QUEEN'S UNIVERSITY GREENHOUSE GAS INVENTORY REPORT 2018

August 2019

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 eleventh GHG Inventory Report published, and contains data from January 1, 2018 until December 31, 2018.

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)

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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 2017 was used for this year's report, and the calculation will be updated when values for 2018 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.

2018 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 **43,698 $MTCO_2e$**. See Table 1 for a summary of the 2018 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.*

	2018 Total Emissions – including hospitals ($MTCO_2e$)	2018 Adjusted Emissions – Queen's only ($MTCO_2e$)
Scope 1	50,137	40,593
Scope 2	3,105	3,105
Total	**53,242**	**43,698**
Per Capita Emissions	1.586	1.302
Emissions Per 1000 SF	6.532	5.361

Table 1. Breakdown of the 2018 Queen's University emissions by scope, population, and campus area

2018 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 89% of Scope 1 emissions in 2018. The next largest emissions source is from stand alone heat generation in buildings that are not connected to the CHP, contributing approximately 9.3% of the Scope 1 emissions in 2018. The remaining emissions are created by fuel combustion from the campus vehicle fleet, chemical emissions from laboratory chemicals, and fire suppression systems.

Scope 1 GHG Sources (adjusted)	2018 Totals ($MTCO_2e$)
Net CHP Emissions	35,906
Heat Generation in Buildings	3,795
Refrigerant Leakage	428
Fuel Combustion in Equipment	385
Laboratory Chemicals	24
Fire Suppression Systems	34
SF6 Leakage	16
Scope 1 Total	**40,593**

Table 2. Breakdown of Scope 1 emissions in 2018

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	2018 Totals ($MTCO_2e$)
Owned Offices – Net Grid	1,680
Leased Offices – Heating	1,325
Leased Offices – Grid Electricity	83
Leased Offices – Cooling	18
Scope 2 Total	**3,105**

Table 3. Breakdown of Scope 2 emissions in 2018

RESULTS IN CONTEXT

Total GHG emissions have fluctuated annually over the past 11 years, but show an overall downward trend, with 2017 representing a 30% decrease in emissions from 2008 to 2017. Each year there are factors that affect emissions, in 2018 the major factors were a hotter summer and colder winter which resulted in our 2018 emissions increasing by 8% from 2017. In 2018, the total adjusted emissions were 43,698 $MTCO_2e$, an increase from the 40,643 $MTCO_2e$ in 2017 and 42,723 $MTCO_2e$ in 2016. This increase however is an outlier from our overall downward trend in emissions from 2008, reflected in the 24% decrease from 2008 to 2018. With the university's continued investment in energy reduction projects and Ontario's improvements in clean energy, our 2019 emissions are expected to decrease to 2017 emission levels, and lower.

