	Total utility cost	[$/yr]	58,146	57,553	592	1.0
Financial	Assumed life	[yrs]	15	15	—	—
	Project cost	[$]	0	75,000	—	—
	Incentive amount	[$]	0	1,281	—	—
	Incremental project cost	[$]	0	73,719	—	—
	Life cycle cost	[$]	1,482,726	1,577,721	—	—
	Net present value	[$]	0	-94,996	—	—
	Project cost per GHG reduction	[$yr/tCO2e]	—	7,675	—	—
	Simple payback period	[yr]	—	>20	—	—

5.7 Exterior LED lighting upgrade

Measure description

Existing condition

The building exterior lighting utilizes LED and CFL lighting.

Opportunity

Replace all non-LED fixtures with LED equivalent fixtures.

Utility-savings mechanism

Reduced lighting energy use through more energy-efficient lamps. Given the fixtures are exterior to the building (i.e. unconditioned spaces), there are no effects on heating and cooling.

Design description

Overview

The lighting system shall be designed to meet the latest ASHRAE 90.1 energy codes, IESNA standards, the Waterfront Pool and Fitness Centre standards and other applicable regulations and standards.

The existing site has gone through some recent LED upgrades. It will be proposed that all the remaining fluorescent fixtures will be replaced with new LED fixtures.

LED luminaires shall be provided with an expected service life of over 50,000 hours, dark-sky compliant, and be listed on the Energy Star Qualified Commercial Lighting List or the Design Lights Consortium List (DLC) for incentive eligibility from the IESOs Save on Energy Program.

With the extended lifespan associated with LED fixtures, the likelihood of a complete fixture failure is significantly less likely than previous fixture types. Rather, the user would witness a slow degradation of the lighting output of the fixtures. It would be recommended that an annual lighting review is conducted to measure the lighting levels after dusk or before dawn. At the 70% output level, the owner would expect a much quicker decline in the loss of lighting output in each fixture. As such, at the 70% lighting level, it would be recommended that the fixtures be replaced.

Type H2 fixtures should be replaced. It is estimated that there are 10 fixtures to replace at 30W each, and that replacements will be 9W each.

Project cost estimate

Table 29: Project cost estimate (Exterior LED lighting upgrade)

Category	Line item	Unit	Value
Materials and labour	Exterior LED lighting upgrade	[$]	2,000
Contingency	Subtotal after Materials and labour	[$]	2,000
	General Contingency (50%)	[$]	1,000
Total	Total	[$]	3,000

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**: Exterior lighting is assumed to consume 0.3 kW.
- **Proposed**: It is assumed that the exterior lighting is replaced with an LED equivalent which consumes 0.09 kW.

Utility analysis results

Table 30: Exterior LED lighting upgrade analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	369,678	905	0.24
	Natural gas use	[m3/yr]	59,962	59,961	1.8	0.00
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	369,678	905	0.24
	Natural gas energy	[kWh/yr]	633,007	632,988	19.3	0.00
	Total energy	[kWh/yr]	1,003,590	1,002,665	925	0.09
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.8	0.02	0.24
	Natural gas GHGs	[tCO2e/yr]	116	116	0.00	0.00
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	125	0.03	0.02
Utility cost	Electricity utility cost	[$/yr]	36,762	36,672	89.8	0.24
	Natural gas utility cost	[$/yr]	15,590	15,590	0.48	0.00
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,793	0.18	0.00
	Total utility cost	[$/yr]	58,146	58,055	90.5	0.16
Financial	Assumed life	[yrs]	15	20	–	–
	Project cost	[$]	0	3,000	–	–
	Incentive amount	[$]	0	0	–	–
	Incremental project cost	[$]	0	3,000	–	–
	Life cycle cost	[$]	1,482,726	1,483,477	–	–
	Net present value	[$]	0	-751	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	119,190	–	–
	Simple payback period	[yr]	–	>20	–	–

5.8 Geothermal implementation

Measure description

Existing condition

Using geothermal on-site from a regulatory and site conditions perspective may be possible. HVAC heating and cooling, for the most part, are performed by natural gas-fired boilers and DX coils, respectively.

Opportunity

Consider implementing a geothermal loop at the facility and converting heating and cooling systems in the building to geothermal.

Utility-savings mechanism

Installing a geothermal loop is primarily to facilitate the conversion of the heating systems' heat sources from natural gas combustion (GHG-intensive) to electrically-energized heat pumps (which are more energy-efficient and less GHG-intensive). Implementing a geothermal loop at the site will not affect energy use or GHG emissions by itself; rather, it would be required to support converting any specific system to a ground source, as analyzed in other measures throughout this feasibility study.

Design description

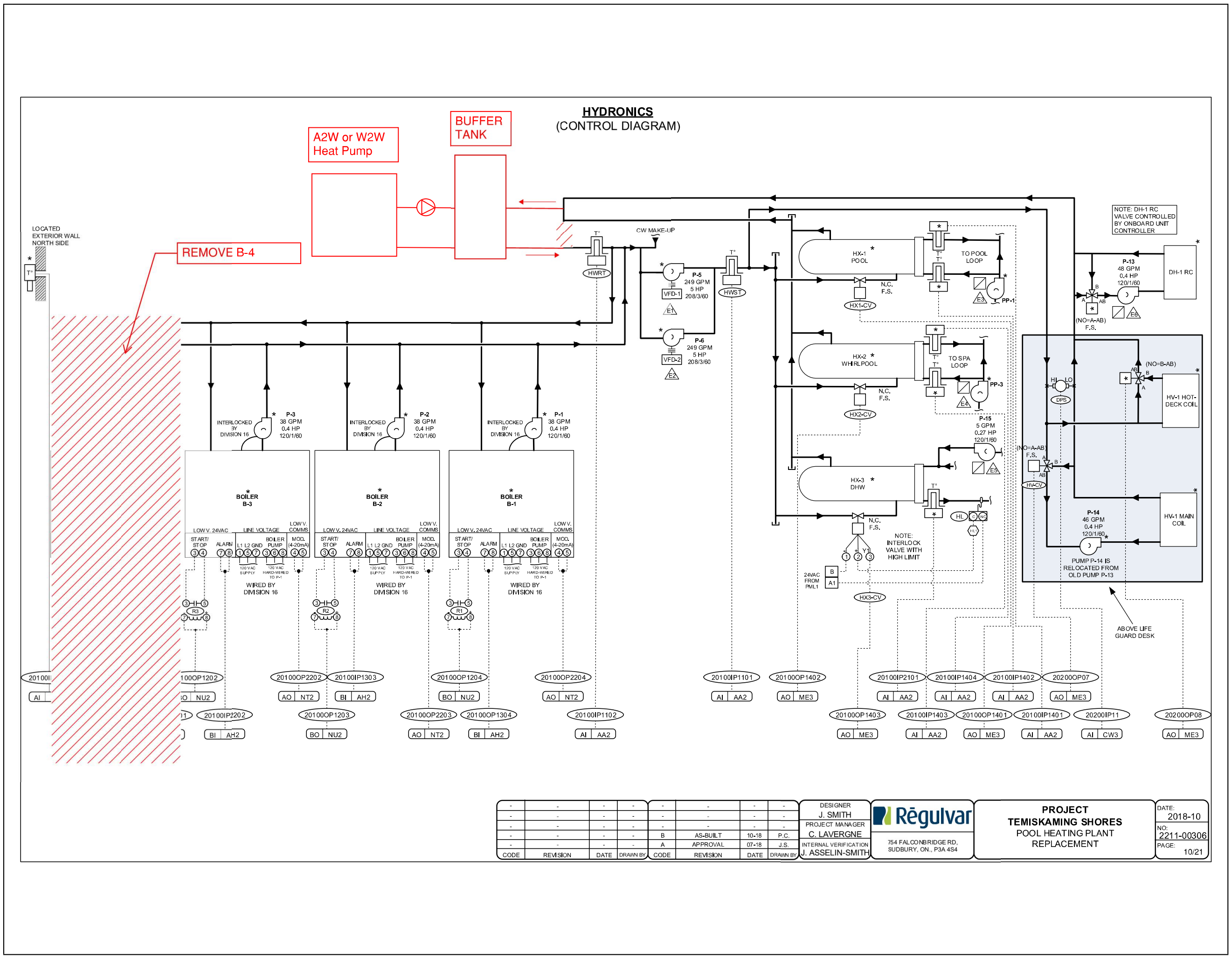
Overview

Install a lake-based geothermal system to source for a new water-to-water heat pump.

Upgrade the boiler plant to include an air source heat pump to act as the base load for heating in the building. The remaining boilers will provide backup heating.

Supply one (1) 30 ton water-to-water heat pump, remove one boiler, supply one plate and frame exchanger complete with circulation pump, piping to boiler room for heating and piping to HV1 mechanical room for cooling coil, and replace HV1 cooling coil suitable for hydronic.

A water based geothermal loop will be installed that includes 10 circuits of 1.25 inch HDPE pipe run into the lake. Each circuit shall be 800 feet and shall be wrapped with aircraft cable to allow the pipe to be buoyant when filled with air but sink when filled with antifreeze. Additional cinder blocks are used to fix the pipe to the bottom of the lake. The pipes will run out to a location of at least 15 feet in depth.



Electrical

The geothermal pump will add approximately 45 kW of power to the existing system, which will put the system at 140.68 kW, which is approximately 61% of the full load of the electrical capacity of the building.

Project cost estimate

Table 31: Project cost estimate (Geothermal implementation)

Category	Line item	Unit	Value
Construction	Supply	[$]	100,000
	Install	[$]	150,000
	Circulating Pumps and controls	[$]	80,000
	Piping and Architectural Considerations	[$]	120,000
	Lake Heat Exchanger piping	[$]	90,000
	Electrical	[$]	20,000
	General requirements (25%)	[$]	140,000
Contingency	Subtotal after Construction	[$]	700,000
	Design Contingency (25%)	[$]	175,000
	Construction Contingency (10%)	[$]	70,000
Design, Contractors, PM	Subtotal after Contingency	[$]	945,000
	Engineering Design and Field Review (10%)	[$]	94,500
	Contractor Fee (7%)	[$]	66,200
Total	Total	[$]	1,105,700

Utility analysis

Utility analysis methodology

The following assumptions were applied to the energy model to estimate utility use impacts.

- **Baseline**. The boilers have a thermal efficiency of 95%.
- **Proposed**. A geothermal system is implemented with a heating COP of 4 and cooling COP of 6. Backup heat is provided from natural gas boilers. Also note that the boilers would remain to maintain a minimum entering water temperature to prevent heat pump failure.

Utility analysis results

Table 32: Geothermal implementation analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	495,030	-124,447	-33.6
	Natural gas use	[m3/yr]	59,962	9,672	50,290	83.9
	Carbon offset use	[tCO2e/yr]	0	0	0	—
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	495,030	-124,447	-33.6
	Natural gas energy	[kWh/yr]	633,007	102,109	530,898	83.9
	Total energy	[kWh/yr]	1,003,590	597,138	406,452	40.5
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	11.8	-3.0	-33.6
	Natural gas GHGs	[tCO2e/yr]	116	18.7	97.2	83.9
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	—
	Total GHGs	[tCO2e/yr]	125	30.5	94.2	75.5
Utility cost	Electricity utility cost	[$/yr]	36,762	49,107	-12,345	-33.6
	Natural gas utility cost	[$/yr]	15,590	2,515	13,075	83.9
	Carbon offsets utility cost	[$/yr]	0	0	0	—
	Federal carbon charge	[$/yr]	5,793	935	4,859	83.9
	Total utility cost	[$/yr]	58,146	52,556	5,589	9.6
Financial	Assumed life	[yrs]	15	15	—	—
	Project cost	[$]	0	1,105,700	—	—
	Incentive amount	[$]	0	221,140	—	—
	Incremental project cost	[$]	0	884,560	—	—
	Life cycle cost	[$]	1,482,726	2,654,801	—	—
	Net present value	[$]	0	-1,172,075	—	—
	Project cost per GHG reduction	[$yr/tCO2e]	—	9,390	—	—
	Simple payback period	[yr]	—	>20	—	—

5.9 HVAC re-commissioning

Measure description

Existing condition

The facility utilizes a BAS to control its HVAC system.

Opportunity

The City is recommended to undergo a re-commissioning program to optimize existing BAS controls.

Utility-savings mechanism

Implementing this measure will save natural gas and electricity by optimizing BAS controls.

Design description

Overview

Conduct a retro-commissioning exercise for the HVAC systems serving the facility.

It is recommended that the commissioning exercise be conducted according to the following steps.

- Meet with the users of the space and the building operators to identify and document the specific requirements of the spaces in terms of occupancy, setpoints, and airflow requirements.
- Investigate the existing project documentation, including design drawings, controls as-builts, testing and balancing information, and commissioning reports to learn how the systems were originally set up to operate.
- Execute virtual functional testing on the systems to confirm the proper operation of individual components and overall systems.
- Identify opportunities for the repair of failed components and for the improvement of control sequences with respect to energy efficiency and to better meet the goals of the facility.
- Implement agreed-upon measures with the assistance of a controls contractor and other contractors as required.
- Ensure that the building operators and occupants are trained on changes that are implemented and trained on how to optimally operate the systems and make required changes.

As part of the process, the following items are to be optimized at a minimum:

- Scheduling of air handling units according to user requirements.
- Limiting the OA provided at each air handler to the unit to the occupancy requirements.
- Coordination of heating and cooling setpoints between adjacent units to prevent simultaneous heating and cooling.
- Setback of temperature setpoints during unoccupied periods.
- Economizer control on air handling units.
- Boiler supply water reset schedules.
- Boiler cycling periods.

The costing provided below is an estimate for the investigation phase of the work. Costs for implementing any energy-saving measures would be in addition to the pricing below. Pricing is based on a virtual review of the existing BAS, and must include the recommissioning measures noted in the City Hall and Temiskaming Shores Library reports.

- Virtual meeting with the controls contractor supplied by the City.
- Provide action items in a brief report to be provided to the controls contractor.
- Virtual meeting with the controls contractor to clarify any issues.

Exclusions:

- This work does not include pricing for the controls contractor or replacement parts.
- Does not include a site visit by the controls engineer.

Project cost estimate

Table 33: Project cost estimate (HVAC re-commissioning)

Category	Line item	Unit	Value
Materials and labour	EBCx Consultant Fee (Desktop review)	[$]	5,000
	Allowance for Controls Contractor Assistance - Investigation Phase	[$]	20,000
Total	Total	[$]	25,000

Utility analysis

Utility analysis methodology

Baseline: the HVAC controls remain as is.

Proposed: The following changes are implemented:

- Optimize schedules for HV1, EF1, and EF2 to follow occupancy and turn on only to meet the temperature.
- Use an OAT reset schedule for the HWST.

