Queen's
UNIVERSITY

Greenhouse Gas Inventory Report 2022

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SUMMARY

Queen's University in Kingston, Ontario is committed to advancing the United Nations Sustainable development Goals, and specifically to the University's role in addressing climate change. As a learning and research institution, Queen's has an opportunity to contribute to climate change issues, support the efforts of its innovators, and educate a future generation of decision makers.

In 2010, Queen's University signed the University and College Presidents' Climate Change Statement of Action for Canada, thereby committing to reduce greenhouse gas (GHG) emissions. As part of this agreement, Queen's is required to track and report all GHG emissions. This is the fourteenth annual Greenhouse Gas Inventory Report published, which contains a summary of Queen's Scope 1&2 emissions as calculated according to the World Resources Institute (WRI) GHG Protocol for Corporate Accounting standard.

In total, Queen's emitted 38,785 tCO2e from January 1 to December 31, 2022 which is a slight increase from 2021.

The Queen's Climate Action Plan (CAP) was developed to reduce the GHG emissions emitted by the University, with a goal of being carbon neutral by 2040. Milestone targets for 2020 and 2030 have also been set to structure an achievable timeline for carbon neutrality. The CAP's target of 35% GHG reductions by 2020 was successfully met, and Queen's is now working towards the second milestone of 70% reduction by 2030. This report provides a breakdown of the university's emissions in 2022 as well as an overview of Queen's plan for further emission reduction.

Joseph S. Stauffer Library

BACKGROUND INFORMATION

Scope of Emissions

This report reviews the overall emissions associated with the operations of Queen's University, including the direct (Scope 1) and indirect (Scope 2) emissions of all Queen's facilities and operations within the province of Ontario. This encompasses leased and owned buildings both on and off campus. The report excludes any satellite offices outside of Ontario and the Bader International Study Centre at Herstmonceux, England.

Scope 1 emissions include all emissions directly produced by the University, most of which are caused by local energy production to heat the campus. The main contributors to Scope 1 emissions include:
- Stationary combustion from the boilers, cogeneration plant, generators, furnaces, and kitchen equipment
- Mobile combustion from various fleet vehicles and grounds maintenance equipment
- Fugitive emissions from electrical switches, fire suppression equipment, lab chemicals, and refrigerants

Scope 2 emissions include all indirect emissions associated with energy that the University purchases, including:
- The University's Main and West Campus electricity consumption
- The electricity consumption of Queen's Biological Station (QUBS)
- The electricity, heating, and cooling in all leased spaces

Scope 3 emissions include all other indirect emissions, and are comprised of 15 unique categories, such as commuting and, that are not included in the scope of this report
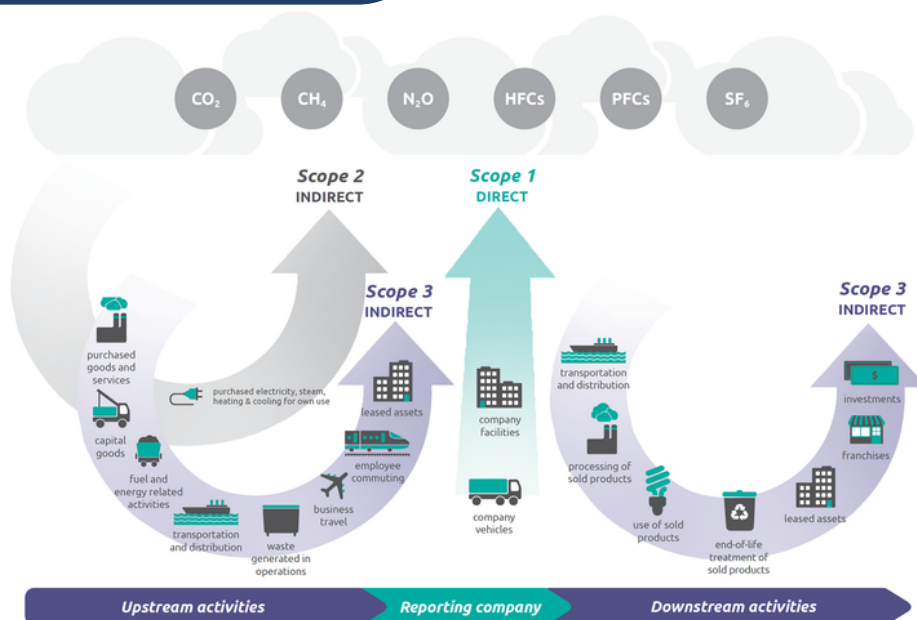
Source: *https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf*

