QUEEN'S UNIVERSITY GREENHOUSE GAS INVENTORY REPORT 2017

September 2018

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 eighth GHG Inventory Report published, and contains data from January 1, 2017 until December 31, 2017.

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.

Queen's University Sustainability

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 2016 was used for this year's report, and the calculation will be updated when values for 2017 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.

2017 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 St. Mary's of the Lake Hospital. 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 **40,643 $MTCO_2e$**. See Table 1 for a summary of the 2017 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.*

	2017 Total Emissions – including hospitals ($MTCO_2e$)	2017 Adjusted Emissions – Queen's only ($MTCO_2e$)
Scope 1	45,695	35,972
Scope 2	4,670	4,670
Total	**50,365**	**40,643**
Per Capita Emissions	1.523	1.229
Emissions Per 1000 SF	6.475	5.225

Table 1. Breakdown of the 2017 Queen's University emissions by scope, population, and campus area

2017 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 87% of Scope 1 emissions in 2017. The next largest emissions source is from standalone heat generation in buildings that are not connected to the CHP, contributing approximately 10% of the Scope 1 emissions in 2017. 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)	2017 Totals ($MTCO_2e$)
Net CHP Emissions	31,459
Heat Generation in Buildings	3,547
Refrigerant Leakage	559
Fuel Combustion in Equipment	333
Laboratory Chemicals	24
Fire Suppression Systems	34
SF6 Leakage	16
Scope 1 Total	**35,972**

Table 2. Breakdown of Scope 1 emissions in 2017

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	2017 Totals ($MTCO_2e$)
Owned Offices – Net Grid	4,176
Leased Offices – Heating	420
Leased Offices – Grid Electricity	61
Leased Offices – Cooling	14
Scope 2 Total	**4,670**

Table 3. Breakdown of Scope 2 emissions in 2017

RESULTS IN CONTEXT

Total GHG emissions have fluctuated annually over the past 9 years, but show an overall downward trend. This is reflected in the 30% decrease in emissions from 2008 to 2017. In 2017, the total adjusted emissions were 40,643 $MTCO_2e$, a decrease from the 42,723 $MTCO_2e$ in 2016 and 42,989 $MTCO_2e$ in 2015. The decrease is a result of a combination of factors including a cool summer, decreased grid emission factors, and a variety of projects that have reduced energy usage on campus.

