Town of Devon

GHG Reduction Pathway Study

DECARBONIZATION REPORT



CIMA+ project number: Z0024367
28-March-2025 – Final Report

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Table of involved resources

In addition to the signatories of this report, the following individuals have also been involved in the study and writing of the report as technical experts within the project team:

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Register of issues			
Issue No.	Reviewed by	Date	Description of the review
1st	Keming Yan	2025-03-26	Internal review
2nd	Julie Hardy	2025-03-27	Internal review
3rd	Keming Yan	2025-03-28	Final review

Confidentiality and ownership

Cost disclaimer

This report has been prepared based upon information provided and includes the input and commentary from the professionals involved. In some cases, assumptions have been made to enable calculations to be completed. The costs shown in this report represent the professional consultant team's best estimate given the project constraints and sustainability requirements. It is the responsibility of the owner to confirm these costs.

Executive Summary

The Town of Devon is committed to enhancing the energy efficiency of its building portfolio and reducing greenhouse gas (GHG) emissions by at least 5%. In support of this goal, Recollective Consulting Inc. (Recollective) has been engaged to conduct a Greenhouse Gas (GHG) Reduction Study for six municipal building assets and provide a GHG Reduction Pathway. This project is part of Climate Ready Infrastructure Service (CRIS) and is managed by Canadian Urban Institute (CUI). Recollective has joined forces with CIMA+ in December 2024 and is part of CIMA+ group.

This report presents an overview of these buildings, focusing on energy performance, GHG emissions, and the identification of energy conservation measures (ECMs) that will help achieve the desired reductions.

The study started with an initial assessment that includes on-site investigations, data collection, and a review of building condition reports, utility data, and energy audits, when available. Compared to the National energy benchmark, the portfolio is standing in a reasonable condition with an average 14% better energy use intensity among the peer building type, a summary of the building's energy and emissions performance is provided in Table 1. However, assessing the current energy systems in the portfolio uncovers significant opportunities for carbon reduction, with the Arena being particularly notable among the six buildings due to its specialized equipment, large floor area, high occupancy demand, and extended operating hours throughout the year.

Table 1: Presentation of annual building energy performance

Building	Address in Town of Devon	Measured Floor area	GHG Emission Intensity	Energy Use Intensity	Benchmark energy use intensity
		m^2	$kgCO_2/m^2$	(GJ/m^2)	(GJ/m^2)
Arena	32 Haven Ave.	7502	76	1.07	1.1
Community Center	20 Haven Ave.	1425	51	0.72	1.19
Fire Hall	9 Columbia Ave West	675	87	1.2	1.21
RCMP	13 Columbia Ave West	451	90	0.96	1.21
Public Workstation	10 & 11 Exploration Dr.	954	94	1.16	1.19
Town Office	1 Columbia Ave. West	912	87	1.01	1.25

The proposed ECMs present major opportunities to improve energy efficiency, reduce GHG emissions, and lower annual energy costs. Key measures listed in Table 2 include upgrading the gas water heating system with an Air Source Heat Pump (ASHP), which saves 5% GHG emissions, and integrating the Building Automation System (BAS) and Outdoor Air Ventilation (ODV), resulting in a 7% in GHG emissions. Replacing the overaged gas-fired HVAC system with ASHP leads to an 18% decrease in GHG emissions and lighting upgrade to LED saves 3% in carbon emissions. The most impactful measure is integrating energy recovery with the Arena ice plant system, which accounts for 24% of the total energy savings and 17% of GHG reductions.

Table 2: List of proposed Energy Conservation Measures (ECMs) and their contribution to the Overall Portfolio Performance

# ECM	Description of ECMs	Annual saving vs the status que					
		Energy (GJ)	GHG (Tonne CO2)	Cost ($)	Energy (%)	GHG (%)	Cost (%)
Status que, presenting current condition		12415	911	157849	0	0	0
1	Upgrading gas water heating system with ASHP for all buildings	914	48	4296	7%	5%	3%
2	Integrating BAS and ODV with the energy systems for all buildings	1264	66	5941	10%	7%	4%
3	Upgrading gas HVAC with ASHP systems per Table 21	3107	163	14603	25%	18%	9%
4	Upgrading Lighting type and control system for all buildings excluded Arena	160	24	6712	1%	3%	4%
5	Integrating energy recovery with Arena ice plant system	2931	154	1377	24%	17%	9%

Furthermore, CIMA+ provided an extra recommendation measuring the potential of site area for the renewable solar energy generation which could be a potential replacement for the utilized grid electricity and mitigating associated carbon by 150 kg/GJ. Collectively, these measures have the potential to deliver substantial savings in both energy and costs, while reducing GHG emissions beyond the objective 5% level.

In summary, this report provides a roadmap for Devon’s energy and emissions reduction efforts, offering a combination of immediate and long-term strategies that will not only help meet regulatory requirements but also position the town as a leader in sustainable, energy-efficient building management.

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1. Project Introduction and Background

The Town of Devon is dedicated to improving the energy efficiency of six Town-owned facilities (the portfolio) and reducing greenhouse gas (GHG) emissions by at least 5% as part of the Municipal Energy Manager (MEM) program, which is connected to the Municipal Climate Change Action Centre in Alberta. This program helps municipalities manage energy use and lower GHG emissions in Town-owned buildings. Although seven facilities were originally planned for inclusion, one was excluded due to its large process load, leaving a portfolio of six buildings as outlined in Section 2.

To support this objective, Recollective Consulting Inc. (Recollective) has been engaged to carry out a Greenhouse Gas (GHG) Reduction Study for the six municipal building assets and develop a GHG Reduction Pathway. This project is part of the Climate Ready Infrastructure Service (CRIS) and is managed by the Canadian Urban Institute (CUI). In December 2024, Recollective joined forces with CIMA+ and became part of the CIMA+ group.

The goal of this project is to assist the town in creating a long-term strategy to improve energy efficiency and achieve a 5% reduction in GHG emissions. CIMA+ has been tasked with conducting a thorough study, including on-site assessments and a desktop review, to identify effective GHG reduction measures in the building envelope, mechanical systems, and electrical systems. The report will also analyze the facilities' energy usage, operational carbon footprint, asset service life, and associated costs, helping to identify the most effective strategies and solutions for reducing GHG emissions.

1.1 Objectives

The main goal of the portfolio evaluation is to assess the overall condition of buildings and identify energy conservation measures that can help reduce the portfolio's carbon emissions by at least 5%.

1.2 Study Workflow

To achieve the study objectives, CIMA+ follows a structured workflow, see Figure 1. As shown, the process began with an initial meeting between the Town and CIMA+ to develop expectations and a decarbonization plan for CIMA+'s scope of investigation and intervention. The next steps included a site visit, data collection, and subsequent review, organization, and verification of the information in collaboration with the Town to confirm input and fill in any missing data, thereby establishing a consolidated baseline for portfolio assessment. The following step involves analyzing and reviewing the collected data to evaluate the energy and carbon performance of individual buildings, comparing them to the national median energy consumption for asset benchmarking. This analysis offers initial insights into the portfolio's condition and helps prioritize areas for GHG reduction.

In the next phase, CIMA+ combines the findings from each asset analysis to outline the energy and carbon distribution across the portfolio. This step also identifies high-potential energy conservation measures (ECMs), supported by energy cost and carbon analysis, to create GHG reduction packages that aid in informed decision-making. Finally, CIMA+ presents the finalized report to the Town of Devon, detailing the investigation scope for the specified GHG reduction measures.

Figure 1: Project study workflow

1.3 Reference: Carbon and Energy Cost Breakdown

According to a recent article published, May 2024, by the Government of Canada for the province of Alberta, the carbon emissions from 1GJ of electricity are three times higher than those from natural gas, and the cost per 1GJ of electricity is nearly nine times greater than that of 1GJ of natural gas (see Tables 3-5). These factors justify transitioning the majority of building energy usage to natural gas. However, fluctuations in the carbon price related to natural gas could impact the long-term energy costs of the portfolio and also the town goal's for achieving Net Zero and clean energy resources are strong motivations to revise the building energy systems and approach sustainable, green solutions.

Table 3: Tonne CO2eq emission per GJ type of energy use[1]

tonne/GJ CO2 emission per GJ electricity use	tonne/GJ CO2 emission per GJ gas use
0.15	0.0526

Table 4: Breakdown of Gas bill cost in Alberta[2]

Cost category-Gas	(%) of total bill
Natural gas use	33%
Administrational charge	4%
Municipal franchise fee	7%
Federal carbon tax	17%
GST	5%
Delivery charge	23%
Rate riders	11%

Table 5: Breakdown of Electricity bill cost in Alberta[3]

Cost category-Electricity	(%) of total bill
Electricity charge	25%
Delivery charge	51%
Administration fee	9%
Municipal fee	9%
GST	5%
Rate riders	1%

[1] Emission factor and references value
[2] Alberta utility commission
[3] EnergyRate.ca/Alberta

2. Portfolio Assessment

The Town of Devon, Alberta, provided their asset portfolio including six non-residential buildings with a total conditioned floor area of 11,919 m², for an energy performance and GHG reduction assessment. Section 2.1 studies the weather data for the portfolio site, Section 2.2 overview the portfolio assets, and Section 2.3 presents the building energy and emission performance assessment based on utility data monitored and collected by Diamond software.

2.1 Weather Data

The Town of Devon, Alberta, has a warm-summer humid continental climate (Köppen: Dfb), with heating degree days (below 18°C) ranging from 4500 to 5500 hours, placing it in ASHRAE climate zone 7A. The area experiences significant seasonal variations in temperature and precipitation. During the Winter (November to March), the average daily temperature stays below 30°F (-1°C), with January being the coldest month, where average lows can reach around 6°F (-14°C). In the Summer (May to September), the average daily temperature exceeds 63°F (17°C), with July peaking at average highs of about 73°F (23°C) and lows around 52°F (11°C).

According to Climate data for the Town of Devon, the annual average temperature during the 1971-2000 period was 3.0°C. Under a high emissions scenario, the annual average temperature is projected to rise to 4.7°C for the 2021-2050 period, 6.6°C for 2051-2080, and 8.4°C for the final 30 years of the century.

The average annual precipitation during the 1971-2000 period was 498 mm. Under the high emissions scenario, it is expected to increase by 5% during the 2051-2080 period and by 6% during the last 30 years of this century.

The snowy season lasts from October to May, with March typically receiving the most snowfall, averaging around 3.2 inches (8.1 cm). The clearest period spans from June 18 to October 13, with August being the sunniest month, as clear or mostly clear skies occur approximately 58% of the time.

2.2 Building Descriptions

The Town of Devon has identified six non-residential buildings with a total floor area of 11,919 m², as detailed in Table 6. These major buildings are primarily located between Columbia and Haven avenues, which define a dedicated urban area for the Town's facilities. Most of the buildings were constructed around the year 2000, with some, including the Arena, Fire Hall, and Public Shop Service, being expanded in subsequent years. The documents provided for each facility are listed in Table 6. In terms of asset lifespan, the building envelopes are in the middle of their expected life cycle, while the HVAC systems and lighting are nearing the end of their lifespan and require further assessment, as discussed in Section 3.

When compared to the Canadian Energy Star[4] benchmarks, the buildings are categorized into four classes based on their use type: recreation ice rink, office, meeting hall, and service shop facility. Table 6 presents the equivalent benchmark energy use intensity for each property category. Further analysis of the buildings' energy performance in relation to the peer benchmark is provided in Section 2.3.