Method of Calculation

The quantification methods used to calculate GHG emissions for Queen's University in this report were developed according to the WRI GHG Protocol for Corporate Accounting standard.

All fuel combustion and electricity consumption has been determined from invoice records and utility metering. These sources account for approximately 96% of Queen's GHG footprint. The remaining 4% is calculated based on estimations of non-metered sources such as fugitive releases from laboratory chemicals, refrigerant leakage, wood combustion and small fuel-consuming equipment.

Using emission factors, which are unique to each emission source, the raw data has been converted to metric tonnes of CO2 equivalent emissions (tCO2e). This allows for normalized comparison between different types of emissions sources.

The emission factors used in the calculations are based on national industry standards that tend to remain static for most fuels, with the exception of electricity. The grid emission factor used for electricity calculations fluctuates year to year depending on the Ontario electricity grid supply mix, and is published annually in Environment Canada's National Inventory Report.

The data provided in this report was prepared by Queen's Facilities Energy & Sustainability Team. Any questions regarding the methods used to collect and calculate these values can be directed to sustain@queensu.ca.

2022 EMISSIONS OVERVIEW

Emissions Summary

Queen's University produced 35,612 tCO2e Scope 1 and 3,173 tCO2e Scope 2 emissions throughout 2022, summing to a total carbon footprint of 38,785 tCO2e. To determine Queen's net carbon footprint, the portion of emissions associated with energy exported off-site to Kingston General Hospital (KGH) was excluded.

Over three quarters of Scope 1 emissions on campus come from the Central Heating Plant (CHP) which is owned and operated by Queen's. The CHP produces steam with natural gas boilers for heating buildings, and intermittently produces electricity and steam with cogeneration turbines. In addition to serving Queen's Campus, the CHP also generates electricity and steam for KGH.

The total emissions produced by Queen's including exports to KGH in 2022 was 47,299 tCO2e. KGH demand from the plant was responsible for approximately 20% of that total, so that portion is removed from Queen's Scope 1 emissions. A summary of Queen's emissions is shown below in Table 1, including emissions normalized by population and area.

tCO2e is a metric tonne of carbon dioxide equivalents. This is a universal unit of measure that indicates the global warming potential (GWP) of each of the six greenhouse gases (CO2, CH4, N2O, HFCs, PFCs, and SF6) expressed in terms of the GWP of one unit of carbon dioxide. This enables the normalized summation of emissions from all GHGs).
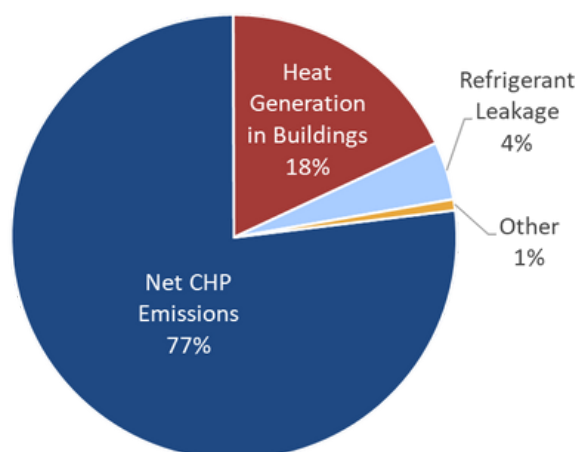
	Queen's Emissions (tCO2e)
Scope 1	35,612
Scope 2	3,173
Total	**38,785**
Per Capita	1.08
Per 100 m2 Floor Space	5.02

Table 1: Summary of Queen's University's 2022 Scope 1 & 2 carbon emissions

Emissions Breakdown by Scope

Scope 1 Emissions

Scope 1 emissions are those emitted on site due primarily to energy generation and unintentional chemical release. A source by source breakdown of Queen's Scope 1 emissions is shown in Table 2. The greatest contributors to these emissions are the Central Heating Plant (CHP), which uses natural gas powered boilers to heat the campus in the winter, and stand alone heat generation in buildings that are not connected to the CHP. The remaining emissions are created by fuel combustion from the campus vehicle fleet, laboratory chemicals, and wood combustion.