Utility analysis results

Table 34: HVAC re-commissioning analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	366,582	4,001	1.1
	Natural gas use	[m3/yr]	59,962	59,968	-6.0	-0.01
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	366,582	4,001	1.1
	Natural gas energy	[kWh/yr]	633,007	633,070	-63	-0.01
	Total energy	[kWh/yr]	1,003,590	999,652	3,938	0.39
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.8	0.10	1.1
	Natural gas GHGs	[tCO2e/yr]	116	116	-0.01	-0.01
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	125	0.08	0.07
Utility cost	Electricity utility cost	[$/yr]	36,762	36,365	397	1.1
	Natural gas utility cost	[$/yr]	15,590	15,592	-1.5	-0.01
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,794	-0.58	-0.01
	Total utility cost	[$/yr]	58,146	57,751	395	0.68
Financial	Assumed life	[yrs]	15	15	–	–
	Project cost	[$]	0	25,000	–	–
	Incentive amount	[$]	0	0	–	–
	Incremental project cost	[$]	0	25,000	–	–
	Life cycle cost	[$]	1,482,726	1,501,859	–	–
	Net present value	[$]	0	-19,133	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	297,286	–	–
	Simple payback period	[yr]	–	>20	–	–

5.10 Implement pool and spa covers

Measure description

Existing condition

The pool and spa do not have covers when the facility is unoccupied.

Opportunity

Provide pool covers to reduce heat loss from pool and spa.

Utility-savings mechanism

Reduced pool heating energy use through reduced evaporation from pools. Reduced dehumidification energy use through reduced latent load in the space associated with pool water evaporation.

Design description

Overview

Install pool covers to cover the pool and spa when the facility is unoccupied.

Project cost estimate

Table 35: Project cost estimate (Implement pool and spa covers)

Category	Line item	Unit	Value
Materials and labour	Pool cover	[$]	75,800
	Spa cover	[$]	5,000
Contingency	Subtotal after Materials and labour	[$]	80,800
	General Contingency (20%)	[$]	16,200
Total	Total	[$]	97,000

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**: Evaporation rates from the pool and spa remain consistent with unoccupied evaporation rate during unoccupied hours.
- **Proposed**: It is assumed that the unoccupied evaporation rate from the pool and spa are reduced to 10% of the current unoccupied evaporation rate.

Utility analysis results

Table 36: Implement pool and spa covers analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	335,457	35,126	9.5
	Natural gas use	[m3/yr]	59,962	54,024	5,939	9.9
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	335,457	35,126	9.5
	Natural gas energy	[kWh/yr]	633,007	570,314	62,693	9.9
	Total energy	[kWh/yr]	1,003,590	905,771	97,819	9.7
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.0	0.84	9.5
	Natural gas GHGs	[tCO2e/yr]	116	104	11.5	9.9
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	112	12.3	9.9
Utility cost	Electricity utility cost	[$/yr]	36,762	33,277	3,485	9.5
	Natural gas utility cost	[$/yr]	15,590	14,046	1,544	9.9
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,220	574	9.9
	Total utility cost	[$/yr]	58,146	52,543	5,602	9.6
Financial	Assumed life	[yrs]	15	15	–	–
	Project cost	[$]	0	97,000	–	–
	Incentive amount	[$]	0	1,485	–	–
	Incremental project cost	[$]	0	95,515	–	–
	Life cycle cost	[$]	1,482,726	1,475,630	–	–
	Net present value	[$]	0	7,096	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	7,756	–	–
	Simple payback period	[yr]	–	17	–	–

5.11 Interior LED lighting upgrade

Measure description

Existing condition

Some areas of the building currently operate with LED fixtures (e.g. natatorium). The remaining areas of the building primarily utilize fluorescent or CFL lighting.

Opportunity

Replace remaining fixtures containing CFL and fluorescent lamps with new LED fixtures.

Utility-savings mechanism

Reduced interior lighting energy use with higher efficiency LED fixtures. However, heating energy use will increase to offset the reduction in internal heat gain from the fixtures, while cooling energy use will decrease.

Design description

Overview

The lighting system shall be designed to meet the latest ASHRAE 90.1 energy codes, IESNA standards, the Waterfront Pool and Fitness Centre standards and other applicable regulations and standards.

The existing site has gone through some recent LED upgrades. It will be proposed that all the remaining fluorescent fixtures will be replaced with new LED fixtures.

LED luminaires shall be provided with an expected service life of over 50,000 hours and be listed on the Energy Star Qualified Commercial Lighting List or the Design Lights Consortium List (DLC) for incentive eligibility from the IESOs Save on Energy Program.

With the extended lifespan associated with LED fixtures, the likelihood of a complete fixture failure is significantly less likely than previous fixture types. Rather, the user would witness a slow degradation of the lighting output of the fixtures. It would be recommended that an annual lighting review is conducted to measure the lighting levels within each space of the facility. At the 70% output level, the owner would expect a much quicker decline in the loss of lighting output in each fixture. As such, at the 70% lighting level, it would be recommended that the fixtures within that room be replaced.

Type B, D, and H fixtures should be replaced. A lighting takeoff indicates that there are 36 Type B fixtures, 28 Type D fixtures, and 55 Type H fixtures at the facility.

Project cost estimate

Table 37: Project cost estimate (Interior LED lighting upgrade)

Category	Line item	Unit	Value
Materials and labour	Interior LED lighting upgrade	[$]	9,000
Contingency	Subtotal after Materials and labour	[$]	9,000
	General Contingency (50%)	[$]	4,500
Total	Total	[$]	13,500

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**: The lighting power density for each space is summarized in Table 11.
- **Proposed**: It is assumed that the LPD for each space type is reduced by 50%, with the exception of the natatorium and crossfit areas, which already use LED lighting. Operation schedules are maintained.

Utility analysis results

Table 38: Interior LED lighting upgrade analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	357,991	12,592	3.4
	Natural gas use	[m3/yr]	59,962	60,531	-568	-0.95
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	357,991	12,592	3.4
	Natural gas energy	[kWh/yr]	633,007	639,007	-6,000	-0.95
	Total energy	[kWh/yr]	1,003,590	996,997	6,592	0.66
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.6	0.30	3.4
	Natural gas GHGs	[tCO2e/yr]	116	117	-1.1	-0.95
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	126	-0.80	-0.64
Utility cost	Electricity utility cost	[$/yr]	36,762	35,513	1,249	3.4
	Natural gas utility cost	[$/yr]	15,590	15,738	-148	-0.95
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,848	-54.9	-0.95
	Total utility cost	[$/yr]	58,146	57,099	1,046	1.8
Financial	Assumed life	[yrs]	15	20	–	–
	Project cost	[$]	0	13,500	–	–
	Incentive amount	[$]	0	0	–	–
	Incremental project cost	[$]	0	13,500	–	–
	Life cycle cost	[$]	1,482,726	1,466,705	–	–
	Net present value	[$]	0	16,021	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	-16,933	–	–
	Simple payback period	[yr]	–	13	–	–

5.12 Roof upgrade to high performance

Measure description

Existing condition

The exterior layer of the roof consisted of standing seam metal roofing that was installed in 2022. No additional insulation was added during this renovation.

Opportunity

Upgrade upon the end of useful life or as required to meet scenario criteria.

Utility-savings mechanism

Reduced heating energy use through improved thermal performance of the roof.

Design description

Overview

The thermal performance of the roof currently rates around R11, which is considered inadequate, especially for a northern climate. Although the shingled roof has been recently replaced with standing seam metal roofing - a durable option - it appears that no additional insulation was added. As a result, the thermal performance remains unchanged.

To enhance the thermal performance of the roof, we recommend installing at least 16 inches of batt insulation in any attic or truss spaces. This would improve the thermal performance in those areas to approximately R71, meeting the current code minimum for attic spaces.

For areas where the roof structure is exposed to the interior and insulation is installed above the roof deck, we do not recommend any immediate improvements to thermal performance. However, we suggest reviewing the condition of the metal roofing after 10 to 20 years. It seems that this new roof has been placed over the original plywood sheathing, which protects the existing rigid insulation. At that time, we recommend adding at least 8 inches of rigid insulation on top of the plywood sheathing, as well as installing a new membrane if necessary, and reinstalling the metal roof if it remains in good condition. This would elevate the roof insulation to meet the current code standards for thermal performance, which is R40.

Additionally, it will be necessary to rework the parapets and soffits to accommodate the thicker assembly. It is important to examine the joints between the walls and the roof to ensure there is no air leakage or thermal bridging. Where leaks are found, sealants or spray foam should be applied, as these can significantly impact thermal performance.

Project cost estimate

Table 39: Project cost estimate (Roof upgrade to high performance)

Category	Line item	Unit	Value
Construction	Additional insulation	[$]	112,000
	General requirements (25%)	[$]	28,000
Contingency	Subtotal after Construction	[$]	140,000
	Design Contingency (25%)	[$]	35,000
	Construction Contingency (10%)	[$]	14,000
Design, Contractors, PM	Subtotal after Contingency	[$]	189,000
	Engineering Design and Field Review (10%)	[$]	18,900
	Contractor Fee (7%)	[$]	13,200
Total	Total	[$]	221,100

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**. An average roof U-value of 0.091 BTU/hr.ft2.F (R11) was assumed.
- **Proposed**. It is assumed that for most of the roof (excluding the roof over the natatorium), the average U-value is improved to 0.0141 BTU/hr.ft2.F (R71).

Utility analysis results

Table 40: Roof upgrade to high performance analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	370,358	225	0.06
	Natural gas use	[m3/yr]	59,962	59,864	98.2	0.16
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	370,358	225	0.06
	Natural gas energy	[kWh/yr]	633,007	631,970	1,037	0.16
	Total energy	[kWh/yr]	1,003,590	1,002,328	1,262	0.13
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.9	0.01	0.06
	Natural gas GHGs	[tCO2e/yr]	116	116	0.19	0.16
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	125	0.20	0.16
Utility cost	Electricity utility cost	[$/yr]	36,762	36,740	22.3	0.06
	Natural gas utility cost	[$/yr]	15,590	15,565	25.5	0.16
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,784	9.5	0.16
	Total utility cost	[$/yr]	58,146	58,088	57.3	0.10
Financial	Assumed life	[yrs]	15	40	–	–
	Project cost	[$]	0	221,100	–	–
	Incentive amount	[$]	0	44,220	–	–
	Incremental project cost	[$]	0	176,880	–	–
	Life cycle cost	[$]	1,482,726	1,589,057	–	–
	Net present value	[$]	0	-106,331	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	906,329	–	–
	Simple payback period	[yr]	–	>20	–	–

5.13 Solar PV canopy

Measure description

Existing condition

There is no canopy solar PV. Some parking lot space is available.

Opportunity

Install a solar PV system on canopies in the parking lot where feasible. A net-metering agreement is recommended so that the reduced GHG emissions associated with the electricity generated by the system can be retained by the City of Temiskaming Shores or exported to the grid if on-site electricity consumption is fulfilled.

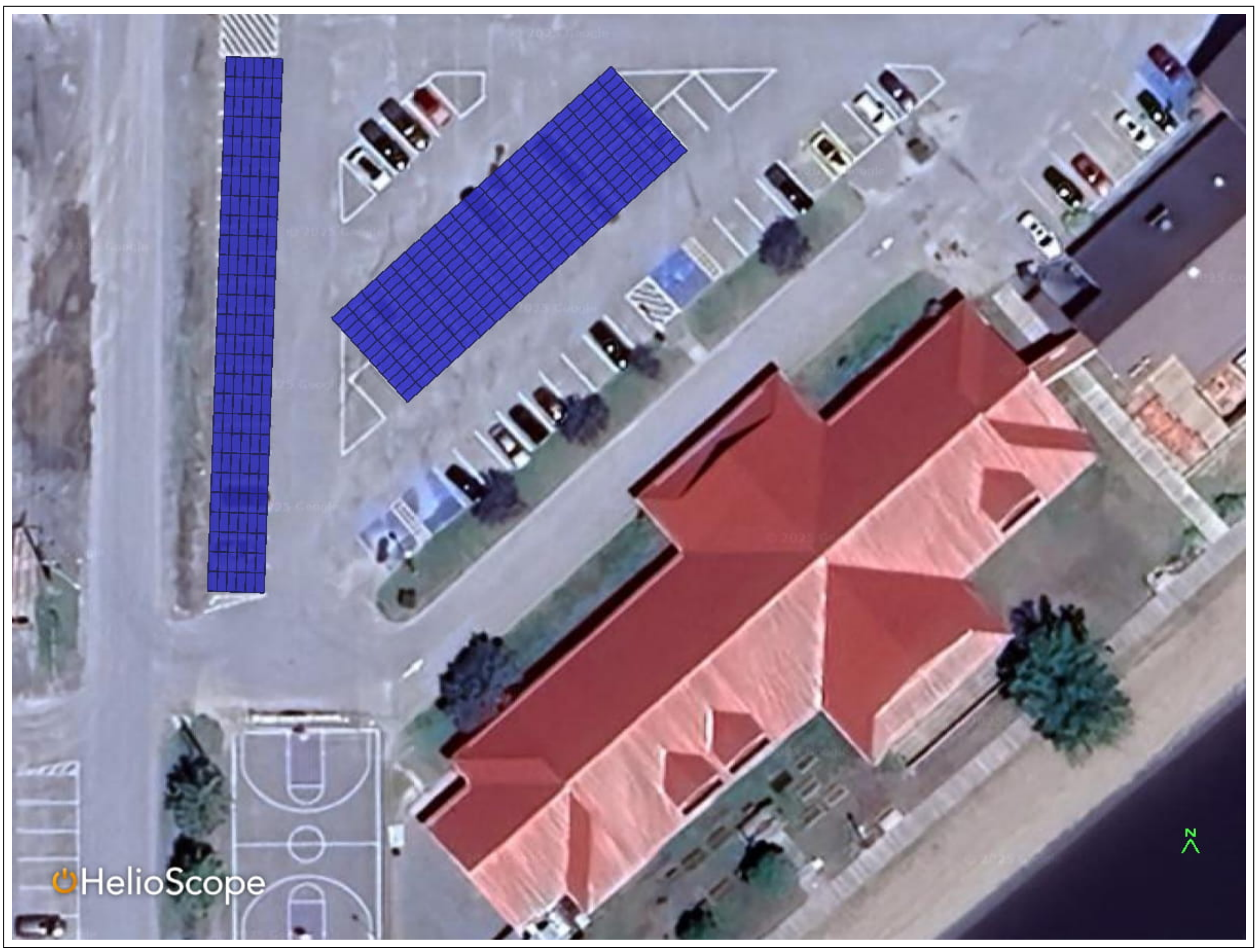
Utility-savings mechanism

The solar PV system will reduce the electricity use from the grid, GHG emissions, and utility costs.

Design description

Helioscope overview

Helioscope was used to determine a preliminary design concept for the proposed solar PV system depicted in the following image.



Based on the results from the Helioscope model, the proposed solar PV system was assumed to have the following output capacity.

- Total system output capacity (DC) = 165 kW.

Proposed scope

Supply and install a canopy solar PV electricity generation system, including the following.

- Solar PV modules.
- Parking lot canopy structures for mounting the solar panels onto.
- DC to AC inverters.
- Wiring, disconnects, meters, panels and transformers. AC output from inverters to be wired into a dedicated solar PV electrical panel before being connected to the main switchboard via a new breaker.
- Connection impact assessment, and other requirements to satisfy the utility provider for executing a Net Metering agreement.
- Installation of the above.

Electrical

With the existing system, the main switchboard is not rated high enough to accommodate the additional solar energy. A new switchboard will need to be added in to accommodate the large solar load, and the existing main 800 A switchboard will be powered from this.