Figure 2: Spatial distribution of assets (Google Map)

[4] Energy Star Canada

Table 6: Summary of building asset information listed in the Town of Devon portfolio

Building	Address in Town of Devon	Building type	Supporting documents received till March 20 2025	Measured Floor area	Benchmark energy use intensity
				m^2	(GJ/m^2)
Arena	32 Haven Ave.	Rec- Ice rink facility	Addition drawing set (Aug 2022) Energy audit (2019)	7502	1.1
Community Center	20 Haven Ave.	Meeting hall	Building layout Building condition assessment (2016)	1425	1.19
Fire Hall	9 Columbia Ave West	Office	Addition drawing set (July 2011)	675	1.21
RCMP	13 Columbia Ave West	Office	No Document	451	1.21
Public Workstation	10 & 11 Exploration Dr.	Service shop	Addition drawing set (July 2008)	954	1.19
Town Office	1 Columbia Ave. West	Office	Blueprint copy (Jan 2000)	912	1.25

2.3 Building Energy and Emission Performance Assessment

The Town of Devon supplied the building's utility data, with gas, electricity, and water usage tracked through Diamond software from 2015 to 2024. Taking into account the latest energy consumption data for the facilities and ensuring consistency across all buildings (including the most recent expansion in 2022), utility data for all energy sources were analyzed from 2023-2024 to evaluate the portfolio's energy performance.

Comparing natural gas consumption across six buildings, Arena contributes the most, accounting for 67% of the total gas use, while RCMP uses the least, contributing only 3%. This variation is largely due to the building's use-type and overall conditioned floor area. The primary gas consumers in the portfolio are water heating and HVAC systems, which together account for an average of 79% of the total energy demand. Notably, Arena's gas consumption is more than twice the average of the other five buildings, which is strongly tied to the excessive energy use of equipment discussed in Section 3.1.1.

The Town's natural gas costs an average of 4.7 $/GJ annually, with 2.06 $/GJ allocated to the consumed natural gas and 2.69 $/GJ covering service fees related to natural gas use, including the federal fuel charge. The federal carbon tax alone costs the Town an average of 7,903 $ per year, which presents an opportunity for cost savings if total GHG reductions can be achieved through more efficient gas end-use management.

In terms of total GHG emissions from gas use, the portfolio emits 514 tonnes of CO2eq. To meet a 5% GHG reduction target, approximately 866 GJ of gas usage needs to be reduced, which represents 9% of the portfolio's total gas consumption.

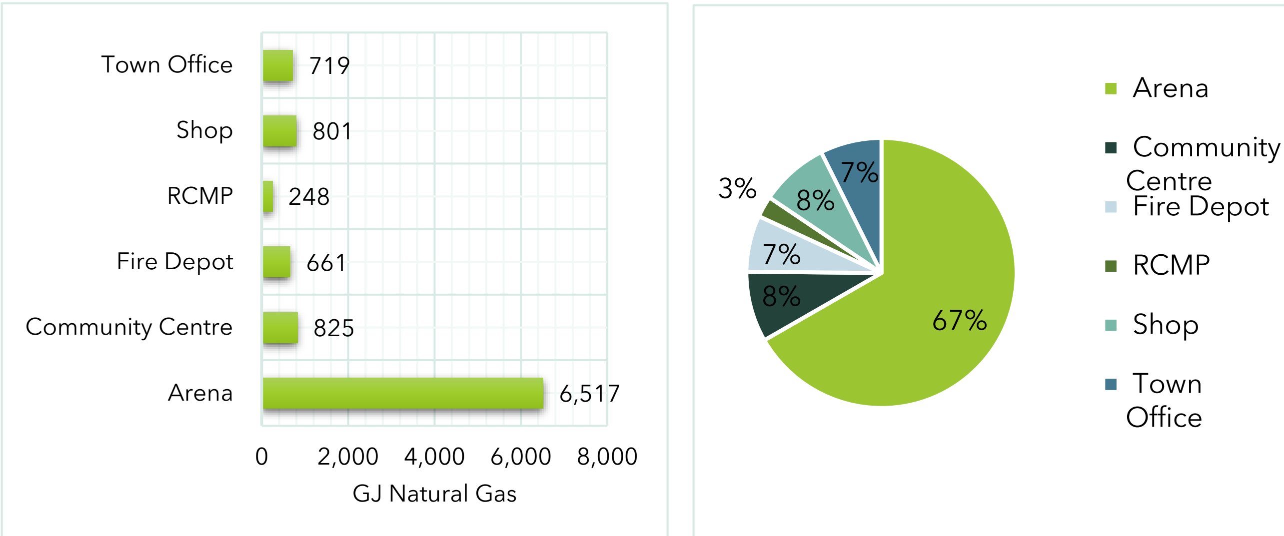


Figure 3: Distribution Gas Consumption in the Portfolio

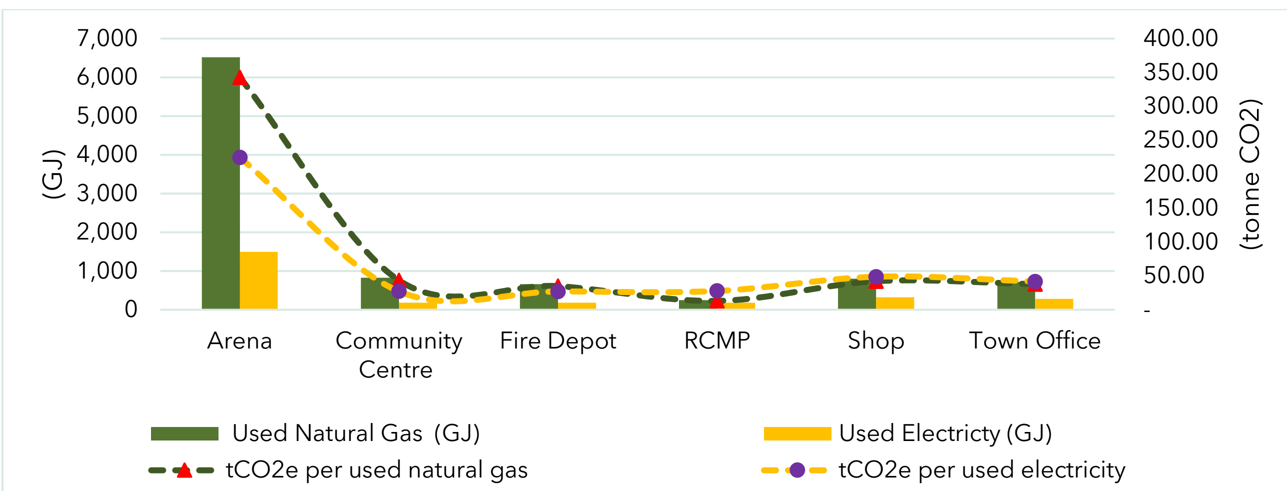
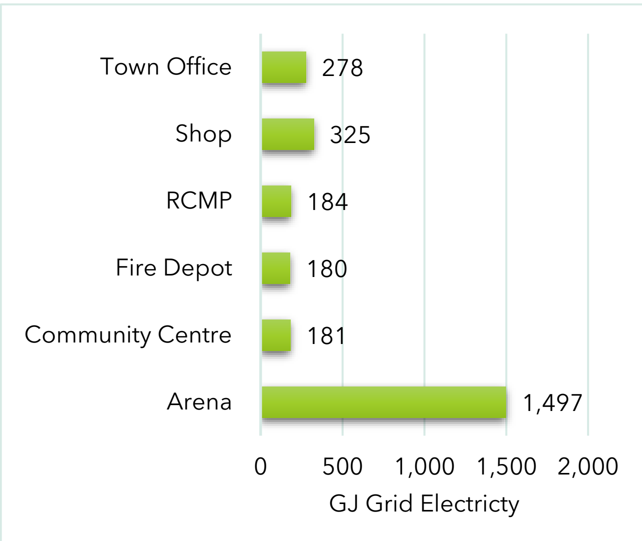


Figure 4: Distribution Energy Use Intensity and GHG emission per Fuel Type

As calculated, 21% of the portfolio's annual energy consumption is attributed to grid electricity, primarily used for lighting, receptacles, and miscellaneous loads. Arena has the highest electricity consumption, followed by the Shop and Town office, with respective contributions of 57%, 12%, and 10%.

The Town incurs an average cost of 42 $/GJ per year, with 14.21 $/GJ allocated to consumed electricity and 27.94 $/GJ covering service and energy distribution costs. The portfolio emits 397 tonnes of CO2eq annually, representing 44% of the total portfolio emissions. Given the significant impact of electricity on carbon generation compared to natural gas in Alberta, it is strongly recommended to improve the efficiency of electrical systems and shift the load to renewable energy sources. This approach will help offset carbon emissions and contribute to achieving sustainable, green solutions.



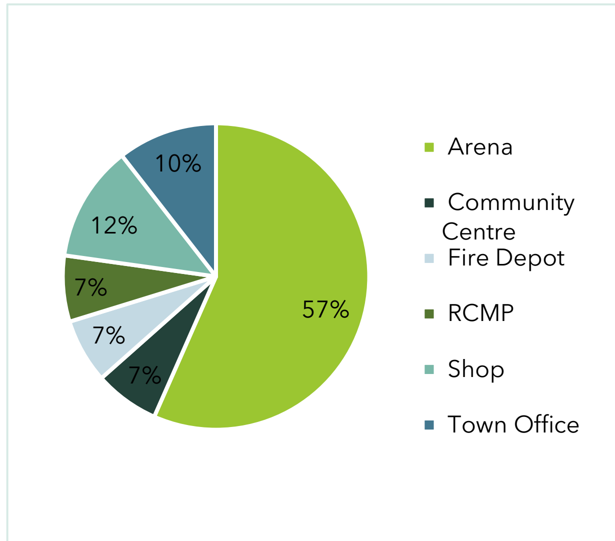


Figure 5: Distribution Electricity Consumption in the Portfolio

Upon reviewing the facility's energy use intensity, the average across the portfolio is 1.02 GJ/m², which is 14% better than the national benchmark for similar buildings. However, a review of the documents provided for each facility in Section 3 reveals significant energy conservation and GHG reduction measures, which are discussed in Section 4.