Scope 1 GHG Sources	Total Emissions (tCO2e)
Net CHP Emissions	27,386
Heat Generation in Buildings	6,440
Refrigerant Leakage	1,502
Fuel Combustion in Equipment	244
Laboratory Chemicals	23
SF6 Leakage	16
Wood Combustion	2
Scope 1 Total	**35,612**

Table 2: Queen's Scope 1 emission source breakdown

Scope 2 Emissions

Scope 2 emissions are indirectly produced by the University through electricity usage in Queen's owned and leased buildings. A source by source breakdown of Queen's Scope 2 emissions is shown in Table 3.

The quantity of emissions produced by a kWh of electricity from the grid is calculated as an annual grid emissions factor, representing an average based on all forms of electricity production contributing to the provincial grid.

Scope 2 GHG Sources	Total Emissions (tCO2e)
Owned Buildings Grid Electricity	2,994
Leased Buildings Heating	82
Leased Buildings Grid Electricity	80
Leased Buildings Cooling	18
Scope 2 Total	**3,173**

Table 3: Queen's Scope 2 emission source breakdown
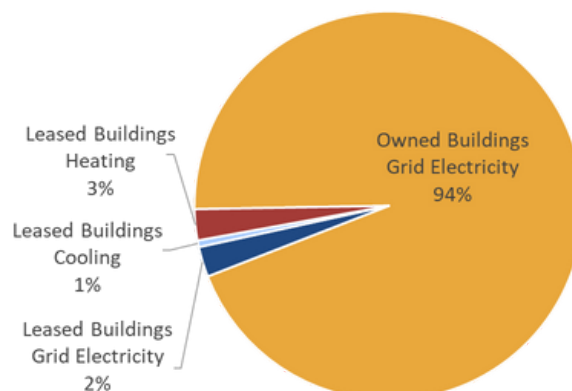
Emissions Over Time

From 2008 to 2022, Queen's has reduced its total GHG emissions from 57,716 tCO2e to 38,785 tCO2e. Figure 1 shows a year over year breakdown of Queen's total Scope 1 & 2 emissions. In 2020, the University was successful in reaching its goal of 35% emissions reduction from the 2008 baseline. In 2022, Queen's emissions rose slightly. This increase can be attributed to the addition of the new 334-bed student residence, as well as increased ventilation and reduced recirculation in all campus buildings as students returned to classes following the COVID-19 pandemic shutdown. When COVID-19 ventilation measures are lifted, Queen's is expected to shed the additional emissions that come with these safety procedures.
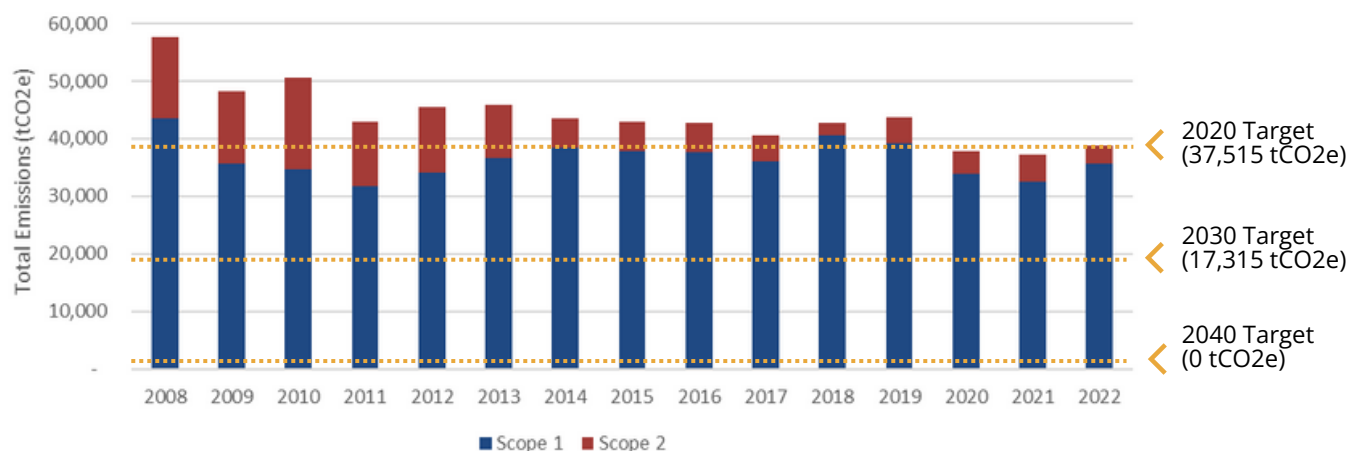