Project cost estimate

Table 41: Project cost estimate (Solar PV canopy)

Category	Line item	Unit	Value
Materials and labour	Solar PV electricity system installed (assuming 165 kW at 3500 $/kW)	[$]	577,500
	Electrical	[$]	40,000
Contingency	Subtotal after Materials and labour	[$]	617,500
	General Contingency (20%)	[$]	123,500
	Design Contingency (10%)	[$]	61,800
Total	Total	[$]	802,800

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**. There is no solar PV present at this site.
- **Proposed**. The proposed solar PV electricity generation system described above was assumed to be implemented. Helioscope was used to model the hourly electricity output from the solar PV system. All electricity generated by the system was assumed to be used on-site, directly reducing grid electricity consumption, GHG emissions and utility costs.

Utility analysis results

Table 42: Solar PV canopy analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	221,336	149,247	40.3
	Natural gas use	[m3/yr]	59,962	59,962	0	0
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	221,336	149,247	40.3
	Natural gas energy	[kWh/yr]	633,007	633,007	0	0
	Total energy	[kWh/yr]	1,003,590	854,343	149,247	14.9
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	5.3	3.6	40.3
	Natural gas GHGs	[tCO2e/yr]	116	116	0	0
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	121	3.6	2.9
Utility cost	Electricity utility cost	[$/yr]	36,762	21,957	14,805	40.3
	Natural gas utility cost	[$/yr]	15,590	15,590	0	0
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,793	0	0
	Total utility cost	[$/yr]	58,146	43,340	14,805	25.5
Financial	Assumed life	[yrs]	15	30	–	–
	Project cost	[$]	0	802,800	–	–
	Incentive amount	[$]	0	160,560	–	–
	Incremental project cost	[$]	0	642,240	–	–
	Life cycle cost	[$]	1,482,726	1,613,860	–	–
	Net present value	[$]	0	-131,134	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	180,051	–	–
	Simple payback period	[yr]	–	>20	–	–

5.14 Solar PV rooftop

Measure description

Existing condition

There is no solar PV on the roof. Some rooftop space is available.

Opportunity

Install a solar PV system on the roof where feasible. A net-metering agreement is recommended so that the reduced GHG emissions associated with the electricity generated by the system can be retained by the City of Temiskaming Shores or exported to the grid if on-site electricity consumption is fulfilled.

Utility-savings mechanism

The solar PV system will reduce the electricity use from the grid, GHG emissions, and utility costs.

Design description

Helioscope overview

Helioscope was used to determine a preliminary design concept for the proposed solar PV system. The Helioscope model is depicted in the following image.

Based on the results from the Helioscope model, the proposed solar PV system was assumed to have the following output capacity.

- Total system output capacity (DC) = 225 kW.

Proposed scope

Supply and install a rooftop solar PV electricity generation system, including the following.

- Solar PV modules.
- Racking system for mounting the solar panels onto.
- DC to AC inverters.
- Wiring, disconnects, meters, panels and transformers. The AC output from inverters is to be wired into a dedicated solar PV electrical panel before being connected to the main switchboard via a new breaker.
- Connection impact assessment, and other requirements to satisfy the utility provider for executing a Net Metering agreement.
- Installation of the above.

Electrical

With the existing system, the main switchboard is not rated high enough to accommodate the additional solar energy. A new switchboard will need to be added in to accommodate the large solar load, and the existing main 800 A switchboard will be powered from this.

Project cost estimate

Table 43: Project cost estimate (Solar PV rooftop)

Category	Line item	Unit	Value
Materials and labour	Solar PV electricity system installed (assuming 225 kW at 2000 $/kW)	[$]	450,000
	Electrical	[$]	35,000
Contingency	Subtotal after Materials and labour	[$]	485,000
	General Contingency (20%)	[$]	97,000
	Design Contingency (10%)	[$]	48,500
Total	Total	[$]	630,500

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**. There is no solar PV present at this site.
- **Proposed**. The proposed solar PV electricity generation system described above was assumed to be implemented. Helioscope was used to model the hourly electricity output from the solar PV system. All electricity generated by the system was assumed to be used on-site, directly reducing grid electricity consumption, GHG emissions and utility costs.

Utility analysis results

Table 44: Solar PV rooftop analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	169,630	200,953	54.2
	Natural gas use	[m3/yr]	59,962	59,962	0	0
	Carbon offset use	[tCO2e/yr]	0	0	0	—
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	169,630	200,953	54.2
	Natural gas energy	[kWh/yr]	633,007	633,007	0	0
	Total energy	[kWh/yr]	1,003,590	802,637	200,953	20.0
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	4.1	4.8	54.2
	Natural gas GHGs	[tCO2e/yr]	116	116	0	0
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	—
	Total GHGs	[tCO2e/yr]	125	120	4.8	3.9
Utility cost	Electricity utility cost	[$/yr]	36,762	16,827	19,934	54.2
	Natural gas utility cost	[$/yr]	15,590	15,590	0	0
	Carbon offsets utility cost	[$/yr]	0	0	0	—
	Federal carbon charge	[$/yr]	5,793	5,793	0	0
	Total utility cost	[$/yr]	58,146	38,211	19,934	34.3
Financial	Assumed life	[yrs]	15	30	—	—
	Project cost	[$]	0	630,500	—	—
	Incentive amount	[$]	0	126,100	—	—
	Incremental project cost	[$]	0	504,400	—	—
	Life cycle cost	[$]	1,482,726	1,367,586	—	—
	Net present value	[$]	0	115,140	—	—
	Project cost per GHG reduction	[$yr/tCO2e]	—	105,023	—	—
	Simple payback period	[yr]	—	>20	—	—

5.15 Wall upgrade to high performance

Measure description

Existing condition

There are two main wall assemblies at the Waterfront Pool and Fitness Centre. Exterior finishes include metal siding and veneer brick.

Opportunity

Upgrade upon the end of useful life or as required to meet scenario criteria.

Utility-savings mechanism

Reduced heating energy use through improved thermal performance of exterior walls.

Design description

Overview

The current wall performance is approximately R15, which falls short of the required R20 according to current building codes. To improve the insulation, there are two main options: either remove the existing exterior block cladding, increase the insulation in the cavity, and then replace the cladding, or apply an EIFS (Exterior Insulation and Finish System) directly to the face of the existing block.

The EIFS system is significantly more cost-effective and could nearly double the performance of the wall to about R30, assuming it makes financial sense within a 10-20 year payback period. This system can also be finished with a masonry veneer if desired; however, an assessment of the block ties would be necessary to ensure they can support the additional weight. Generally, adding 150mm of EIFS with an acrylic stucco finish to existing brick or block does not pose structural issues regarding the brick ties.

If the decision is made not to add insulation to the exterior walls, we recommend conducting thermal imaging and blower door testing to identify any significant air leaks or thermal bridging. These issues can be addressed locally using sealants and spray foam.

Project cost estimate

Table 45: Project cost estimate (Wall upgrade to high performance)

Category	Line item	Unit	Value
Construction	Add EIFS system to existing exterior wall	[$]	405,000
	General requirements (25%)	[$]	101,200
Contingency	Subtotal after Construction	[$]	506,200
	Design Contingency (25%)	[$]	126,600
	Construction Contingency (10%)	[$]	50,600
Design, Contractors, PM	Subtotal after Contingency	[$]	683,400
	Engineering Design and Field Review (10%)	[$]	68,300
	Contractor Fee (7%)	[$]	47,800
Total	Total	[$]	799,500

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**. An average wall U-value of 0.0654 BTU/hr.ft2.F (R15) was assumed.
- **Proposed**. An average wall U-value of 0.0333 BTU/hr.ft2.F (R30) was assumed. Infiltration flow was assumed to be reduced by 10% in total relative to the Baseline for affected spaces.

Utility analysis results

Table 46: Wall upgrade to high performance analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	362,683	7,900	2.1
	Natural gas use	[m3/yr]	59,962	57,478	2,485	4.1
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	362,683	7,900	2.1
	Natural gas energy	[kWh/yr]	633,007	606,776	26,231	4.1
	Total energy	[kWh/yr]	1,003,590	969,459	34,131	3.4
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.7	0.19	2.1
	Natural gas GHGs	[tCO2e/yr]	116	111	4.8	4.1
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	120	5.0	4.0
Utility cost	Electricity utility cost	[$/yr]	36,762	35,978	784	2.1
	Natural gas utility cost	[$/yr]	15,590	14,944	646	4.1
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,553	240	4.1
	Total utility cost	[$/yr]	58,146	56,476	1,670	2.9
Financial	Assumed life	[yrs]	15	75	–	–
	Project cost	[$]	0	799,500	–	–
	Incentive amount	[$]	0	159,900	–	–
	Incremental project cost	[$]	0	639,600	–	–
	Life cycle cost	[$]	1,482,726	1,657,242	–	–
	Net present value	[$]	0	-174,516	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	128,170	–	–
	Simple payback period	[yr]	–	>20	–	–

5.16 Windows and doors to high performance

Measure description

Existing condition

The facility has double glazed windows complete with aluminum frames that original to the building. All windows were of the picture type. The facility has swing doors with glazing, sliding doors with glazing, and hollow metal doors.

Opportunity

Upgrade upon the end of useful life or as required to meet scenario criteria.

Utility-savings mechanism

Reduced heating energy use through improved thermal performance of windows and doors.

Design description

Windows

We recommend replacing all windows with Passive House Certified Triple-glazed, thermally broken windows. These could be framed in aluminum, vinyl or fiberglass. This will improve the thermal performance of the windows, which are a significant percentage of the building envelope, from about R2 or R3 to at least R7 or R8.

Doors

Doors are a significant source of heat loss and air infiltration. To minimize their impact, we recommend the following measures:

- **Hollow Metal Doors:** Replace existing hollow metal doors with insulated doors in thermally broken frames.

- **Glazed Entry Doors:** Should be triple-glazed and thermally broken as part of the curtain wall/window improvements.

Project cost estimate

Table 47: Project cost estimate (Windows and doors to high performance)

Category	Line item	Unit	Value
Construction	Window and door replacement	[$]	411,000
	General requirements (25%)	[$]	102,800
Contingency	Subtotal after Construction	[$]	513,800
	Design Contingency (25%)	[$]	128,400
	Construction Contingency (10%)	[$]	51,400
Design, Contractors, PM	Subtotal after Contingency	[$]	693,600
	Engineering Design and Field Review (10%)	[$]	69,400
	Contractor Fee (7%)	[$]	48,600
Total	Total	[$]	811,600

Utility analysis

Utility analysis methodology

The following assumptions were applied to the calibrated energy model to estimate utility use impacts.

- **Baseline**. The average U-value of all windows and doors was assumed to be 0.4 and 0.6501 BTU/hr.ft2.F, respectively.
- **Proposed**. The average U-value of all windows and doors was assumed to be 0.125 BTU/hr.ft2.F (R8). Infiltration flow was assumed to be reduced by 10% in total relative to the Baseline for affected spaces.

Utility analysis results

Table 48: Windows and doors to high performance analysis results summary

Category	Description	Unit	Baseline	Proposed	Reduction	Reduction [%]
Utility use	Electricity use	[kWh/yr]	370,583	366,813	3,770	1.0
	Natural gas use	[m3/yr]	59,962	58,215	1,748	2.9
	Carbon offset use	[tCO2e/yr]	0	0	0	–
Equivalent energy use	Electricity energy	[kWh/yr]	370,583	366,813	3,770	1.0
	Natural gas energy	[kWh/yr]	633,007	614,559	18,448	2.9
	Total energy	[kWh/yr]	1,003,590	981,372	22,217	2.2
GHG emissions	Electricity GHGs	[tCO2e/yr]	8.9	8.8	0.09	1.0
	Natural gas GHGs	[tCO2e/yr]	116	112	3.4	2.9
	Carbon offsets GHGs	[tCO2e/yr]	0	0	0	–
	Total GHGs	[tCO2e/yr]	125	121	3.5	2.8
Utility cost	Electricity utility cost	[$/yr]	36,762	36,388	374	1.0
	Natural gas utility cost	[$/yr]	15,590	15,136	454	2.9
	Carbon offsets utility cost	[$/yr]	0	0	0	–
	Federal carbon charge	[$/yr]	5,793	5,625	169	2.9
	Total utility cost	[$/yr]	58,146	57,148	997	1.7
Financial	Assumed life	[yrs]	15	40	–	–
	Project cost	[$]	0	811,600	–	–
	Incentive amount	[$]	0	162,320	–	–
	Incremental project cost	[$]	0	649,280	–	–
	Life cycle cost	[$]	1,482,726	1,858,663	–	–
	Net present value	[$]	0	-375,937	–	–
	Project cost per GHG reduction	[$yr/tCO2e]	–	187,280	–	–
	Simple payback period	[yr]	–	>20	–	–

5.17 Measure risk analysis

Utility use sensitivity

Figure 148 indicates how sensitive cumulative electricity and natural gas use are to variations in each risk parameter.

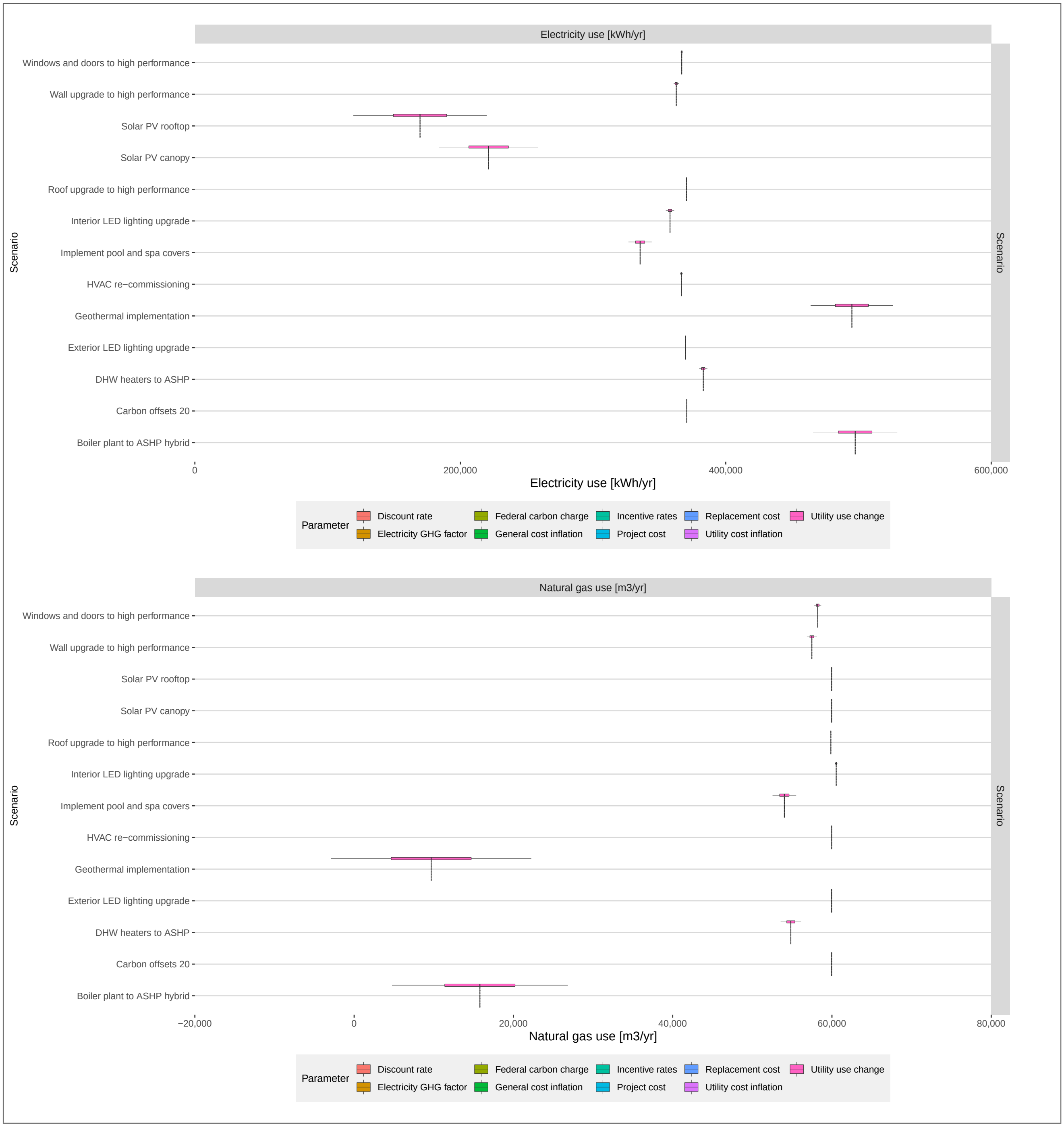


Figure 148: Utility cumulative use sensitivity analysis

GHG emissions and life cycle cost sensitivity

Figure 149 indicates how sensitive cumulative GHG emissions and life cycle costs are to variations in each risk parameter.