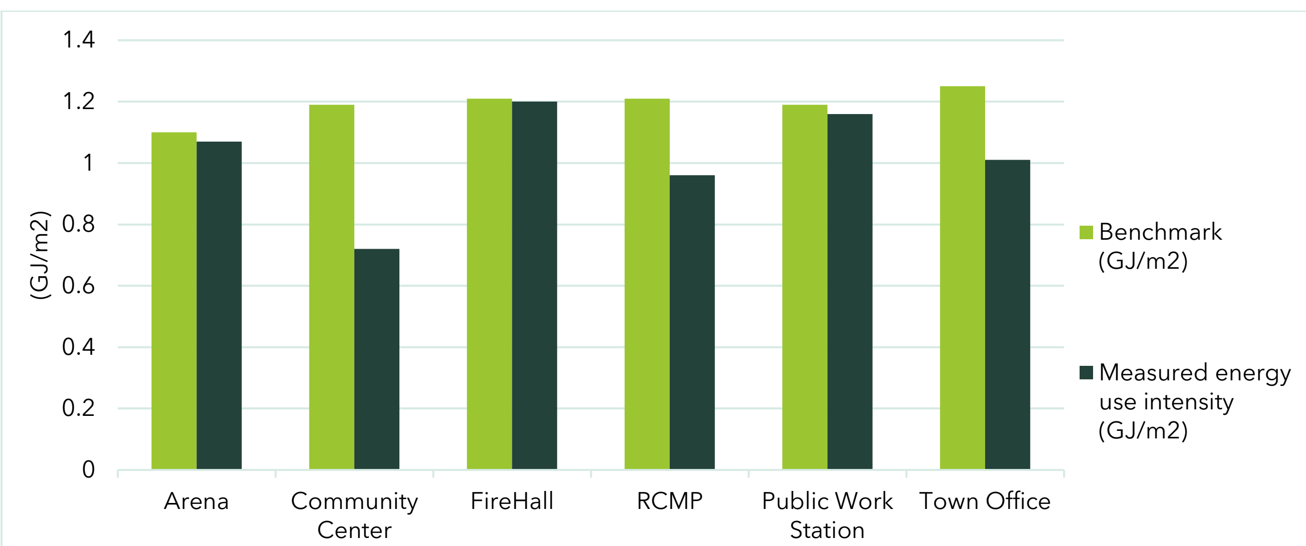


Figure 6: Comparison of building energy use intensity vs their peer cases (benchmark)

3. Building Specific Assessment

3.1.1 Building 1- Arena

The GFL Twin Arena, located at 32 Haven Avenue, Devon, Alberta, has a floor area of 7,502 m² and features two ice rinks—one built before 2000 and the other permitted for construction in 2022. The building consists of two stories surrounding the ice rinks, which include storage areas, washrooms, a mechanical room, a concession kitchen, and a spectator area. The received documentation for the building is listed below, and details of its energy systems are provided in Tables 7 and 8.

- Dale Fisher Arean Expansion issued in Aug 2022
- Building Scoping Audit report provided in Nov 2019

CIMA+ visited the facility on February 20, 2025, and the observations from the visit are included in Section 3.1.1.1.
According to the Town's sustainability manager, both ice rinks at the Arena are typically in use from 8 am to 10 pm, seven days a week, from September to March. In April, the schedule runs from about 8 am to 7 pm, with the summer schedule yet to be determined. The old building does not have an automation system and is mainly managed by the Arena Manager while the new-built portion utilizes a building management system. It has been verified availability of occupancy sensors in the changing rooms, and also exterior lighting is controlled by a photocell. It is also noted that waste heat from the ice plant is used to heat the indoor snowmelt pit for the Zamboni.

Figure 7: Dale Fisher Arean, 32 Haven Ave, Devon (Google Map)

Table 7: List of utilized building energy systems in the expansion drawing (Aug 2022)

Category	Description	CIMA+ comments
Floor area	4317 m^2 expansion area	-

Category	Description	CIMA+ comments
Built year	2022	-
Occupancy and schedule	Building Work Schedule: - WD: 8 am-10pm - WE: 8 am-10pm Setpoint temperature: - 18 C in Ice rink, kitchen, office, and lobby - 21 C in changing room Occupancy: - 3 staff on site & 2500 visitors /week during winter season - 3 staff onsite & 500 visitors per week during summer season	The information is confirmed by the town operation manager.
Envelope	- Exterior walls are covered with pre-engineered assembly with 4inch (R 20) rigid insulation and metal cladding. - Roof is made of 2 ply SBS with pre-adhered membrane board and R 35 rigid insulation at drain section, and air barrier membrane. - Slab on grade is composed of reinforced concrete with R10.8 at the slab edge with vertical coverage of 1.2m	-
HVAC	Equipment inventory: - 3 Roof top unit (RTU) with gas fired heating (81% efficiency) and mechanical cooling served back up areas, - 5 gas fired radiant tube heater (5x 11,7 kW) with 80% efficiency serves spectator areas, - 2 gas fired air system with 293- and 131-kW capacity, 80% efficiency, and heat recovery wheel served ice rink and changing room, - 4 Electric forced flow systems (13 kW) serve stairs - 5 electric baseboards (11.5 kW) serve washrooms - 2 electric unit heaters (30) serve ice plants HVAC control: - Building automation system: Integrated with the new installed system - Ventilation demand control is confirmed for the Changing room	
Domestic water heating	- 2x gas water heaters with 146.5 kW/each capacity and 95% thermal efficiency	-
Lighting	- Luminaire type: LED - Total power density: 27.01 kW - Lighting control: BMS control (the drawing recommended daylight and occupancy control but the site has not verified it yet)	-

Category	Description	CIMA+ comments
	- Exterior light: 0.7 kW with photocell control	
Special process load	- 1x Ice plant cooling tower with 26.3 l/s flow and 25.3 kW Fan power	-

the Scoping Audit-2019, focused on the older built part of the building, list the building's energy systems as follows.

Table 8: List of utilized building energy systems in the primary built floor area (Scoping Audit 2019)

Category	Description	CIMA+ comment
Floor area	3185 m^2 old	-
Built year	Estimated before 2000	-
Occupancy and schedule	Building Work Schedule: - WD: 8 am-10pm - WE: 8 am-10pm Setpoint temperature: - 18 C in Ice rink, kitchen, office, and lobby with no off-hour's settings - 21 C in changing room with no off-hour's settings Occupancy: - 3 staff on site & 2500 visitors /week during winter season - 3 staff onsite & 500 visitors per week during summer season	The information is confirmed by the town operation manager.
Envelope	- Exterior walls include concrete with rigid insulation avg RSI 3.9 - Gable roof with RSI 5.6 extended over the entire structure - Windows are fixed, aluminum frame, double pans ¼" glazing with air space, and without thermal break - Its measured 12% window to wall ratio - Its monitored pool sealing at door joints - Its reported degraded flooring at Zamboni room	
HVAC	Equipment inventory: - 2x Natural gas fired make-up air unit with 100% outdoor air to serve concession kitchen and changing room, with 123.1kW and 175.8 kW heating capacity and AFUE 80% and 72.4 (evaluated at acceptable condition) - 2x Natural gas fired RTU with 135.4 kW and 67.4 kW heating capacity (mixing return and fresh air and having economizer for free cooling) serve (i) ice rink and (ii) lobby, washroom, and office. Ice rink RTU is evaluated at poor condition and needs reconsideration.	MAU and RTU are confirmed

<table>
<tr><th>Category</th><th>Description</th><th>CIMA+ comment</th></tr>
<tr><td></td><td>- 5x Natural gas fired radiant tube heater (RTH) serve ice rink (AFUE 55.6% and capacity of 5x29.3 kW and 1x13.2 kW)
- 1x Natural gas fired radiant tube heater serve Zamboni room (AFUE 62.2% and capacity of 11.7 kW)
- Ceiling mounted electric heater (80 kW) circulate interior heat serve storage rooms, Zamboni, ice plant room and entrance vestibule
HVAC control:
- Nonprogrammable electromechanical thermostat for unit heaters and Zamboni RTH
- Programmable digital thermostat for TU located in the lobby
- On/off control for ice rink RTH with 30 min run time
- Temperature setpoint on MAU 1-2
- Manual on/off control for RTU 1, located in the ice rink
- Ice plant room intake/exhaust system is controlled by the ammonia gas detection system</td><td></td></tr>
<tr><td>Domestic water heating</td><td>- 2x Electric tankless on-demand water heater tank serves kitchen and washrooms
- 3x Natural gas storage water heater serves ice plant and changing room</td><td>The number of systems is updated per site visit.</td></tr>
<tr><td>Lighting</td><td>- Luminaire type: Fluorescent
- Total power density: 9.21 kW
- Lighting control: Not available
- Exterior lighting: 0.678 kW</td><td>Lighting upgraded to LED</td></tr>
<tr><td>Special process load</td><td>- Electric tape to heat condenser water pipe in the ice plant room (estimated length and power is 2m-117 W)
- Vending machine located in the lobby
- Natural gas oven (52.8 kW)
- Natural gas fryer (26.37 kW)
- Food warmer (2.93 kW)</td><td>Ice Plant replacement has been recently replaced and 101kW solar array has been installed</td></tr>
<tr><td>Comments</td><td>Excess ventilation due to an uncontrolled schedule for outdoor air intake resulted to 5218 l/s additional air intake and heating.

Table 4: Ventilation Air Flow Rates
<table>
<tr><th>Space Type</th><th>Estimated Total Ventilation Rate (L/s)</th><th>Estimated O/A Ventilation Rate (L/s)</th><th>Min O/A Ventilation Rate (ASHRAE 62.1) (L/s)</th></tr>
<tr><td>Concession Kitchen</td><td>1,652</td><td>1,652</td><td>32</td></tr>
<tr><td>Lobby/Washrooms/Office</td><td>2,501</td><td>750</td><td>125</td></tr>
<tr><td>Ice Rink/Zamboni-Ice Plant R.</td><td>3,304</td><td>3,304</td><td>2,073</td></tr>
<tr><td>Change rooms/Mech. R.</td><td>1,888</td><td>1,888</td><td>146</td></tr>
<tr><td>Total</td><td>9,345</td><td>7,594</td><td>2,376</td></tr>
</table></td><td>The same problem was confirmed in the concession room, refer to Section 3.1.1.1.1.</td></tr>
</table>

3.1.1.1 Site visit and primary assessment

Arena site assessment was provided on February 20, 2025, and the feedback on the current systems are discussed below.

3.1.1.1.1 Concession MUA/EF system

Concession make-up air unit and kitchen exhaust fan was operational during our site visit. This is the only ventilation in the concession. There is a wall mounted manual controller by the entry door that turns the unit on/off. There is also a thermostat in the room, which controls the temperature of the make up air unit.

There was no one in the concession during our visit, and our understanding is this system operates continuously. Maintenance personnel indicated this was recommended to them as a safety precaution. The gas appliances were in standby mode, ready for cooking and heat could be felt coming from the appliances.

The concession MUA has poor temperature control, making it the facility's biggest operational challenge. Maintenance will manually adjust the MUA room thermostat depending on outdoor conditions, especially during shoulder seasons.

3.1.1.1.2 Change Room MUA system

Room thermostat for this MUA is blanked off in the change room corridor, room temperature control doesn't work. Temperature control is done strictly from unit discharge temperature only.

3.1.1.2 Utility data analysis

Per average of utility data analysis from 2023-2024, the building's total annual energy consumption is 8014 GJ, with 81% coming from gas use for space and water heating systems, and 19% from electricity used for plug loads and lighting system. The facility's total carbon emissions amount to 567 tonnes of CO2eq, with 60% of these emissions resulting from gas use and 40% from electricity consumption.

In terms of energy costs, electricity is the largest expense at 56%, followed by gas at 28% and water at 16%. Table 9 shows the distribution of energy carbon cost in the asset.

When compared to a similar building type (Rec Center-Ice Rink) in the Energy Star Portfolio Manager benchmark, the Arena's energy consumption is 6% better than the benchmark. Given the building's size and the opportunities for retrofitting and operational improvements, the Arena holds significant potential for energy and carbon savings, which could lead to substantial reductions in annual facility energy costs.

