QUEEN'S UNIVERSITY GREENHOUSE GAS INVENTORY REPORT 2020

June 2021

INTRODUCTION

In 2010, Queen's University signed the *University and College Presidents' Climate Change Statement of Action for Canada*, thereby committing to taking action 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 twelfth GHG Inventory Report published, and contains data from January 1, 2020 until December 31, 2020. The Queen's Climate Action Plan was developed to reduce the GHG emissions emitted by the University, with a target 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. Notably, **the target of 35% GHG reductions by 2020 was successfully met.** The breakdown of these results is explained in the *Results in Context* section of this report.

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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, the Bader International Study Centre at Herstmonceux, England, and student rental homes leased by Queen's Community Housing.

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 usage
- The electricity consumption of Queen's Biological Station (QUBS)
- The electricity, heating, and cooling in all leased spaces

Figure 1: The Queen's Central Heating Plant (CHP)

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METHOD

The methods used to determine GHG emissions in this report have been developed according to standard approaches. Emissions calculations are based on a standard equation, where an activity level is multiplied by a corresponding emission factor. Activity levels are derived from reports documenting the consumption of different fuels and energy. Throughout the year, invoices and metering data are collected and stored for all fuel combustion, electricity consumption, and heating of independent buildings. This information is then compiled and the associated greenhouse gas emissions are calculated. The calculations represent approximately 97% of all Queen's University emissions. The final 3% is calculated based on assumptions and includes elements such as fugitive emissions from laboratory chemicals and fire suppression units, leased space, and some small fuel-consuming equipment.

The emission factors used in the calculator are based on national industry standards that tend to remain static for most fuels. However, the grid emission factors used for electricity calculations come from Environment Canada's National Inventory Report. Additionally, data for lighting energy use, as well as heating and cooling for office spaces come from Natural Resources Canada. For both emission factor sources, there is usually a two-year lag period in the availability of these values. Thus, data from 2019 was used for this year's report, and the calculation will be updated when values for 2020 become available.

In 2014, the tracking of emissions has changed from following the Queen's fiscal year (May-April) to the calendar year (January - December), in order to reflect the style required by the Ontario Ministry of the Environment and Climate Change (MOECC) Provincial GHG Report.

The Grid Emission Factor

The Grid Emission Factor is a measure of the Provincial Electricity Grid's carbon intensity, or the average output of carbon dioxide per unit of electrical output.

Different types of electricity generation have their own carbon intensities. Output from fossil fuel plants have varying levels of carbon intensity depending on the fuel, which in Ontario is natural gas. Carbon-neutral sources such as nuclear, hydro, wind, and solar are generally viewed as having no carbon emissions and so their carbon intensities are zero. The transmission infrastructure also adds to carbon intensity when accounting for line losses. A weighted calculation of these elements within the grid is equal to the annual Grid Emission Factor.

2020 RESULTS

Scope 1 and Scope 2 emissions were calculated to demonstrate the overall carbon footprint of the University. Two final numbers have been calculated: a total emissions value and an adjusted emissions value. This is because Queen's owns and operates a Central Heating Plant (CHP) which produces steam to heat campus buildings by burning natural gas and oil. A portion of this steam (20%) is used to heat other facilities including Kingston General Hospital and the Burr Wing. As such, some of the emissions produced by the University are not directly associated with its own facilities. Shown below are tables depicting the overall emissions of Queen's University, including energy produced for the above external facilities, and the adjusted emissions which exclude energy exported from campus. The total adjusted GHG emissions for Queen's University was **37,428.61 $MTCO_2e$**. See Table 1 for a summary of the 2020 campus emissions.