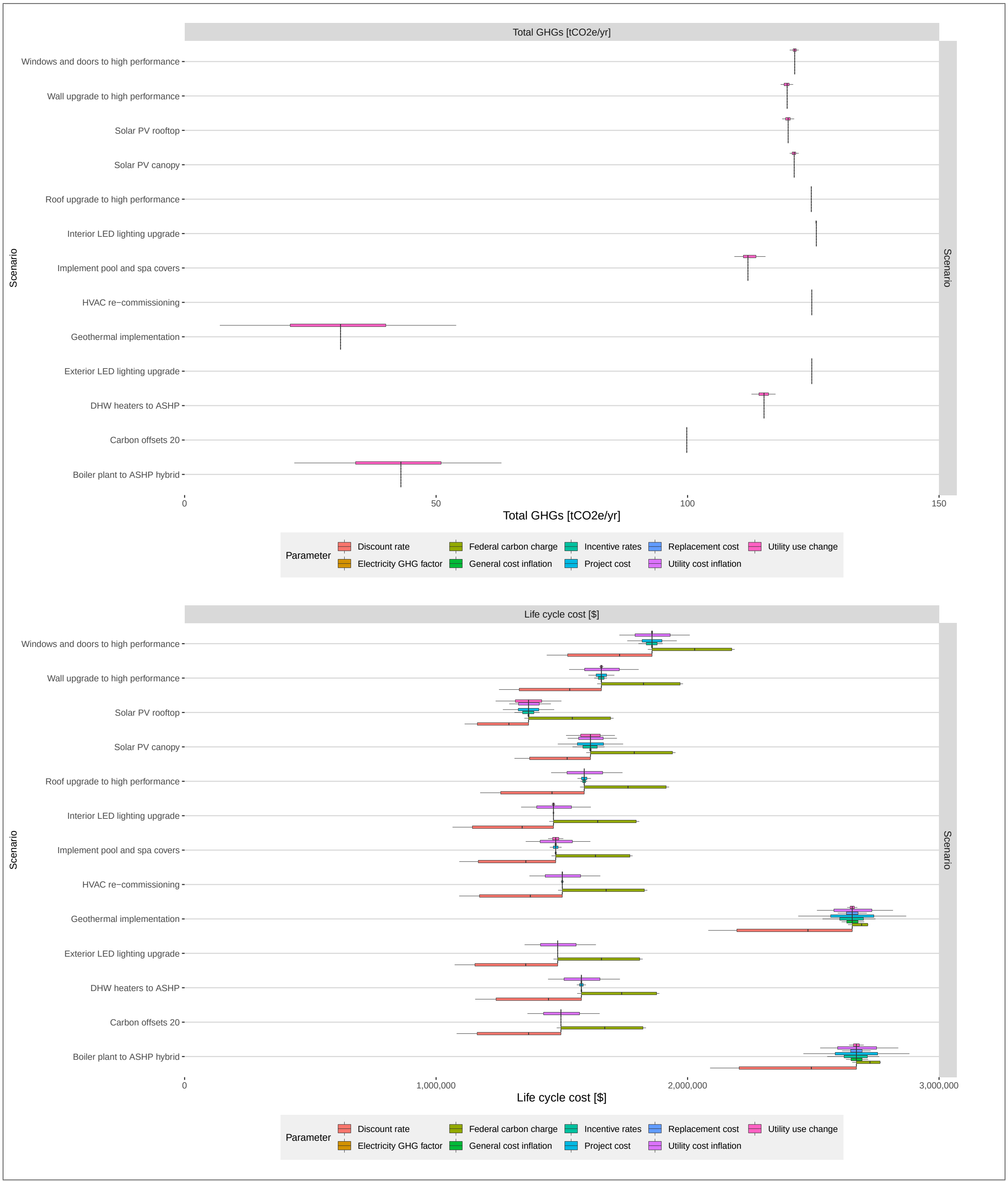


Figure 149: GHG cumulative emissions and life cycle cost sensitivity analysis

5.18 Measure analysis summary

For each analyzed measure, the analysis results are summarized in Table 49.

Table 49: Measure analysis summary

Measure ID	Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial							
Measure name	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Incentive amount**	**Incremental project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$]	[$]	[$yr/tCO2e]	[yr]
Baseline	370,583	100.0	59,962	100.0	1,003,590	100.0	125	100.0	58,145	100.0	15	0	0	0	1,482,726	0	-	-
Boiler plant to ASHP hybrid	-126,924	-34.2	44,169	73.7	339,358	33.8	82	66.0	3,161	5.4	15	1,086,000	217,200	868,800	2,671,411	-1,188,685	10,554	275
Carbon offsets 20	0	0.0	0	0.0	0	0.0	25	20.0	-748	-1.3	20	-	0	-	1,496,373	-13,647	-	-
DHW heaters to ASHP	-12,454	-3.4	5,125	8.5	41,649	4.2	10	7.7	592	1.0	15	75,000	1,281	73,719	1,577,721	-94,995	7,675	124
Exterior LED lighting upgrade	905	0.2	2	0.0	925	0.1	0	0.0	90	0.2	20	3,000	0	3,000	1,483,477	-751	119,190	33
Geothermal implementation	-124,447	-33.6	50,290	83.9	406,452	40.5	94	75.5	5,589	9.6	15	1,105,700	221,140	884,560	2,654,801	-1,172,075	9,390	158
HVAC re-commissioning	4,001	1.1	-6	-0.0	3,938	0.4	0	0.1	395	0.7	15	25,000	0	25,000	1,501,859	-19,133	297,286	63
Implement pool and spa covers	35,126	9.5	5,939	9.9	97,819	9.7	12	9.9	5,602	9.6	15	97,000	1,485	95,515	1,475,630	7,096	7,756	17
Interior LED lighting upgrade	12,592	3.4	-568	-0.9	6,592	0.7	-1	-0.6	1,046	1.8	20	13,500	0	13,500	1,466,705	16,021	-16,933	13
Roof upgrade to high performance	225	0.1	98	0.2	1,262	0.1	0	0.2	57	0.1	40	221,100	44,220	176,880	1,589,057	-106,331	906,329	3,086
Solar PV canopy	149,247	40.3	0	0.0	149,247	14.9	4	2.9	14,805	25.5	30	802,800	160,560	642,240	1,613,860	-131,134	180,051	43
Solar PV rooftop	200,952	54.2	0	0.0	200,952	20.0	5	3.9	19,934	34.3	30	630,500	126,100	504,400	1,367,586	115,140	105,023	25
Wall upgrade to high performance	7,900	2.1	2,485	4.1	34,131	3.4	5	4.0	1,670	2.9	75	799,500	159,900	639,600	1,657,242	-174,516	128,170	383
Windows and doors to high performance	3,769	1.0	1,748	2.9	22,217	2.2	3	2.8	997	1.7	40	811,600	162,320	649,280	1,858,663	-375,937	187,280	651
Total project cost	-	-	-	-	-	-	-	-	-	-	-	5,670,700	-	-	-	-	-	-
Boiler renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	30	84,000	0	84,000	1,550,726	-68,000	-	-
DHW renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	4,000	0	4,000	1,487,450	-4,724	-	-
Exterior lighting renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	20	1,000	0	1,000	1,483,765	-1,039	-	-
Exterior walls renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	75	5,000	0	5,000	1,484,345	-1,619	-	-
Interior lighting renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	20	27,000	0	27,000	1,510,791	-28,065	-	-
Roof renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	40	543,000	0	543,000	1,812,404	-329,679	-	-
Windows and doors renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	40	131,000	0	131,000	1,562,262	-79,536	-	-
BAU measure totals	-	-	-	-	-	-	-	-	-	-	-	795,000	-	-	-	-	-	-

6 SCENARIO ANALYSIS

6.1 Cluster scenario analysis methodology

A scenario analysis was completed to estimate the costs and benefits expected from implementing various combinations (i.e. scenarios) of the measures that were individually analyzed in Section 5. Whereas in Section 5, each measure was individually analyzed as though implemented by itself, in Section 6, scenarios of multiple measures being implemented together were analyzed, and the interactive effects between measures within each scenario were accounted for. The scenario analysis was completed according to the following methodology.

1. **Cluster scenario objectives**. All scenarios that were analyzed and their objectives were defined as summarized in Table 50.
2. **Cluster scenario composition**. Each scenario was composed by iteratively assigning measures to that scenario to achieve the objectives of that scenario as closely as possible. Results are presented in Section 6.3.
3. **Cluster scenario performance analysis**. Each scenario was analyzed using the energy model to estimate the overall performance that implementing all measures in that scenario would have on utility use, equivalent energy use, GHG emissions, utility costs and several financial performance metrics. Results are presented in Section 6.4.
4. **Cluster scenario analysis discussion**. Results of the scenario analysis were discussed in Section 6.4.

6.2 Cluster scenario objectives

The cluster scenarios that were analyzed and their objectives are summarized in Table 50.

Table 50: Scenario objectives

Scenario	Objectives
Control optimization	To estimate the impact of all control optimization measures combined.
Envelope upgrades	To estimate the impact of all envelope upgrade measures combined.
Load minimization	To estimate the impact of all controls optimization, envelope upgrades, and other measures intended to reduce the thermal and electrical load of the facility, which would ideally reduce the capacity requirements of new equipment.
Comprehensive cluster	To understand the limit of GHG reductions possible by implementing all measures that have the greatest reduction on GHG emissions.

6.3 Cluster scenario composition

In the scenario composition exercise, individual measures were assigned to each scenario in an iterative process to achieve the objectives of that scenario as closely as possible. Figure 150 and Table 51 present the results of this exercise, indicating which measures were assigned to which scenario.

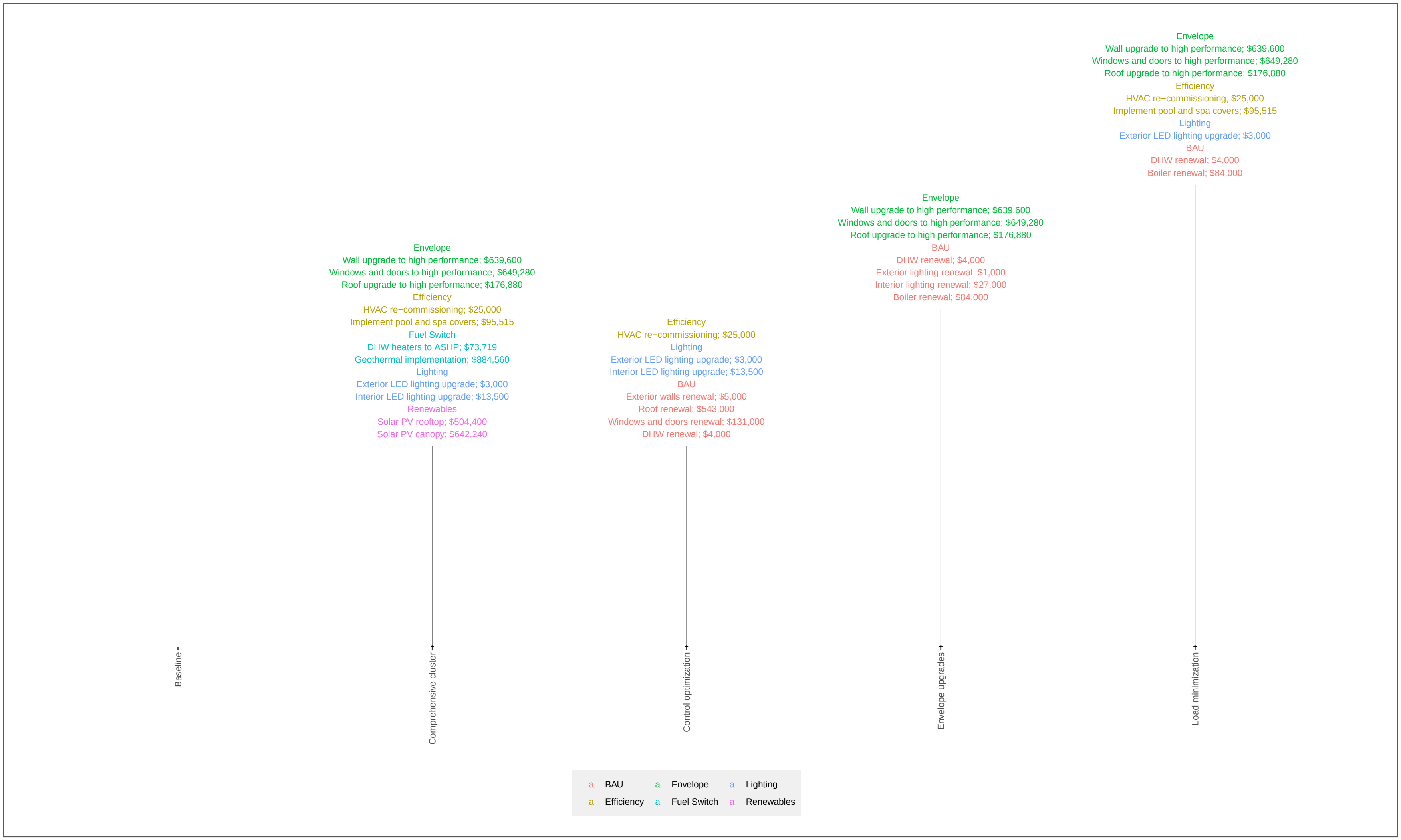


Figure 150: Scenario composition

Table 51: Cluster composition

Measure	Control optimization	Envelope upgrades	Load minimization	Comprehensive cluster
Boiler plant to ASHP hybrid	✖	✖	✖	✖
Carbon offsets 20	✖	✖	✖	✖
DHW heaters to ASHP	✖	✖	✖	✔
Exterior LED lighting upgrade	✔	✖	✔	✔
Geothermal implementation	✖	✖	✖	✔
HVAC re-commissioning	✔	✖	✔	✔
Implement pool and spa covers	✖	✖	✔	✔
Interior LED lighting upgrade	✔	✖	✖	✔
Roof upgrade to high performance	✖	✔	✔	✔
Solar PV canopy	✖	✖	✖	✔
Solar PV rooftop	✖	✖	✖	✔
Wall upgrade to high performance	✖	✔	✔	✔
Windows and doors to high performance	✖	✔	✔	✔
Boiler renewal	✖	✔	✔	✖
DHW renewal	✔	✔	✔	✖
Exterior lighting renewal	✖	✔	✖	✖
Exterior walls renewal	✔	✖	✖	✖
Interior lighting renewal	✖	✔	✖	✖
Roof renewal	✔	✖	✖	✖
Windows and doors renewal	✔	✖	✖	✖

6.4 Cluster scenario performance analysis

The scenario performance analysis was completed by using the energy model (see Section 4) to determine the expected performance of implementing all measures in each scenario. Results are presented throughout Section 6.4.