Table 9: Distribution of energy resources, energy charge, and GHG emission

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
Arena	GJ	$	tonne CO2	GJ	$	tonne CO2	M3	$
2023	5,859	29,350	308	2,006	78,274	301	3,032	13890
2024	7,175	29,556	377	988	39,339	148	3,808	18,560

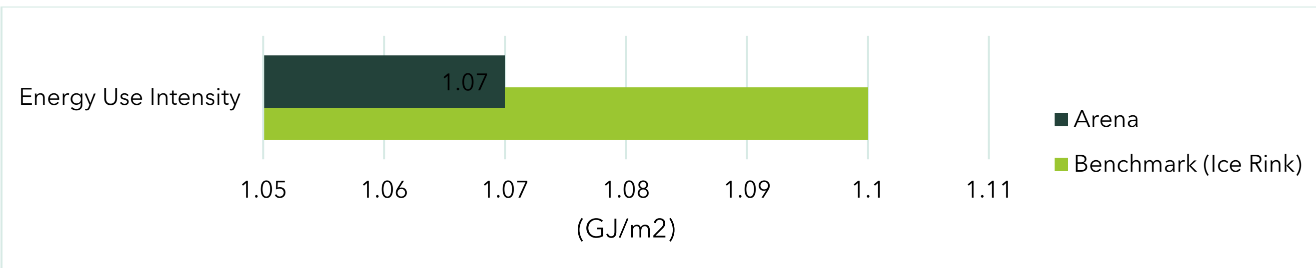


Figure 8:Comparison of Total Building Energy Use with Benchmark (National Median of Peer Cases)

3.1.2 Building 2- Community Center

The Town of Devon Community Center, located at 20 Haven Avenue, Devon, Alberta, covers a floor area of 1,319 m². According to the building condition assessment report from 2016 (BCAR-2016), the building was designed by GMH Architects and Merwin Engineering Ltd, with construction documents issued in 1997. No additions or modernization have been made since then. The structure is a single-story, wood-framed building with load-bearing nominal wood-framed walls supporting a sloped wood roof and a small flat roof section over the mechanical/storage area. The building functions as a community center, providing amenities for meetings, assemblies, banquets, storage, and washrooms, and includes commercial kitchen facilities. The reference information for the building energy system is BCAR-2016 and notes received from the town operation manager is listed in Table 10.

Figure 9: The Town of Devon Community Center, 20 Haven Avenue, Devon (Google Map)

Table 10:List of utilized building energy systems (BCA-2016 and the town operation manager notes)

Category	Description
Floor area	1319 m^2
Built year	1997
Schedule and Occupancy	Building Work Schedule: - WD: 8:30 am-4:30pm - WE: Closed Setpoint temperature: - 21 C with no off-hour's settings Occupancy: - Not determined
Envelope	- Exterior wall system is exterior insulated finishing system (EIFS) with R-20 batt insulation - Roof is made of asphalt shingles on plywood sheathing supported by nominal wood trusses with R-40 batt insulation and polyurethane vapour barrier - Double glazed units with prefinished metal trim on the exterior
HVAC	Equipment inventory: - 5x gas fired RTU with supplemental duct furnaces to additional outdoor air capacity for high occupancy. The units would be nearing 20 years old at the time of report (2016) - 1x Exhaust fan for kitchen and 1x for the dishwasher HVAC Control: - Confirmed Occupancy sensors in washrooms and storage rooms
Domestic water heating	- Considered gas water heating tank per design for peer buildings
Lighting	- Luminaire type: Fluorescent (3ftT8) - Total power density: Insufficient information - Lighting control: Not available - Exterior lighting: Metal halide, controlled using photocell

Category	Description
Special process load	Process gas for cooking in the commercial kitchen
Comments	BCAR-2016 recommends separating the air supply of kitchen from other spaces by having an additional MAU.

3.1.2.1 Utility data analysis

Per average of utility data analysis from 2023-2024, the building's annual energy consumption totalled 1006 GJ, with 82% coming from gas usage for systems like HVAC, water heating, and gas process load, and 18% from electricity used for lighting and plug loads. The total carbon emissions from the facility amounted to 70.54 tonnes of CO2eq, with 62% of emissions from gas use and 38% from electricity consumption.
In terms of energy costs, the building's largest expense was electricity at 51%, followed by gas at 27% and water at 23%, see Table 11.

When compared to a similar building type (Meeting Hall) in the Energy Star Portfolio Manager benchmark, the Community Center shows a 40% improvement in energy consumption. Given the potential for retrofitting and enhancing operational performance, the Community Center presents cost-effective opportunities for energy, carbon, and cost savings.

Table 11: Distribution of energy resources, energy charge, and GHG emission

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
Community Center	GJ	$	tonne CO2	GJ	$	tonne CO2	M3	$
2023	728	3,940	38.3	180	7,808	27.0	633.5	3437
2024	922	$4,262	48.5	182	7,932	27.3	567.0	3425

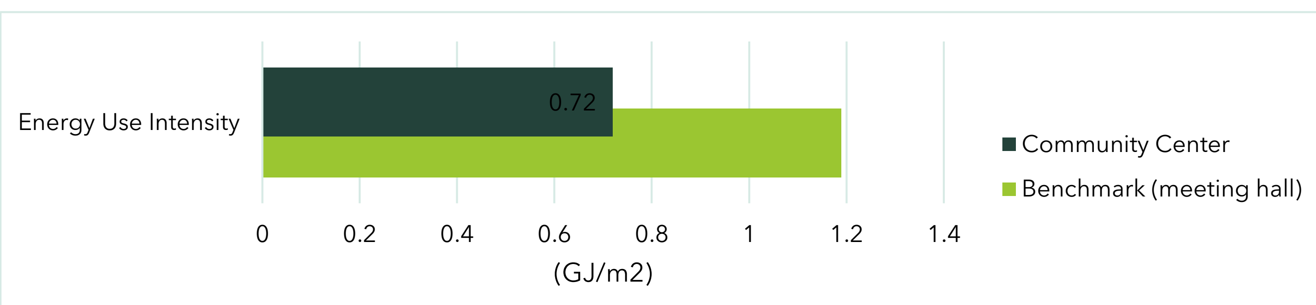


Figure 10: Comparison of Total Building Energy Use with Benchmark (National Median of Peer Cases)

3.1.3 Building 3- FireHall

Fire Hall 01 station is located in 9 Columbia Ave West, Devon, Alberta. The existing building has developed in two duration, 567 m2 built before 2000 and expanded by 108m2 after 2011. The building has developed in one story on the ground level including a large parking bay with three rollup doors, office spaces, demonstration area, kitchenette, training room, storage and washrooms.

The received documentation for processing the building energy system is a tender issued drawing in July 2011 "Devon Firehall proposed addition and renovation" and also the notes provided by the town facility manager which are listed in Table 12.

Figure 11: Fire Hall 01 station, 9 Columbia Ave West, Devon (Google Map)

Table 12: List of utilized building energy systems (refer to the tender set 2011 and the town facility manager)

Category	Description
Floor area	675 m^2
Built year	Estimated before 2000 and expanded in 2011
Schedule and Occupancy	Building Work Schedule: - WD: 8:00 am-4:30pm - WE: Closed Setpoint temperature: - 21 C with no off-hour's settings Occupancy: - Staff do occupy facility for emergencies
Envelope	- Exterior wall is EIFS with 2" EPS rigid insulation - Roof is made of 2ply SBS with 4" Polyiso extended over the entire roof

Category	Description
	- Slab on the ground includes 2" extruded polystyrene insulation around the edge with 1.2m vertical height
HVAC	Equipment inventory in the expansion area: - 1x Gas fired RTU (LENNOX), 97 MBU input and 77.6 MBU output, heat/cool unit, w/ economizer and low ambient kit, programmable, meet Alberta Building Code 2006 - 4-ton air conditioning and condenser unit for existing MAYTAG PGF furnace (old part of building) - 2x Exhaust fans in kitchenette, and training room with 350 and 300 cfm - 1x exhaust fan in the storage room with 600cfm HVAC Control: - Its confirmed availability of occupancy sensors in washrooms and storage rooms
Domestic water heating	- Gas fired water heating tank
Lighting	- Luminaire type: Fluorescent for interior - Total power density: 2.28 kW - Lighting control: Not available - Exterior lighting: Metal halide with photocell control
Special process load	Gas range in the kitchen

3.1.3.1 Site visit and primary assessment

Night setback temperature adjustments for the infrared tube heaters in the fire truck parking garage were discussed during our visit. Since this facility is used for emergencies, night setback temperatures for the infra red tube heaters were not recommended.

3.1.3.2 Utility data analysis

Per average of utility data analysis from 2023-2024, the building's annual energy consumption was 840 GJ, with 79% of this coming from gas use for HVAC and water heating, and gas process load, and 21% from electricity used for systems like lighting and plug loads. The total carbon emissions from the facility amounted to 61.7 tonnes of CO2eq, with 56% of emissions resulting from gas use and 44% from electricity consumption.

In terms of energy costs, the largest expense was electricity at 71%, followed by gas at 23% and water at 6%, see Table 13.

When compared to a similar building type (Fire Hall station) in the Energy Star Portfolio Manager benchmark, Fire Hall 01 shows an 8% improvement in energy consumption. Given the building's usage schedule and frequency, there are low-cost opportunities to optimize energy performance and contribute to carbon savings across the portfolio.

Table 13: Distribution of energy resources, energy charge, and GHG emission

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
Fire Hall 01	GJ	$	tonne CO2	GJ	$	tonne CO2	M3	$
2023	655	3,810	34.4	182	9,188	27.4	31.00	755
2024	667	3,248	35.0	177	9,800	26.5	39.50	835

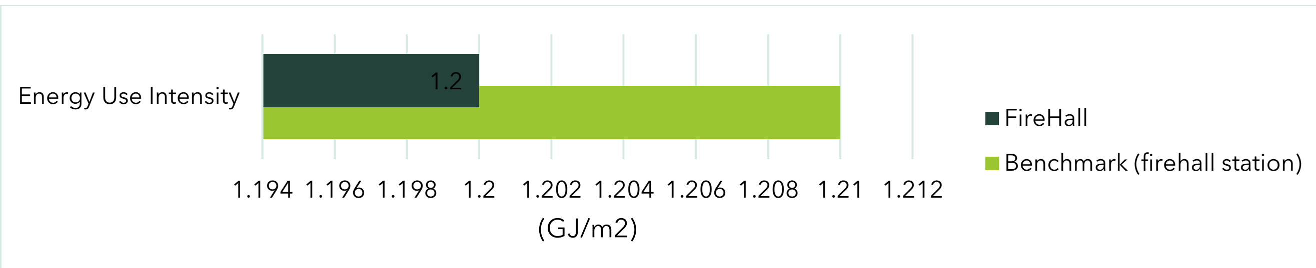


Figure 12: Comparison of Total Building Energy Use with Benchmark (National Median of Peer Cases)

3.1.4 Building 4- RCMP

The RCMP (Royal Canadian Mounted Police) building is located at 13 Columbia Avenue West, Devon, Alberta. It serves as the front desk for the police department, with a floor area of 451.46m² based on utility data. There is limited information available about the building's energy system, and Table 14 presents the details gathered from Google Maps and notes provided by the town's operations manager.