Figure 1: Queen's year over year Scope 1 & 2 GHG emissions and emission targets set in 2010

While Queen's observed an increase in total emissions in 2022, the University also experienced a decrease in emissions per unit of building floor space. As shown in Figure 2, there was a decrease from 5.22 tCO2e/100 m2 to 5.02 tCO2e/100 m2 from 2021 to 2022, indicating an overall improvement in energy efficiency. Even with significant campus and student growth, overall emissions have still been trending downwards, resulting in a 47.9% reduction in emissions per building area since 2008.
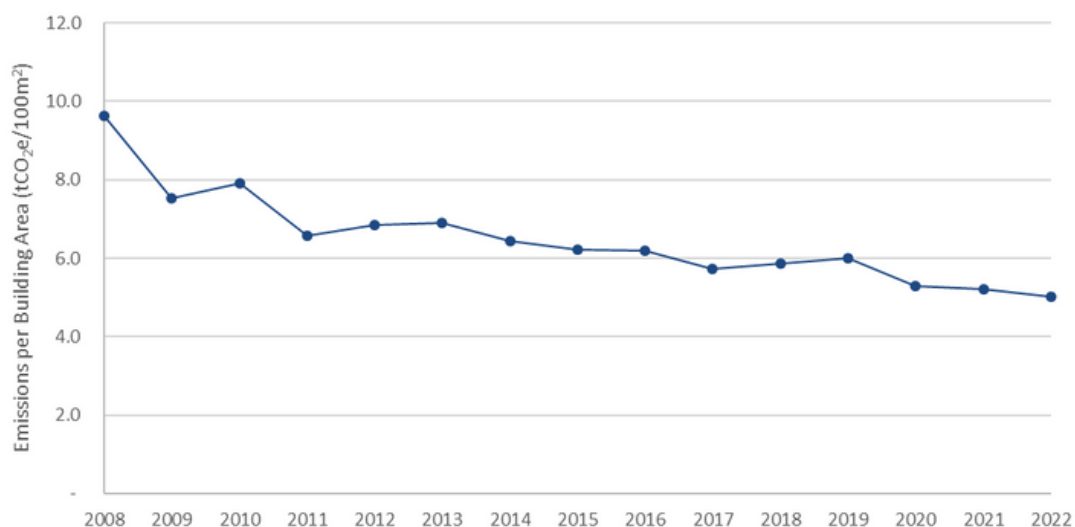

Figure 2: Queen's year over year total GHG Emissions per 100 m2 of campus building floor space

QUEEN'S CLIMATE ACTION PLAN

Outline

Queen's Climate Action Plan was established in 2016 to align with the goals set out by the University and College Presidents' Climate Change Statement of Action for Canada, signed in 2010. The three areas of focus for the original plan included reduction of point-of-use consumption, improving efficiency and fuels at the CHP, and actualizing the use of renewable energy generation. Queen's reached the goal of achieving a 35% reduction in emissions by 2020. Table 4 outlines the targets set in the Climate Action Plan.