Cluster scenario performance analysis summary

Results of the scenario analysis are summarized in Table 52, which indicates all individual measures that were considered to be implemented under each scenario, the measure-specific impacts that each measure was estimated to have if implemented by itself, and the combined impacts that implementing all measures in each scenario is expected to have, accounting for the interactive effects between measures within each scenario.

Table 52: Scenario analysis summary

Measure ID		Utility use				Equivalent energy use		GHG emissions		Utility cost		Financial							
Scenario	**Measure name**	**Electricity use reduction**	**Electricity use reduction**	**Natural gas use reduction**	**Natural gas use reduction**	**Total energy reduction**	**Total energy reduction**	**Total GHG reduction**	**Total GHG reduction**	**Utility cost reduction**	**Utility cost reduction**	**Assumed life**	**Project cost**	**Incentive amount**	**Incremental project cost**	**Life cycle cost**	**Net present value**	**Project cost per GHG reduction**	**Simple payback period**
-	-	[kWh/yr]	[%]	[m3/yr]	[%]	[kWh/yr]	[%]	[tCO2e/yr]	[%]	[$/yr]	[%]	[yrs]	[$]	[$]	[$]	[$]	[$]	[$yr/tCO2e]	[yr]
Comprehensive cluster	Combined	241,221	65.1	55,424	92.4	826,317	82.3	113	90.5	43,694	75.1	-	4,584,700	877,006	3,707,694	3,435,838	-1,953,112	32,851	85
Comprehensive cluster	Wall upgrade to high performance	7,900	2.1	2,485	4.1	34,131	3.4	5	4.0	1,670	2.9	75	799,500	159,900	639,600	1,657,242	-174,516	128,170	383
Comprehensive cluster	Windows and doors to high performance	3,769	1.0	1,748	2.9	22,217	2.2	3	2.8	997	1.7	40	811,600	162,320	649,280	1,858,663	-375,937	187,280	651
Comprehensive cluster	Roof upgrade to high performance	225	0.1	98	0.2	1,262	0.1	0	0.2	57	0.1	40	221,100	44,220	176,880	1,589,057	-106,331	906,329	3,086
Comprehensive cluster	HVAC re-commissioning	4,001	1.1	-6	-0.0	3,938	0.4	0	0.1	395	0.7	15	25,000	0	25,000	1,501,859	-19,133	297,286	63
Comprehensive cluster	DHW heaters to ASHP	-12,454	-3.4	5,125	8.5	41,649	4.2	10	7.7	592	1.0	15	75,000	1,281	73,719	1,577,721	-94,995	7,675	124
Comprehensive cluster	Implement pool and spa covers	35,126	9.5	5,939	9.9	97,819	9.7	12	9.9	5,602	9.6	15	97,000	1,485	95,515	1,475,630	7,096	7,756	17
Comprehensive cluster	Exterior LED lighting upgrade	905	0.2	2	0.0	925	0.1	0	0.0	90	0.2	20	3,000	0	3,000	1,483,477	-751	119,190	33
Comprehensive cluster	Interior LED lighting upgrade	12,592	3.4	-568	-0.9	6,592	0.7	-1	-0.6	1,046	1.8	20	13,500	0	13,500	1,466,705	16,021	-16,933	13
Comprehensive cluster	Geothermal implementation	-124,447	-33.6	50,290	83.9	406,452	40.5	94	75.5	5,589	9.6	15	1,105,700	221,140	884,560	2,654,801	-1,172,075	9,390	158
Comprehensive cluster	Solar PV rooftop	200,952	54.2	0	0.0	200,952	20.0	5	3.9	19,934	34.3	30	630,500	126,100	504,400	1,367,586	115,140	105,023	25
Comprehensive cluster	Solar PV canopy	149,247	40.3	0	0.0	149,247	14.9	4	2.9	14,805	25.5	30	802,800	160,560	642,240	1,613,860	-131,134	180,051	43
Control optimization	Combined	17,226	4.6	-566	-0.9	11,251	1.1	-1	-0.5	1,507	2.6	-	724,500	0	724,500	1,875,181	-392,455	-1,062,391	481
Control optimization	HVAC re-commissioning	4,001	1.1	-6	-0.0	3,938	0.4	0	0.1	395	0.7	15	25,000	0	25,000	1,501,859	-19,133	297,286	63
Control optimization	Exterior LED lighting upgrade	905	0.2	2	0.0	925	0.1	0	0.0	90	0.2	20	3,000	0	3,000	1,483,477	-751	119,190	33
Control optimization	Interior LED lighting upgrade	12,592	3.4	-568	-0.9	6,592	0.7	-1	-0.6	1,046	1.8	20	13,500	0	13,500	1,466,705	16,021	-16,933	13
Control optimization	Exterior walls renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	75	5,000	0	5,000	1,484,345	-1,619	-	-
Control optimization	Roof renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	40	543,000	0	543,000	1,812,404	-329,679	-	-
Control optimization	Windows and doors renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	40	131,000	0	131,000	1,562,262	-79,536	-	-
Control optimization	DHW renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	4,000	0	4,000	1,487,450	-4,724	-	-
Envelope upgrades	Combined	9,426	2.5	3,023	5.0	41,342	4.1	6	4.9	2,013	3.5	-	1,948,200	366,440	1,581,760	2,202,469	-719,743	260,701	786
Envelope upgrades	Wall upgrade to high performance	7,900	2.1	2,485	4.1	34,131	3.4	5	4.0	1,670	2.9	75	799,500	159,900	639,600	1,657,242	-174,516	128,170	383
Envelope upgrades	Windows and doors to high performance	3,769	1.0	1,748	2.9	22,217	2.2	3	2.8	997	1.7	40	811,600	162,320	649,280	1,858,663	-375,937	187,280	651
Envelope upgrades	Roof upgrade to high performance	225	0.1	98	0.2	1,262	0.1	0	0.2	57	0.1	40	221,100	44,220	176,880	1,589,057	-106,331	906,329	3,086
Envelope upgrades	DHW renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	4,000	0	4,000	1,487,450	-4,724	-	-
Envelope upgrades	Exterior lighting renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	20	1,000	0	1,000	1,483,765	-1,039	-	-
Envelope upgrades	Interior lighting renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	20	27,000	0	27,000	1,510,791	-28,065	-	-
Envelope upgrades	Boiler renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	30	84,000	0	84,000	1,550,726	-68,000	-	-
Load minimization	Combined	49,172	13.3	8,906	14.9	143,191	14.3	18	14.7	8,054	13.9	-	2,045,200	367,925	1,677,275	2,188,976	-706,250	91,232	208
Load minimization	Wall upgrade to high performance	7,900	2.1	2,485	4.1	34,131	3.4	5	4.0	1,670	2.9	75	799,500	159,900	639,600	1,657,242	-174,516	128,170	383
Load minimization	Windows and doors to high performance	3,769	1.0	1,748	2.9	22,217	2.2	3	2.8	997	1.7	40	811,600	162,320	649,280	1,858,663	-375,937	187,280	651
Load minimization	Roof upgrade to high performance	225	0.1	98	0.2	1,262	0.1	0	0.2	57	0.1	40	221,100	44,220	176,880	1,589,057	-106,331	906,329	3,086
Load minimization	HVAC re-commissioning	4,001	1.1	-6	-0.0	3,938	0.4	0	0.1	395	0.7	15	25,000	0	25,000	1,501,859	-19,133	297,286	63
Load minimization	Implement pool and spa covers	35,126	9.5	5,939	9.9	97,819	9.7	12	9.9	5,602	9.6	15	97,000	1,485	95,515	1,475,630	7,096	7,756	17
Load minimization	Exterior LED lighting upgrade	905	0.2	2	0.0	925	0.1	0	0.0	90	0.2	20	3,000	0	3,000	1,483,477	-751	119,190	33
Load minimization	DHW renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	15	4,000	0	4,000	1,487,450	-4,724	-	-
Load minimization	Boiler renewal	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	30	84,000	0	84,000	1,550,726	-68,000	-	-

Utility use comparison

The following figures compare the total expected yearly utility use by end use between each scenario.

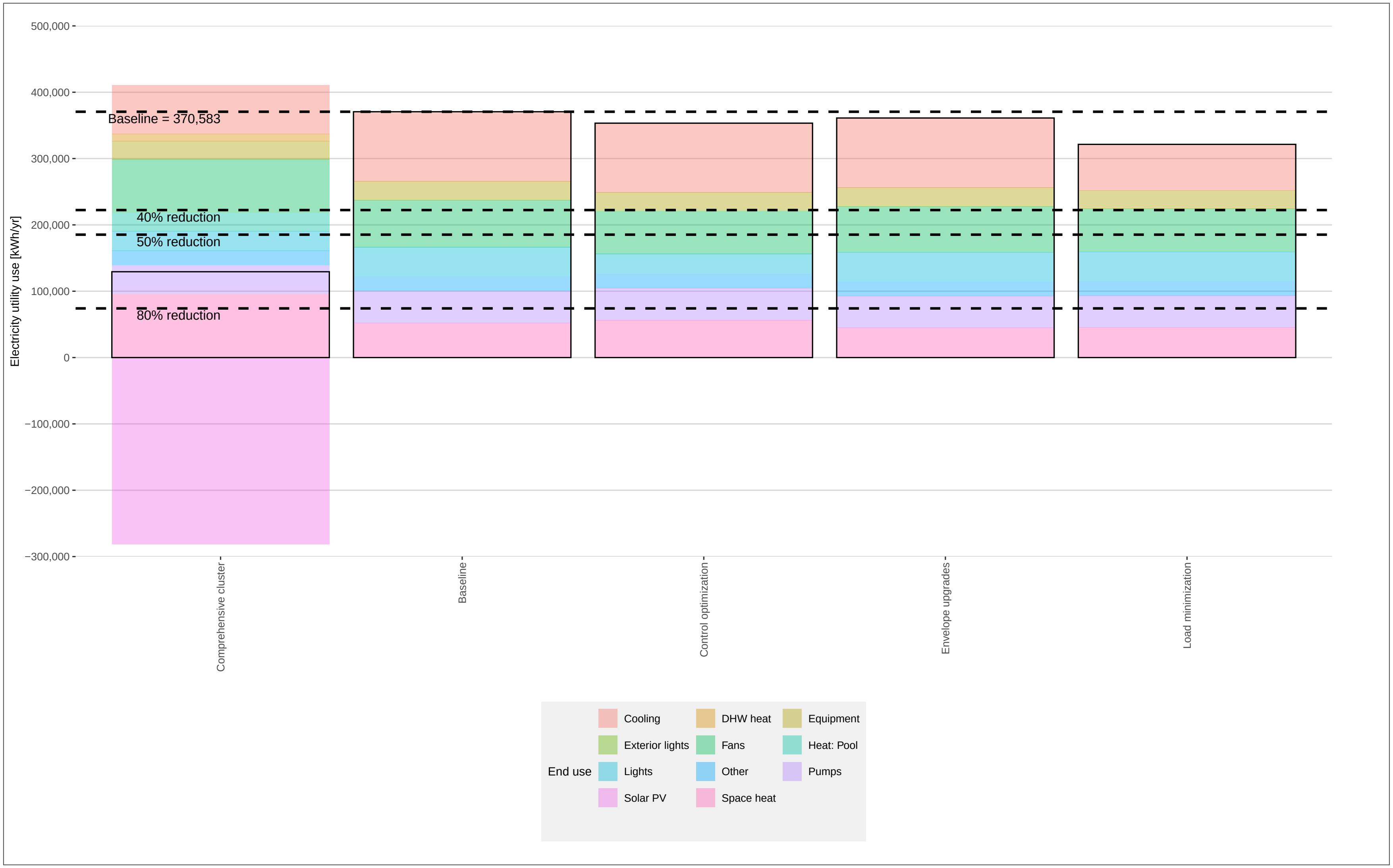


Figure 151: Electricity utility use expected yearly for each scenario by end use

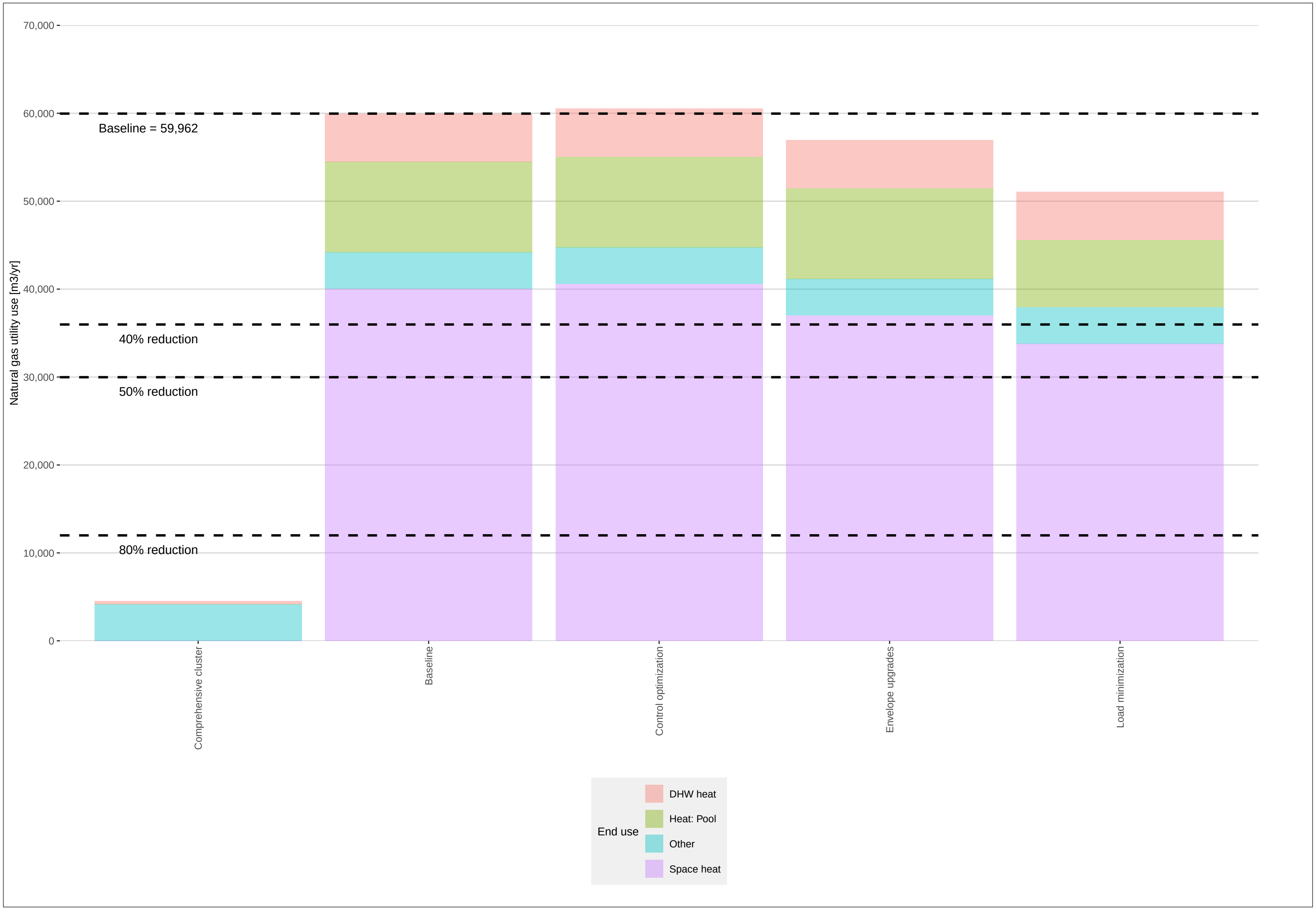


Figure 152: Natural gas utility use expected yearly for each scenario by end use

Energy, GHG and utility cost comparison

The following figures compare the total expected yearly equivalent energy use, GHG emissions and utility costs between each scenario.