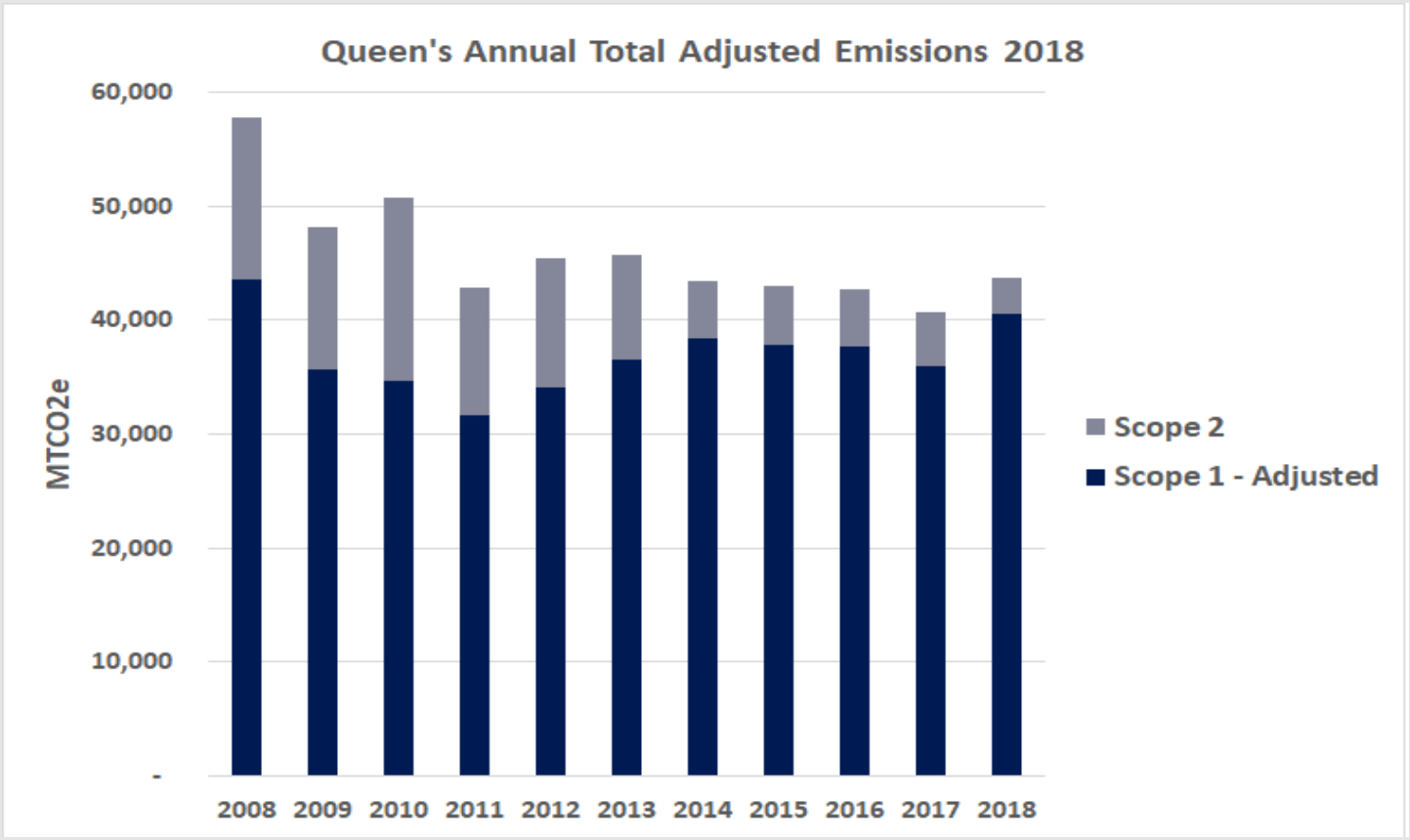

Figure 2: Total Queen's University GHG Emissions from 2008-2018

Upward Trend

Between 2017 and 2018, the overall adjusted campus GHG emissions increased by 3,056 $MTCO_2e$, due largely to the following reasons.

Cooling Degree Days

The summer of 2018 had nearly double the number of Cooling Degree Days (CDDs) as 2017, amounting to 321 CDDs compared to 162 in 2017. 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 increase in CDDs contributes to an increase 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, which for 2018 significantly contributed to our increased GHG emissions as it operated more often than 2017. Participating in the peak management program enabled Queen's University to avoid $4,432,000 in electricity charges for 2018. 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 89% of the total scope 1 emissions. In 2018 the total number of HDDs was 4165 compared to 3948 in 2017, representing a 6% increase from 2017. This contributed to a 5% increase in natural gas consumption in 2018, and increased total CHP emissions by 1092 $MTCO_2e$.

Oil Usage

In 2018, the CHP used significantly more oil than in 2017 due to a spike in the spot price of natural gas in January of 2018. This increase in price forced the CHP to run on oil for 3 days, resulting in the consumption of 304,470 litres of oil for 2018 and production of 946 $MTCO_2e$, greatly impacting our 2018 GHG emissions. There is an approximate 30% reduction in carbon emissions per gigajoule of energy when burning natural gas versus oil.

Energy Reduction Projects

Despite Queen's increased emissions for 2018, our participation in the peak demand management program enabled us to avoid $4,432,000 in electricity costs. A portion of these funds are reinvested 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. New opportunities for energy reduction projects on campus are currently being explored, and are planned to be implemented in 2019/2020.

Grid Emission Factor

The grid emission factor has stayed relatively stable since 2017. 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.

CONCLUSION

The total adjusted emissions for Queen's University increased from 40,643 $MTCO_2e$ in 2017 to 43,698 $MTCO_2e$ in 2018. This increase was driven primarily by a hotter summer and a colder winter. These factors significantly increased the electricity consumption required to maintain campus buildings at a comfortable temperature for occupants. An increase in the spot price of natural gas in January of 2018 also forced the university to purchase oil for the Central Heating Plant operations for 3 days. This significantly increased the university's emissions.

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

Table 4. Scope 1 and 2 emissions from 2008-2018

By severing the main to west campus steam and condensate lines and introducing a more efficient district energy system, Queen's will further reduce its annual emissions by 1,500 $MTCO_2e$. 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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