Figure 13: RCMP, 13 Columbia Avenue West, Devon

Table 14: List of utilized building energy systems (refer to google map, engineering judgement, and town operation manager)

Category	Description	CIMA+ comment
Floor area	451.46 m^2	
Built year	Estimated before 2000	
Schedule and Occupancy	Building Work Schedule: - WD: 8:00 am-4:30pm - WE: Closed Setpoint temperature: - 22 C with no off-hour's settings Occupancy: - Information not provided	Information provided by the town operation manager.
Envelope	- Information not provided	Based on non-residential neighbor buildings, it estimated the building follows as below. - Exterior wall is EIFS with 2" EPS rigid insulation - Roof is made of 2ply SBS with 4" Polyiso extended over the entire roof - Slab on the ground includes 2" extruded polystyrene insulation around the edge with 1.2m vertical height

Category	Description	CIMA+ comment
HVAC	HVAC system: - Information not provided HVAC control: - Information not provided	Based on google map showing roof top and utility data analysis, its estimated RCMP is utilizing gas fired RTU or gas furnace integrated with condensing unit (AFUE <80%) Additional recognized system is an exhaust fan in the north-west side of the building.
Domestic water heating	- Information not provided (assumed gas fired water heating tank)	
Lighting	- Luminaire type: Information not provided - Total power density: Information not provided - Lighting control: Not available - Exterior lighting: controlled by photocell	The primary assumption is fluorescent since the first choice of the town facilities has been fluorescent. The lighting density assumption is Alberta Building Code.
Special process load	- No information was provided.	

3.1.4.1 Utility data analysis

Per average of utility data analysis from 2023-2024, the building's annual energy consumption totalled 432 GJ, with 57% of this coming from gas use for systems such as HVAC, water heating, and gas process load, and 43% from electricity used for lighting and plug loads. The facility's total carbon emissions amounted to 40.69 tonnes of CO2eq, with 68% of emissions resulting from electricity consumption and 32% from gas use.

In terms of energy costs, the building's largest expense was electricity at 72%, followed by gas at 16% and water at 12%, as shown in Table 15.

When comparing the energy use intensity to a similar building type (Police station) in the Energy Star Portfolio Manager benchmark, the RCMP building demonstrates a 21% improvement in energy consumption.

Table 15: Distribution of energy resources, energy charge, and GHG emission

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
RCMP	GJ	$	tonne CO2	GJ	$	tonne CO2	M3	$

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
2023	228	1,596	11.9	199	7,598	29.9	79.1	1146
2024	268	1,550	14.0	169	6,752	25.4	97.0	1342

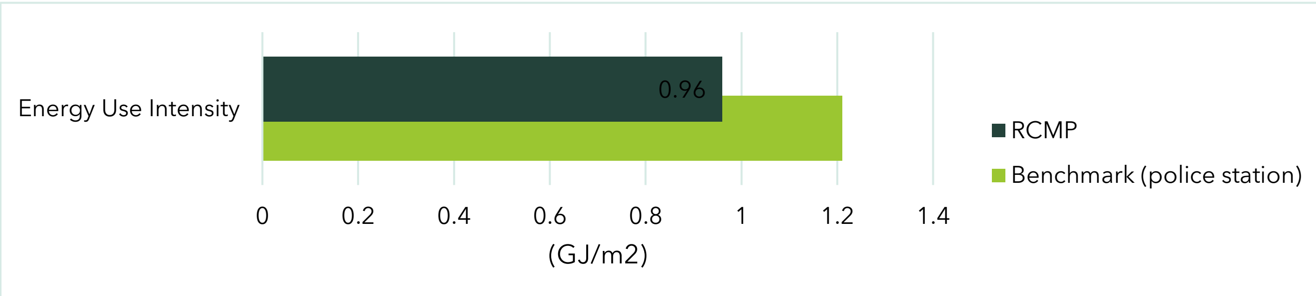


Figure 14: Comparison of Total Building Energy Use with Benchmark (National Median of Peer Cases)

3.1.5 Building 5- Public Work/Shop Station

The Town Shop Station, located at 10 & 11 Exploration Drive, Devon, Alberta, serves as a service area for the town's mini trucks. According to the building expansion drawing from July 2008, the original floor area is 645 m², with an additional 309 m² of space added. The energy system designed for the expanded area is outlined in Table 16, along with additional notes from the town's facility manager.

Figure 15: Town Shop Station, 10 & 11 Exploration Drive, Devon (Google Map)

Table 16: List of Utilized Building Energy Systems in the Building

Category	Description	CIMA+ comment
Floor area	966 m^2	

Category	Description	CIMA+ comment
Built year	Estimated before 2000	
Schedule and Occupancy	Building Work Schedule: - WD: 8:00 am-4:30pm - WE: Closed Setpoint temperature: - 22 C during occupied hours - 18 C during unoccupied hours Occupancy: - Information not provided	
Envelope	- Exterior wall is composed of 2x8 @ 16" OC with R20 Fiberglass batt - Roof is made of engineered truss @24" with R40 infill insulation - No insulation below slab or at the slab edge.	As noted in the drawing, the designed envelope is in consistency with the existing building.
HVAC	Equipment inventory: - 3x gas infrared tube heater - 1x gas ceiling hung unit heater - 2x wall mount exhaust fan HVAC Control: - Its confirmed Washrooms, file room, and hallways controlled by occupancy sensors	The information for the former developed floor area is not provided and it's assumed the building is using the same HVAC type for the rest of building.
Domestic water heating	- Electric hot water heater (2.250 kW) - assumed gas water heating tank per design for peer buildings	
Lighting	- Luminaire type: Fluorescent - Total power density: its measured 4.104 kW for the additional area its estimated 8.56 kW for the existing area - Lighting control: - Exterior light: Metal Halide (total 1600W) controlled by photocell	

3.1.5.1 Utility data analysis

Per average of utility data analysis from 2023-2024, the building's annual energy consumption totalled 1,125 GJ, with 71% of this coming from gas use for systems such as HVAC, water heating, and gas process loads, and 29% from electricity used for lighting and plug loads. The facility's total carbon emissions amounted to 90.79 tonnes of CO2eq, with 54% of emissions resulting from electricity consumption and 46% from gas use.

In terms of energy costs, the building's largest expense was electricity at 69%, followed by gas at 20% and water at 11%, see Table 17.

When comparing the energy use intensity to a similar building type (Service Shop) in the Energy Star Portfolio Manager benchmark, the Town Shop Station's energy consumption shows a 2% improvement.

Table 17: Distribution of energy resources, energy charge, and GHG emission

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
Public Shop	GJ	$	tonne CO2	GJ	$	tonne CO2	M3	$
2023	737	4,325	38.77	325	14,692	48.7	317	2148
2024	864	4,106	45.45	324	14,522	48.6	321	2336

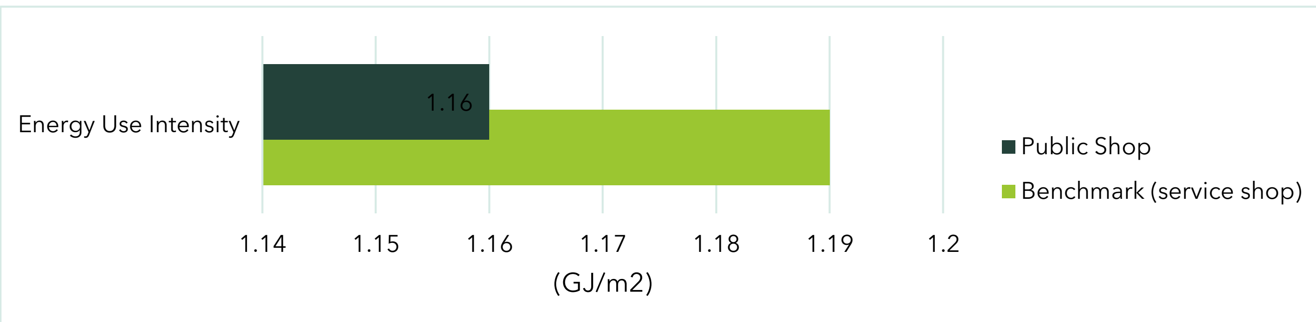


Figure 16: Comparison of Total Building Energy Use with Benchmark (National Median of Peer Cases)

3.1.6 Building 6- Town Office

Town office building provides the town administration service with 912m^2 floor area located in 1st Columbia Ave W, Devon, Alberta. According to the building permit drawing set issued in January 2000, the building serves spaces of council, conference, offices, storage, washrooms, and mechanical rooms. The available details of drawing set are listed in Table 18.

Figure 17: Town Office, 1st Columbia Ave W, Devon (Google Map)

Table 18: List of utilized building energy systems (refer to permit set 2000 and the town operation manager)

Category	Description	CIMA+ comment
Floor area	912 m^2	
Built year	2000	
Schedule and Occupancy	Building Work Schedule: - WD: 8:00 am-5:00pm - WE: Closed Setpoint temperature: - 21 C and no off-hour's settings Occupancy: - Information not provided	
Envelope	- Exterior walls are composed of 2x6 stud @ 16" OC and with R20 batt insulation - Flat roof is made of engineering truss with 3" rigid insulation continuous over the entire roof - Sloped roof is made of engineering truss with R40 within between truss spacing - 2" rigid insulation is installed at interior side of basement wall and there is no insulation below the slab or foundation.	
HVAC	Equipment inventory: - 5x gas fired RTU (680 MBH) ventilate council, north open office, basement, enclosed offices - 2x forced flow heating serve storage room and stairs	

Category	Description	CIMA+ comment
	- Gas hydrant baseboards connected to the boiler (630 MBH) serve enclosed offices - 1x radiant heating serves washrooms - 2x exhaust fans serve washrooms HVAC Control: - Not available	
Domestic water heating	- Gas water heating system (32 MBH)	
Lighting	- Luminaire type: Fluorescent (F32T8 & PL DDT) - Total power: 2.66 kW - Lighting control: Occupancy sensors in hallways, washrooms, lunchroom, file/copy rooms, and closets - Exterior light: Metal Halide (104 W) controlled by photocell	
Special process load	Gas cook stove	

3.1.6.1 Utility data analysis

Per average of utility data analysis from 2023-2024, the building's annual energy consumption totals 997.83 GJ, with 72% attributed to gas usage for systems such as HVAC, water heating, and gas process loads, and 28% from electricity for systems like lighting and plug loads. The building's total carbon emissions amount to 79.6 tonnes of CO2eq, with 52% of emissions coming from electricity consumption and 48% from gas use.

In terms of energy costs, the highest expense is electricity (71%), followed by gas (21%) and water (8%), as shown in Table 19.

When comparing the building's energy use intensity to a similar office building type in the Energy Star Portfolio Manager benchmark, the town office shows a 19% improvement in energy consumption.

