THE CITY OF WINDSOR
ONTARIO, CANADA

ENERGY MANAGEMENT PLAN

2024-2028

CITY OF WINDSOR

June 10, 2024

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Executive Summary

This Energy Management Plan (EMP) is prepared in compliance with Ontario Regulation 25/23 - Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans - of the Electricity Act, which has replaced O.Reg. 507/18.

Energy conservation and the strategic management of energy usage are critical steps in contributing to reducing the effects of greenhouse gas (GHG) emissions on the environment, ensuring a reliable energy supply, and securing a sustainable community.

This Energy Management Plan (EMP) builds upon the 2019 EMP and supports the Municipal Environmental Master Plan, Windsor's Community Energy Management Plan and Corporate Climate Action Plan 2017.

The City of Windsor has implemented several measures from the 2019 EMP, listed below.

- Lighting upgrades to LED at multiple facilities, resulting in energy savings of 2,850,050 ekWh/yr, and cost savings of 410,410 $/yr
- Windsor International Aquatic and Training Centre (WIATC) CHP
- Net Metering Project
- Forest Glade Arena Upgrade Project
- EV Charging Stations
- Solar PV installation at the following facilities
  - Optimist Community Centre and Library
  - Forest Glade Community Centre and Library
  - John Atkinson Community Centre
  - Fire Hall 2
  - Fire Hall 5
  - Fire Hall 6 and EOC
  - Fire Hall 7
  - Fire Apparatus Building
  - Parks and Recreation Facilities Storage
  - Parks and Recreation Maintenance Yard
  - South Windsor Library
  - Fontainebleau Library

Table 1 summarizes the proposed actions to be undertaken as part of the 2024 EMP.

Table 1: Summary of planned actions to undertake in the short term (2024-2029)

Facility	Action	Estimated impact on energy use (ekWh/yr)	Estimated impact on in GHG emissions (tCO2e/yr)
Multiple facilities	DHW to heat pump	-786,803	-202
Multiple facilities	HVAC schedule optimization	-558,123	-77
Multiple facilities	HVAC system optimization	-970,014	-137
Multiple facilities	HVAC to heat pump	-2,720,525	-699
Multiple facilities	Lighting upgrade	-665,747	16
Multiple facilities	Pool heat to heat pump	-138,253	-36
Multiple facilities	Roof upgrade to high performance	-333,356	-61
Multiple facilities	Solar PV implementation	-1,044,055	-31
Multiple facilities	Wall upgrade to high performance	-177,239	-32
Multiple facilities	Windows and doors to high performance	-15,603	-3
Capri Pizzeria Recreation Complex	Change room DHW heating to ASHP	-172,827	-42
Capri Pizzeria Recreation Complex	DEH1 and DEH2 mode scheduling	-78,147	-10
Capri Pizzeria Recreation Complex	Exhaust fans to BAS	-10,353	-2
Capri Pizzeria Recreation Complex	Faucet aerator upgrade	-5,017	-1
Capri Pizzeria Recreation Complex	Laundry DHW heating to hybrid	-8,674	-2
Capri Pizzeria Recreation Complex	Old RTU upgrade to ASHP	-732,543	-176
Capri Pizzeria Recreation Complex	RTU OA control upgrades	-128,426	-23
Capri Pizzeria Recreation Complex	Snow melt via recovered heat	-8,887	-1
Forest Glade Arena	AC1 library controls optimization	-29,705	-6
Forest Glade Arena	DEH3 and DEH4 heating electrification	-65,421	-53
Forest Glade Arena	General recommissioning	0	0
Forest Glade Arena	Rink HVAC controls upgrade	-167,791	-26
Gino A Marcus Community Centre	Gym temperature setpoint optimization	-15,932	-3
Gino A Marcus Community Centre	North wing temperature setpoint optimization	-29,948	-5
John Atkinson Community Centre	Boiler upgrade (ASHP)	-66,363	-16
John Atkinson Community Centre	EnergyStar appliances	-2,681	-0
John Atkinson Community Centre	Sports gym DCV	-22,781	-4
John Atkinson Community Centre	Window and door upgrade	-11,459	-2
Optimist Community Centre	Add HVAC1 and HVAC2 to BAS	-100,398	-14
Optimist Community Centre	DHW to ASHP	-6,235	-1
Optimist Community Centre	Disconnect the natural gas fireplace	-15,614	-3
Optimist Community Centre	Temperature setback on AC1 to AC4	-2,684	-0
WFCU Centre	AH101 schedule optimization	-67,786	-11
WFCU Centre	CHP use for Class A peak mitigation	84,821	48
WFCU Centre	DH3, 4, 5 setpoint scheduling	-994,890	-122
WFCU Centre	ERV1, 2, 3 unoccupied heating	-86,281	-13
WFCU Centre	General recomissioning	0	0
WFCU Centre	Low flow shower heads	-91,566	-17
WFCU Centre	P5, P6 variable speed controls	-135,515	-4
WFCU Centre	RTU control upgrade and optimization	-1,499,209	-258

Note: Projects showing zero (0) reductions in emissions or energy use could not be estimated. Also note that "CHP use for Class A peak mitigation" is primarily intended as a utility cost-saving mechanism and is anticipated to result in an increase in the WFCU Centre's energy use and GHG emissions.

Additional projects under consideration include:

- 400 City Hall BrainBox – Pilot Project to implement BrainBox AI (BBAI) to better control and optimize HVAC system controls. BBAI is a cloud based AI that uses a learning algorithm to provide a customized approach to HVAC controls. The system will continually monitor the building to implement real-time optimization and continual improvement during changing climate patterns and building utilization. If successful, the system can be implemented on multiple sites.

- Capri Pizzeria Recreation Complex – Study to investigate the use of wastewater as a source of energy for a new heat pump system for the facility. The system will investigate the use of a heat exchanger in the public sewer network as a source of year-round heating/cooling for the facility (similar to a ground source heat pump system).

As these measures are currently under investigation, no associated savings are included in this report.

The 5-year vision of this plan would entail a reduction in electricity consumption of **2%** and natural gas consumption of **11%**, which would reduce annual energy use by **6%**, corresponding to an increase of **1%** compared to 2014. The recommended measures are also anticipated to decrease annual utility costs by $756,298, or **4%**. Note that, although the City's electricity and natural gas consumption are projected to decrease, the electricity emissions factor is expected to increase from 2024 to 2029. As such, there is projected to be an overall increase in GHG emissions of **4%** by 2029, or an overall increase of **41%** from the 2014 baseline.

1 Corporate Energy Management Plan

1.1 Introduction

Ontario Regulation 25/23 - Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans (which has replaced O.Reg. 507/18) is a regulation which requires public agencies, such as municipalities, to annually report their greenhouse gas (GHG) emissions and to develop an Energy Management Plan (EMP). The EMP should include a summary of the public agency's GHG emissions, a description of previous conservation measures undertaken, proposed measures to undertake over the course of the current plan, and the estimated savings for these measures. A more detailed breakdown of the requirements for the O.Reg 25/23 EMP is presented below:

- A summary of the annual GHG emissions for each of the public agency's prescribed operations.
- Proposed activities and energy conservation measures that the public agency can undertake to save energy and reduce GHG emissions.
- Cost and energy saving estimates for the proposed measures.
- A description of renewable energy generated by the public agency, and the annual amount of energy produced, including:
  - the ground source energy utilized by ground source heat pump technology operated by the public agency,
  - the solar energy utilized by thermal air technology or thermal water technology operated by the public agency, and
  - the proposed plan, if any, to operate heat pump technology, thermal air technology or thermal water technology.
- The estimated length of time the public agency's current and proposed activities and measures will be in place.
- A confirmation that the energy conservation and demand management plan has been approved by the public agency's senior management.

1.2 Corporate Vision

The City of Windsor will continue to reduce energy consumption and mitigate costs through the wise use of energy as well as demonstrating environmental sensitivity. This will involve a collaborative effort to increase conservation awareness and a better understanding of energy management within the Corporation.

1.3 Goals and Objectives

To safeguard the success and strategic direction of the EMP, a number of goals and objectives must be aligned with its development and implementation. The goals and objectives identified below will act as a guide and provide a common focus and direction for the Plan:

- Achieve a reduction in overall energy consumption of at least 6% from 2024 to 2029.
- Improve financial accountability achieved through savings and cost avoidance that will lead to both direct and indirect annual corporate savings.
- Develop a broad-based corporate awareness and commitment.
- Become a leader in energy conservation and demand management among municipalities in Ontario.
- Integrate information systems and coordinate corporate programs to support energy related actions.

- Improve energy efficiency and environmental performance.
- Introduce new technologies where prudent.
- Implement measures to reduce GHG emissions to stay on track for achieving net zero emissions by 2050.

1.4 City of Windsor Energy and Emissions Plans

The City of Windsor has several plans focusing on reducing energy consumption and GHG emissions, outlined below.

1. **2014 Energy Management Plan**

   As per O.Reg. 397/11, the City of Windsor released an Energy Management Plan in 2014-2019.

   Some of the key successes from this plan were a corporate-wide energy efficiency and retrofit program, and a City-wide traffic signal lights conversion to LED.

   This plan aimed to decrease energy consumption by 10% over the 2014 to 2018 time period. Some of the key recommended measures from this EMP are listed below:

   - Conduct energy audits to identify conservation and demand management measures.
   - Install combined heat and power (CHP) systems at the Huron Lodge Long Term Care Facility, and one at the WFCU Centre.
   - City-wide streetlight conversion to LED.
   - Install solar PV (photovoltaic) systems.

   This plan resulted in the implementation of the following:

   - Installed two combined heat and power (CHP) systems; one at the Huron Lodge Long Term Care Facility, and one at the WFCU Centre.
   - Converted over 23,500 streetlights to LED.
   - Installed three solar PV (photovoltaic) rooftop sytstems.
   - Participated in a building optimization pilot project.
   - WFCU Centre upgrades.
   - Reclassified the Lou Romano Water Reclamation Plant, Little River Pollution Control Plant, and WIATC as Class A accounts.
   - Implemented EnergyCAP, an energy management software solution.

   This resulted in the following savings compared to 2014:

   - Total electricity savings: 17.7 million kWh (19.8%)
   - Total electricity cost savings: $2.94 million (23.2%)
   - Total natural gas savings: 680,000 m3
   - Annual solar PV production: 2 million kWh
   - Annual solar PV corporate revenue: $750,000
   - Annual CHP electricity displacement: 3.2 million kWh
   - Annual CHP thermal displacement: 475,000 m3 natural gas
   - Annual GHG emissions reduction: 1631 tCO2e

2. **2019 Energy Management Plan**

   As per O.Reg. 507/18, the City of Windsor released an Energy Management Plan in 2019.

   The 2019 EMP aimed to take further action to decrease energy consumption by 10% over the 2019 to 2023 time period. Some of the key recommended measures for the 2019 EMP are listed below:

   - WIATC CHP system
   - Lighting conversion to LED for 32 corporate buildings
   - Forest Glade Arena ice plant upgrade
   - Integrated Site Energy Master Plan for the Lou Romano Water Reclamation Plant and Little River Pollution Control Plant
   - Energy / Battery storage Feasibility Study
   - Net metering
   - Hybrid photovoltaic-thermal solar collectors
   - Sub-metering at largest energy consumers to better track the energy consumption of various building systems
   - Enterprise-wide energy management system software
   - Pelican wireless thermostat pilot project at the Gino A Marcus Community Complex
   - Voltage harmonization pilot project
   - Municipal storm and sanitary pumping stations installation of capacitors and/or variable frequency drives
   - Caron Pump Station / WIATC wastewater energy transfer pilot program
   - Transition of corporate fleet vehicles to electric vehicles
   - Installation of public electric vehicle charging stations

   This resulted in the following savings over the period of 2019 to 2023:

   - Total electricity savings of 8.6 million kWh (12%)
   - Total electricity cost savings of $1.6 million (15%)
   - Total natural gas savings of 61,000 m3 (1%)

   Note that these utility savings are the savings associated with the projects listed above, and have reduced the electricity and natural gas use at the corresponding facilities. The City of Windsor's portfolio-wide natural gas consumption has increased as a result of acquiring additional facilities, such as the Windsor Biosolids Processing Facility and the Paul Martin Building.

3. **2023 GHG Reduction Pathway Feasibility Studies**

   The City of Windsor has performed GHG feasibility studies for the following facilities:

   - Forest Glade Arena (Arena, Library and Community Centre)
   - Gino A Marcus Community Centre
   - John Atkinson Community Centre
   - Optimist Community Centre and Chisholm Library
   - Capri Pizzeria Recreation Complex
   - WFCU Centre

These studies have identified measures to reduce the energy use and GHG emissions at each facility, which have been incorporated into this EMP.

4. **2017 Environmental Master Plan**

   The City of Windsor's Environmental Master Plan is a set of goals which aims to make Windsor cleaner, greener, healthier, and more sustainable. This plan presents a series of objectives to meet in order to accomplish the following goals:

   - Improve the City's air quality
   - Improve the City's water quality
   - Responsible land use
   - Use resources efficiently
   - Promote awareness

5. **2017 Corporate Climate Action Plan**

   The Corporate Climate Action Plan (CCAP) is a plan to reduce corporate energy and emissions from municipal operations and fleet, including both direct and indirect GHG emissions from City operations. The scope of the CCAP includes organizational & institutional policy change, buildings, fleet (transit and non-transit), water & wastewater processing, street & intersection lights, renewable energy generation, and solid waste management. The plan presents an overview of the City's energy use and GHG emissions, and recommended actions to take to reduce energy consumption and GHG emissions.

   Some of the key recommendations from this plan are:

   - Increase staff training, education, and awareness.
   - Continue to perform building retrofits.
   - Increase efficiency through new building design and building replacement.
   - Integrate support infrastructure for existing and new buildings.
   - Continue to implement actions from the Greening the City Fleet Manual.
   - Develop long-term water conservation and sanitary and stormwater master plans.
   - Complete street and intersection light conversion to LED.
   - Explore net metering and solar PV systems.
   - Establish a corporate solid waste diversion target and strategy.

6. **2017 Community Energy Plan**

   The Community Energy Plan (CEP) evaluates community-wide energy use and emissions and develops a plan to reduce energy use and emissions while considering the impact of future growth. The target of this CEP is to achieve a per capita reduction of 40% in both energy use and GHG emissions by 2041.

   Some of the strategies identified in this plan are:

   - Create a Deep Retrofit Program for existing homes.
   - Integrate energy performance labelling for homes and buildings.
   - Continually increase industrial energy efficiency.
   - Encourage a modal shift towards public transit.
   - Foster the adoption of electric vehicles.
   - Designate and plan district energy areas.

- Encourage the installation of solar arrays.
- Develop an education and communication campaign to support the CEP.

1.5 Energy Management Plan Components

This EMP consists of the following components:

1. **Section 2: Windsor Corporate Energy Use and Emissions**

   Presents an overview of historical (2014-2023) utility use data, including electricity, natural gas, heated water, and chilled water. This section also shows the corresponding energy use, utility cost, and GHG emission trends, and provides a breakdown of the sectors and assets which have the highest contribution to energy consumption and GHG emissions. This data is the benchmark to evaluate future actions, monitor results, and set future targets.

2. **Section 3: Renewable Energy**

   Outlines the existing and future renewable energy systems in use at the City of Windsor.

3. **Section 4: Energy Saving Measures**

   Identifies energy reduction opportunities encompassing technical, renewable, behavioural, and organizational measures. Measures are identified for implementation in the short (2024-2029), medium (2030-2035), and long (2035-2050) term.