$MTCO_2e$ *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.*

	2020 Total Emissions – including hospitals ($MTCO_2e$)	2020 Adjusted Emissions – Queen's only ($MTCO_2e$)
Scope 1	41,953	33,958
Scope 2	3,824	3,824
Total	**45,777**	**37,782**
Per Capita Emissions	1.276	1.053
Emissions Per 1000 SF	5.953	4.913

Table 1. Breakdown of the 2020 Queen's University emissions by scope, population, and campus area

2020 RESULTS BY SCOPE

Scope 1 Emissions

Scope 1 emissions are those emitted on site due primarily to energy generation and unintentional release from laboratory chemicals. The greatest contributor to these emissions is the Central Heating Plant (CHP), used to heat the campus in the winter. The CHP emissions represented 84% of Scope 1 emissions in 2020. The next largest emissions source is from stand alone heat generation in buildings that are not connected to the CHP, contributing approximately 14% of the Scope 1 emissions in 2020. The remaining emissions are created by fuel combustion from the campus vehicle fleet, chemical emissions from laboratory chemicals, wood combustion and fire suppression systems.

Scope 1 GHG Sources (adjusted)	2020 Totals ($MTCO_2e$)
Net CHP Emissions	28,446
Heat Generation in Buildings	4,695
Refrigerant Leakage	327
Fuel Combustion in Equipment	410
Laboratory Chemicals	24
Fire Suppression Systems	34
SF6 Leakage	16
Scope 1 Total	**33,958**

Table 2. Breakdown of Scope 1 emissions in 2020

Scope 2 Emissions

Scope 2 emissions are indirectly produced by the University through electricity usage in Queen's owned and leased offices.

The associated emissions per kWh of electricity are calculated by the province as grid emission factors, representing an average based on all forms of electricity production contributing to the provincial grid.

Scope 2 GHG Sources	2020 Totals ($MTCO_2e$)
Owned Offices – Net Grid	3,058
Leased Offices – Heating	670
Leased Offices – Grid Electricity	79
Leased Offices – Cooling	17
Scope 2 Total	**3,824**

Table 3. Breakdown of Scope 2 emissions in 2020

Climate Action Plan 2020 Results

Scope 1 and Scope 2 emissions were calculated to demonstrate the overall carbon footprint of the University. Queen's first conducted a GHG inventory in 2008 in order to establish a baseline from which to measure future emissions reductions. Total emissions from the inventory were 57,716 Metric Tonne Carbon Dioxide Equivalent (MTCO2e) with Scope 1 emissions of approximately 43,500 MTCO2e and Scope 2 emissions of approximately 14,200 tonnes CO2e. Queen's has successfully reached the goal of 35% GHG

Year	Target Reduction	MTCO2e Emissions Reduction	Actual Reduction	Actual MTCO2e Reduction
2020	35%	20,200	**34.5%**	19,934
2030	70%	40,400	TBD	TBD
2040	**100% - Carbon Neutrality**	**57,716**	**TBD**	**TBD**

Table 4. Breakdown of the Climate Action Plan 2020 Results

RESULTS IN CONTEXT

Total GHG emissions have fluctuated annually over the past 13 years, but show an overall downward trend, with 2020 representing a 35% decrease in emissions from 2008 to 2020. Each year there are factors that affect emissions, some of which is general fluctuation specific to that year while others are a result of projects taken by the university to reduce GHG emissions and will last long-term. In 2020, the total adjusted emissions were 37,428.61 $MTCO_2e$, a decrease from the 43,805 $MTCO_2e$ in 2019 and 43,698 $MTCO_2e$ in 2018. This significant reduction is compelling, but it is important to realize that there are more factors at play. It is expected that there will be a pullback on the reductions in the following year, as external factors including the global pandemic and a warm winter have contributed to this decrease.