Table 19: Distribution of energy resources, energy charge, and GHG emission

Building name	Gas			Electricity			Water	
	Energy used	Charge	emission	Energy use	Charge	emission	Energy use	Charge
Town Office	GJ	$	tonne CO2	GJ	$	tonne CO2	M3	$
2023	707	4,026	37.2	278	12,725	41.6	111.1	1311
2024	732	3,762	38.5	279	13,485	41.85	129.9	1489

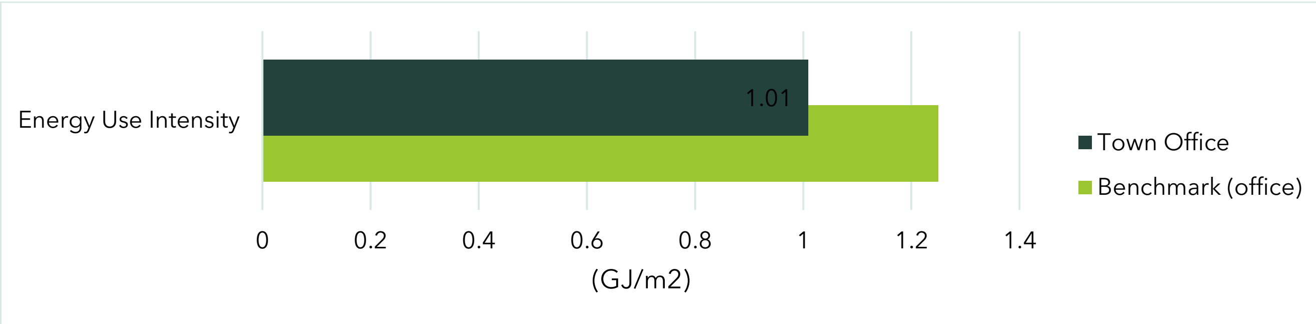


Figure 18: Comparison of Total Building Energy Use with Benchmark (National Median of Peer Cases)

4. Emission Reduction Strategies

To evaluate the portfolio's performance, CIMA+ utilizes the review of carbon emissions from natural gas and electricity along with the energy costs presented in Section 1.3. to challenge the major energy system applied in the portfolio and highlight potential opportunities for reducing energy consumption and GHG emissions. The recommended energy conservation measures (ECMs) and their contribution in achieving the target GHG reduction will be addressed in the following sections.

4.1.1 Energy Conservation Measures # 1 – Upgrading Domestic Hot Water Heating System

Focusing on the portfolio's water heating system, 14% of the total natural gas consumption is allocated to domestic water heating, amounting to 1344 GJ of gas use and emitting 70.7 tonnes of GHG per year. Figure 19 illustrates the distribution of energy demand versus water used across the portfolio, assuming the total measured water use is connected to the heating system.

Replacing the current system with a heat pump that has a coefficient of performance (COP) greater than 2.5 could significantly reduce energy consumption and carbon emissions. Table 20 highlights the potential impact of various domestic water heating systems on reducing GHG emissions. As indicated, a solar heat pump water heating system offers the greatest benefit by combining the advantages of solar thermal energy with heat pump technology and reducing total 7% energy use and 7.7% emission of the portfolio. While the initial investment may be higher than conventional systems, it can result in considerable savings on energy bills over the system's lifetime. Contribution of gas heat pump is very close to the solar heat pump; however, it will need reconsideration if the Town is planning to approach Net-Zero and green technologies.

Considering annual energy cost savings under different scenarios, the solar heat pump saves $6317, followed by the gas heat pump with $4296 in savings. In contrast, an electric heat pump would increase annual costs by $11,747 due to the higher cost of electricity per GJ.

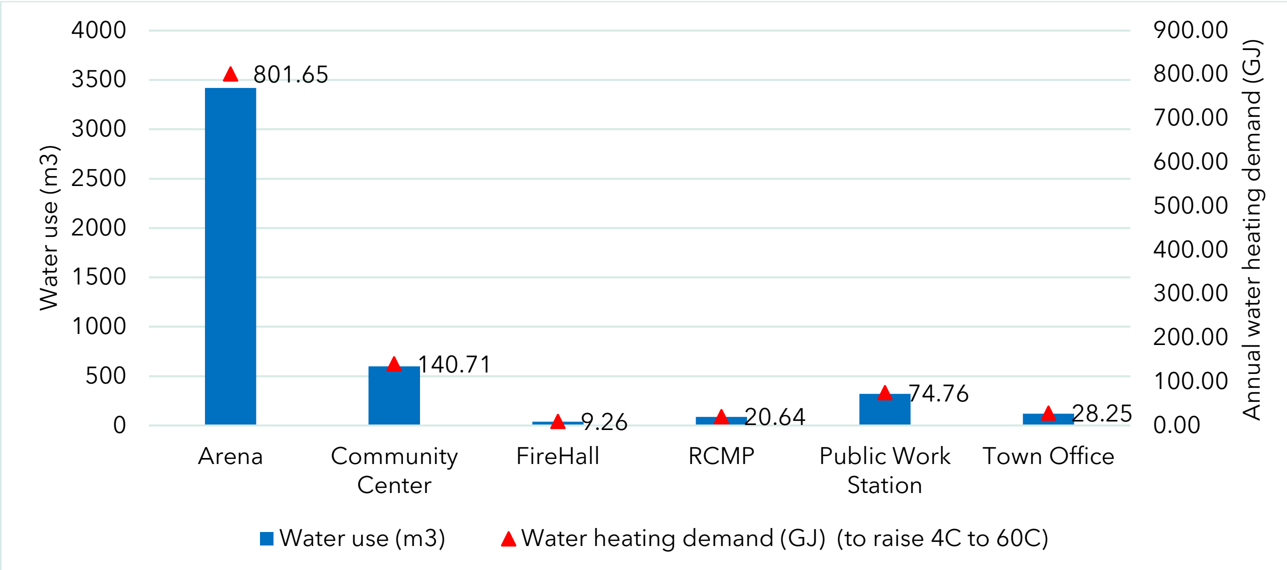


Figure 19: Distribution of annual water use and required heating to increase the temperature from 4C to 60C

Table 20: Proposed water heating system for effective portfolio retrofitting and decarbonization

Cost category-Electricity	System type and efficiency	Annual energy demand (GJ)	GHG emission (tonne CO2)	Annual energy saving (%)	Annual GHG saving (%)
Domestic water heating demand	-	1075	-	-	-
Current water heating system	Gas fired water heating with 80% efficiency	1344	70.7	-	-
Proposed system (i)	Electric heat pump with COP> 2.5	430	64.5	7%	1%
Proposed system (ii)	Gas heat pump with COP> 2.5	430	22.6	7%	5%

Cost category-Electricity	System type and efficiency	Annual energy demand (GJ)	GHG emission (tonne CO2)	Annual energy saving (%)	Annual GHG saving (%)
Proposed system (iii)	Solar heat pump water heating with COP > 2.5	430	0	7%	7.7%

4.1.2 Energy Conservation Measures # 2 – Integrating BAS and ODV Systems with the Portfolio

Subtracting the required natural gas used for water heating systems from the utility data, its calculated 8427 GJ natural gas used by HVAC systems for spaces heating. As recorded, there is not a clarified control on the system operation except Arena that is controlled manually by the building manager and public workstation which has night cycle setback.

The heating energy use intensity of office spaces falls between 0.46 to 0.96 (GJ/m2) with an average of 0.57 GJ/m2. While the expected range for office buildings in cold climate (ASHRAE zone 7) is between 0.18-0.25. The critical condition among office spaces belongs to the Town office which has two times higher demand from the upper limit of office spaces. Regarding the office spaces mixed with garage, the expected range falls between 0.18-0.36 (GJ/m2) and Firehall is consuming three times of the upper limit and public workstation two times. Regarding Arena, ice rink building type, the expected range is higher due to the activity types of building and the expected heating energy use is between 0.18-0.54 (GJ/m2), and Arena consumes 30% more than the higher limit. Figure 20 shows the heating energy use density per buildings compared to the expected range for the building type.

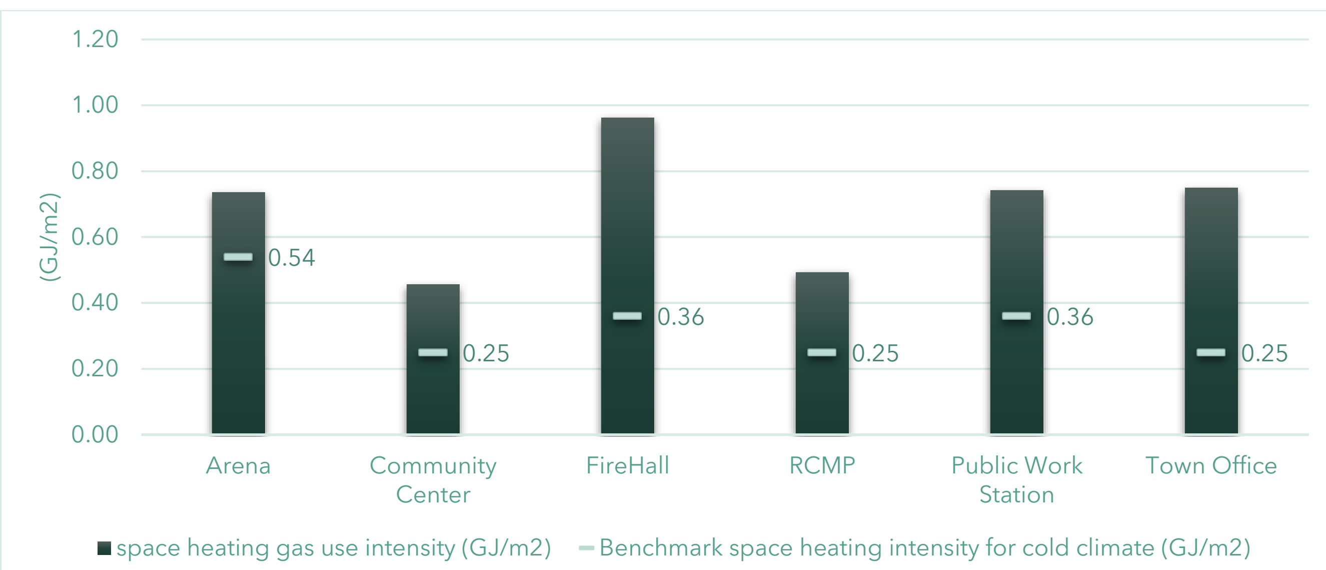


Figure 20: Distribution of space heating energy use intensity in the portfolio

The installed systems have low efficiency (<80%) and many of the heating systems are beyond their effective lifespan, causing the HVAC system to fail in achieving optimal operation. This results in excessive energy consumption. To address this energy loss across the portfolio, the primary recommendation is to integrate a Building Automation System (BAS) and Occupant Demand Ventilation (ODV) with the current energy systems.

BAS helps reduce heating consumption through the following steps:

- Optimized HVAC Operation: BAS enables scheduling and real-time adjustments to heating systems, ensuring that heating is only used when necessary. It can turn off or reduce heating in unoccupied areas or when outdoor temperatures are mild.
- Temperature Setpoint Control: BAS dynamically adjusts temperature setpoints based on factors like occupancy and weather conditions. For instance, it can lower heating during off-hours or overnight and increase it when occupancy is expected, or outdoor temperatures drop.
- Load Shedding and Energy Efficiency: BAS prioritizes heating in spaces that need it most, reducing heating demand in less critical areas. It can also integrate with energy management systems to enhance overall building energy efficiency.
- Prevent Overheating: BAS ensures that the building does not overheat by maintaining precise temperature control, preventing systems from working unnecessarily hard and wasting energy.

ODV contributes to heating consumption by implementing the following strategies:

- Reduced Ventilation Load: Traditional HVAC systems often use fixed schedules or occupancy estimates for ventilation. ODV systems adjust ventilation rates based on actual occupancy, ensuring that fresh air is provided only when needed. By reducing unnecessary ventilation, ODV decreases the workload of heating systems that must compensate for incoming cold air.
- Demand-Based Fresh Air Intake: ODV reduces the intake of cold outdoor air when fewer occupants are present, lowering the need for additional heating to warm incoming air. This can lead to substantial heating demand reductions, particularly during winter.
- Improved Comfort: ODV maintains indoor air quality without over-ventilating, enhancing occupant comfort and reducing the need for heating systems to compensate for excessive air exchange.