4. **Section 5: Implementation Plan**

   Presents the projected change in utility use, utility cost, energy use, and GHG emissions if the identified energy saving measures are undertaken as planned.

5. **Section 6: Monitoring and Evaluation**

   Recommends metering systems and energy management software that provides analytical data to assist with decision-making, identifying anomalies, optimizing daily operations, and evaluating achievements related to energy reduction targets.

2 Windsor Corporate Energy Use and Emissions

2.1 Assets

The assets considered under this Energy Management Plan are summarized in Table 2. Note that a more detailed breakdown of the assets included in this plan is presented in Appendix A.

Table 2: Asset summary

Sector	Number of Assets
Biosolids Processing Plant	1
CoW Administration	8
Fire Facilities	9
Lighting	39
Parking Facilities	29
Parks Facilities	39
Recreational Facilities	47
Traffic Signal Lights & Poles	11
Transit Windsor	3
Various Facilities	24
Wastewater Treatment Facilities	56
Windsor Police Services	2
Windsor Public Libraries	7

2.2 Historical Data

2.2.1 Electricity historical utility use data

The City of Windsor's historical annual electricity use data is presented in Figure 1 below.

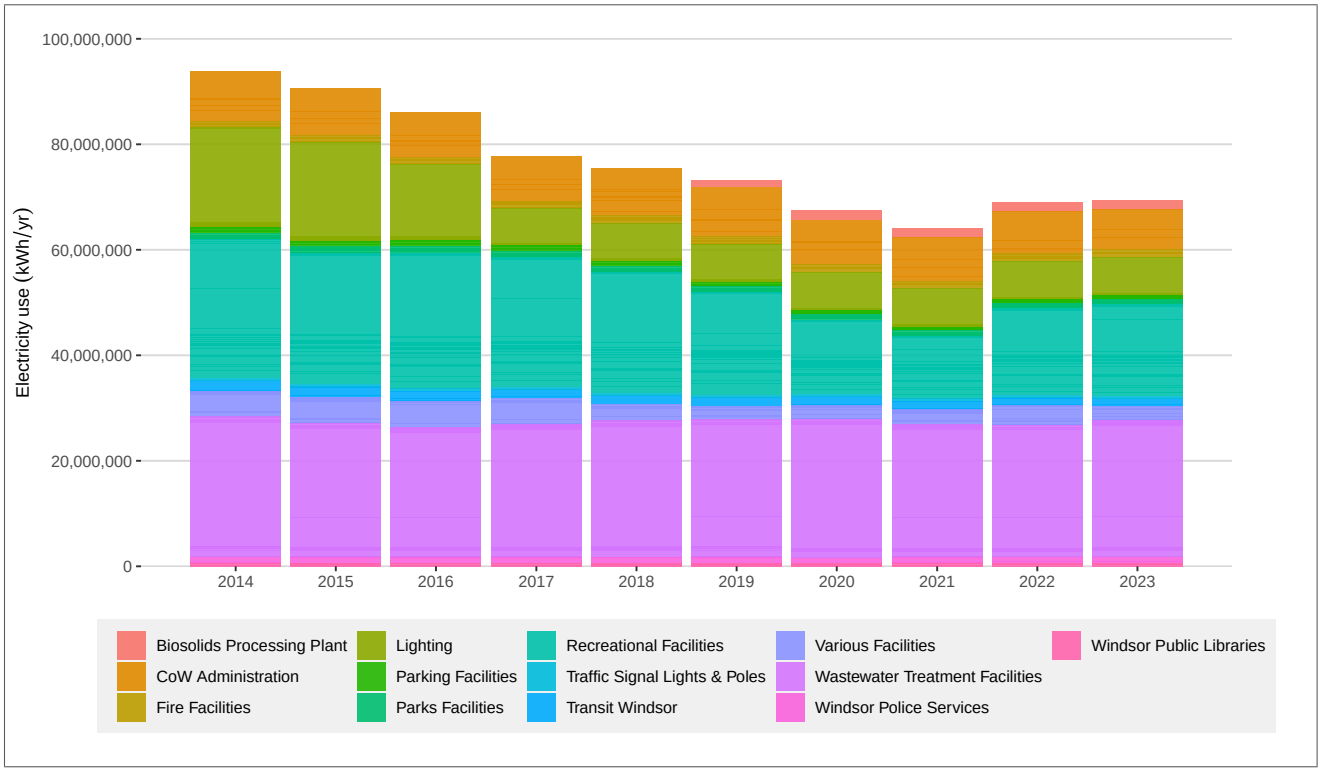

Figure 1: Electricity historical utility use data of all assets

Electricity.

- The City of Windsor's electricity use has gradually decreased from 2014 to 2021, and increased slightly in 2022 and 2023.
- The increase in electricity consumption in 2022 and 2023 is largely due to an increase in the electricity consumption of recreation facilities (e.g. indoor aquatic and ice facilities) in 2022. This suggests that some of the decrease in electricity consumption in 2020 and 2021 was due to reduced operations from the COVID-19 pandemic, and the increase came as these facilities returned to normal operations.
- Overall, there is a reduction of approximately 26% in electricity consumption of all assets from 2014 to 2023, which highlights the progress made by the City of Windsor in decreasing their electricity consumption.

2.2.2 Natural gas historical utility use data

The City of Windsor's historical annual natural gas consumption data is presented in Figure 2 below.

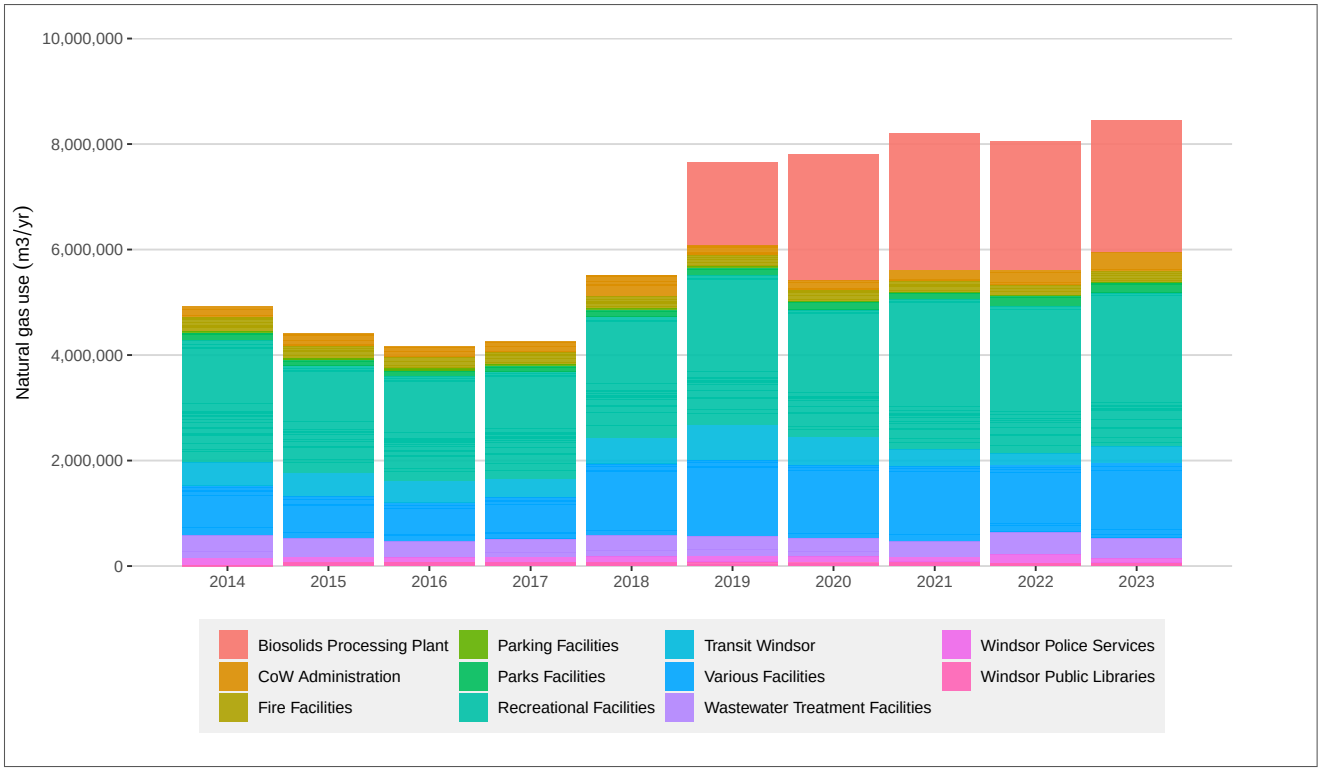

Figure 2: Natural gas historical utility use data of all assets

Natural gas.

- The natural gas consumed by the City of Windsor's assets decreases slightly from 2014 to 2016, increases slightly from 2017 to 2018, and has a considerable increase in 2019 before remaining relatively constant until the current year.
- The increased natural gas consumption from 2019 to present is primarily a result of the City taking ownership of the Windsor Biosolids Processing Facility in 2019, as this facility consumes a significant portion of the City's natural gas.
- In addition to this, the City of Windsor has acquired additional assets (such as the Paul Martin Building) and has implemented CHP, which have increased the portfolio-wide natural gas consumption.
- There are natural gas savings based on the measures undertaken from the 2019 to 2023 EMP which have reduced the natural gas consumption at these facilities. However, the overall natural gas consumption has increased as a result of the City's recent acquisitions.

2.2.3 Heated water historical utility use data

The City of Windsor's historical annual heated water use data is presented in Figure 3 below.

Figure 3: Heated water historical utility use data (of assets with district energy only)

Heated water.

- Some of the City's facilities are serviced by a district energy system, which provides heated and chilled water for heating and cooling.
- The City's heated water use at these facilities has remained relatively consistent from 2014 to 2023.
- The heated water use in indoor aquatic facilities decreased from 2019 to 2020, which is likely a result of the COVID-19 pandemic.
- In 2022 and 2023, when most facilities had returned to pre-COVID operations, the City's heated water use remains lower than pre-COVID levels, which could suggest operational improvements to reduce the heated water use.
- The installation of combined heat and power (CHP) at recreation facilities reduced the heated water load at those facilities.

2.2.4 Chilled water historical utility use data

The City of Windsor's historical annual chilled water use data is presented in Figure 4 below.

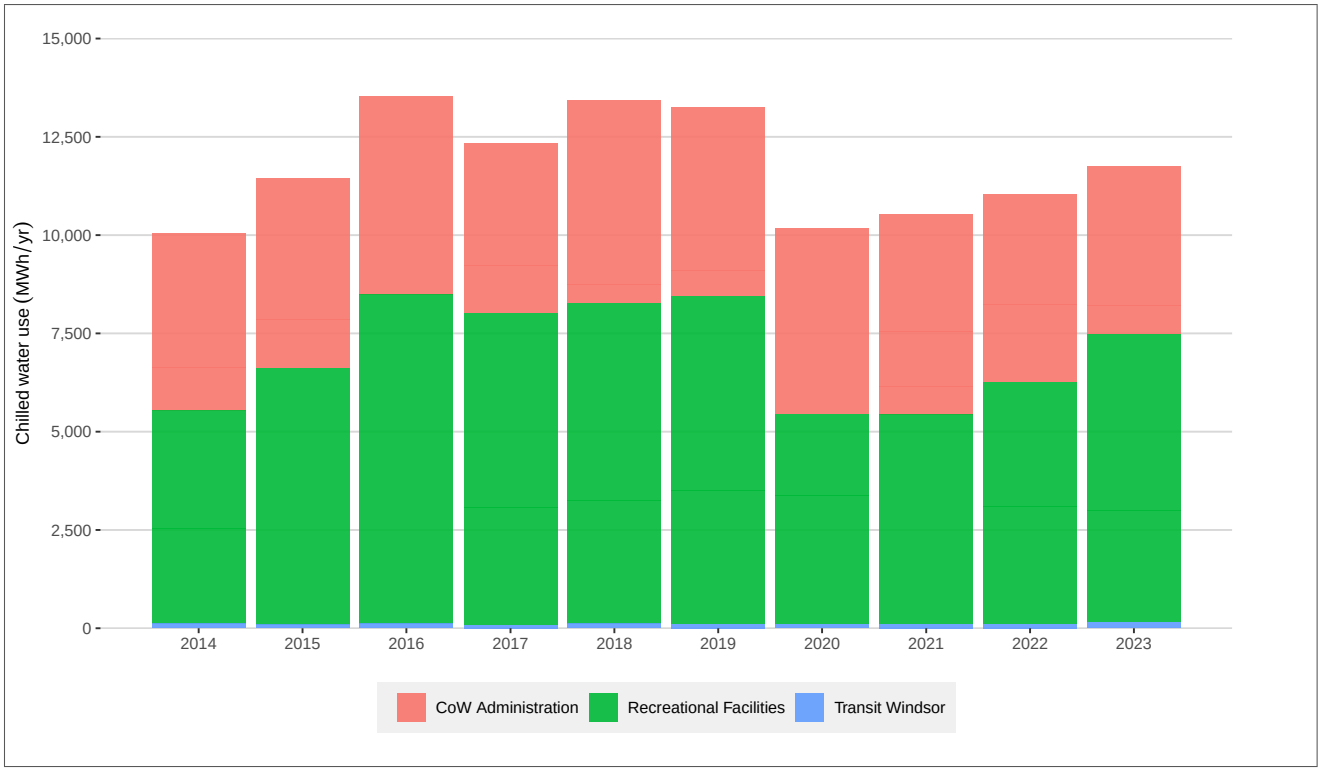

Figure 4: Chilled water historical utility use data (of assets with district energy only)

Chilled water.

- Some of the City's facilities are serviced by a district energy system, which provides heated and chilled water for heating and cooling.
- The City's chilled water use at these facilities has remained relatively consistent from 2014 to 2023.
- The chilled water use in indoor aquatic facilities decreased from 2019 to 2020, which is likely a result of the COVID-19 pandemic.
- In 2022 and 2023, when most facilities had returned to pre-COVID operations, the City's chilled water use remains lower than pre-COVID levels, which could suggest operational improvements to reduce the chilled water use.

2.2.5 Historical energy use data

The City of Windsor's historical annual energy use data is presented in Figure 5 below.