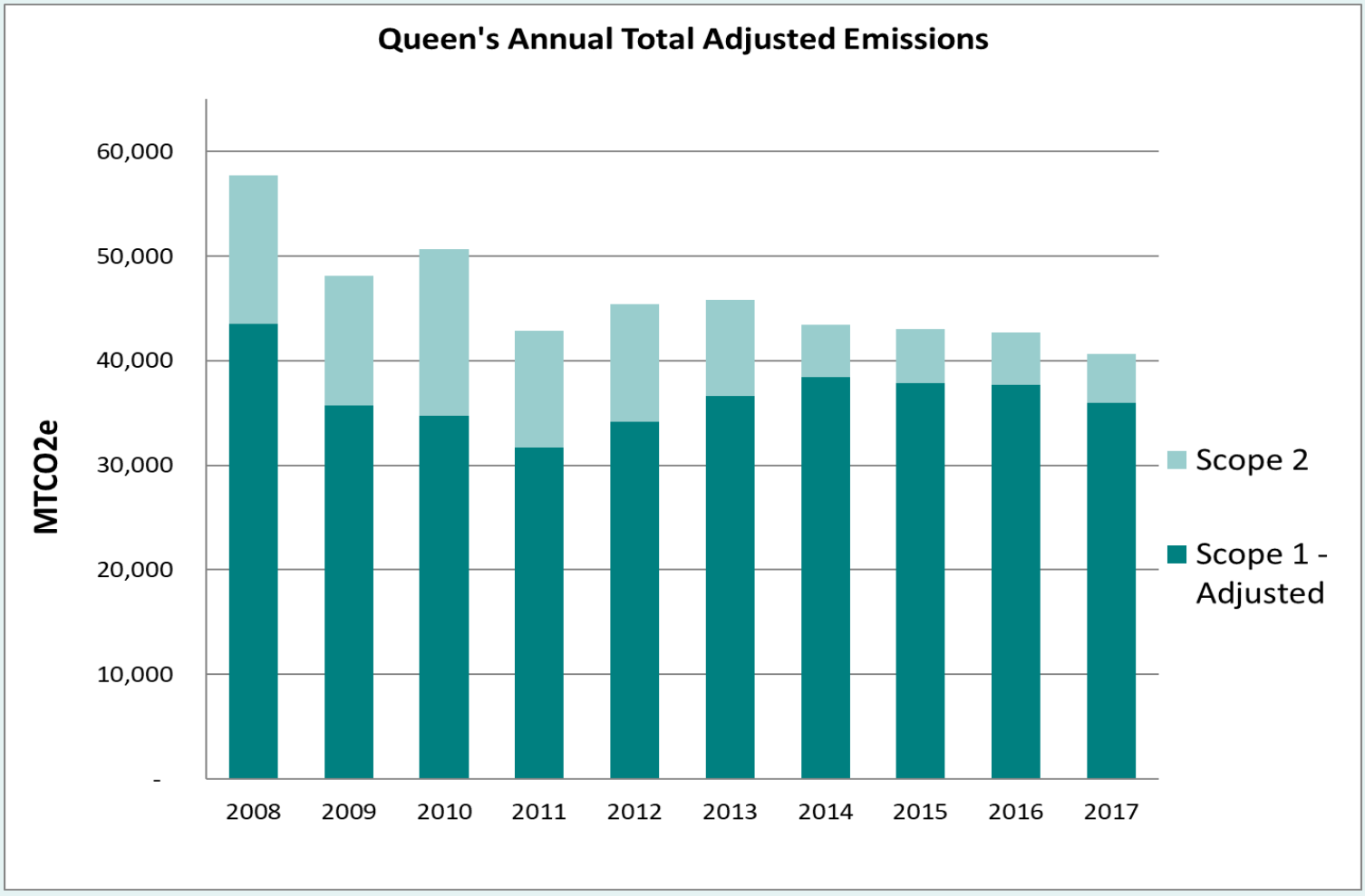

Figure 2: Total Queen's University GHG Emissions from 2008-2017

Downward Trends

Between 2016 and 2017, the overall adjusted campus GHG emissions went down by 2081 $MTCO_2e$, due largely to the following reasons.

Energy Reduction Projects

In 2017 Queen's benefitted from the results of CAPit, its energy conservation program. The installation of new heat recovery coils at Chernoff Hall and updates to the mechanical air handling systems to more efficiently heat and cool the spaces in Duncan McArthur Hall, Dunning Hall, and Humphrey Hall have provided a carbon reduction of 1234 MTCO2e per year. Other lighting and water system retrofit projects in over 60 buildings on campus have contributed additional reductions of 1566 MTCO2e per year.

Grid Emission Factor

In addition to reduced electricity consumption, the provincial electric grid emission factor has decreased this year, after an increase in 2016. 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.

Cooling Degree Days

Cooling Degree Days (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. The total number of CDDs for 2017 was 162, compared to the 312 in 2016. With fewer CDDs, significantly less electricity is required to keep all campus buildings at a comfortable temperature for occupants.

Heating

Producing steam and electricity at the central heating plant (CHP) is responsible for 87% of the total scope 1 emissions. Similar to CDD, the number of Heating Degree Days is the total number of degrees that a daily average temperature is below 18°C. In 2017 the total number of HDDs was 3948 compared to 3859 in 2016. Even with a higher heating load this year the total CHP emissions decreased by 837 MTCO2e. This downward trend is likely due to the energy reduction projects mentioned above.

Reduction of Oil Usage

Queen's continues to burn less oil at the Central Heating Plant (CHP). In 2017 18,475 liters of oil was consumed compared to 2016's consumption of 57,427 liters, which was offset by using more natural gas. There is an approximate 30% reduction in carbon emissions per gigajoule of energy when burning natural gas versus oil.

CONCLUSION

The total adjusted emissions for Queen's University decreased from 42,723 $MTCO_2e$ in 2016 to 40,643 $MTCO_2e$ in 2017, which is the fewest emissions reported on Queen's campus since 2008. This decrease was driven primarily by energy reduction projects that reduced building level electricity loads, and fewer cooling degree days.

In collaboration with Honeywell, an Energy Service Company (ESCo), Queen's implemented the largest energy reduction projects to ever take place on campus. Through the CAPit energy conservation program, a heat recovery system in Chernoff, better building energy management systems in Duncan Mcarthur, Dunning and Humphrey Hall as well as numerous lighting and water retrofit projects have reduced campus emissions in 2017 by 2800 MTCO2e.

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

Table 4. Scope 1 and 2 emissions from 2008-2017

Next up, 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 MTCO2e. 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 30% decrease in carbon emissions since 2008 is leading us towards our sustainability goals.

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