Studies indicate that implementing BAS can reduce overall energy consumption by 5–15%, while ODV can reduce heating demand by 10–20%. The combined impact of BAS and ODV could result in a 15–30% reduction in heating consumption, depending on how effectively the systems are integrated and tailored to building needs. With the lower limit of operation control impact considered, the estimated contribution of BAS and ODV would be a reduction of 1264 GJ, equivalent to a 66.48 tonne reduction in CO2eq emissions of the portfolio (7% of total GHG emission).

4.1.3 Energy Conservation Measures # 3– Upgrading the Outdated HVAC Systems

The secondary recommendation for improving heating energy use is to retrofit the HVAC systems that are in poor condition due to their low efficiency or nearing the end of their lifespan. It is recommended to replace these systems with high-efficiency, advanced technologies. Based on the provided documents, some systems should be prioritized for action. Table 21 outlines the estimated energy cost savings and GHG reductions for each system.

Upgrading the listed systems has the potential to reduce energy consumption by 3107 GJ and cut CO_2 emissions by 163 tonnes, which represents approximately 18% of the current energy use in the operating portfolio.

Table 21: Recommended HVAC system replacement and their contribution to the energy-carbon saving

Building	Current System type and efficiency	Proposed system	Heating capacity	Annual saving vs the current	
				Energy (GJ)	GHG (tonne CO2eq)
Arena	Natural gas fired MAU serving concession kitchen (AFUE 80%)	Electric or gas fired heat pump MAU with COP> 2.5	123.1	907.33	47.73
	5x Natural gas fired RTH serving ice rink (AFUE 55.6%)		159.7	1177.10	61.92
Community Center	5x gas fired RTU with OA intake (AFUE 80%)	Electric or gas fired heat pump RTU with COP> 2.5	-	441.40	23.22

Building	Current System type and efficiency	Proposed system	Heating capacity	Annual saving vs the current	
				Energy (GJ)	GHG (tonne CO2eq)
		Electric or gas fired heat pump MAU with COP> 2.5 for kitchen	-		
Firehall	1x Gas furnace serving the old building w/ AFUE < 80%	Electric or gas fired heat pump RTU with COP> 2.5	-	147.20	7.74
RCMP	As is	Electric or gas fired heat pump RTU with COP> 2.5	-	151.10	7.95
Town Office	5x gas fired RTU w/ AFUE < 80%	Electric or gas fired heat pump RTU with COP> 2.5	199.2	282.56	14.86
	Boiler w/ AFUE < 80%	Electric or gas fired heat pump with COP> 2.5	-	-	-

MAU: make up air unit
RTH: radiant tube heater
RTU: rooftop unit

4.1.4 Energy Conservation Measures # 4 – Upgrading Lighting Types and Control System

Considering the reviewed lighting layout in the portfolio, fluorescent is the widely utilized lighting type applied with limited occupant's sensor or dimming in the major spaces of the portfolio. Fluorescent lights are around 35-40% efficient in converting electricity into light while LED lights are much more efficient, typically around 80-90% efficient in converting electricity into light. For instance, a 32-watt fluorescent bulb might be replaced by an 18-watt LED that delivers the same amount of light (lumens). Hence, by switching a 32 watts fluorescent bulb to an LED 18 watts, it is possible to save 14 watts per bulb resulting in $18.5 cost and 66 kgCO2eq saving per year per bulb.

Per received drawings from the town of Devon, its estimated range between 821.5 to 1686 GJ electricity to be used for interior spaces utilizing ASHRAE 90.1 schedule and continuously on during working days as the best and worse case scenarios. By switching the current fluorescent lighting to LED for all buildings excluded Arena, the lighting load reduces by 26% which is potential to drop the electricity consumption range to 662-1245 GJ. Focusing on the minimum range of energy reduction, turning lighting types to LED helps to reduce portfolio electricity use by 5% , accounting for 159.82 GJ electricity use, 23.97 tonneCO2eq (3% of total GHG reduction), and $6712 energy cost per year.

For the town information, Figure 21 reveals the effect of adding scheduled control over the lighting power use of the portfolio compared to the continuously on schedule. As shown, an average of 865 (GJ) annual electricity reduction occurs by switching the continuously on lighting to scheduled based on occupancy presence and daylight[5]; it contributes to approximately 130 tonne GHG reduction (18% of annual baseline GHG) and $36,310 cost saving.

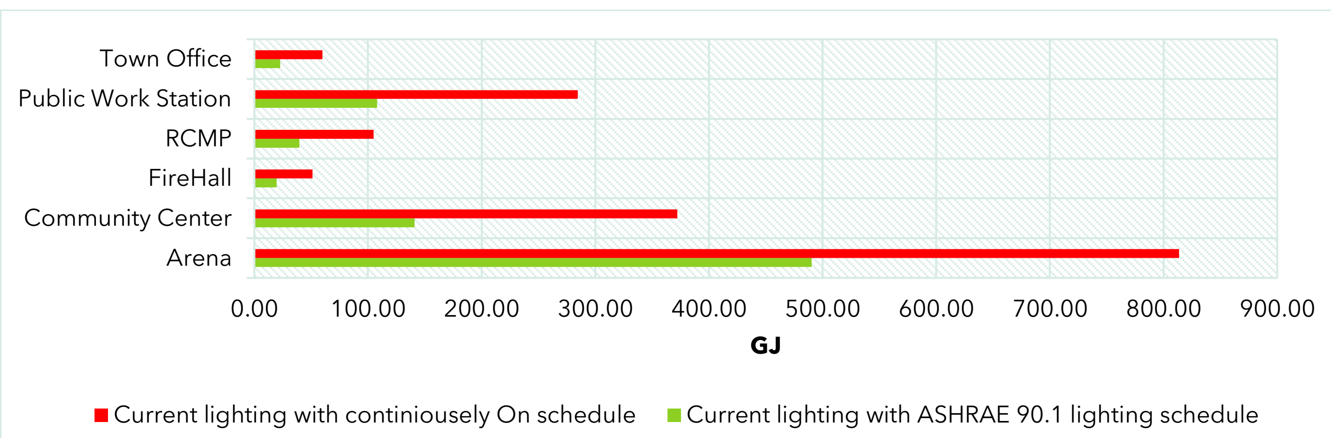


Figure 21: Review the lighting control energy saving scenarios over the baseline lighting power use in the portfolio

[5] ASHRAE 90.1-2016 (User's Manual), Table G-E for assembly use-type and Table G-H for office spaces

4.1.5 Energy Conservation Measures # 5 – Energy Recovery System Addition

ECM#5 provides an analysis of adding energy recovery systems to recover energy from the compressors of the ice plant in the Arena. Per Scoping audit-2019, Arena utilizes two compressors, 60 HP/each to serve the ice plant refrigerant cycle. Implementing energy recovery systems to harness waste heat from ice plant compressors can lead to substantial energy savings, particularly in space heating applications. By capturing and repurposing this waste heat, facilities can markedly reduce their reliance on traditional heating systems.

Studies have shown that ice rinks equipped with heat recovery systems can achieve overall heating savings exceeding 75%. This is achieved by utilizing the waste heat generated by the ice plant—often more than sufficient to meet the daily heating requirements of the facility. The recovered heat can be employed for various purposes, including space heating, domestic water heating, and preheating ventilation air. Similarly, air compressors, which are only 10-15% efficient, dissipate 85-90% of their energy input as waste heat. Implementing heat recovery systems can capture this excess thermal energy, which can then be used to heat spaces within the facility.

To estimate the potential of the heating energy, a 100-horsepower compressor can have up to 156,000 Btu/hr of recoverable heat. Recovering even half of that heat throughout the year could result in significant energy savings, translating to reduced operational costs and a smaller carbon footprint.

By effectively integrating waste heat recovery systems, ice plants can enhance their energy efficiency, leading to considerable reductions in energy consumption and operational expenses.

4.1.6 Recommendation #6 - Renewable Energy Integration

ECM 5 evaluates the potential of renewable solar power to reduce the electricity demand of the portfolio by replacing grid-supplied electricity. By installing one square meter of Monocrystalline Silicon photovoltaic (PV) panel (Table 22), approximately 215 kWh per year can be harvested. Based on initial analysis, the facility could achieve a 5% reduction in GHG emissions by shifting 304 GJ of onsite electricity consumption from the grid to PV-generated electricity. This would be possible by installing 393 m² of PV panels on unused spaces such as building roofs and parking canopies, see Figure 22 for potential suitable areas. To fully meet the electricity demand, a PV installation of 3,415 m² would be needed. However, the required area could be significantly reduced if the building's operations are optimized.

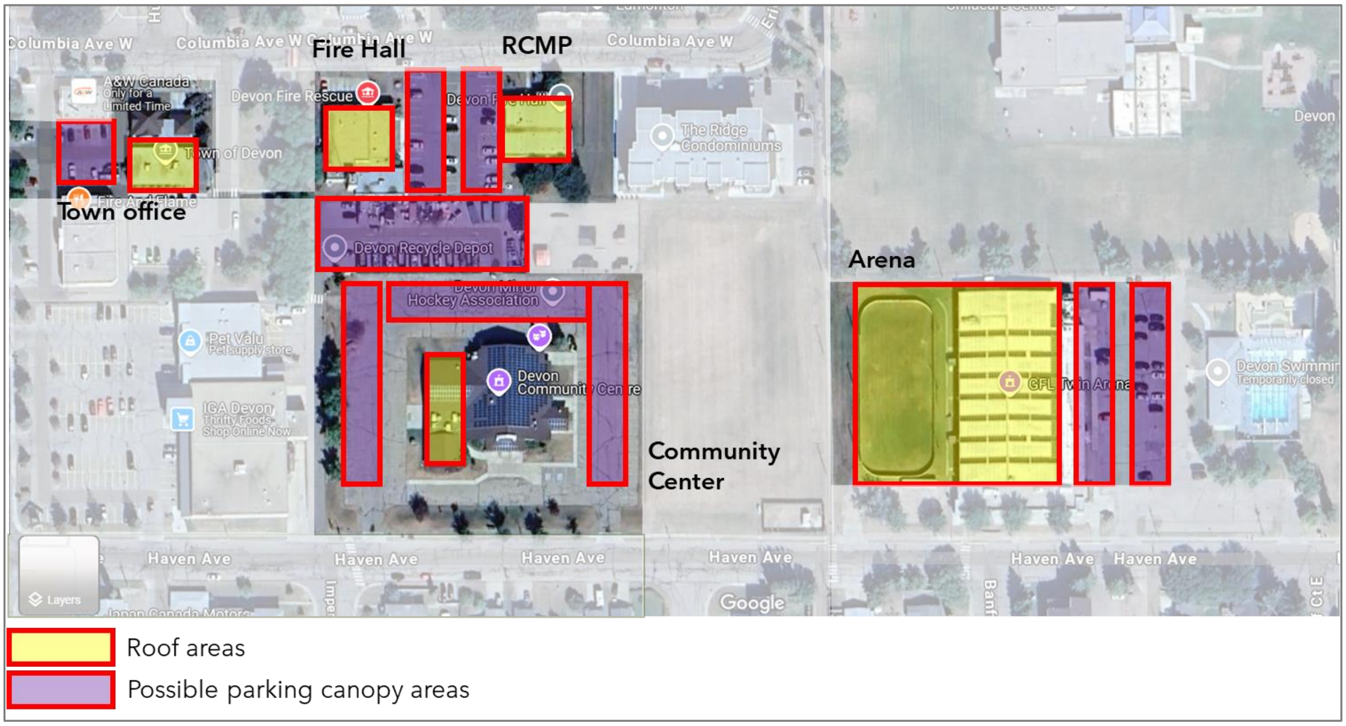


Figure 22: Potential roof and parking canopy areas for PV installation

Table 22: Specification of modeled photovoltaic panel

Monocrystalline Silicon Specification		
Module Nominal Efficiency	-	0.2
Nominal Cell temperature	(C)	42
Reference irradiance for NOCT	(W/m2)	1000
temperature coefficient for module efficiency	(%/C)	-0.36
Rated power	(kWdc/m2)	0.2
Degradation factor	0.99	0.99
Electrical conservation efficiency	0.96	0.96
Azimuth	(Degree)	180
Inclination	(Degree)	0
Shading factor	-	1