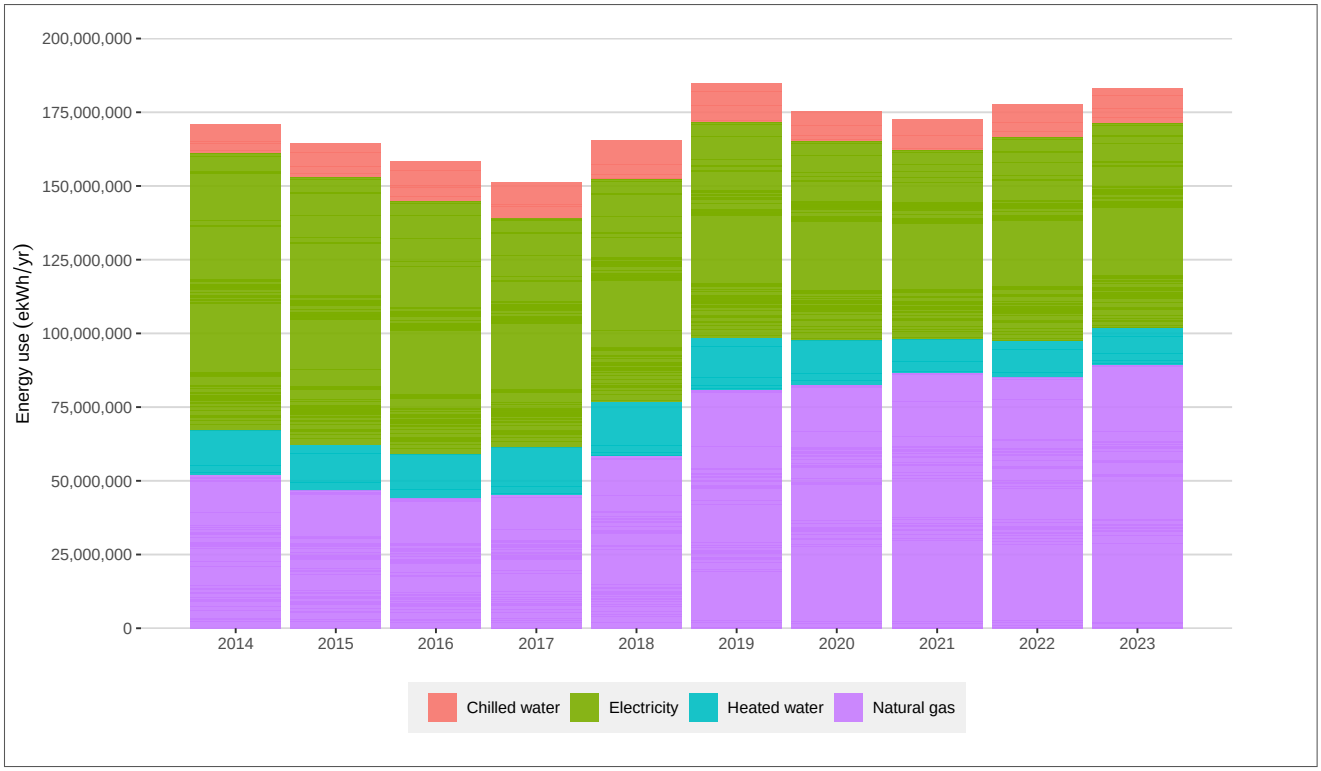

Figure 5: Historical energy use data of all assets

Energy use.

- Based on trends identified in the City's utility use, the energy use decreased from 2014 to 2017, increased from 2017 to 2019, and has largely remained consistent since then.

2.2.6 Historical utility cost data

The City of Windsor's historical annual utility cost data is presented in Figure 6 below.

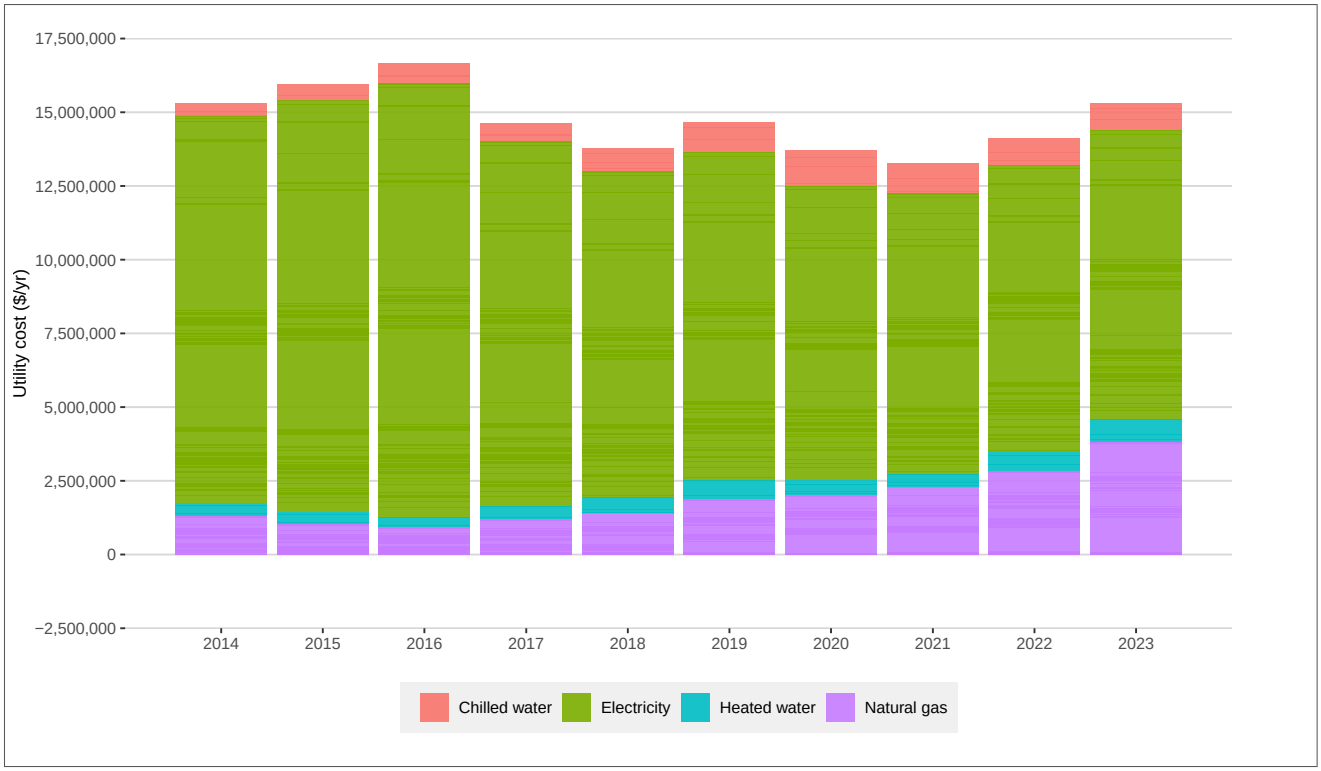

Figure 6: Historical utility cost data of all assets

Utility cost.

- Electricity generation in the province of Ontario is managed by the Independent Electricity System Operator (IESO) organization and is a deregulated market. This facilitates the effective price of electricity as generators that provide electricity can bid into the open market system. Wholesale pricing (the Hourly Ontario Energy Price, or HOEP) and Global Adjustment (GA) is the hourly price charged to local distribution companies and experiences significant volatility. The GA accounts for the difference between the HOEP and rates paid to generators and also experiences considerable volatility.
- The average effective price of electricity has increased from 9.1 to 10.4 c/kWh from 2014 to 2023, although in 2020 it was as high as 13.2 c/kWh, and there are considerable fluctuations on a month-to-month basis, further showing the volatility of the cost of electricity.
- A variety of costing models are available to end users which provides a more stabilized costing approach.
- Despite the increased cost of electricity and the increase in natural gas, the City's utility costs have decreased from 2014 to 2021 as a result of the City's decrease in electricity use over this period, as electricity has historically been responsible for the majority of the City's utility costs.
- Ontario's electricity grid also has a variety of energy sources, including nuclear, hydro, wind energy, solar, and fossil fuels. As the demand on the electrical grid increases, and various levels of government and the public push for decarbonizing the grid, the amount of electricity generated by each source is impacted. This will impact the cost of generating electricity, as well as the electrical grid emission factor, adding significant variability and uncertainty to future utility cost and GHG emissions.
- In addition, the federal carbon charge associated with burning fossil fuels, was introduced in 2019 and is projected to continue to increase until 2030 to $170/tCO2e, which has increased the effective cost of natural gas and will continue to increase it going forward.

- The City of Windsor has an agreement with their local distribution company, EnWin Utilities Ltd., and the IESO, called net metering. Net metering will stabilize the volatility of the City's utility costs, as the City can offset their utility costs using electricity generated through its renewable systems.
- Additional energy sources may become available in the future which the City of Windsor could utilize. This includes potential sources such as hydrogen as a fuel source, to reduce the quantity of fossil fuels burned and decrease the annual federal carbon tax fees which natural gas producers are currently conducting pilot projects in Canada to determine long-term feasibility.
- CHP also plays a significant role in the consumption of natural gas. At the time, political and financial support drove CHP however, based on current political and financial economy, consideration will be given to phasing out the CHPs as the net benefit is greatly reduced due to carbon tax, low electricity prices etc.

2.2.7 GHG emissions historical trends

The City of Windsor's historical annual GHG emissions data is presented in Figure 7 below.

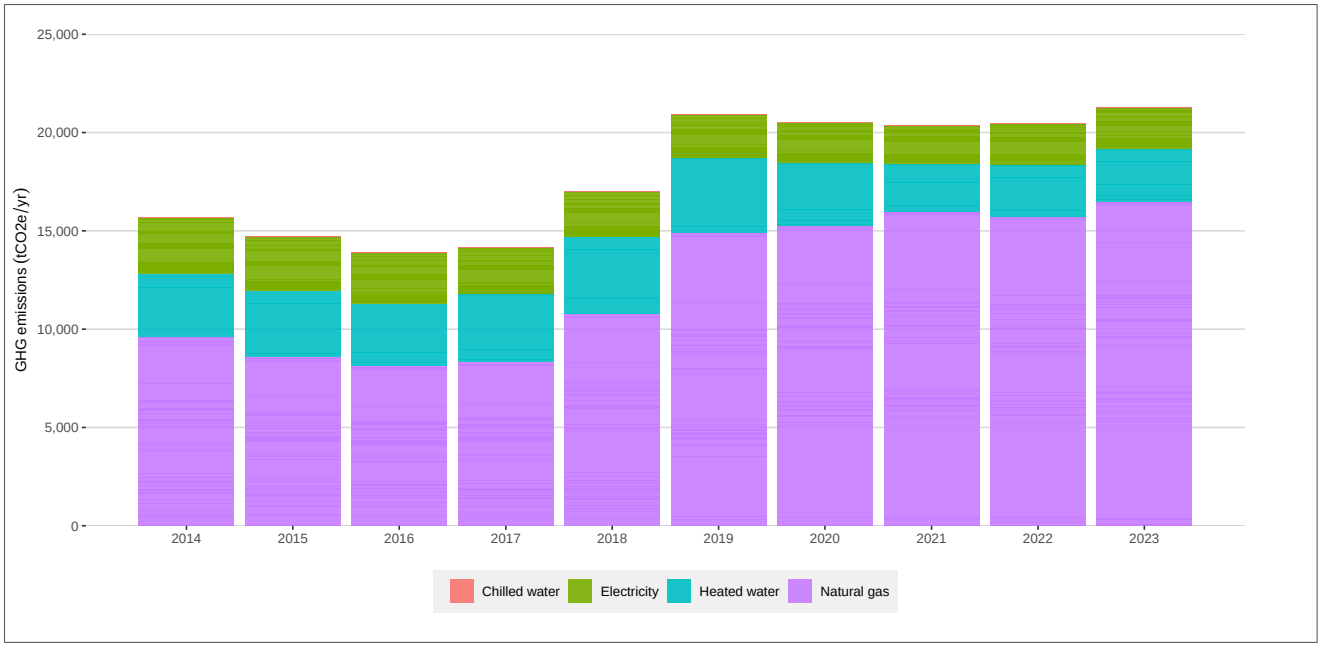

Figure 7: GHG emissions historical data of buildings

GHG emissions.

- GHG emissions largely follow the same trends as the energy use data, although the natural gas and heated water have higher emissions factor than electricity and chilled water.
- The City's overall GHG emissions were gradually decreasing from 2014 to 2017, although with the acquisition of the Windsor Biosolids Processing Facility in 2019, there was a large increase in GHG emissions which maintained higher emissions until 2023.

2.3 Energy and Emissions Breakdown

The City of Windsor's energy consumption breakdown by asset type is presented in Figure 8 below.

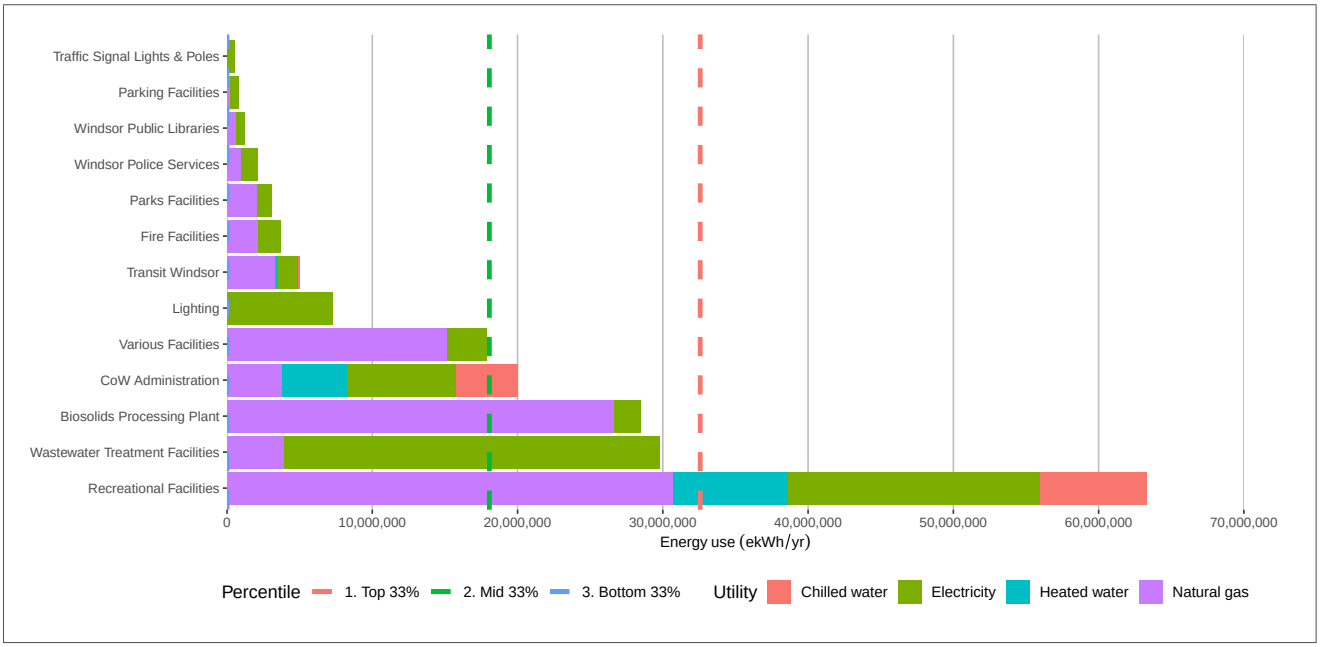

Figure 8: Current energy use: contributions by energy type

Sectors.

- Buildings have the greatest contribution to energy use, followed by the wastewater treatment sector, followed by the biosolids processing plant. Comparatively, the energy use due to public lighting and miscellaneous assets is minor.

Types.

- Types refer to the various asset types within each sector. The type is used to break down the buildings sector based on the building's purpose.
- The recreational facilities sector has the highest energy use, as it contains indoor aquatic facilities and indoor ice facilities, which have high energy use due to ice resurfacing water heating, pool water heating, and high domestic hot water loads (e.g. showers), in addition to space heating.
- The wastewater treatment facilities, which include all wastewater treatment facilities other than the Windsor Biosolids Processing Facility, has the next highest energy use.
- The biosolids processing plant asset type, which only contains Windsor Biosolids Processing Facility, is the third highest consumer of energy at the City of Windsor.

The City of Windsor's GHG emission breakdown by asset type is presented in Figure 9 below.