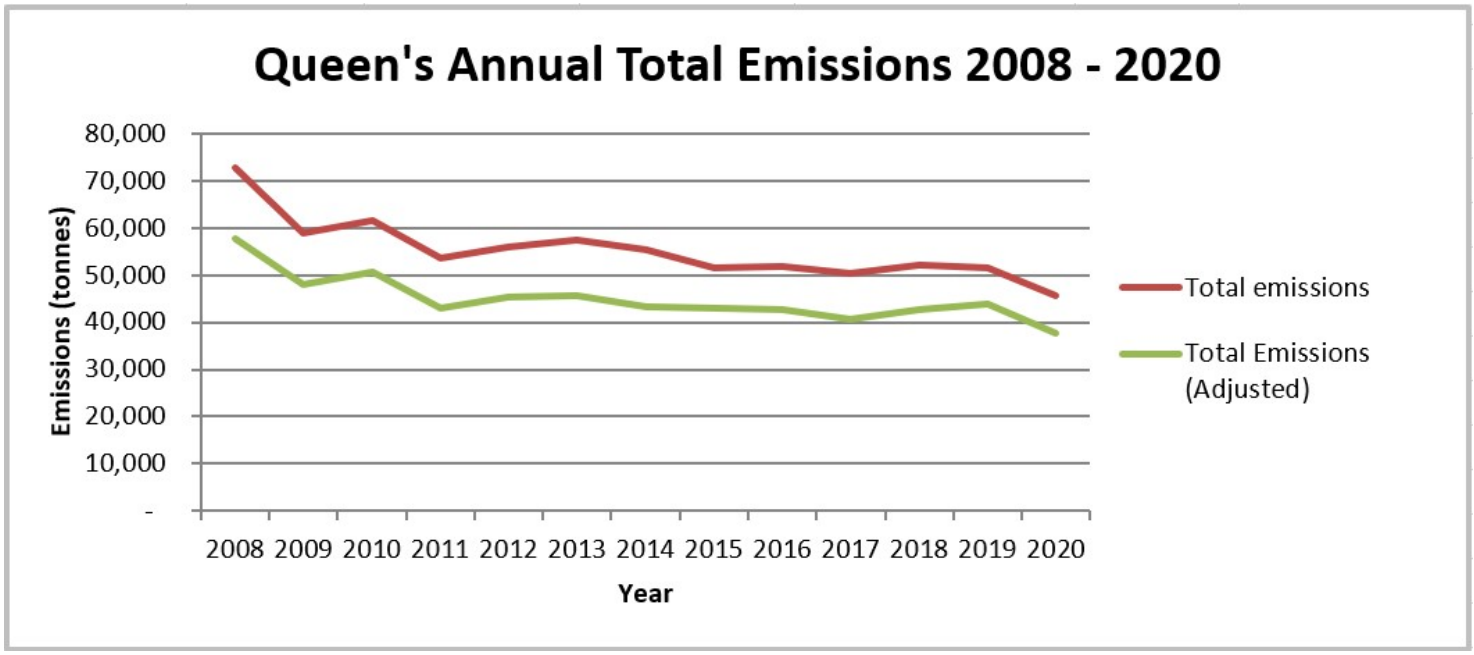

Figure 2: Total Queen's University GHG Emissions from 2008-2020

Significant Downward Trend

Between 2019 and 2020, the overall adjusted campus GHG emissions decreased by 6376 $MTCO_2e$, due largely to the following reasons.

West Campus Steam-line Disconnect Project

Currently the majority of campus is heated using district energy steam produced at the CHP. This accounts for a significant portion of the GHG emissions in order to heat the campus during the winter. With an old system, there are significant losses in energy from heat escaping during the travel time from main to west campus. Work was done on to disconnect the steam line from West Campus and the former site of St. Mary's of the Lake Hospital in early 2020 to mitigate this. With a new boiler plant installed at the west campus site, the efficiency of the steam line has greatly increased, resulting in an estimated 1535 MTCO2e reduction annually.

Heating Degree Days

Heating Degree Days is the total number of degrees that a daily average temperature is below 18°C. Producing steam and electricity at the central heating plant (CHP) is responsible for 84% of the total scope 1 emissions. In 2020 the total number of HDDs was 3888 compared to 4308 in 2019, representing a decrease of 420 or 9.7% decrease from 2019. Because all buildings on campus are currently heated using fossil fuels, this reduction directly correlates to an estimated 10% reduction in natural gas usage.

Industrial Conservation Initiative Peak Hiatus

Queen's participates in the industrial conservation initiative for class A electricity consumers, which means that electricity costs are largely based on the campus usage during the five highest usage hours (peaks) in Ontario over the course of the year. Because of this, Facilities will run cogeneration units using natural gas to offset electricity demand on a day when a peak is expected. This initiative can save Queen's over 5 million dollars on electricity costs which can go towards new sustainability initiatives. As a result of the COVID-19 pandemic, the province paused the initiative two months into the year to give businesses a chance to focus on recovering from the economic effects. The CHP therefore stopped running the cogen. units by July, resulting in a 962 MTCO2e emissions reduction from 2019 to 2020.