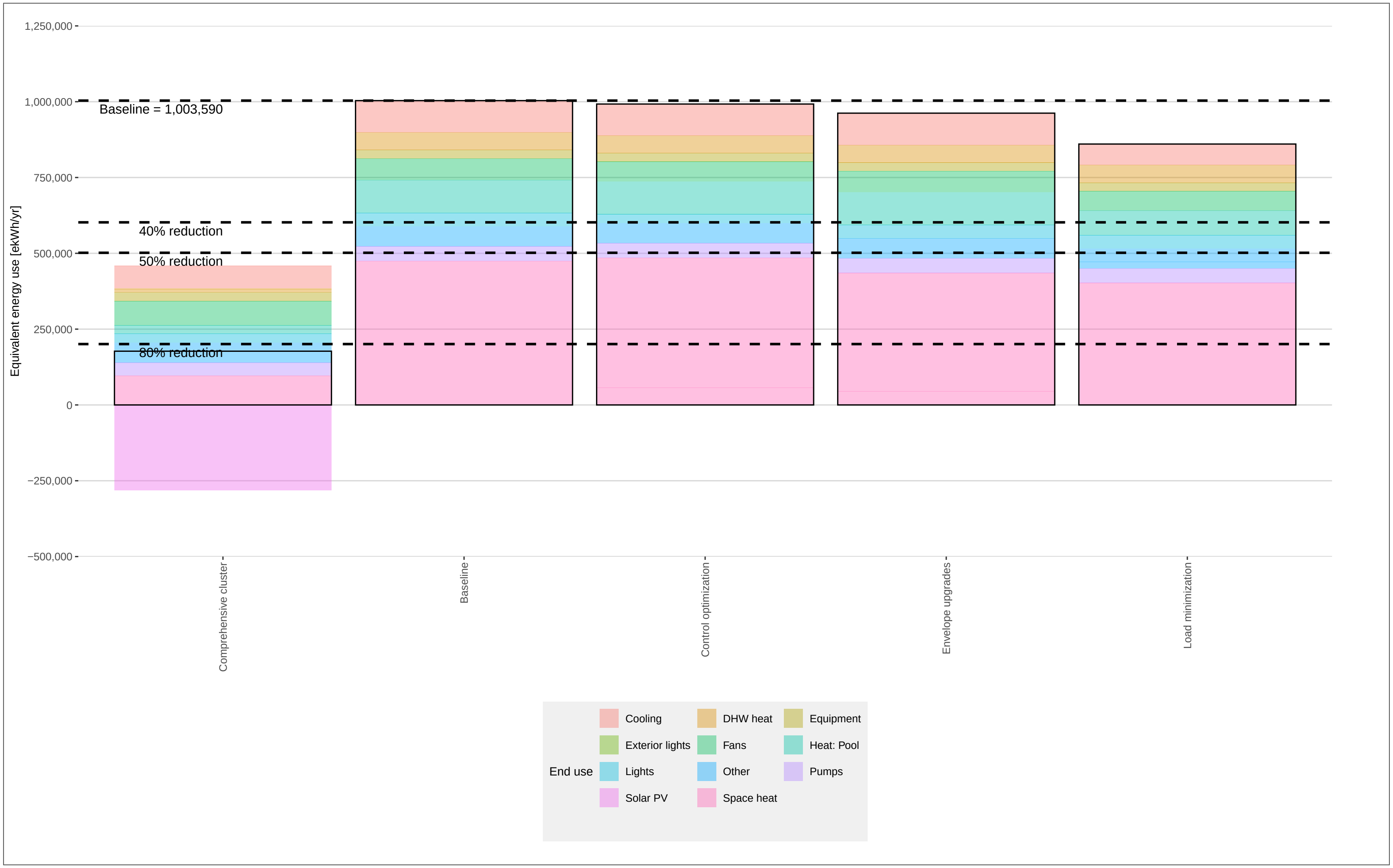


Figure 153: Equivalent energy use expected yearly for each scenario by end use

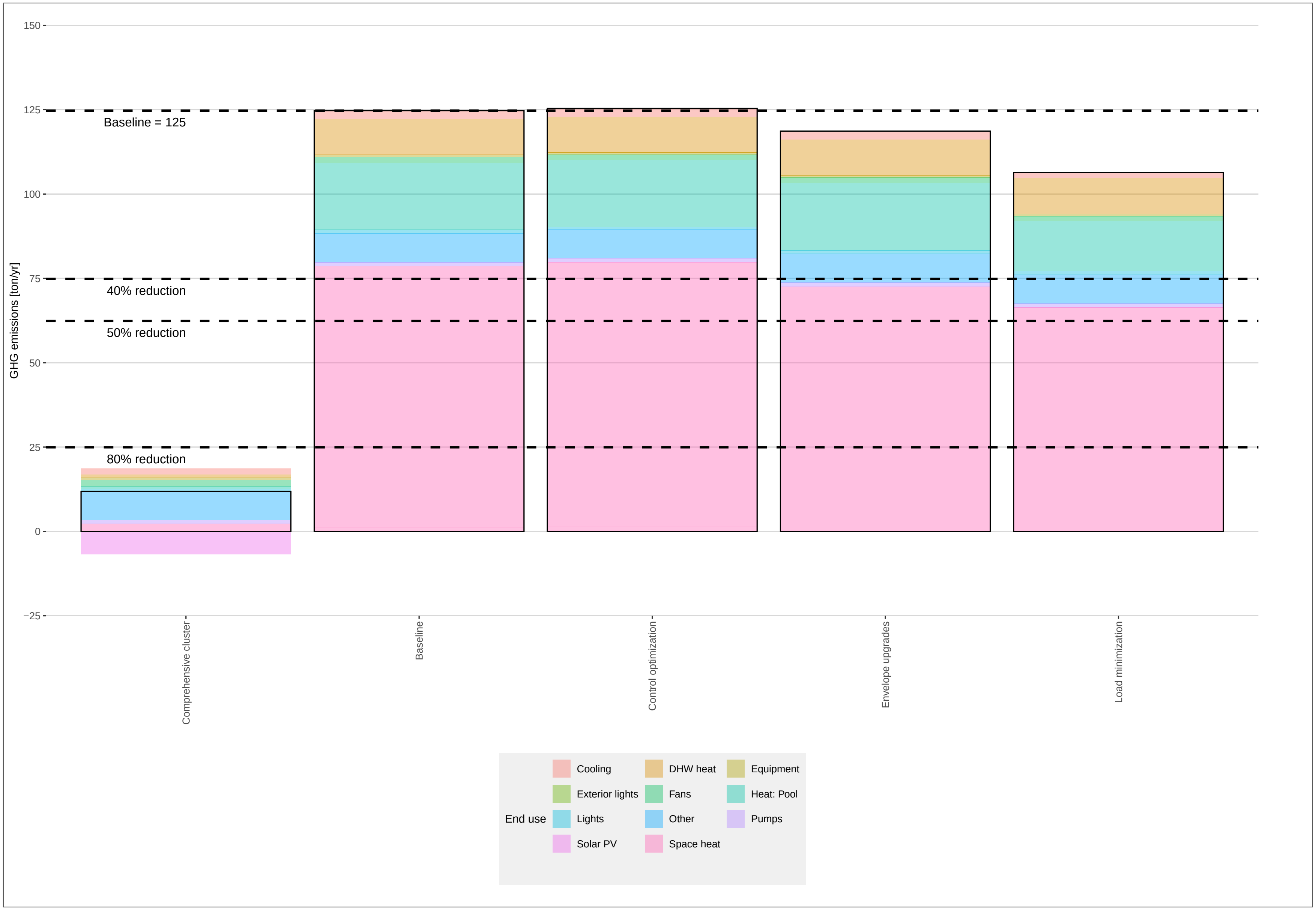


Figure 154: GHG emissions expected yearly for each scenario by end use

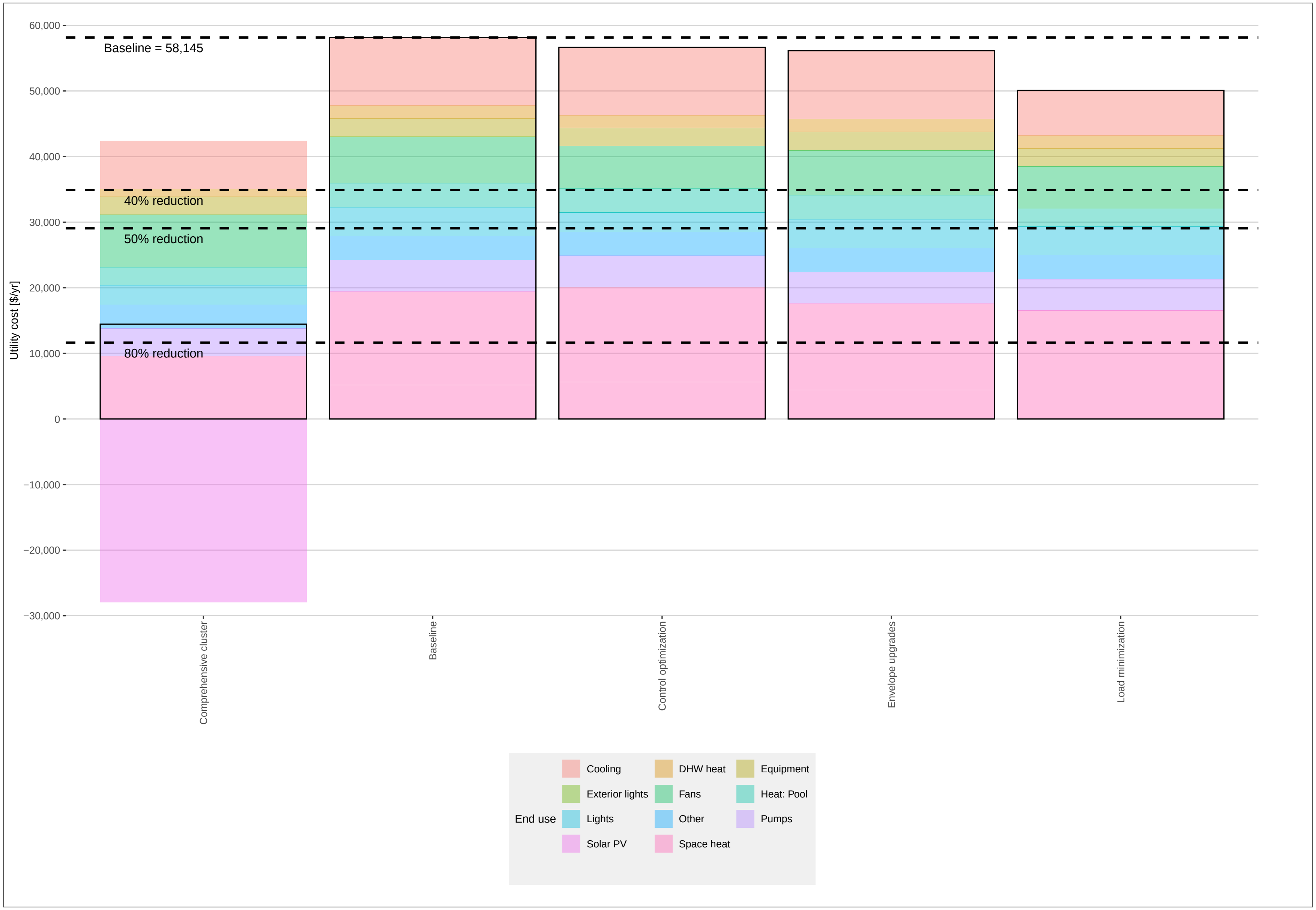


Figure 155: Utility costs expected yearly for each scenario by end use

Financial performance comparison

The following figures compare the financial performance between each scenario.