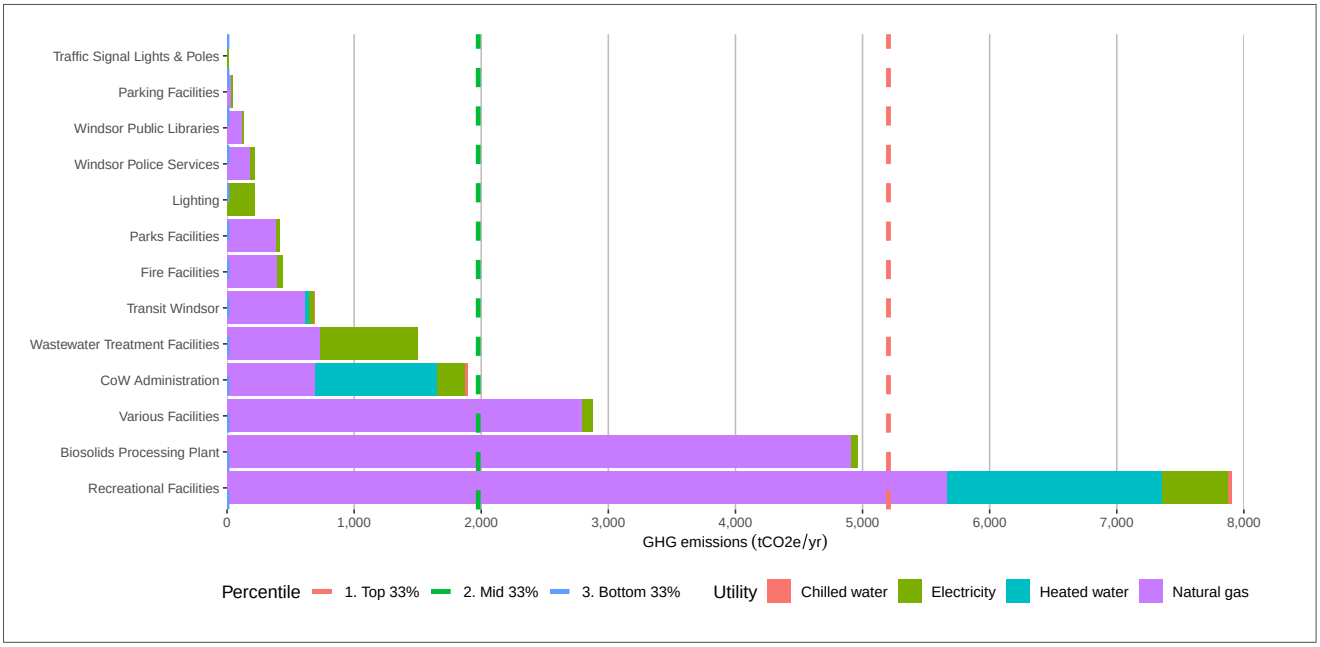

Figure 9: Current GHG emissions: contributions by energy type

Sectors.

- Buildings have the greatest contribution to GHG emissions, followed by the biosolids processing plant, followed by the wastewater treatment sector. Comparatively, the GHG emissions due to public lighting and miscellaneous assets is minor.

Types.

- Types refer to the various asset types within each sector. The type is used to break down the buildings sector based on the building's purpose.
- The recreational facilities sector has the highest energy use, as it contains indoor aquatic facilities and indoor ice facilities, which have high energy use due to ice resurfacing water heating, pool water heating, and high domestic hot water loads (e.g. showers), in addition to space heating.
- The activities mentioned above are often natural-gas fired, which has a higher emissions factor than electric equipment.
- The biosolids processing plant asset type, which only contains Windsor Biosolids Processing Facility, is the second highest consumer of energy at the City of Windsor. This is due to the large amount of natural gas consumption used in the drying process.
- The various facilities and wastewater treatment facilities types are the third and fourth highest contributors to the City's GHG emissions.

The City of Windsor's GHG emission breakdown by asset is presented in Figure 10 below.

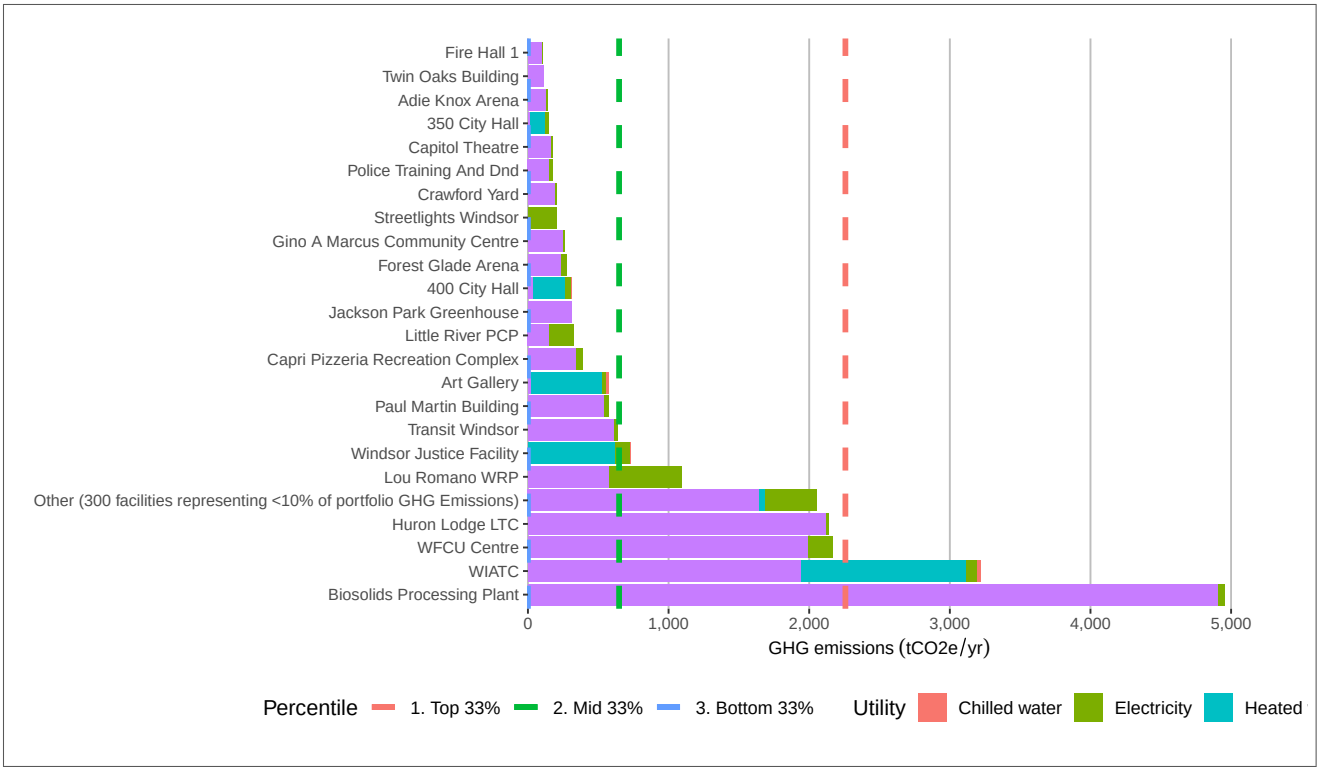

Figure 10: Current GHG emissions: contributions by energy type

Assets.

- The Windsor Biosolids Processing Facility (WBPF) is the asset which is responsible for the largest portion of energy use and GHG emissions from the City of Windsor's profile.
- The WIATC and WFCU centre, which are both recreation facilities, are also responsible for a high portion of the City's energy use and GHG emissions.
- As such, these facilities should be targeted in energy and emissions reduction strategies, as they have the potential to have the greatest impact on the City's energy and emissions profiles.

2.4 Change from Baseline Year

The change between the baseline and the most recent utility use and GHG emissions data is presented in Table 3. The current utility use is taken as the utility use in 2023, as this is the most recent year with complete utility use data available. 2014 is used as the baseline year as it is the initial reporting year for energy use under O.Reg 25/23. Note that a positive change indicates an increase since 2014, and a negative change indicates a decrease.

Table 3: GHG emissions comparison from baseline year

	Energy use				GHG emissions			
Sector	**Baseline (2014)**	**Current (2023)**	**Change**	**Percent change**	**Baseline (2014)**	**Current (2023)**	**Change**	**Percent change**
-	[ekWh/yr]	[ekWh/yr]	[ekWh/yr]	[%]	[tCO2e/yr]	[tCO2e/yr]	[tCO2e/yr]	[%]
Buildings	119,678,353	116,328,433	-3,349,920	-2.8	13,404	14,531	1,127	8.4
Wastewater Treatment	31,560,720	30,351,296	-1,209,424	-3.8	1,680	1,565	-115	-6.9
Public Lighting	18,857,211	7,243,620	-11,613,591	-61.6	566	217	-348	-61.6
Miscellaneous	894,880	701,721	-193,159	-21.6	27	21	-6	-21.6
Biosolids Processing Plant	0	28,443,586	28,443,586	-	0	4,958	4,958	-
Overall	170,991,163	183,068,655	12,077,492	7.1	15,677	21,292	5,615	35.8

The overall percent changes were calculated based on the total change compared to the total baseline value for energy and GHG emissions, respectively. Also note that no percent change is shown for the Biosolids Processing Plant, as a percent change cannot be calculated from a baseline value of 0.

As shown in Table 3, the energy use and GHG emissions for most sectors decreased from 2014 to 2023. There was a slight increase in GHG emissions in the buildings from 2014 to 2023, due to the addition of certain assets (such as the Paul Martin Building), and due to the use of CHPs, which is included in the buildings category. The acquisition of the Windsor Biosolids Processing Facility in 2019 increased the City's electricity and natural gas consumption, resulting in an overall increase in the City's energy use and GHG emissions when compared to the 2014 baseline.

3 Renewable Energy

3.1 Solar Energy

3.1.1 Solar PV (Photovoltaic) arrays

The City of Windsor currently has three solar PV arrays installed. There is one solar system at the WIATC with a capacity of 350 kW, capable of generating 500,000 kWh per year with annual revenues of $260,000. In addition, there are two 500 kW systems (one at WFCU Centre, and one at Transit Windsor) which can generate 1.5 million kWh combined, and have annual revenues of approximately $500,000.

Finally, multiple solar PV systems are being implemented, shown in Table 4.

Table 4: Estimated capacity, production, and cost savings for solar PV systems installed from 2019 to 2023

Building	Installed Power (DC)	Installed Power (AC)	Annual Production	Installation Cost	Project Lifetime Cost Savings
-	[kWdc]	[kWac]	[kWh/yr]	[$]	[$]
Optimist Community Centre and Library	155.87	120	148,726	294,279	479,122
Forest Glade Community Centre and Library	138.43	80	145,490	294,369	626,181
John Atkinson Community Centre	132.75	106	136,796	247,711	492,574
Fire Hall 2	54.5	49.5	59,950	169,638	211,671
Fire Hall 5	63.22	49.5	65,812	177,297	239,153
Fire Hall 6 and EOC	110.09	100	116,369	230,344	529,194
Fire Hall 7	53.41	49.5	60,059	172,224	208,728
Fire Apparatus Building	14.17	10	15,587	35,398	58,377
Parks and Recreation Facilities Storage	173.86	115.4	171,342	286,655	682,866
Parks and Recreation Maintenance Yard	158.05	115.4	165,621	272,809	601,511
South Windsor Library	67.58	49.5	68,053	164,711	274,498
Fontainebleau Library	94.5	72	112,020	292,229	437,151

3.1.2 Solar thermal pool water heating systems

The City of Windsor has three solar pool water heating systems. When solar heat is available, these systems pump pool water through unglazed solar collectors mounted on the roof. These systems are simpler than solar domestic water heating systems, as they do not use potable water, and only need to heat the water to about 28°C. These systems cannot provide heat at night and can only operate in the summer months; however, on average, they reduce gas consumption by approximately 35%.

These systems have been installed at the following facilities:

- Lanspeary Park
- Remington Park
- Mic Mac Park

3.1.3 Net metering

The City of Windsor has an agreement with their local distribution company, EnWin Utilities Ltd., and the IESO, called net metering. Net metering allows customers to generate renewable energy, such as solar or wind power, on-site and offset their electricity consumption with the excess energy they produce. Under this program, customers can install renewable energy systems on their property and connect them to the grid. When these systems generate more electricity than the customer consumes, the surplus energy is exported to the grid, and the customer receives credits on their electricity bill for the excess energy supplied. Credits can be carried forward for up to 12 months.

These credits are applied to future electricity bills, effectively offsetting the cost of electricity consumption during periods when the renewable energy system is not generating enough electricity to meet the customer's demand. The net metering program allows customers to reduce their electricity bills, generate clean energy, and contribute to Ontario's transition to a more sustainable energy future.

The City of Windsor has recently implemented this net metering initiative, and these savings are anticipated to be presented as part of the next EMP.

3.1.4 Hybrid Photovoltaic-Thermal Solar Collectors

Administration is investigating combining Solar-thermal collectors with photovoltaic (PV) modules to produce hybrid PV-thermal (PV-T) collectors. This integration of these systems can simultaneously deliver heat and electricity from the same installed area at a higher efficiency compared to separately installed solar-thermal and PV panels.

3.1.5 Battery Storage

Administration is investigating the use of battery storage due to its advantageous role in the strategy of Global Adjustment Busting (GA Busting). GA Busting involves reducing electricity consumption during peak demand hours to lower the global adjustment costs for class A consumers.

Battery storage plays a significant role in GA Busting by providing a reliable way to reduce electricity consumption during peak demand hours through the use of stored energy.

3.2 Anaerobic Digestion

Anaerobic digestion is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste or to produce fuels.

The Integrated Site Energy Master Plan for the two wastewater treatment plants will investigate on-site renewable energy generation and evaluate the potential for anaerobic digestion and renewable natural gas production.

4 Energy Saving Measures

4.1 Methodology

The implementation plans for the short, medium, and long term were developed and analyzed according to the following methodology.

1. **Recommended measures**. Each asset considered under this EMP was reviewed and specific measures that could be implemented for each specific asset were identified. Where possible, measures were identified using the GHG Reduction Pathway Feasibility Studies undertaken for certain assets (Forest Glade Arena, Gino A Marcus Community Centre, John Atkinson Community Centre, Optimist Community Centre, South Windsor Arena, and WFCU Centre). For assets where those studies were not available, general measures were recommended based on building operation and the priorities identified in Section 2. The savings and costs associated with these measures were estimated based on detailed measures modelled for buildings of similar sizes and functions. Note that these measure recommendations are high-level and may not reflect actual building conditions; a detailed feasibility study would be recommended before pursuing any measures.
2. **Plan identification**. In this plan, two main scenarios are considered: the Business as Planned scenario, and the GHG Reduction Plan. The Business as Planned scenario is presented as a benchmarking tool to observe the change in utilities and GHG emissions if no energy conservation measures (ECMs) are undertaken. The GHG Reduction Plan is the recommended plan to meet the City's GHG emission goals by implementing various ECMs, and is broken down into short term (2024-2029), medium term (2030-2034), and long term (2035-2050) plans.
3. **Scenario utility analysis**. A utility analysis was completed for each scenario, in which the yearly utility use for each asset was projected from 2024 to 2050 (i.e. the evaluation period) for all utilities (i.e. electricity and natural gas), based on the measure implementation plan specific to each scenario. Also, yearly GHG emissions and utility costs were projected from 2023 to 2050 based on the yearly utility use projections for each scenario by applying the assumed GHG factors and utility cost rates indicated below.
    - **GHG emissions factors for electricity**. The electricity grid emissions factor for 2023-2025 was obtained from the National Inventory Report (NIR). The projected emissions factor was taken from the IESO 2022 Planning Outlook for remaining short term projections (2026-2029), and from the Low Carbon Economy Fund (LCEF) numbers (obtained from Environment and Climate Change Canada (ECCC)'s *2022 Reference Case GHG Emissions*) for the 2030-2050 projections. Figure 11 presents the electricity grid GHG emissions factors assumed over the evaluation period.