Queen's Leased Spaces

In 2020, Queen's reduced the amount of space being leased by 50%. The emissions for leased spaces is determined by taking a standard estimate on the energy usage per square foot of space. With this change, there was a 615 MTCO2e reduction that will get carried forward into future years.

COVID-19 Global Pandemic

The pandemic has greatly decreased occupancy around campus over the past year. This creates a drop in usage across the board, with cafeterias using less natural gas, research using less utilities, and an overall electricity drop of 6.7% year over year. While it may seem significant, the direct result of the decrease in occupancy has a relatively small impact on the total GHG Reductions.

Energy Reduction Projects

The university continually invests funds into energy reduction projects and sustainability initiatives on campus. Savings from 2017 were invested in the recently completed severing of the steam and condensate lines between Main Campus and West Campus. This project will contribute to approximately 1,500 $MTCO_2e$ annual emissions reductions in the future.

Another ongoing energy reduction project is the Mcarthur Library Lighting Upgrade which converts fluorescent lighting in the library to LED equivalents. The project also included daylight harvesting which turns off lighting when there is enough sunlight. Estimated savings from this project is $22,000, or 200 MWh's of electricity.

The University is also in the strategic design phase of addressing high energy use lab spaces. The project will significantly reduce the usage of ventilation and make up air. During the winter season, this will significantly reduce the energy required to heat the incoming air, resulting in an estimated 1750 $MTCO_2e$ annual emissions reductions.

New to the Queen's Building Standard this year is the requirement that new buildings and major renovations must use non fossil fuel based heating. This has already been set in motion in a few areas around campus, including the development of a geo-exchange based cooling and heating at 355 King st and West Campus. 355 King is set to be complete in 2022 while the West Campus project is still in the early stages of development.

Despite being contained under the scope 3 emissions category, Queen's Facilities are continually looking for water reduction projects as well. The Dupuis vacuum pump project reduced the water usage by 26,000 cubic meters, or $65 000 in annual water savings.. New opportunities for energy reduction projects on campus are continually being explored, and are planned to be implemented in 2021/2022.

Grid Emission Factor

The grid emission factor has stayed relatively stable with a slight increase since 2017 and decreased significantly since 2005 due to the phase out of coal fired electrical generation and the support for solar and wind. The provincial grid continues to get cleaner and rely on more carbon-neutral sources (such as nuclear, hydro, wind, and solar), which has a direct impact on the emissions of our university. Transitioning the universities energy use to electricity will continue to be a key carbon reduction strategy. Due to delays from the province, the emission factor is always a year behind, so the 2019 factor was used for this report (2020). The emission factor for 2019 is approximately 0.033 tonnes/MWh, approximately a 14% increase from previous years. Emission factors from 2006-2018 are outlined in the 2019 carbon footprint report.

CONCLUSION

The total adjusted emissions for Queen's University decreased from 43,805 $MTCO_2e$ in 2019 to 37,782 $MTCO_2e$ in 2020. This major decrease was primarily due to effects from the pandemic, a warm winter, and energy efficiency projects taken on by the university.

The Queen's Climate Action Plan aimed to reduce GHG emissions by 35% from 2008 levels by 2020, and by 70% by 2030. Even with the increasing energy demand created by new buildings and an increasing student and staff population, the 35% decrease was attained and more projects are planned to continue to push us further towards 70% by 2030.

Year	Scope 1 adjusted ($MTCO_2e$)	Scope 2 ($MTCO_2e$)	Total ($MTCO_2e$)
2008	43,532	14,182	57,716
2009	35,675	12,451	48,126
2010	34,700	15,973	50,672
2011	31,710	11,171	42,881
2012	34,167	11,248	45,415
2013	36,575	9,204	45,779
2014	38,414	5,006	43,420
2015	37,815	5,174	42,989
2016	37,681	5,042	42,723
2017	35,972	4,670	40,643
2018	40,593	3,105	43,698
2019	39,226	4,579	43,805
2020	33,958	3,824	37,782

Table 5. Scope 1 and 2 emissions from 2008-2020

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