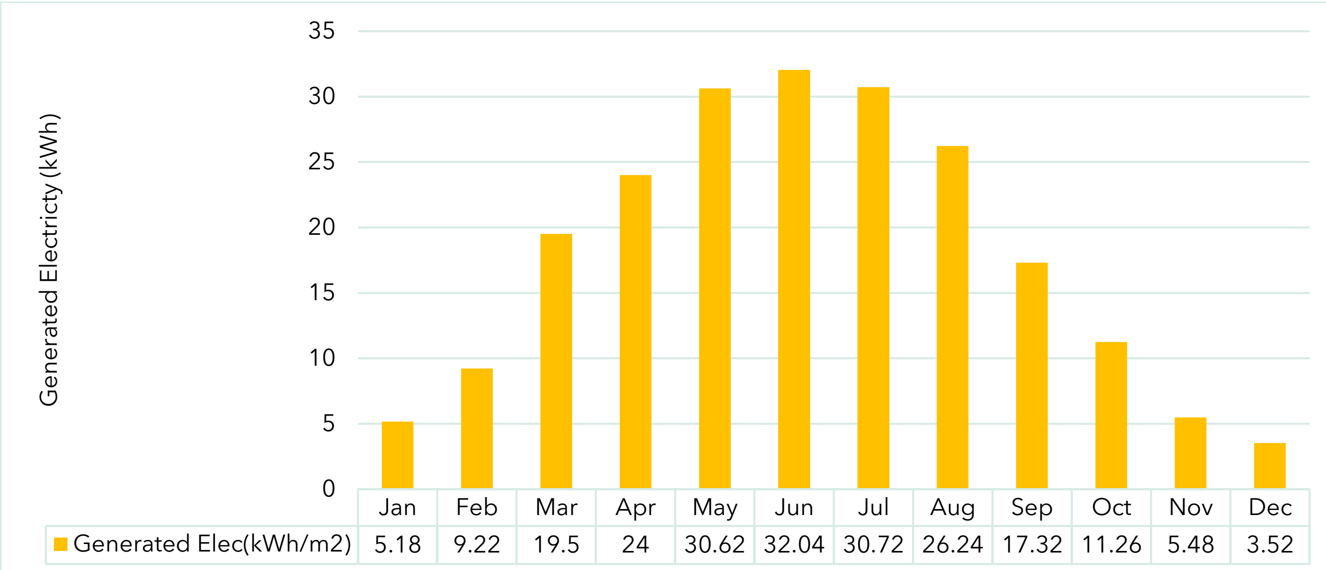


Figure 23: Breakdown of electricity generation per square meter of PV panels

5. Conclusion

In conclusion, the proposed Energy Conservation Measures (ECMs) offer significant opportunities to enhance energy efficiency, reduce greenhouse gas (GHG) emissions, and lower costs across the portfolio. Upgrading the gas water heating system with an Air Source Heat Pump (ASHP) provides notable savings, reducing total annual energy consumption by 7% and cutting portfolio GHG emissions by 5%. The integration of the Building Automation System (BAS) and Outdoor Air Ventilation (ODV) with the energy systems of the portfolio has the potential to deliver a 10% reduction in energy use and a 7% decrease in GHG emissions annually.

Replacing the aging gas-fired HVAC system (over 25 years old per Table 21) with ASHP technology brings substantial savings, reducing annual energy consumption by 25% and lowering GHG emissions by 18%. The lighting upgrade across the entire portfolio, excluding Arena, from fluorescent to LED results in modest improvements, with a 1% reduction in energy consumption and a 3% decrease in carbon emissions. The most impactful measure is integrating energy recovery with the Arena ice plant system (considering 2,190 hours operation per year), yielding the greatest reductions in both energy use and GHG emissions. This measure alone accounts for 24% of the total energy savings and 17% of the GHG reductions.

Table 23: Matix of proposed Energy Conservation Measures (ECM) and their contribution to the annual energy, carbon, cost saving compared to the status quo

ECM	Description	Annual saving vs the status quo					
		Energy (GJ)	GHG (Tonne CO2)	Cost ($)	Energy (%)	GHG (%)	Cost (%)
Status que, representing current condition		12415	911	157849	0	0	0
1	Upgrading gas water heating system with ASHP for all buildings	914	48	4296	7%	5%	3%
2	Integrating BAS and ODV with the energy systems for all buildings	1264	66	5941	10%	7%	4%
3	Upgrading gas HVAC with ASHP systems per Table 21	3107	163	14603	25%	18%	9%
4	Upgrading Lighting type and control system for all buildings excluded Arena	160	24	6712	1%	3%	4%
5	Integrating energy recovery with Arena ice plant system	2931	154	1377	24%	17%	9%

Furthermore, CIMA+ offered an additional recommendation to assess the potential of the site area for renewable solar energy generation. This renewable energy source could serve as a viable alternative to the grid electricity currently in use, significantly reducing the carbon footprint associated with energy consumption. By generating solar power on-site, the carbon emissions could be mitigated by approximately 150 kg/GJ of energy produced. In addition to this, CIMA+ suggested exploring the feasibility of installing solar panels to maximize the site's energy production potential, taking into account factors such as roof space, orientation, and local climate conditions to optimize energy generation.

When combined with the other energy conservation and decarbonization measures, these solar energy initiatives present an opportunity to achieve substantial savings, not only in terms of energy consumption and cost but also in reducing greenhouse gas (GHG) emissions. The cumulative impact of these actions could result in a level of GHG reduction that exceeds the initial target of 5%, contributing to the Town's long-term sustainability goals and positioning it as a leader in environmentally responsible practices. Through these efforts, the Town could potentially reduce reliance on non-renewable energy sources, enhance energy security, and further align with regional and national climate change mitigation strategies.

6. Key terms and abbreviation

Air Change per Hour (ACH); A measurement of air exchange which is the total volume of air in a space or building that is turned over in one hour.

Air Conditioning (AC); A system that removes heat and humidity from an enclosed space to create a more comfortable environment.

Air-sourced Heat Pump (ASHP); A heating and cooling system that transfers heat from the outside air into a building in the winter and removes heat from a building and transfers it outside in the summer.

ASHRAE; American Society of Heating, Refrigerating and Air-Conditioning Engineers.

British Thermal Unit (BTU); Unit of measurement for heat energy.

Building Automation/Management System (BAS); A control system capable of monitoring environmental and system loads and adjusting HVAC operations accordingly to conserve energy while maintain comfort.

Canadian Weather Year for Energy Calculation (CWEC); A dataset created by the Canadian government that provides typical weather conditions for a specific location.

Cubic Feet per Minute (CFM); A volumetric measurement for air flow in buildings.

Coefficient of Determination (R^2); A statistical metric that measures how well a regression model fits the data, with values ranging from 0 to 1.

Coefficient of performance (CoP); A measure of the efficiency of a heat pump or refrigeration system. It's the ratio of the heating or cooling output to the electrical energy input.

Current Replacement Value (CRV); The amount that an entity would have to pay to replace an asset at the present time, according to its current worth.

Domestic Hot Water (DHW); Heated water used for purposes of washing, cooking, etc.

Direct Expansion (DX); A type of air conditioning system where a pressurized liquid refrigerant is expanded and evaporates into gaseous form to produce a cooling effect.

Electrical Vehicle (EV); A vehicle that can be powered by an electric motor that draws electricity from a battery and is capable of being charged from an external source.

Energy Conversion Measure (ECM); the process of upgrading a facility's equipment or systems to reduce energy consumption.

Energy Efficiency Ratio (EER); A measure of the cooling efficiency of an HVAC system.

Energy Star; Program designed by the US Environmental Protection Agency to help market equipment, appliances, homes, and buildings that use less energy.

Energy Use Intensity (EUI); The annual energy usage for a specific fuel and end use per square foot of end-use floor stock.

IES VE; Its an hourly based energy simulation software validated by ASHRAE 140 standard to predict a building's energy consumption and evaluate the impact of design decisions on energy efficiency.

Facility Condition Index (FCI); The total cost of needed building repairs and renewal divided by the current cost of replacing the building.

Greenhouse Gas (GHG); The gases in the atmosphere that raise the surface temperature of planets such as the Earth.

Ground Source Heat Pump (GSHP); A geothermal heat pump is a heating and cooling system that utilizes the constant temperature of the earth as a heat source or heat sink.

Heating Degree Days (HDD); A measurement designed to quantify the demand for energy needed to heat a building. HDD is derived from measurements of outside air temperature.

High Volume, Low Speed (HVLS); Large industrial ceiling fans designed to circulate air efficiency and effectively in expansive spaces.

HVAC; The equipment, distribution network and terminals that are used to provide the processes of heating, ventilation, or air-conditioning in a building.

Insulated Glass Unit (IGU); Window units made of multiple glass panels, sealed with a spacer and can be filled with gas between them.

kg eCO_2; Equivalent Kilogram of Carbon Dioxide is a unit used to quantify the total greenhouse gas emissions of a product or process, expressed in terms of the equivalent amount of CO_2.

Light Emitting Diode (LED); A technology that produces light by causing electrons to flow through the lamp and release energy in the form of light.

Makeup Air Unit (MAU); An HVAC system component that brings in fresh outside air, potentially conditions it (heating, cooling, and filtering) and supplies it to a building to replace air that has been exhausted.

MBH (thousands BTUs per hour); A measure of the size of air conditioning system in the traditional Imperial System of measurements.

National Energy Code of Canada for Buildings (NECB); A construction code that regulates the energy efficiency of buildings constructed in Canada.

Natural Resources Canada (NRC); Develops policies and programs to enhance the natural resources sector's economic contribution, improve quality of life, and conduct innovative science.

Normalized Root Mean Square Error (NRMSE); A statistical metric that measures the relative error between predicted and actual values, often used in machine learning and forecasting models.

Photovoltaic (PV); PV systems capture light from the sun and convert it into electricity through solar panels usually installed on roofs.

Roof Top Unit (RTU); A type of HVAC system located on the roof and typically contained within a single packaged unit

R-value; A unit of thermal conductivity resistance used for comparing insulating values of different materials; the higher the R-value the greater its insulating properties

Variable Air Volume (VAV); An HVAC system that varies the air flow rate to meet the temperature requirements.

Variable Frequency Drive (VFD); a type of AC motor drive (system incorporating a motor) that controls speed and torque by varying the frequency of the input electricity.

Variable Volume and Temperature (VVT); This is an HVAC system that controls both the volume and temperature of air delivered to different zones in a building.