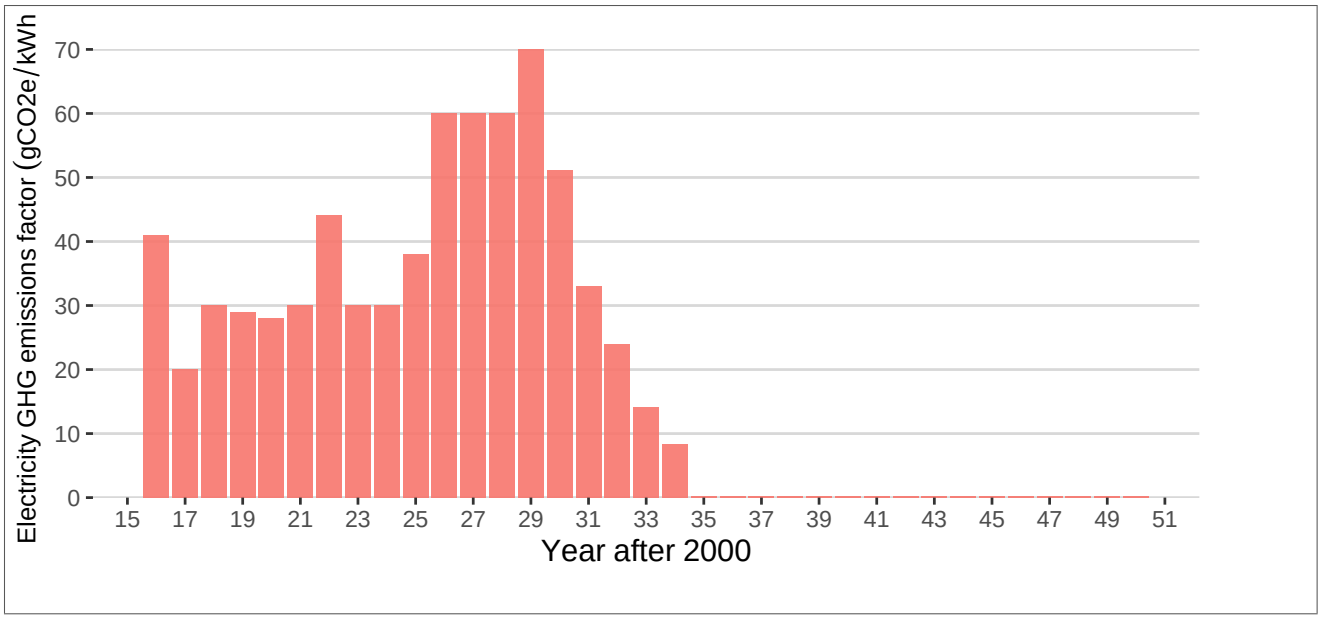

Figure 11: Electricity GHG emissions factor assumptions (from NIR (2023-2025), IESO's 2022 Planning Outlook (short term) and ECCC's 2022 Reference Case GHG Emissions (long term))

- **GHG emissions factors for other utilities**. All other GHG emissions factors assumptions were as per Table 5, based on the emission factor in 2023.

Table 5: GHG emissions factor assumptions

Utility	Unit	Value
Electricity	[gCO2e/kWh]	30
Natural gas	[gCO2e/m3]	1947
Chilled water	[gCO2e/MWh]	5242
Heated water	[gCO2e/MWh]	213474

- **Utility cost rates for federal carbon charge**. The federal carbon charge was assumed to change over time, based on existing legislation. In this analysis, the federal carbon charge is applied to all GHG emissions associated with scope 1 GHG emissions (GHG emissions due to direct fuel combustion). Figure 12 presents the federal carbon charge rates assumed over the evaluation period.

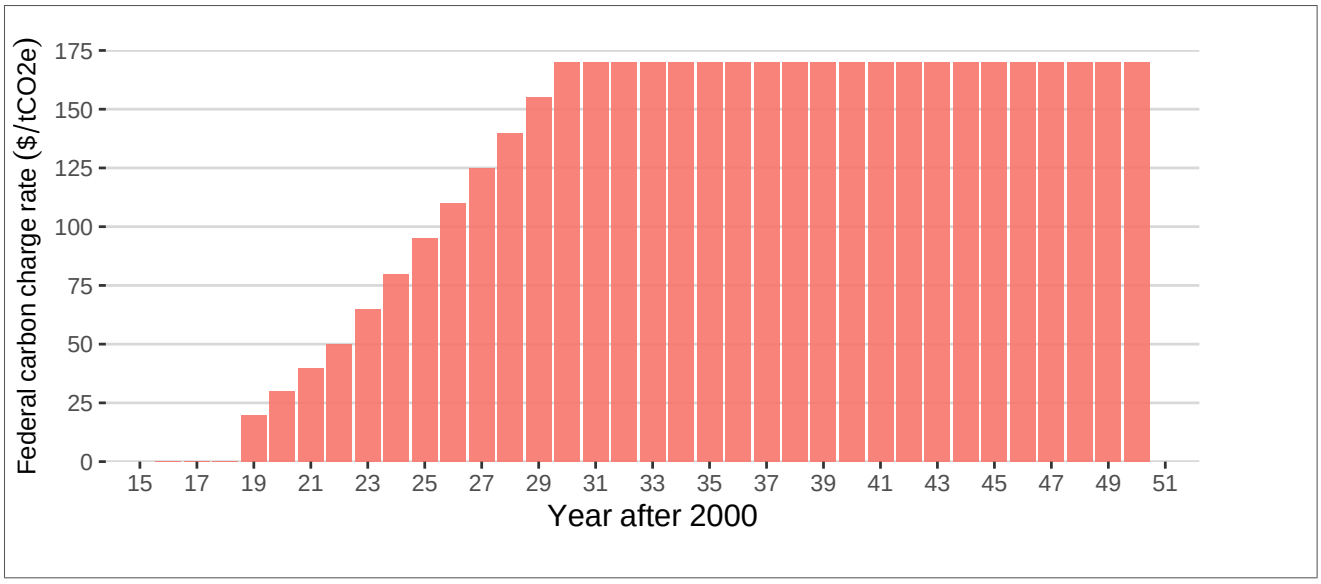

Figure 12: Federal carbon charge projection (Source: Government of Canada (up to 2030); Assumed (After 2030))

- **Utility cost rates for other utilities**. All other utility cost rate assumptions in 2023 were as per Table 6, assuming a general inflation rate of 2.2%.

Table 6: Utility cost rate assumptions

Utility	Unit	Value
Electricity	[$/kWh]	0.14
Natural gas	[$/m3]	0.26
Chilled water	[$/MWh]	88.39
Heated water	[$/MWh]	62.98
Carbon offsets	[$/tCO2e]	24

4. **Additional recommendations**. In addition to the quantifiable measures presented, additional recommendations are listed. These recommendations are anticipated to have indirect utility use savings, but are anticipated to help the City of Windsor to achieve their climate change targets.

4.2 Previous Measures

From 2019 to 2023, the City of Windsor undertook multiple projects, including several lighting upgrades to LED. Table 7 lists the energy conservation measures and saving which were implemented during the 2019 to 2023 EMP as it relates to LED lighting conversion.

Table 7: Estimated annual energy savings for LED lighting measures implemented during the 2019-2023 EMP

Status	Building	Measure	Energy Savings	Cost Savings
-	-	-	[ekWh/yr]	[$/yr]
Complete	Fire Station #1 - Headquarters	LED Project Phase 1	54,660	7,871
	Fire Station #7	LED Project Phase 1	6,465	931
	International Transit Terminal	LED Project Phase 1	52,021	7,491
	Parking Garage 1	LED Project Phase 1	149,611	21,544
	Parking Garage 2	LED Project Phase 1	210,778	30,352
	WFCU Centre	LED Project Phase 1	283,299	40,795
	WIATC Aquatic Centre	LED Project Phase 1	241,694	34,804
	Windsor Joint Justice Facility	LED Project Phase 1	331,056	47,672
	400 City Hall	LED Project Phase 2	297,611	42,856
	Adie Knox Herman Rec Complex	LED Project Phase 2	72,785	10,481
	Art Gallery of Windsor	LED Project Phase 2	64,604	9,303
	Capitol Theatre	LED Project Phase 2	49,118	7,073
	Gino and Liz Marcus Complex	LED Project Phase 2	44,701	6,437
	Lanspeary Park and Rink	LED Project Phase 2	3,514	506
	Little River PCP	LED Project Phase 2	84,326	12,143
	Lou Romano WRP	LED Project Phase 2	475,035	68,405
	Roseland Golf and Curling Club	LED Project Phase 2	102,660	14,783
	Transit Windsor	LED Project Phase 2	326,132	46,963
Not yet implemented	Crawford Yard	LED Project Phase 3	85,840	12,361
	Department of National Defence	LED Project Phase 3	119,403	17,194
	Environmental Drop-off Depot	LED Project Phase 3	26,146	3,765
	Forest Glade Arena	LED Project Phase 3	90,118	12,977
	Huron Lodge Care Facility	LED Project Phase 3	210,479	30,309
	John Atkinson Community Centre	LED Project Phase 3	66,438	9,567
	Optimist Community Centre	LED Project Phase 3	12,465	1,795
	Parks & Rec Administration	LED Project Phase 3	19,153	2,758
	Parks & Rec Maintenance Yard	LED Project Phase 3	28,729	4,137
	Public Works Administration Office	LED Project Phase 3	56,813	8,181
	South Windsor Recreation Complex	LED Project Phase 3	60,833	8,760
	Traffic Yard	LED Project Phase 3	42,208	6,078

In addition to the LED projects noted above, the following projects have been implemented:

- **WIATC CHP:** This project has been completed. Following the COVID-19 pandemic and subsequent closures, facility use was greatly reduced. At present, the CHP has not been running at full capacity likely as a result of the impacts of the COVID-19 pandemic.
- **Net Metering Project:** Net metering is being implemented, although there are not yet savings to be implemented under this EMP.
- **Forest Glade Arena Upgrade Project:** Completed.
- **EV Charging Stations:** 11 public EV charging stations have been implemented in various City properties.

The rest of projects recommended by the 2019 EMP have either been cancelled or are in the investigation phase.

4.3 Recommended Measures and Implementation Plans

4.3.1 Measure descriptions

Descriptions of key measures are listed below.

Electrification measures

Replace gas-fired equipment with electric equipment. Electricity from the Ontario grid has a lower GHG impact than natural gas, and is often more efficient than gas-fired equipment.

Heat pump measures

General measure to represent replacing the heating system (DHW, boiler, HVAC, etc.) with heat pumps. In these measures, air-source heat pumps are considered unless stated otherwise, but each building can be surveyed to check whether a geothermal heat pump would be a suitable alternative. As with the general electrification measures, if the original equipment is gas-fired, the switch to electric equipment can reduce GHG emissions. Additionally, heat pumps are a high efficiency alternative to most existing heating systems, as air-source heat pumps typically have an average COP of around 2.5 (corresponding to 250% efficiency), and geothermal heat pumps often have an average COP above 3.5.

HVAC system optimization

General measure to represent various HVAC upgrades to reduce the heating load. This measure represents a budget to be put aside to optimize the HVAC system, and could include recommissioning measures or HVAC controls upgrades. The most effective controls upgrades will vary depending on the facility, but could include items such as setpoint temperature setbacks, BAS systems, HVAC system scheduling, and demand control ventilation.

Lighting upgrade

General measure to represent upgrading building lighting to reduce the energy consumed by light fixtures. This could include lighting retrofits to LED or upgrading the lighting controls in a building. Depending on which lighting controls are feasible in a facility, this could include daylighting, occupancy sensors, or other opportunities to save on lighting energy.

Solar PV

Implement solar PV arrays to generate renewable energy, to reduce GHG emissions by reducing electricity consumption. Where possible, solar PV system sizes and costs were obtained based on existing arrays planned by the City (Section 3.1). Where not available, solar PV systems were sized based on the gross floor area and may not be suitable in all locations; a feasibility study is recommended to determine whether solar PV would be suitable at each location.

Wastewater process electrification

For the wastewater treatment facilities, process upgrades to reduce natural gas consumption are recommended. Based off of measures undertaken at similar facilities, it is recommended that process heating equipment be replaced with equipment which can be heated using hot water or electric systems. If the equipment can be heated by hot water, it is recommended that the hot water be supplied by heat pumps to further decrease the energy consumption and GHG emissions.

4.3.2 Short term plan (2024-2029)

A five year summarized project plan to reduce GHG emissions is outlined in Table 8. A detailed breakdown of this plan, including estimated project costs, is presented in Appendix B.1. Note that a negative impact is a decrease in the corresponding utility, and a positive impact is an increase.

Table 8: Short term ECMs to implement (2024-2029)

Year	Facility	Measure	Energy use impact	GHG impact	Electricity impact	Natural gas impact	Utility cost impact
-	-	-	[ekWh/yr]	[tCO2e/yr]	[kWh/yr]	[m3/yr]	[$/yr]
2025	Optimist Community Centre	Add HVAC1 and HVAC2 to BAS	-100,398	-14	-28,869	-6,776	-6,789
	WFCU Centre	AH101 schedule optimization	-67,786	-11	-11,240	-5,356	-3,709
	John Atkinson Community Centre	Boiler upgrade (ASHP)	-66,363	-16	26,984	-8,842	392
	Capri Pizzeria Recreation Complex	Change room DHW heating to ASHP	-172,827	-42	63,114	-22,350	263
	Capri Pizzeria Recreation Complex	DEH1 and DEH2 mode scheduling	-78,147	-10	-29,148	-4,642	-5,991
	WFCU Centre	DH3, 4, 5 setpoint scheduling	-994,890	-122	-394,844	-56,840	-78,791
	Optimist Community Centre	DHW to ASHP	-6,235	-1	1,849	-766	-36
	Optimist Community Centre	Disconnect the natural gas fireplace	-15,614	-3	-612	-1,421	-645
	John Atkinson Community Centre	EnergyStar appliances	-2,681	-0	-2,681	0	-384
	WFCU Centre	ERV1, 2, 3 unoccupied heating	-86,281	-13	-19,778	-6,300	-5,301
	Capri Pizzeria Recreation Complex	Faucet aerator upgrade	-5,017	-1	0	-475	-186
	WFCU Centre	General recomissioning	0	0	0	0	0
	Forest Glade Arena	General recommissioning	0	0	0	0	0
	Gino A Marcus Community Centre	Gym temperature setpoint optimization	-15,932	-3	-1,838	-1,335	-787
	Multiple Facilities	HVAC schedule optimization	-558,123	-77	-166,030	-37,142	-38,325
	Capri Pizzeria Recreation Complex	Laundry DHW heating to hybrid	-8,674	-2	3,157	-1,121	12
	Multiple Facilities	Lighting upgrade	-252,819	8	-356,574	9,828	-47,164
	WFCU Centre	Low flow shower heads	-91,566	-17	0	-8,674	-3,402
	Gino A Marcus Community Centre	North wing temperature setpoint optimization	-29,948	-5	-3,973	-2,460	-1,534
	Capri Pizzeria Recreation Complex	Old RTU upgrade to ASHP	-732,543	-176	264,088	-94,407	752
	WFCU Centre	P5, P6 variable speed controls	-135,515	-4	-135,515	0	-19,389
	Atkinson Pool	Pool heat to heat pump	-42,194	-11	19,856	-5,878	535
	Forest Glade Arena	Rink HVAC controls upgrade	-167,791	-26	-30,451	-13,010	-9,460
	WFCU Centre	RTU control upgrade and optimization	-1,499,209	-258	-122,935	-130,370	-68,730
	Capri Pizzeria Recreation Complex	RTU OA control upgrades	-128,426	-23	-2,434	-11,935	-5,030
	Multiple Facilities	Solar PV implementation	-1,044,055	-31	-1,044,055	0	-149,385
	John Atkinson Community Centre	Sports gym DCV	-22,781	-4	-439	-2,116	-893
	Optimist Community Centre	Temperature setback on AC1 to AC4	-2,684	-0	-874	-172	-192
	John Atkinson Community Centre	Window and door upgrade	-11,459	-2	0	-1,085	-426
2026	Forest Glade Arena	AC1 library controls optimization	-29,705	-6	0	-2,814	-1,104
	Forest Glade Arena	DEH3 and DEH4 heating electrification	-65,421	-53	262,529	-31,066	25,376
	Multiple Facilities	DHW to heat pump	-642,840	-165	302,513	-89,550	8,156
	Capri Pizzeria Recreation Complex	Exhaust fans to BAS	-10,353	-2	-190	-963	-405
	Multiple Facilities	HVAC system optimization	-396,891	-46	-175,407	-20,981	-33,325
	Multiple Facilities	Lighting upgrade	-67,418	2	-95,450	2,655	-12,615
	Central Park Pool	Pool heat to heat pump	-37,477	-10	17,636	-5,221	475
	Gino A Marcus Community Centre	Roof upgrade to high performance	-285,254	-52	-2,238	-26,809	-10,837