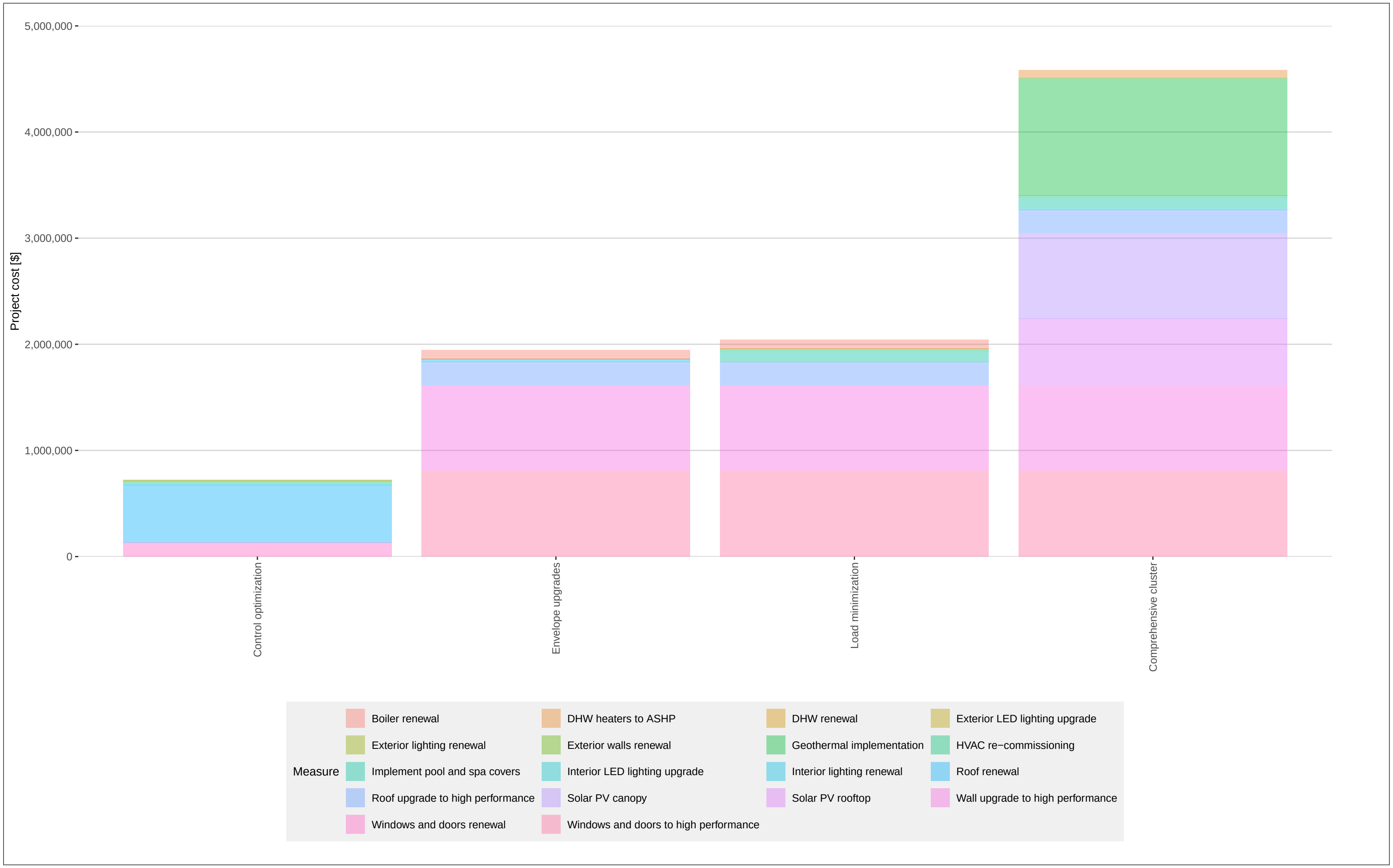


Figure 156: Project cost expected for each scenario by measure

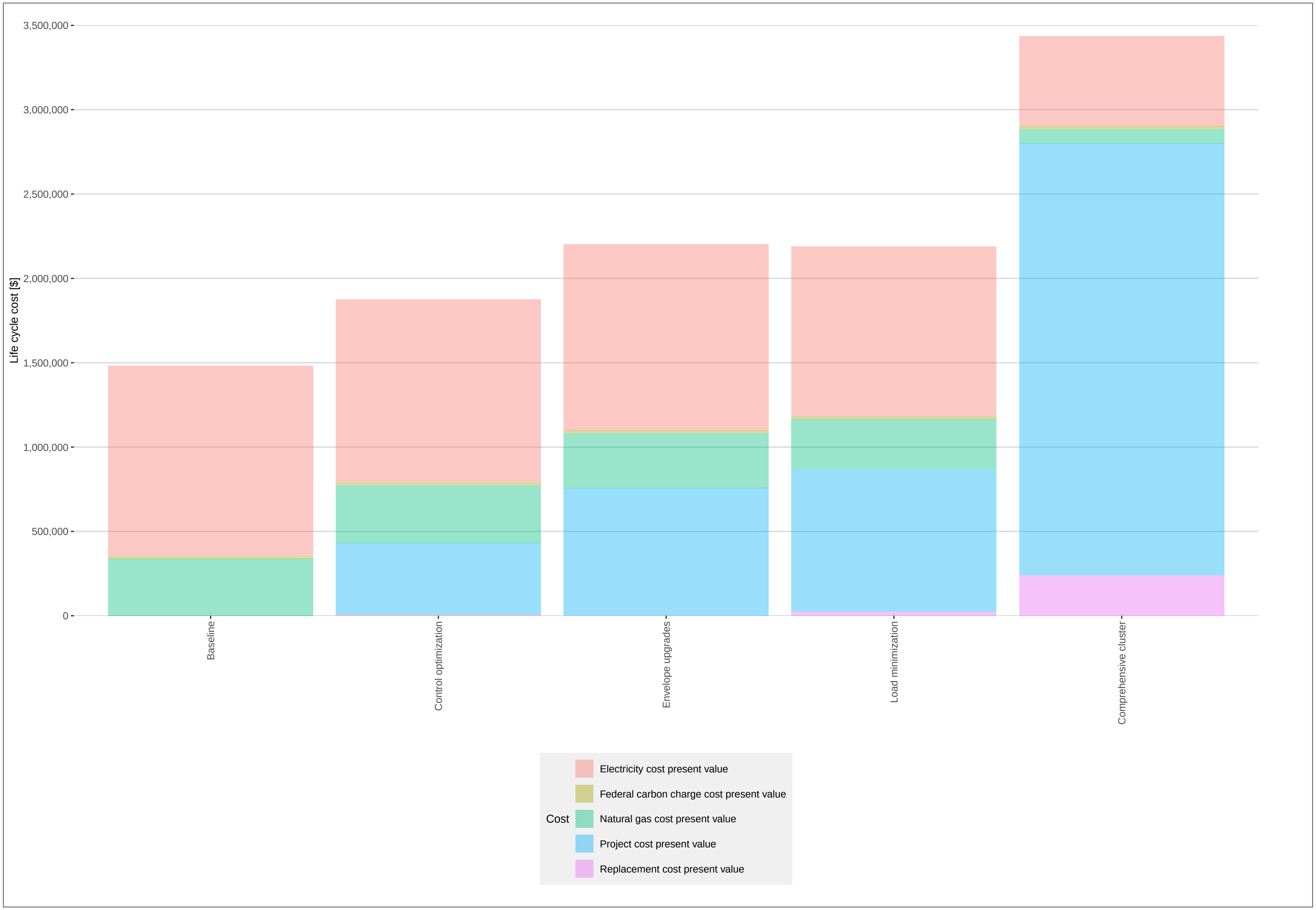


Figure 157: Life cycle cost expected for each scenario by cost item

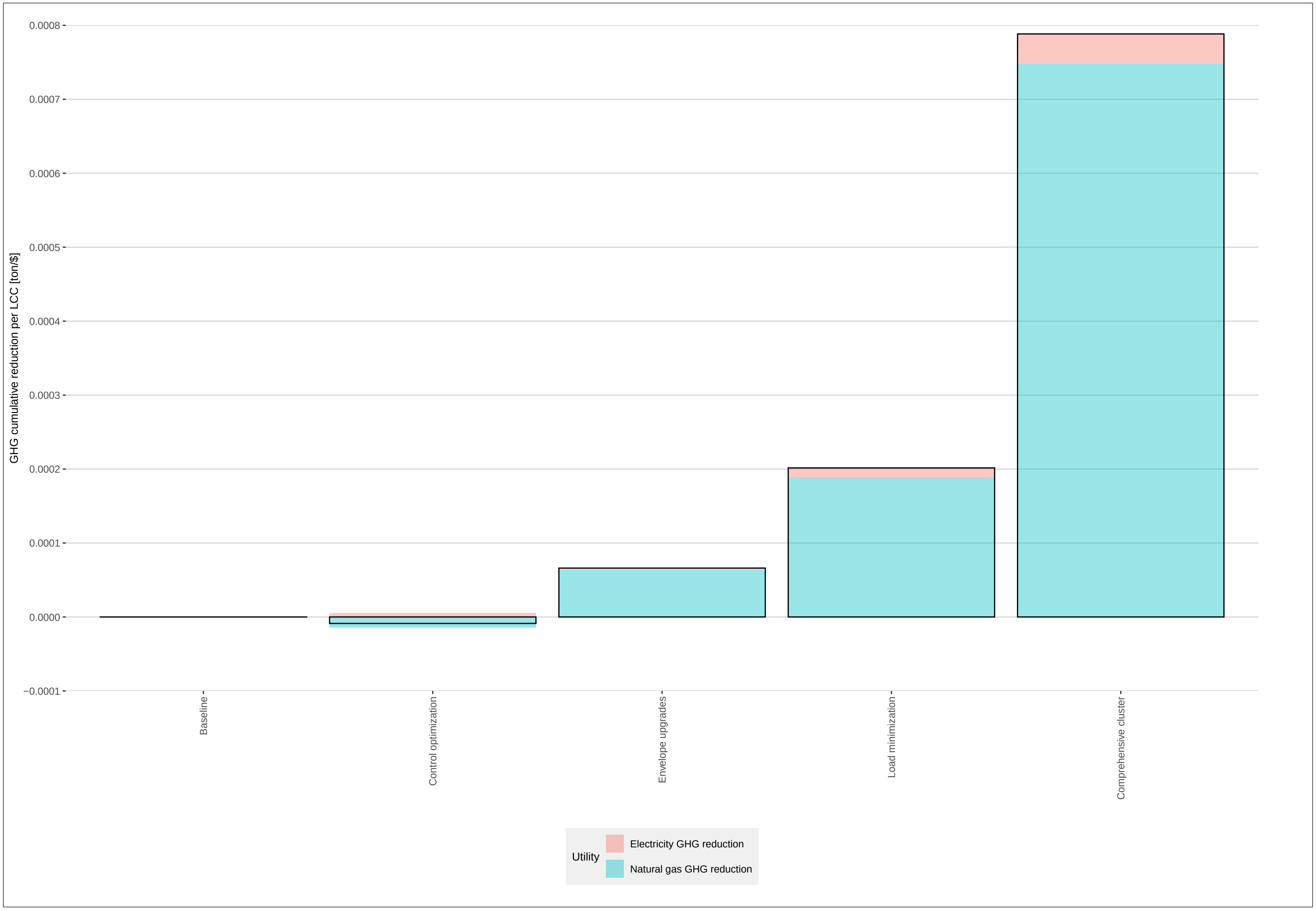


Figure 158: GHG cumulative reduction per life cycle cost (LCC) dollar expected for each scenario by utility

6.5 Plan scenario development

Plan scenario identification and objectives

The plan scenarios that were analyzed and their objectives are summarized in Table 53.

Table 53: Plan scenario identification and objectives

Plan scenario	Objectives
Minimum performance scenario	To achieve a 50% reduction in operational GHG emissions within 10 years and 80% within 20 years. This scenario addresses the minimum performance scenario of FCM's CBR program.
Aggressive deep retrofit	Implement the same measures as in the minimum performance scenario but achieve an 80% reduction in GHG emissions within five years. This scenario addresses the additional scenario requirement of FCM's CBR program.
Comprehensive	To understand the limit of GHG reductions possible by implementing all mutually exclusive measures that have the greatest reduction on GHG emissions and excluding the use of carbon offsets.
Organizational goal alignment	To reduce emissions by 40% GHG emissions from 2019 levels by 2033 and 80% reduction by 2050 of on-site emissions. The remaining 20% is to be addressed through carbon offsets, as noted in the City's Corporate Greenhouse Gas Reduction Plan (GHGRP).
Business as usual	To follow the existing capital renewal plan and replace equipment at the end of its life with like-for-like equipment, meeting minimum energy-efficiency requirements of ASHRAE 90.1.

Plan scenario composition

The plan scenarios were composed with the intent of achieving the objective of each plan scenario, as outlined in Table 53. Results of the plan scenario composition are presented in Figure 159, which is a measure implementation timeline plot indicating which measures were assumed to be implemented in which plan scenarios and when, and the estimated project cost of each measure. The measures are also colour-coded according to measure group. The same information is included in plan performance analysis results figures in Section 6.6 for ease of reference. The plan scenario composition is also presented in Tables 54 to 59.

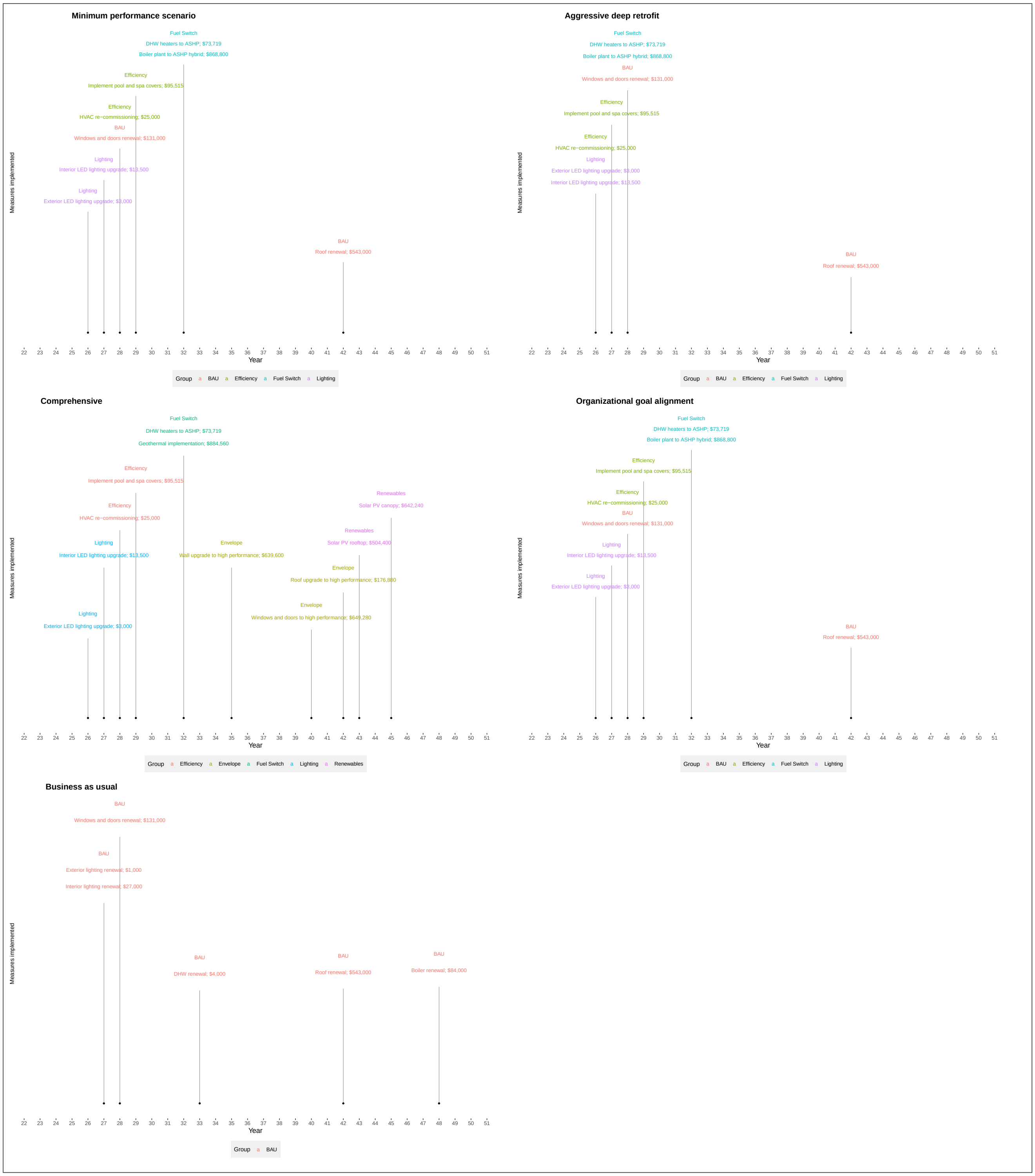


Figure 159: Plan scenario composition, indicating which measures are implemented when and at what cost in each plan scenario

