

QUEEN'S UNIVERSITY GREENHOUSE GAS INVENTORY REPORT 2019

June 2020

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, 2019 until December 31, 2019. 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.

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 goal of these inventory reports is to clarify and identify opportunities to reduce the university's overall emissions.



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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)

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 2018 was used for this year's report, and the calculation will be updated when values for 2019 become available. This methodology is consistent with previous reports.

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.



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2019 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 **43,805 MTCO_{2e}**. See Table 1 for a summary of the 2019 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.

	2019 Total Emissions – including hospitals (MTCO _{2e})	2019 Adjusted Emissions – Queen's only (MTCO _{2e})
Scope 1	47,106	39,226
Scope 2	4,493	4,579
Total	51,599	43,805
Per Capita Emissions	1.481	1.255
Emissions Per 1000 SF	6.330	5.363

Table 1. Breakdown of the 2019 Queen's University emissions by scope, population, and campus area

2019 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 86% of Scope 1 emissions in 2019. The next largest emissions source is from stand alone heat generation in buildings that are not connected to the CHP, contributing approximately 12% of the Scope 1 emissions in 2019. 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 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 1 GHG Sources (adjusted)	2019 Totals (MTCO _{2e})
Net CHP Emissions	33,828
Heat Generation in Buildings	4,544
Refrigerant Leakage	373
Fuel Combustion in Equipment	401
Laboratory Chemicals	24
Fire Suppression Systems	34
SF6 Leakage	16
Scope 1 Total	39,226

Table 2. Breakdown of Scope 1 emissions in 2019

Scope 2 GHG Sources	2019 Totals (MTCO _{2e})
Owned Offices – Net Grid	3,021
Leased Offices – Heating	1,317
Leased Offices – Grid Electricity	146
Leased Offices – Cooling	32
Scope 2 Total	4,579

Table 3. Breakdown of Scope 2 emissions in 2019



RESULTS IN CONTEXT

Total GHG emissions have fluctuated annually over the past 12 years, but show an overall downward trend, with 2019 representing a 24% decrease in emissions from 2008 to 2019. Each year there are factors that affect emissions, in 2019 the major factors were a colder winter and an increased electricity grid emission factor, which resulted in our 2019 emissions increasing by 2% from 2018. In 2019, the total adjusted emissions were 43,805 MTCO_{2e}, an increase from the 43,698 MTCO_{2e} in 2018 and 40,643 MTCO_{2e} in 2017. This increase however is an outlier from our overall downward trend in emissions from 2008, reflected in the 24% decrease from 2008 to 2019. With the university's continued investment in energy reduction projects and Ontario's improvements in clean energy, our 2020 emissions are expected to decrease to 2017 emission levels, and lower.

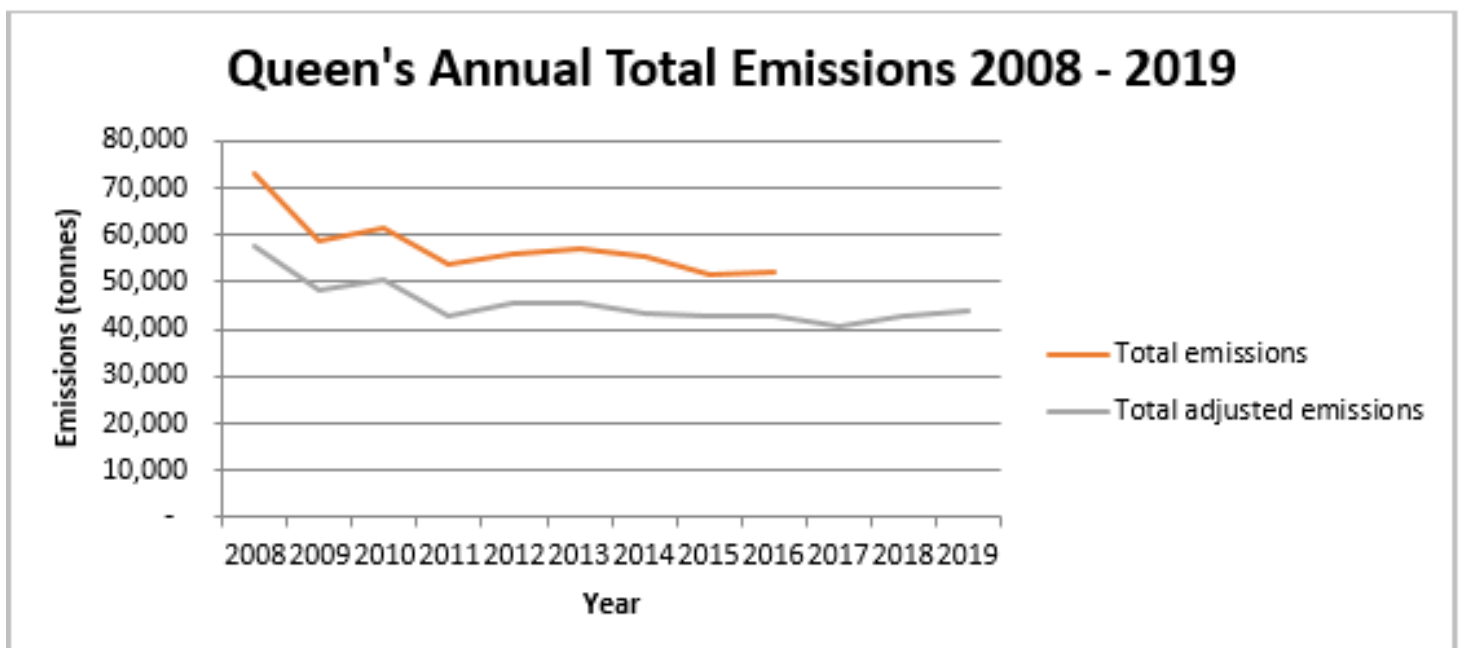


Figure 2: Total Queen's University GHG Emissions from 2008-2018

Slight Upward Trend

Between 2018 and 2019, the overall adjusted campus GHG emissions increased by 107 MTCO_{2e}, due largely to the following reasons.