Table 8: Short term ECMs to implement (2024-2029) *(continued)*

Year	Facility	Measure	Energy use impact	GHG impact	Electricity impact	Natural gas impact	Utility cost impact
	Gino A Marcus Community Centre	Wall upgrade to high performance	-131,994	-24	0	-12,503	-4,905
	Gino A Marcus Community Centre	Windows and doors to high performance	-12,980	-2	0	-1,230	-482
2027	400 City Hall	DHW to heat pump	-10,022	-3	4,716	-1,396	127
	Multiple Facilities	HVAC system optimization	-229,185	-36	-43,466	-17,593	-13,120
	Multiple Facilities	HVAC to heat pump	-479,334	-123	225,569	-66,773	6,081
	Multiple Facilities	Lighting upgrade	-132,984	-1	-151,649	1,768	-21,006
	Optimist Community Centre	Wall upgrade to high performance	-45,245	-8	-1,369	-4,156	-1,826
2028	WFCU Centre	CHP use for Class A peak mitigation	84,821	48	-209,783	27,907	-19,069
	Multiple Facilities	DHW to heat pump	-95,725	-24	45,048	-13,335	1,215
	Multiple Facilities	HVAC system optimization	-86,001	-13	-18,110	-6,431	-5,114
	Multiple Facilities	HVAC to heat pump	-1,989,188	-512	936,088	-277,101	25,235
	Multiple Facilities	Lighting upgrade	-117,687	4	-166,722	4,645	-22,033
	Optimist Community Centre	Roof upgrade to high performance	-48,102	-9	-1,324	-4,431	-1,928
2029	Multiple Facilities	DHW to heat pump	-38,216	-10	17,984	-5,324	485
	Multiple Facilities	HVAC system optimization	-257,937	-43	-32,076	-21,395	-12,982
	Multiple Facilities	HVAC to heat pump	-252,003	-65	118,589	-35,105	3,197
	Multiple Facilities	Lighting upgrade	-94,839	3	-134,356	3,743	-17,754
	Lanspeary Park Pool And Ice Rink	Pool heat to heat pump	-58,582	-15	27,568	-8,161	743
	Capri Pizzeria Recreation Complex	Snow melt via recovered heat	-8,887	-1	-1,263	-722	-464
	Optimist Community Centre	Windows and doors to high performance	-2,623	-0	-36	-245	-101
Short Term	Total	(Accounts for interactive effects and changes in the electricity grid emissions factor)	11,210,314	-836	1,080,680	959,544	-552,573

Note that measures with "0" impact in all utilities, such as the General recommissioning measure, are anticipated to decrease energy use and GHG emissions but the savings cannot be calculated.

4.3.3 Medium term plan (2030-2034)

A five year project plan to reduce GHG emissions in the medium term (2030-2034) is outlined in Table 9. A detailed breakdown of this plan, including estimated project costs, is presented in Appendix B.2. Note that a negative impact is a decrease in the corresponding utility, and a positive impact is an increase.

Table 9: Medium term ECMs to implement (2030-2034)

Year	Facility	Measure	Energy use impact	GHG impact	Electricity impact	Natural gas impact	Utility cost impact
-	-	-	[ekWh/yr]	[tCO2e/yr]	[kWh/yr]	[m3/yr]	[$/yr]
2030	Forest Glade Arena	CC DHW electrification	-6,255	-1	1,854	-768	-36
	Capri Pizzeria Recreation Complex	DEH1 and DEH2 heating electrification	-57,983	-47	232,406	-27,508	22,462
	Forest Glade Arena	DHW preheat via desuperheater	-60,576	-11	0	-5,738	-2,251
	Multiple Facilities	DHW to heat pump	-256,978	-66	120,932	-35,798	3,261
	Multiple Facilities	HVAC system optimization	-1,268,251	-227	-44,533	-115,919	-51,843
	Multiple Facilities	HVAC to heat pump	-7,646,660	-1,966	3,598,428	-1,065,207	97,009

Table 9: Medium term ECMs to implement (2030-2034) *(continued)*

Year	Facility	Measure	Energy use impact	GHG impact	Electricity impact	Natural gas impact	Utility cost impact
	Multiple Facilities	Lighting upgrade	-537,041	13	-723,798	17,691	-96,621
	Mic Mac Pool	Pool heat to heat pump	-18,929	-5	8,908	-2,637	240
	Forest Glade Arena	Rink DHW electrification	-153,056	-35	45,387	-18,798	-880
2031	Multiple Facilities	DHW to heat pump	-166,426	-43	78,318	-23,184	2,111
	Multiple Facilities	HVAC system optimization	-431,892	-52	-176,784	-24,166	-34,775
	WIATC	HVAC to heat pump	-7,145,000	-1,837	3,362,353	-995,324	90,645
	Multiple Facilities	Lighting upgrade	-153,036	1	-186,650	3,184	-25,456
	Gino A Marcus Community Centre	Replace DHW heaters with ASHP	-35,534	-8	10,881	-4,397	-168
	Gino A Marcus Community Centre	Replace pool water heater with ASHP	-155,911	-40	76,165	-21,984	2,274
2032	John Atkinson Community Centre	Changeroom HRV	-7,369	-1	0	-698	-274
	Multiple Facilities	DHW to heat pump	-98,424	-25	46,317	-13,711	1,250
	Paul Martin Building	HVAC system optimization	-316,404	-51	-48,323	-25,394	-16,876
	Fire Hall 7	HVAC to heat pump	-153,098	-39	72,046	-21,327	1,942
	Gino A Marcus Community Centre	HVAC2 conversion	-83,364	-21	35,428	-11,253	655
	Adie Knox Arena	Ice resurfacer conversion	-272	-0	1,087	-129	105
	Multiple Facilities	Lighting upgrade	-151,594	4	-209,215	5,458	-27,796
	Multiple Facilities	Pool heat to heat pump	-192,644	-50	90,657	-26,836	2,444
2033	Multiple Facilities	DHW to heat pump	-45,402	-12	21,366	-6,325	576
	Multiple Facilities	HVAC system optimization	-263,502	-38	-69,946	-18,335	-17,199
	PR Admin Building	HVAC to heat pump	-100,819	-26	47,444	-14,044	1,279
	Multiple Facilities	Lighting upgrade	-1,835,111	-46	-1,889,947	5,194	-268,376
2034	Forest Glade Arena	AC1 rink upgrade to ASHP	-20,663	-5	7,519	-2,670	29
	Forest Glade Arena	DEH3 and DEH4 mode scheduling	-110,562	-14	-40,011	-6,683	-8,346
	Forest Glade Arena	DEH3, 4 dehumidifier electrification	-947	-1	3,789	-449	366
	WFCU Centre	DH1, DH2 electrification	-60,028	-48	240,884	-28,504	23,284
	Multiple Facilities	DHW to heat pump	-170,905	-44	80,425	-23,808	2,168
	Forest Glade Arena	HV upgrade to ERV and ASHP	-301,415	-70	94,893	-37,541	-1,149
	Multiple Facilities	HVAC system optimization	-100,888	-15	-21,909	-7,481	-6,069
	Francois Baby House	HVAC to heat pump	-35,103	-9	16,519	-4,890	445
	WFCU Centre	HVAC1 to HVAC12 electrification	-185,070	-48	90,417	-26,096	2,700
	Multiple Facilities	Lighting upgrade	-472,238	8	-616,131	13,630	-82,809
	WFCU Centre	LTHW testing for future conversion	0	0	0	0	0
	WFCU Centre	MUA1 electrification	-12,445	-11	56,896	-6,568	5,564
	Windsor Waterworld	Pool heat to heat pump	-17,859	-5	8,404	-2,488	227
	Forest Glade Arena	Rink unit heater electrification	-239	-0	955	-113	92
Medium Term	Total	(Accounts for interactive effects and changes in the electricity grid emissions factor)	21,565,170	8,863	-3,819,291	2,404,579	-379,797

Note that measures with "0" impact in all utilities, such as the LTHW testing measure, are anticipated to result in a decrease in energy use and GHG emissions but the savings cannot be calculated.

4.3.4 Long term plan (2035-2050)

A project plan to reduce GHG emissions in the long term (2035-2050) is outlined in Table 10. A detailed breakdown of this plan, including estimated project costs, is presented in Appendix B.3. The following projects are currently planned to take place in the long term; however, the City remains adaptable to new technologies as they become available and the direction for particular measures may change in the long term. Note that a negative impact is a decrease in the corresponding utility, and a positive impact is an increase.

Table 10: Long term ECMs to implement (2035-2050)

Year	Facility	Measure	Energy use impact	GHG impact	Electricity impact	Natural gas impact	Utility cost impact
-	-	-	[ekWh/yr]	[tCO2e/yr]	[kWh/yr]	[m3/yr]	[$/yr]
2035	WFCU Centre	B1-6 electrification without CHP	-3,505,886	-1,294	4,190,298	-729,032	313,567
	Adie Knox Arena	Cold water flooding	-8,672	-2	0	-821	-322
	Multiple Facilities	DHW to heat pump	-43,256	-11	20,356	-6,026	549
	Multiple Facilities	HVAC system optimization	-1,680,209	-277	-212,015	-139,077	-84,892
	Multiple Facilities	HVAC to heat pump	-857,015	-220	403,300	-119,385	10,873
	Gino A Marcus Community Centre	Reznor conversion to ASHP	-88,140	-23	42,287	-12,355	1,204
	John Atkinson Community Centre	RTU upgrade (ASHP)	-187,031	-46	76,396	-24,954	1,142
2036	WFCU Centre	Door upgrade to high-performance	-132,058	-24	0	-12,509	-4,907
	Multiple Facilities	HVAC to heat pump	-69,160	-18	32,545	-9,634	878
	WFCU Centre	Window upgrade to high-performance	-93,084	-17	0	-8,818	-3,459
2037	Multiple Facilities	DHW to heat pump	-142,624	-37	67,118	-19,868	1,809
	Multiple Facilities	HVAC to heat pump	-525,016	-135	247,067	-73,137	6,661
2038	John Atkinson Community Centre	DHW heater upgrade (ASHP)	-17,784	-4	6,619	-2,312	40
	Multiple Facilities	DHW to heat pump	-28,894	-8	13,597	-4,025	367
	Multiple Facilities	HVAC to heat pump	-421,305	-108	198,262	-58,689	5,345
2039	Forest Glade Arena	AC1 library upgrade to ASHP	-46,791	-14	31,599	-7,426	1,608
	Multiple Facilities	DHW to heat pump	-57,372	-15	26,998	-7,992	728
	Multiple Facilities	HVAC to heat pump	-1,139,876	-293	536,411	-158,789	14,460
	Forest Glade Arena	MZU upgrade to air-source VRF	-83,538	-24	55,907	-13,209	2,818
	Multiple Facilities	Solar PV	-1,241,292	-37	-1,241,292	0	-177,604
2040	Multiple Facilities	DHW to heat pump	-9,110	-2	4,288	-1,269	115
	Multiple Facilities	HVAC to heat pump	-1,354,839	-348	637,571	-188,734	17,189
	Capri Pizzeria Recreation Complex	New RTU upgrade to ASHP	-76,611	-20	36,087	-10,676	976
	Biosolids Processing Plant	Process heat pump	-14,025,030	-3,606	6,600,014	-1,953,737	177,928
	Multiple Facilities	Solar PV	-455,520	-14	-455,520	0	-65,176
2041	Multiple Facilities	DHW to heat pump	-50,607	-13	23,816	-7,050	642
	Gino A Marcus Community Centre	General RTUs - ASHP	-154,162	-38	63,262	-20,596	972
	Gino A Marcus Community Centre	HVAC1 conversion to DOAS and VRF	-446,957	-104	142,376	-55,825	-1,528
	Multiple Facilities	Solar PV	-136,656	-4	-136,656	0	-19,552
2042	Optimist Community Centre	HVAC conversion to ASHP with NG	-87,492	-20	28,383	-10,976	-245
	Multiple Facilities	HVAC to heat pump	-562,034	-144	264,488	-78,293	7,130
	Optimist Community Centre	HVAC2 system conversion to ASVRF system	-53,446	-12	16,836	-6,658	-203
	Little River PCP	Process heat pump	-202,640	-52	95,360	-28,228	2,571

Table 10: Long term ECMs to implement (2035-2050) *(continued)*

Year	Facility	Measure	Energy use impact	GHG impact	Electricity impact	Natural gas impact	Utility cost impact
	Multiple Facilities	Solar PV	-91,104	-2	-91,104	0	-13,033
	Capri Pizzeria Recreation Complex	Solar PV in parking lot	-436,160	-13	-436,160	0	-62,406
2043	Multiple Facilities	DHW to heat pump	-23,099	-6	10,870	-3,218	293
	Multiple Facilities	HVAC to heat pump	-277,326	-71	130,506	-38,632	3,518
	Multiple Facilities	Solar PV	-489,684	-15	-489,684	0	-70,064
	Gino A Marcus Community Centre	Solar PV canopy	-32,797	-1	-32,797	0	-4,693
	Gino A Marcus Community Centre	Solar PV rooftop	-160,343	-5	-160,343	0	-22,942
2044	Multiple Facilities	HVAC to heat pump	-518,774	-133	244,129	-72,267	6,582
	Lou Romano WRP	Process heat pump	-779,042	-200	366,608	-108,523	9,883
	Multiple Facilities	Solar PV	-797,160	-24	-797,160	0	-114,056
2045	Transit Windsor	DHW to heat pump	-178,862	-46	84,170	-24,916	2,269
	Multiple Facilities	HVAC to heat pump	-3,181,755	-818	1,497,297	-443,230	40,365
	Paul Martin Building	Solar PV	-68,328	-2	-68,328	0	-9,776
2046	Crawford Yard	HVAC to heat pump	-631,545	-162	297,197	-87,976	8,012
	Multiple Facilities	Solar PV	-444,132	-13	-444,132	0	-63,545
2047	Multiple Facilities	HVAC to heat pump	-433,455	-112	203,978	-60,382	5,498
	Multiple Facilities	Solar PV	-204,984	-6	-204,984	0	-29,328
2048	Multiple Facilities	HVAC to heat pump	-711,419	-183	334,785	-99,103	9,025
	Multiple Facilities	Solar PV	-1,639,872	-49	-1,639,872	0	-234,633
2050	Multiple Facilities	Carbon offsets	0	-21,291	0	0	522,240
Long Term	Total	(Accounts for interactive effects and changes in the electricity grid emissions factor)	35,739,653	13,265	-8,605,727	4,200,679	194,889

4.4 Additional Recommendations and Program Enhancement Measures

Additional recommendations to consider are listed below.