Year	Target Emission Reduction	Actual Emission Reduction
2020	35%	35%
2030	70%	TBD
2040	100%	TBD

Table 4: Emission reduction target milestones

Some projects have already significantly reduced Queen's emissions, including the West Campus energy project which severed the steam line to West Campus eliminating heat losses along the 2.5 km path. Installing a new hot water distribution system on West Campus allowed Queen's to save 1,500 tCO2e annually from the decommissioning of that steam line. Absorption chillers at KGH also reduce waste heat during the summer by using excess steam from the cogeneration units to chill water.

To continue improving the energy efficiency of Queen's buildings, there are multiple projects and policies that have been implemented. Updates to the Queen's Building Standard provide guidelines to ensure sustainability is considered for new projects and builds, eliminating fossil fuels from new designs, requiring efficient building envelopes, and heat recovery in ventilation systems. All new buildings are required to be Leadership in Energy and Environmental Design (LEED) Gold.

As noted in the Climate Action plan, updating the district steam system will be a focus to reduce emissions as heating on campus, both from the CHP and other natural gas boilers currently makes up 87.2% of all emissions.

Given the age and history of many buildings at Queen's, retrofitting and improving building envelopes and mechanical systems will be important to reducing carbon emissions. Minimizing load will help enable electrification, as well as lower cost of conversion to geothermal heating by reducing the required size of the system. Upgrading building controls, including scheduling and occupancy-based HVAC will be a primary focus moving forward to reduce energy consumption and cost - the most economical energy is the energy you do not use.

Emission Reduction Strategies

Queen's has eliminated over a third of its emissions since 2008 through a variety of clean energy projects and building upgrades. With parts of the main campus dating back as for as the mid 1800's, many of the buildings have benefitted from envelope renovations such as improved insulation and windows, as well as occupancy based controls for lighting and ventilation. Some of Queen's recent and upcoming carbon reducing projects are listed below.

355 King Administrative Building Geothermal System - 2022

In 2022 the Facilities team and several other administrative departments moved into a renovated space at 355 King St. This former hospital site, with some sections dating to the late 1800's, underwent a comprehensive renewal that included a geothermal system. Using electrically powered geothermal heating and cooling reduces reliance on greenhouse gas fired heating systems such as natural gas boilers. In addition to these operational emissions savings, thousands of tonnes of embodied emissions related to the construction and materials were also avoided by keeping the structure of the building.

Strategic Lab Revitalization - 2022

In 2022 a major upgrade to lab ventilation in Chernoff Hall was completed which is expected to reduce emissions by 780 tCO2e/year. This project adds occupancy sensors connected to the building automation system to match airflow to required ventilation based on lab occupancy. By managing exhaust according to need, the amount of fresh outdoor make-up air that must be heated or cooled as it is brought into the building is reduced, saving energy and emissions.

Demand Controlled Kitchen Ventilation - 2023

In cold climates commercial kitchen ventilation systems use a significant amount of energy to heat the make-up air that replaces the kitchen exhaust. In 2023 the ventilation in the Leonard Hall kitchen is being upgraded to add a demand controlled system. Instead of running at full speed throughout opening hours, the system will use sensors to determine the amount of ventilation required, and vary the fan speed based on actual need. This project is expected to reduce emissions by 200 tCO2e/year.

Replacement of 8,000 Fluorescent Fixtures with LED - 2022 to 2025

Over a 4 year period a major project to upgrade 8,000 fluorescent fixtures to energy efficient LED is happening in 20 buildings across campus. The resulting electricity savings will reduce Queen's Scope 2 emissions by an amount that will vary depending on the annual Ontario grid emissions factor.

FINAL REMARKS

Queen's University was ranked 3rd in the world and 1st in North America for the 2023 Times Higher Education report on the United Nations Sustainable Development Goals (SDG's).

The results of the carbon reductions over the last 14 years combined with our SDG results showcase the university's commitment to an ongoing strategic approach to sustainability across a diverse range of the SDGs. For more information on the university's strategic plans, please visit the Principal website.

www.queensu.ca/principal/