Table 54: Scenario composition summary

Measure	Minimum performance scenario	Aggressive deep retrofit	Comprehensive	Organizational goal alignment
Boiler plant to ASHP hybrid	✔	✔	✖	✔
Carbon offsets 20	✖	✖	✖	✖
DHW heaters to ASHP	✔	✔	✔	✔
Exterior LED lighting upgrade	✔	✔	✔	✔
Geothermal implementation	✖	✖	✔	✖
HVAC re-commissioning	✔	✔	✔	✔
Implement pool and spa covers	✔	✔	✔	✔
Interior LED lighting upgrade	✔	✔	✔	✔
Roof upgrade to high performance	✖	✖	✔	✖
Solar PV canopy	✖	✖	✔	✖
Solar PV rooftop	✖	✖	✔	✖
Wall upgrade to high performance	✖	✖	✔	✖
Windows and doors to high performance	✖	✖	✔	✖
Boiler renewal	✖	✖	✖	✖
DHW renewal	✖	✖	✖	✖
Exterior lighting renewal	✖	✖	✖	✖
Exterior walls renewal	✔	✔	✖	✔
Interior lighting renewal	✖	✖	✖	✖
Roof renewal	✔	✔	✖	✔
Windows and doors renewal	✔	✔	✖	✔

Table 55: Minimum performance scenario measure implementation timeline

Measure	Year
Exterior LED lighting upgrade	2026
Interior LED lighting upgrade	2027
HVAC re-commissioning	2028
Windows and doors renewal	2028
Implement pool and spa covers	2029
Boiler plant to ASHP hybrid	2032
DHW heaters to ASHP	2032
Roof renewal	2042
Exterior walls renewal	2063

Table 56: Aggressive deep retrofit measure implementation timeline

Measure	Year
Exterior LED lighting upgrade	2026
HVAC re-commissioning	2026
Interior LED lighting upgrade	2026
Implement pool and spa covers	2027
Boiler plant to ASHP hybrid	2028
DHW heaters to ASHP	2028
Windows and doors renewal	2028
Roof renewal	2042
Exterior walls renewal	2063

Table 57: Comprehensive measure implementation timeline

Measure	Year
Exterior LED lighting upgrade	2026
Interior LED lighting upgrade	2027
HVAC re-commissioning	2028
Implement pool and spa covers	2029
DHW heaters to ASHP	2032
Geothermal implementation	2032
Wall upgrade to high performance	2035
Windows and doors to high performance	2040
Roof upgrade to high performance	2042
Solar PV rooftop	2043
Solar PV canopy	2045

Table 58: Organizational goal alignment measure implementation timeline

Measure	Year
Exterior LED lighting upgrade	2026
Interior LED lighting upgrade	2027
HVAC re-commissioning	2028
Windows and doors renewal	2028
Implement pool and spa covers	2029
Boiler plant to ASHP hybrid	2032
DHW heaters to ASHP	2032
Roof renewal	2042
Exterior walls renewal	2063

Table 59: Business as usual measure implementation timeline

Measure	Year
Exterior lighting renewal	2027
Interior lighting renewal	2027
Windows and doors renewal	2028
DHW renewal	2033
Roof renewal	2042
Boiler renewal	2048
Exterior walls renewal	2063

6.6 Plan performance analysis

Figures 160 through 163 present the projected yearly electricity use, natural gas use, GHG emissions and life cycle costs associated with each plan scenario.

Figure 160: Electricity yearly utility use projection for each scenario

Figure 161: Natural gas yearly utility use projection for each scenario

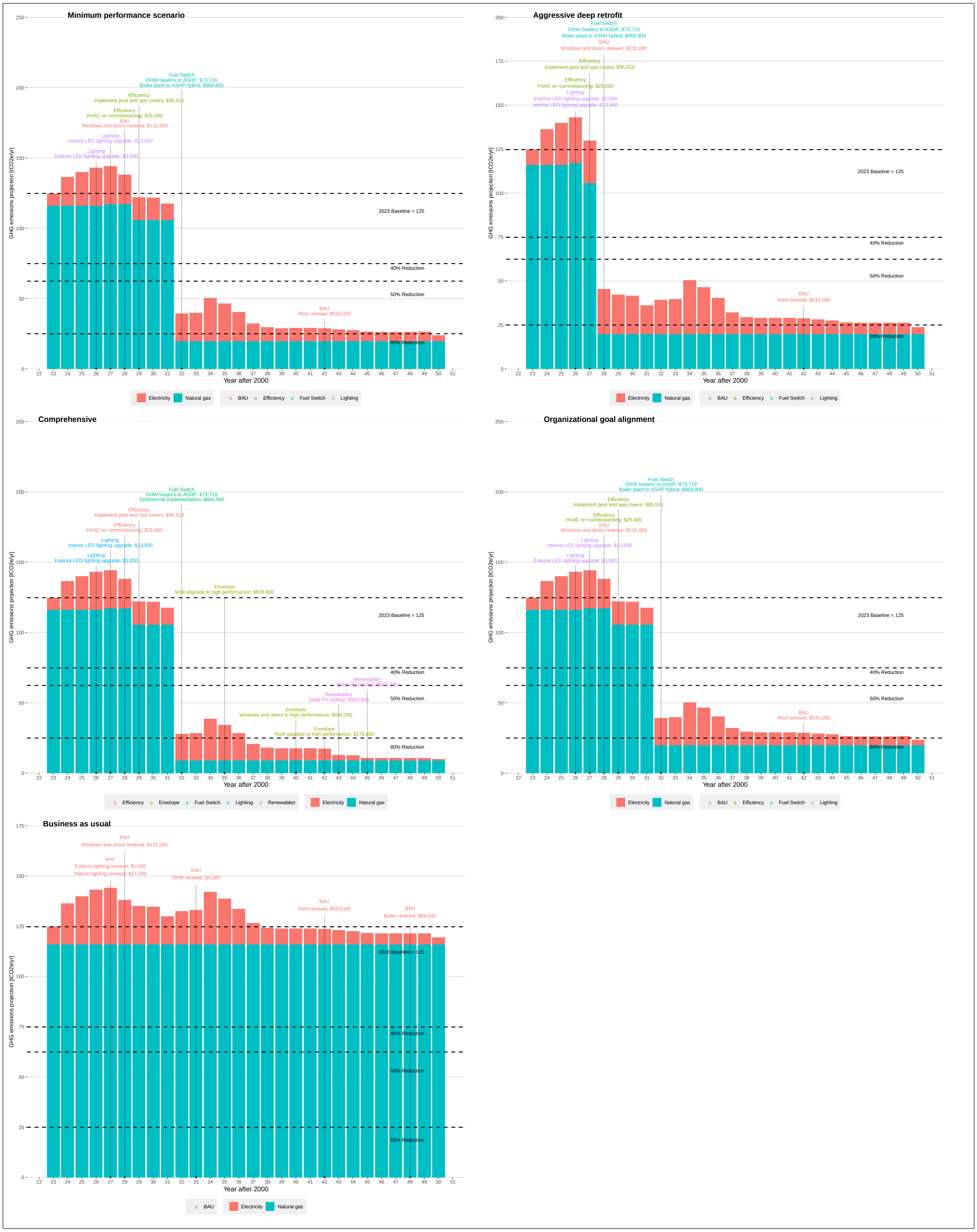


Figure 162: GHG yearly emissions projection for each scenario

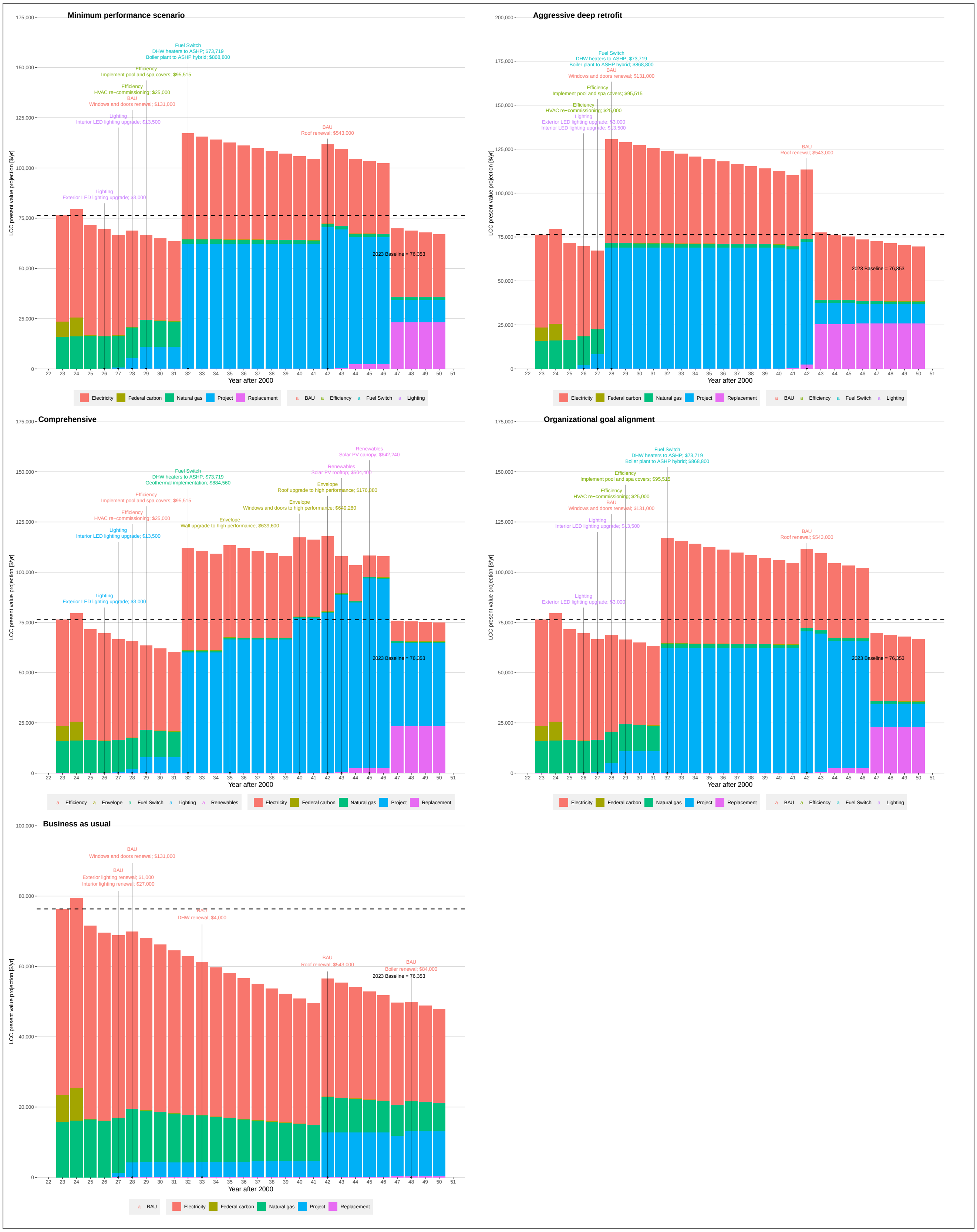


Figure 163: Life cycle yearly cost (after discounting to present value) projection for each scenario

6.7 Plan performance summary

Plan performance summary

Table 60 summarizes the performance of each plan scenario with respect to utility use, GHG emissions, utility cost, and financial metrics. The first half of Table 60 represents the estimated performance in the final year (2050) of the evaluation period. The second half of Table 60 represents the estimated cumulative performance across the entire evaluation period (present to 2050). All final year dollar values are in the value of today's currency. All cumulative dollar values presented in Table 60 are calculated as the simple sum of expenditures over the evaluation period, except for the life cycle cost, which is discounted to present value (as illustrated in Figure 163).

Table 60: Plan performance summary

Section	Description	Unit	Minimum performance scenario	Aggressive deep retrofit	Comprehensive	Organizational goal alignment	Business as usual
Utility use final	Electricity use	[kWh/yr]	433,809	433,809	129,362	433,809	370,583
	Electricity monthly peak (av)	[kW]	80.8	80.8	68.6	80.8	60.0
	Electricity yearly peak (max)	[kW]	102	102	83	102	74
	Natural gas use	[m3/yr]	10,162	10,162	4,538	10,162	59,962
GHG emissions final	Electricity GHGs	[tCO2e/yr]	4.1	4.1	1.2	4.1	3.5
	Natural gas GHGs	[tCO2e/yr]	20	20	9	20	116
	Carbon offsets GHGs	[tCO2e/yr]	0.00	0.00	0.00	0.00	0.00
	Total GHGs	[tCO2e/yr]	24	24	10	24	119
Utility cost final	Electricity utility cost	[$/yr]	105,763	105,763	31,538	105,763	90,348
	Natural gas utility cost	[$/yr]	4,599	4,599	2,054	4,599	27,139
	Carbon offsets utility cost	[$/yr]	0.00	0.00	0.00	0.00	0.00
	Federal carbon charge	[$/yr]	0.00	0.00	0.00	0.00	0.00
	Total utility cost	[$/yr]	110,362	110,362	33,593	110,362	117,487
Utility use cumulative	Electricity use	[kWh]	11,388,999	11,760,971	8,899,412	11,388,999	10,376,317
	Natural gas use	[m3]	717,850	528,764	611,010	717,850	1,678,950
GHG emissions cumulative	Electricity GHGs	[tCO2e]	404	421	362	404	380
	Natural gas GHGs	[tCO2e]	1,387	1,022	1,181	1,387	3,244
	Carbon offsets GHGs	[tCO2e]	0.00	0.00	0.00	0.00	0.00
	Total GHGs	[tCO2e]	1,792	1,443	1,543	1,792	3,625
Utility cost cumulative	Electricity utility cost	[$]	2,177,084	2,238,194	1,615,996	2,177,084	1,961,272
	Natural gas utility cost	[$]	224,098	167,188	183,398	224,098	589,102
	Carbon offsets utility cost	[$]	0.00	0.00	0.00	0.00	0.00
	Federal carbon charge	[$]	16,801	16,801	16,801	16,801	16,801
	Total utility cost	[$]	2,417,983	2,422,183	1,816,194	2,417,983	2,567,175
Financial cumulative	Project cost	[$]	2,381,605	2,274,661	5,974,799	2,381,605	1,065,627
	Replacement cost	[$]	998,658	926,673	1,013,886	998,658	24,798
	Life cycle cost	[$]	2,538,564	2,749,908	2,581,330	2,538,564	1,662,009

6.8 Scenario analysis discussion

Baseline

- This scenario reflects existing conditions.

Minimum performance scenario

- To meet the FCM minimum performance scenario, significant capital retrofits would be required. Heating system electrification would be required.

Aggressive deep retrofit

- For the aggressive deep retrofit, the same measures as the minimum performance scenario need to be implemented, but on a shorter timeframe.

Organizational goal alignment

- To achieve the organizational goal alignment of 80% reduction in GHG emissions without carbon offsets, the heating systems must be electrified, although natural gas can be used as a backup heating source.

Comprehensive

- The comprehensive scenario demonstrates the upper limit of energy-efficiency that the Waterfront Pool and Fitness Centre could achieve, based on the measures that were analyzed under this Pathway to Decarbonization Feasibility Study.

7 END