Additional recommendations

- Continue to perform GHG reduction studies for high-emitting facilities, in particular:
  - Windsor Biosolids Processing Facility
  - Wastewater Treatment Plants
  - WIATC
  - Huron Lodge LTC
- Investigate unused meters. There are roughly 13 locations where there has not been metered utility use for at least a year, but the meters are still operating and the City is paying the customer fee at each location. Cancelling unused accounts could reduce the City's annual utility bills.
- Develop a plan to support electrical upgrades. As part of this plan, perform studies to investigate the electrical feasibility of proposed electrification measures and investigate grid resiliency. Upgrade electrical service where necessary to support electrification measures to reduce GHG emissions.
- Investigate renewable energy.

  - Investigate additional opportunities to implement renewable energy technology (e.g. additional locations for rooftop solar PV or geothermal heat pumps, hydrogen, solar canopies, battery storage, etc.).
  - Using more renewable energy will enable the City of Windsor to reduce the remaining GHG emissions from electricity consumption, which are expected to increase as the grid emissions factor gets higher.
- Implement additional ECMs identified through GHG reduction studies.
- Ensure that new builds are designed to minimize GHG emissions as much as possible.
- Investigate the feasibility of working with FVB Energy Inc. to generate the heat for the heated water system using heat pumps.
- Continuously investigate new technology for consideration in new measures to reduce pre-offset GHG emissions as much as possible.

Behavioural measures

Energy Awareness and Education Campaign

An effective Energy Awareness and Education Campaign is instrumental in reinforcing the City's energy conservation objectives. This campaign aims to increase employees' understanding of energy efficiency while emphasizing the City's goals for energy savings. By fostering a connection between individual actions and energy use, the campaign seeks to motivate employees to modify their behaviour towards energy consumption, ultimately leading to improved operations, increased productivity, and reduced energy costs. Furthermore, the campaign aims to enhance the City's reputation as a positive model for energy conservation and transfer the learned behaviours from the workplace to employees' homes and communities.

By raising awareness of the link between energy consumption and greenhouse gas emissions, the campaign contributes to the City's efforts in reducing its energy use and carbon footprint. Through education and engagement, employees become empowered to make informed decisions that not only benefit the City's energy use but also contribute to a healthier environment for future generations.

To implement the plan, the following steps should be undertaken.

1. Assembling the players:
   - Obtain commitment from Senior Management to support the campaign.
   - Form a dedicated team comprising representatives from various departments to drive the campaign's implementation.
2. Establishing baselines:
   - Establish baseline data for energy consumption across City facilities.
   - Conduct a survey or questionnaire to gauge the current level of energy efficiency awareness among employees.
3. Formulating objectives:
   - Align campaign objectives with the City's energy-saving goals.
   - Define specific awareness and communication objectives to guide the campaign's direction.
4. Developing a communications plan:
   - Identify communication tools such as dashboards, emails, posters, and social media platforms for disseminating energy-saving messages.
   - Identify target audiences within the organization and tailor communication strategies accordingly.
   - Anticipate potential challenges and develop strategies to address them.
5. Implementing the Awareness Campaign:

- Initiate no/low-cost actions such as dashboard messages, emails, newsletters, social media posts, and stickers to raise awareness.
- Organize meetings, lunch-and-learns, and seminars to provide education and training on energy conservation practices.
- Allocate resources for actions requiring a budget, including posters, video messages, calendars, and other promotional materials.

6. Program evaluation:
    - Establish metrics to evaluate the effectiveness of the campaign, such as changes in energy consumption and employee feedback.
    - Regularly assess progress towards campaign objectives and make adjustments as needed.
7. Monitoring and reporting:
    - Implement mechanisms to monitor energy consumption trends and track the impact of the campaign.
    - Generate regular reports to senior management and stakeholders to provide updates on campaign progress.
8. Following through:
    - Reinforce energy-saving messages consistently through ongoing communication channels.
    - Adapt the campaign approach based on feedback and evolving organizational needs.
    - Share success stories and recognize employees' efforts to encourage continued participation.

Organizational measures

Integration of energy management with corporate policy

Integrating energy management with corporate policy is essential for fostering a culture of sustainability and maximizing the effectiveness of energy conservation efforts within an organization. By embedding energy management principles into corporate policy frameworks, organizations can formalize their commitment to energy efficiency, aligning their operations with environmental and financial sustainability goals.

At the core of this integration is the development of comprehensive energy management policies that outline clear objectives, responsibilities, and strategies for optimizing energy use across all aspects of the organization. These policies typically encompass guidelines for energy-efficient practices, investment priorities for energy-saving initiatives, and protocols for monitoring and reporting energy performance. By establishing such policies, organizations signal their dedication to minimizing energy consumption, reducing greenhouse gas emissions, and enhancing operational efficiency.

Furthermore, integrating energy management into corporate policy facilitates accountability and transparency within the organization. By assigning roles and responsibilities for energy management tasks and establishing mechanisms for monitoring and reporting energy performance, the City can ensure that energy efficiency becomes a priority at all levels of the organization. This holistic approach fosters a culture of continuous improvement, where employees are empowered to identify opportunities for energy savings and contribute to the organization's broader sustainability objectives. Ultimately, by integrating energy management with corporate policy, the City can achieve long-term cost savings, mitigate environmental impact, and strengthen their competitive position in an increasingly sustainable-focused marketplace.

5 Implementation Plan

5.1 Projected Utility Use and GHG Emissions Based On the Plan

The projected utility use, GHG emissions, and utility costs for the GHG Reduction Plan compared to a business as usual scenario are presented below. Note: The addition of the Windsor Biosolid Processing Facility and Paul Martin Building had a negative impact on savings. Note that the Paul Martin Building has been sold in 2024, which will decrease the utility use and GHG emissions for the City's portfolio compared to what is presented in this plan. This fact can be seen following the year 2040.