Cooling Degree Days

The summer of 2019 had approximately two third the number of Cooling Degree Days (CDDs) as 2019, amounting to 207 CDDs compared to 321 in 2018. CDDs indicate the energy demand required to cool a building with air conditioning systems. The CDD value is defined as the number of degrees that a day's average temperature is above a baseline of 18°C. For example, if the average temperature is 25°C, the CDD value for that day would be 7. With more CDDs, significantly more electricity is required to keep all campus buildings at a comfortable temperature for occupants. An decrease in CDDs contributes to an decrease in provincial peak demand days. During these days, Ontario's largest electricity users are billed with the Global Adjustment (GA) charge. The GA costs Queen's millions of dollars each year. In an effort to avoid these charges, Queen's operates it's cogeneration unit to produce electricity and steam for the university. The cogeneration unit is fueled by natural gas, and in 2019 was used less than in 2018 GHG. Based on these numbers, it is evident that the lower number of CDDs in 2019 means that this is not a factor of the 21 MTCO_{2e} GHG increase. Participating in the peak management program enabled Queen's University to avoid \$3,852,291.94 in electricity charges for 2019 from Cogen. These funds are reinvested in sustainability and energy reduction projects on campus.

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 86% of the total scope 1 emissions. In 2019 the total number of HDDs was 4356 compared to 4205 in 2018, representing an increase of 151 or 3.5% increase from 2018. Although the number of HDDs increased, we still see a reduction in natural gas usage from 2018 to 2019. This is due to the steam line from main campus to west campus being severed, a result of the West Campus District Energy Plant. Increased natural gas use at West Campus caused more GHG emissions at that site, but the decrease at CHP ultimately resulted in a net decrease in natural gas usage.

Oil Usage

In 2019, the CHP used significantly less oil than in 2018, and in fact did not use any oil at all. CHP has 2 boilers capable of using natural gas, and only use oil if there is something wrong with a boiler, or in an extreme weather situation where gas prices would be inflated. However, the cogeneration plant used 12,612litres of oil in 2019, and used none in 2018. Every two years the Cogen units are tested to operate on diesel, 2019 being one of those years.

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. New boilers were installed in several buildings on West Campus, supporting more efficient energy consumption. This project will contribute to 1,500 MTCO_{2e} annual emissions reductions in the future.

Another ongoing energy reduction project is the Parking Garage Lighting Retrofits that have been occurring across campus. In this project the fluorescent lighting in all of the University’s parking garages were retrofitted with LED equivalents. The project also included an occupancy control system that turns off non emergency lighting when there is no detected occupancy. Estimated savings from this project is \$70,000, or 712.8 MWh’s of electricity going to parking garages.

The University is also developing a significant project to address high energy use labs and develop solutions for the energy use in these buildings. The project is expected to be designed in 2020 and implemented in 2021.

New opportunities for energy reduction projects on campus are currently being explored, and are planned to be implemented in 2020/2021.

Grid Emission Factor

The grid emission factor has stayed relatively stable 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 2018 factor was used for this report (2019). When possible the report will be updated with the 2019 grid emission factor.

Ontario Grid Emission Factors

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CO ₂ e Emissions (Megatonnes)	35.4	30.8	33.9	28.3	15.3	20.3	14.4	14.3	10.3	6.0	6.3	5.5	2.5	4.0
Grid Level Demand (TWh)	157.0	151.1	152.2	148.7	139.2	142.2	141.5	141.3	140.7	139.8	137.0	137.0	132.1	137.4
Emissions Factor (t/MWh)	0.226	0.204	0.223	0.190	0.110	0.143	0.102	0.101	0.073	0.043	0.046	0.040	0.019	0.029

Figure 4: Ontario Grid Emission Factor, 2005– 2018

CONCLUSION

The total adjusted emissions for Queen’s University increased from 43,698 MTCO_{2e} in 2018 to 43,805 MTCO_{2e} in 2019. This slight increase was driven primarily by a colder winter and an increase in the Ontario Electricity Grid Emission Factor. The emission factor increased the University’s scope 2 emissions, while the scope 1 emissions lowered from 2018 to 2019.

The Queen’s Climate Action Plan aims to reduce GHG emissions by 35 percent from 2008 levels by 2020, and by 70 percent by 2030. Even with the increasing energy demand created by new buildings and an increasing student and staff population, the promising 24% decrease in carbon emissions since 2008 is leading us towards our sustainability goals.



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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

Table 5. Scope 1 and 2 emissions from 2008-2019

In spring of 2020, the renovations began to St. Mary’s of the Lake Hospital, which was purchased by the University and is going to be used for administrative offices. This project includes a new geothermal energy system for heating and cooling of the building. Geothermal energy is an effective renewable resource and this project will significantly contribute to Queen’s GHG emission reduction goals.