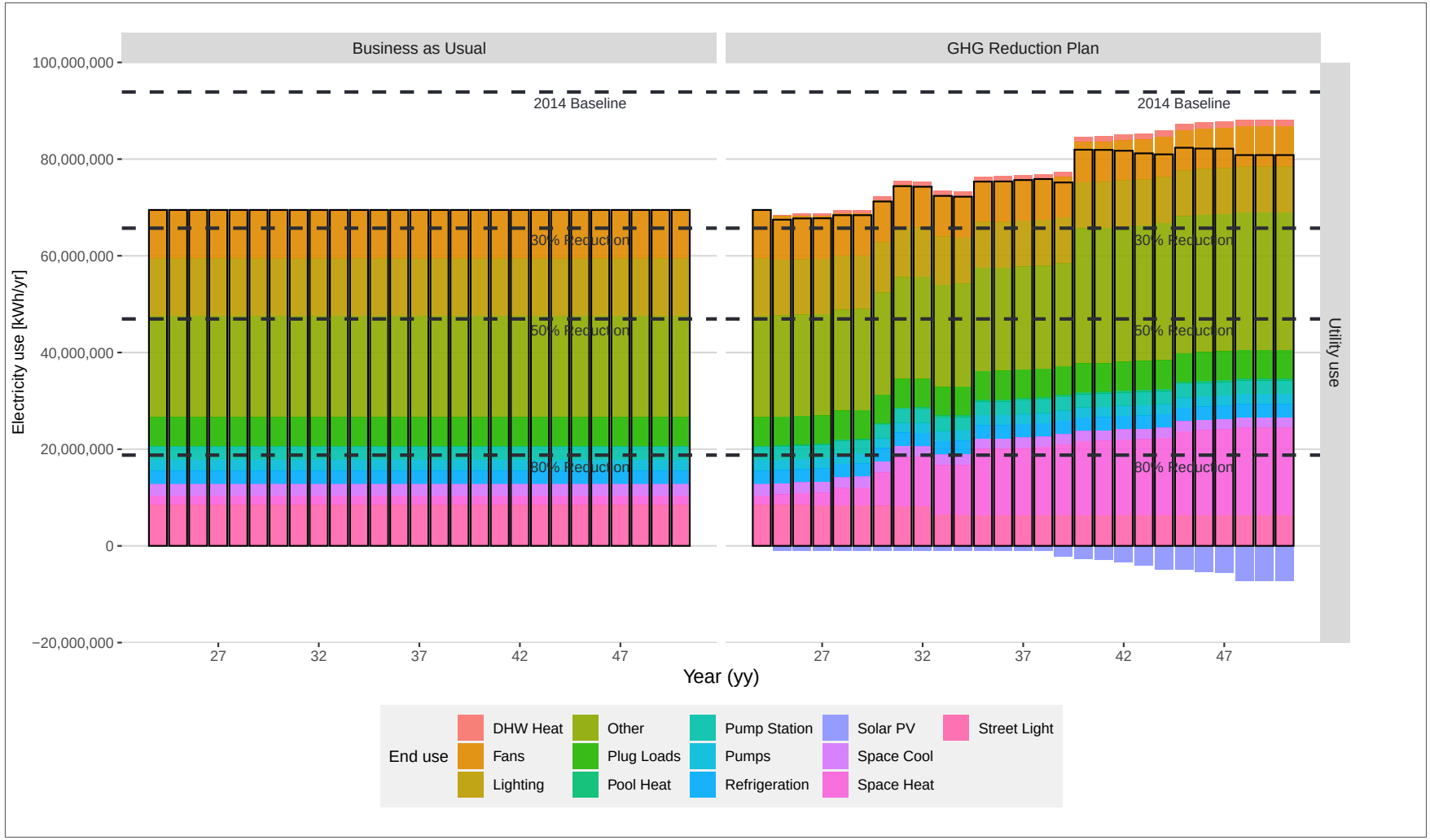

Figure 13: Electricity utility use projection for each scenario

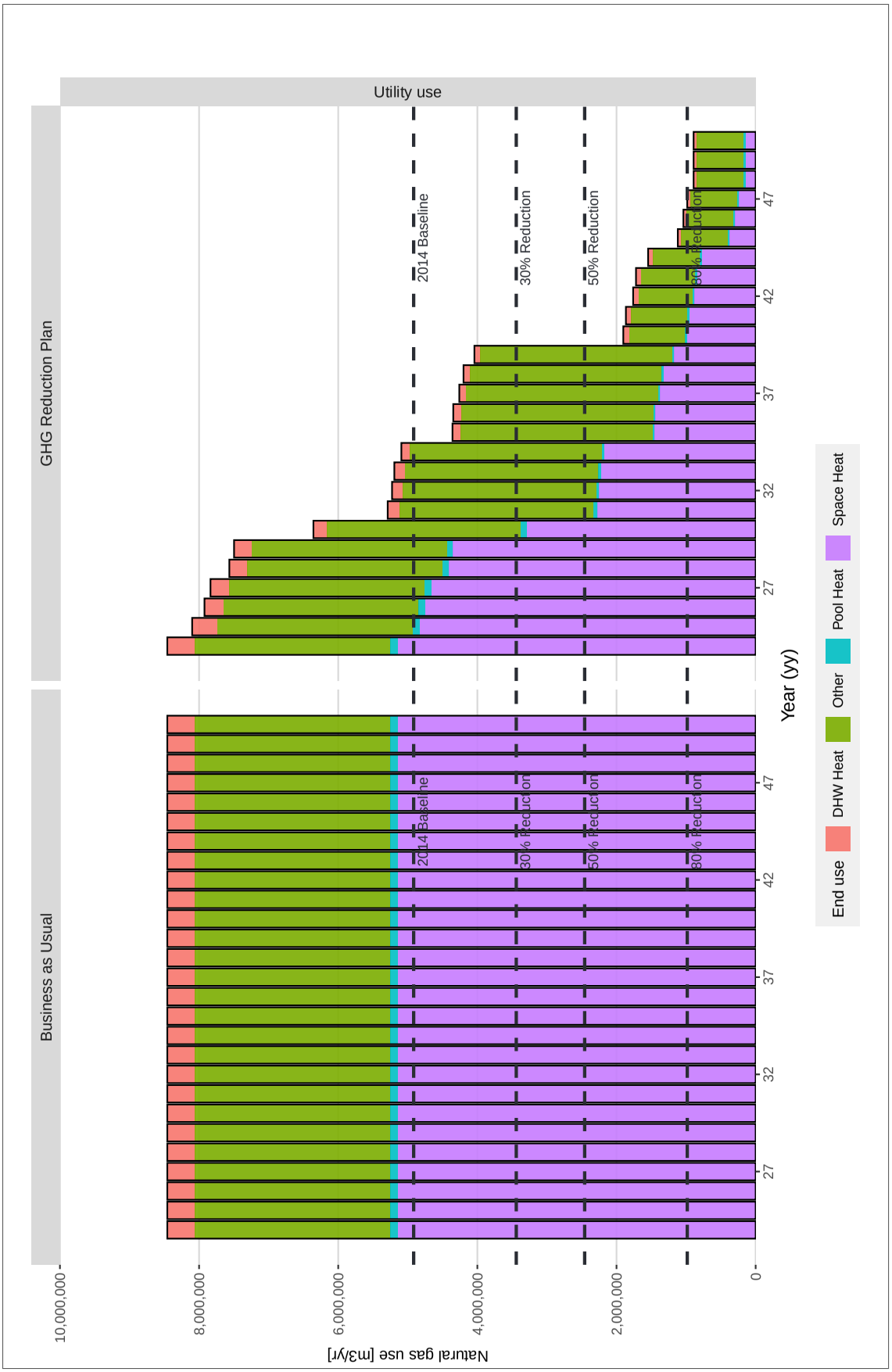

Figure 14: Natural gas utility use projection for each scenario

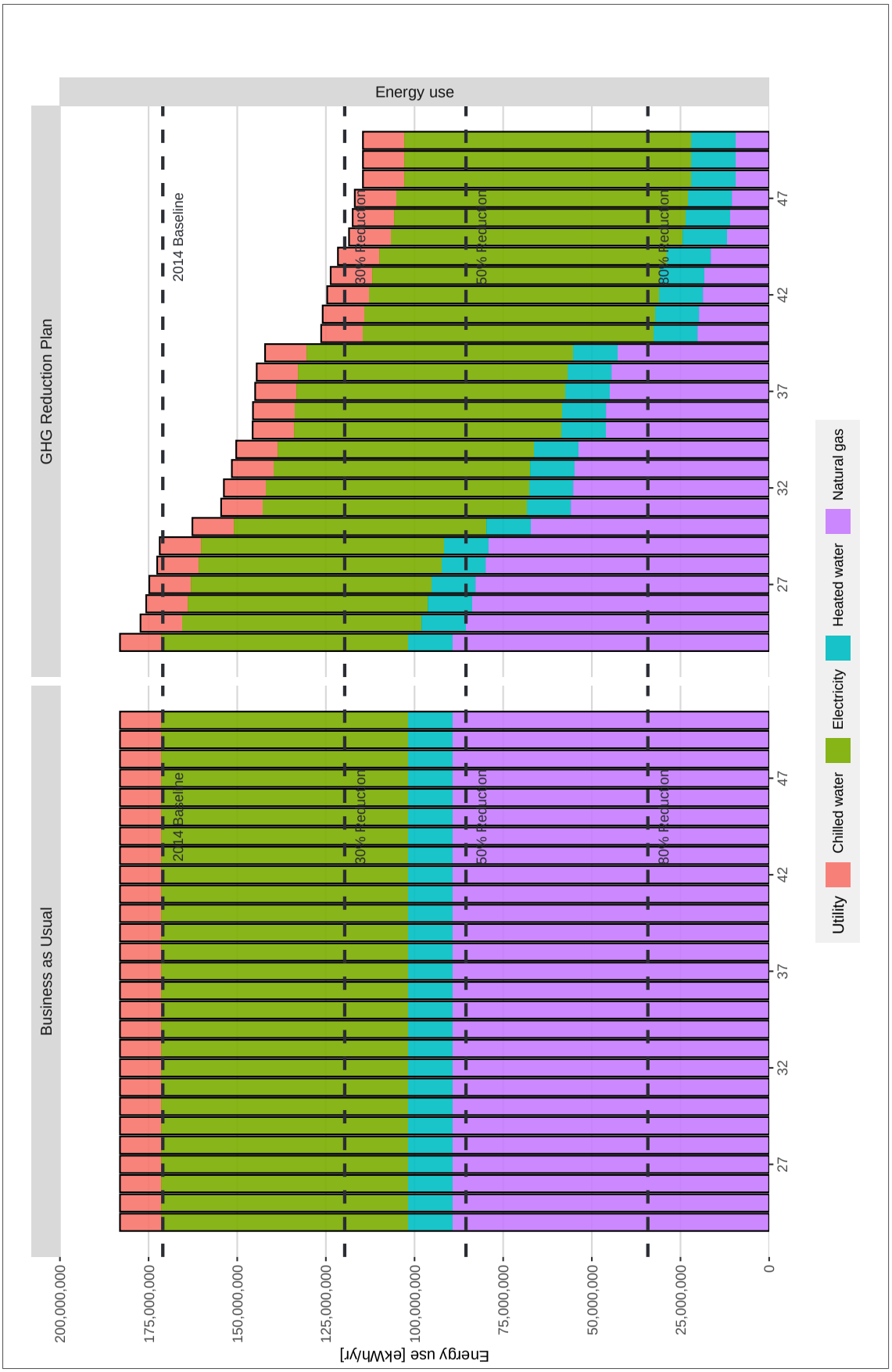

Figure 15: Energy use projection for each scenario

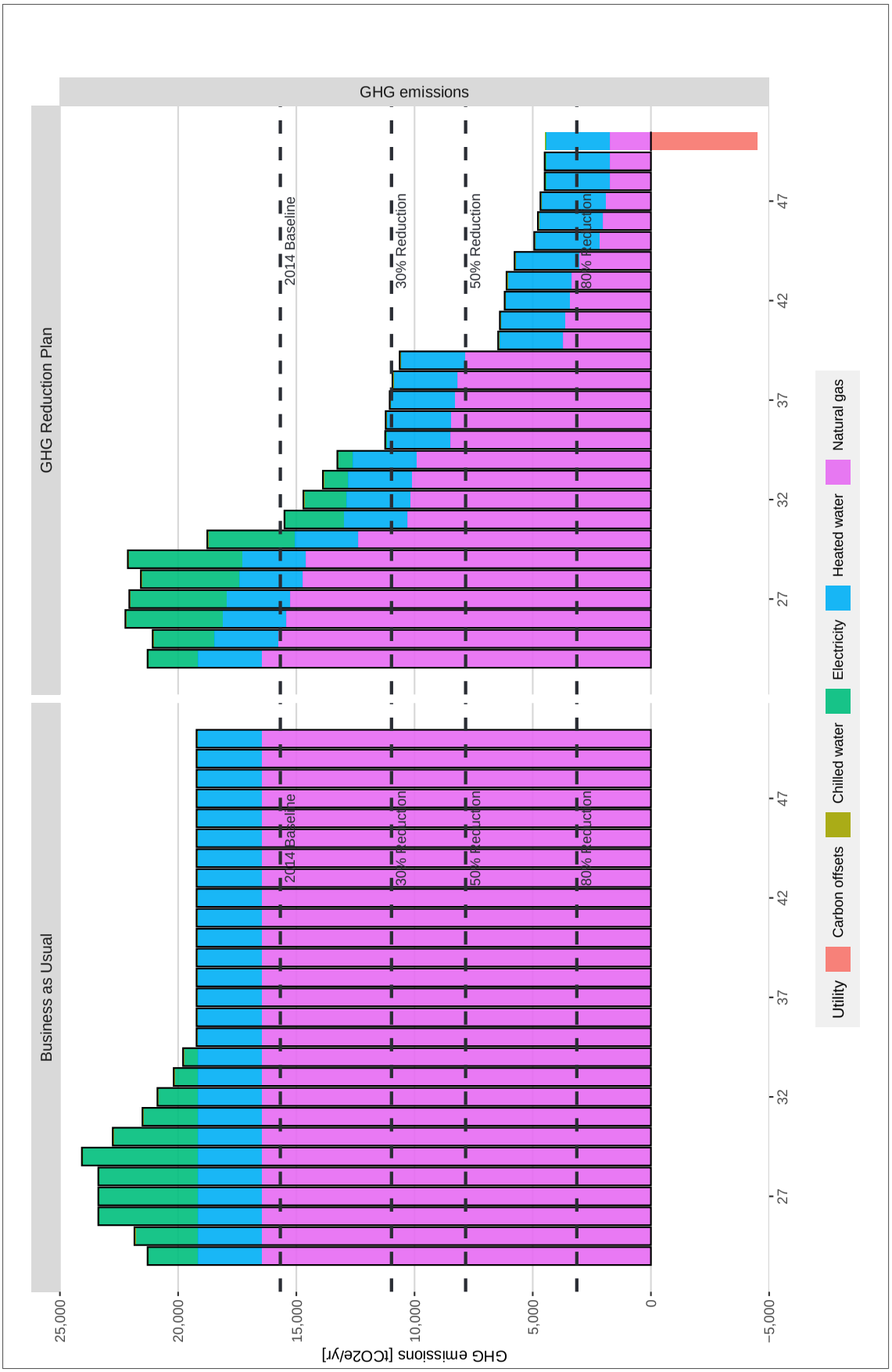

Figure 16: GHG emissions projection for each scenario

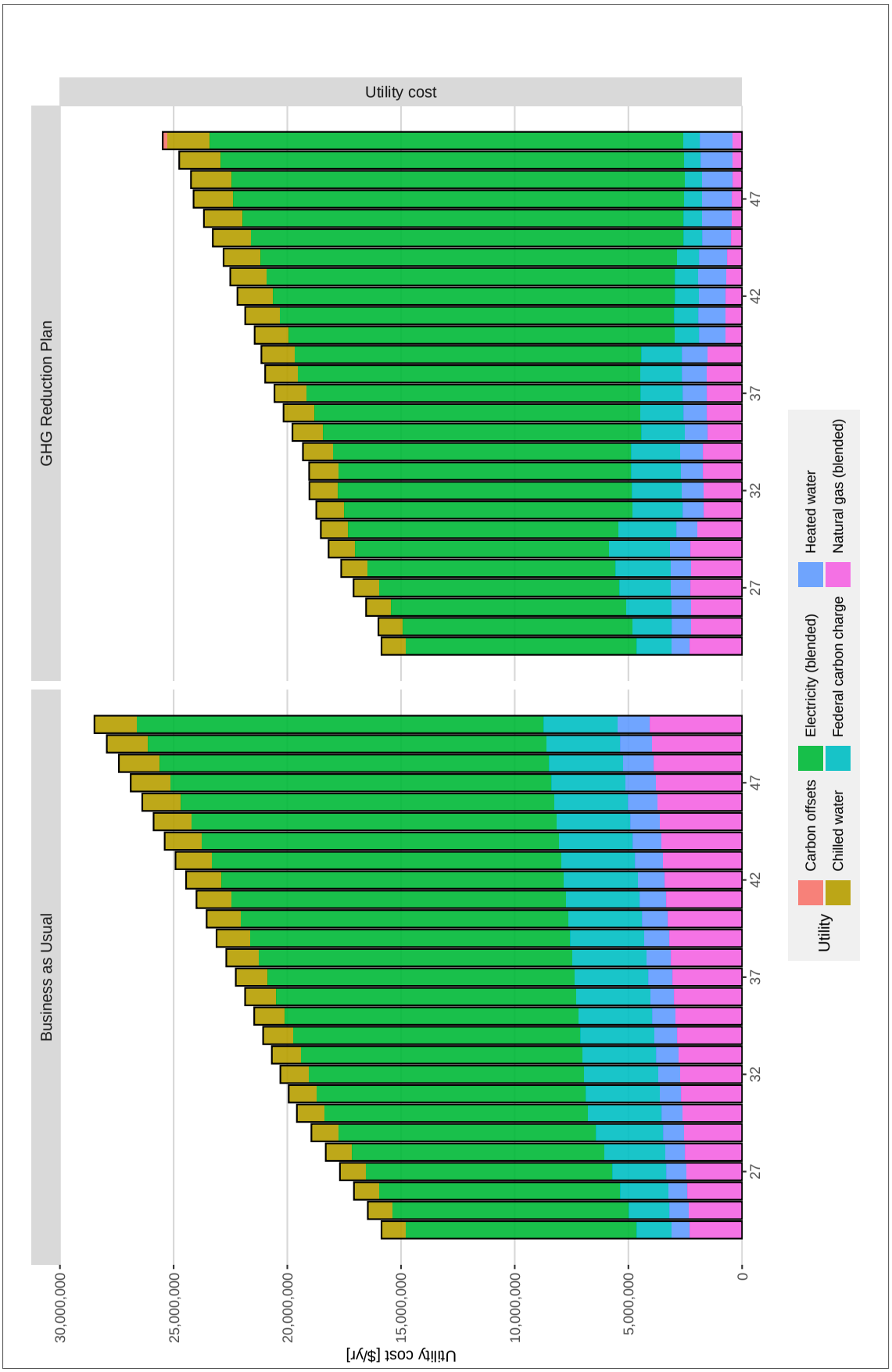

Figure 17: Utility cost projection for each scenario

5.2 Scenario Discussion

The following results are observed from the scenario analysis:

- In the short term, the recommended measures are anticipated to decrease the City's energy use by roughly 6%. This will be the result of implementing low-hanging fruit measures (i.e. lighting retrofits, HVAC recommissioning, and controls upgrades) as well as select measures from feasibility studies.
- In the short term, due to a projected increase in the electrical grid emissions factor, GHG emissions are projected to increase by 4% by 2029.
- The Business as Usual scenario is considered non-viable, because it involves taking no specific action to achieving energy use or GHG reduction targets. In 2050, the Business as Usual scenario also exhibits annual utility costs roughly $3,001,838 (11%) higher than those in the GHG reduction pathway, due to the greater energy use and due to the federal carbon charge.
- The GHG Reduction Pathway Feasibility Studies undertaken for certain buildings provide strategies which allow these buildings to significantly reduce their energy use and GHG emissions.
- By pursuing all recommended ECMs, the energy use can be reduced by approximately 33% compared to the 2014 baseline.
- The maximum GHG emissions that can be achieved by pursuing the ECMs outlined previously, without carbon offsets, is roughly 74% lower than the 2014 baseline.
- By purchasing carbon offsets, net zero GHG emissions can be attained.
- Most of the significant reductions in GHG emissions are a result of measures taken in the medium and long term to reduce the consumption of fossil fuels through process electrification. The electrical grid emissions factor is projected to decrease with time, and using electric equipment where possible can significantly decrease the City's GHG emissions.
- In 2050, most of the remaining GHG emissions are from remaining natural gas use and heated water use. To further reduce GHG emissions, the City is encouraged to implement energy-efficient and renewable energy technology where possible, and continue to investigate new technology and best practices throughout the years.

5.3 Progress Summary

Based on the plans identified, the anticipated progress towards reducing GHG emissions (before purchasing offsets) is presented in Table 11. Note that a negative change is a decrease in the corresponding utility, and a positive change is an increase.

Table 11: Plan Results Summary

Term	Energy use	Cumulative Energy Use % Change	Utility Cost	GHG Emissions	GHG Emissions Change	Cumulative GHG % Change
-	[ekWh/yr]	[%]	[$/yr]	[tCO2e/yr]	[tCO2e/yr]	[%]
Baseline	170,991,163	-	15,298,910	15,677	-	-
Current	183,068,655	7	15,858,607	21,292	5,615	36
Short Term Plan	171,858,341	1	18,185,122	22,128	835	41
Medium Term Plan	150,293,170	-12	19,313,404	13,265	-8,863	-15
Long Term Plan	114,553,518	-33	25,480,611	4,495	-8,769	-71

To achieve the goal of net zero by 2050, carbon offsets can be purchased to offset the remaining GHG emissions.

6 Monitoring and Evaluation

6.1 Plan Review, Monitoring, Verification, and Reporting

Continuous monitoring, verification, and reporting remain critical components of the City's energy management strategy and a necessary tool to track consumption, cost savings / cost avoidance resulting from project implementation. To enhance understanding of energy conservation and best practices, a comprehensive monitoring and verification process will be integrated into the existing framework. This process will provide valuable insights into the effectiveness of energy initiatives and guide future decision-making.

The Asset Planning/Energy Initiatives division will continue to provide periodic updates to City Council. Additionally, real-time energy data management systems will integrate sub-metering data into an enterprise-wide Energy Management Information System (EMIS), facilitating efficient monitoring of energy consumption across facilities and enabling proactive decision-making.

As the various, projects become operational, they will be regularly monitored and reviewed quarterly to document energy consumption, GHG emissions reduction and cost savings. The monitoring process will include updates to the departments affected by the implementation of their projects/measures.

It is recommended that the monitoring process should result in an annual report, which will provide the following information:

- Annual energy consumption with historical comparisons.
- An updated description of current and proposed measures toward conservation, energy reduction, and managing demand for energy.
- A revised forecast of expected results of current and proposed measures.
- An update of actual results achieved to-date.
- A description of any proposed changes to be made to assist the City in achieving established targets and forecasts.

6.2 Energy Data Management

Effective energy management hinges on the availability of accurate and timely data. Building upon current efforts, the City will establish a robust energy data management system that provides real-time feedback on energy consumption. This system will empower facility staff and energy administrators to identify and address operational inefficiencies promptly.

The implementation of an EMIS will enhance analytical capabilities and enable the identification of energy efficiency opportunities more effectively. Real time data analysis provides several benefits that include:

- Swift responses to operational abnormalities
- Better understanding of larger facilities, i.e. wastewater treatment facilities and plants, and recreational facilities
- Ability to better identify conservation opportunities
- Better monitoring and setting of consumption reduction targets
- Assist with budget preparation

Ultimately, the goal is to identify energy efficiency opportunities, reduce energy consumption, manage costs, and minimize the municipal carbon footprint. Leveraging real-time data and advanced analytics through an EMIS, the City aims to cultivate a culture of energy conservation and achieve the net zero emissions target by 2050.