Queen's University Greenhouse Gas Emissions 2013-2014

INTRODUCTION

In 2010, Queen's University signed onto the *University and College Presidents' Climate Change Statement of Action for Canada*, thereby committing to taking firm action to reduce its greenhouse gas (GHG) emissions. As part of this agreement, Queen's is required to track all GHG emissions and report on them. This is the fifth GHG Inventory Report published, and contains data from January 1, 2013 until December 31, 2014. The emissions data is separated by years and the year over year total emissions is compared from 2008 until 2014 (Figure 1). The tracking of the emissions has changed from following the Queen's fiscal year (May-April) to the calendar year, in order to reflect the style of the required provincial greenhouse gas report. The goal of analyses such as these is to allow opportunities for emissions reductions to become clear.

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 due to 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 ground maintenance equipment; and
- Fugitive emissions from electrical switches, fire suppression equipment, lab chemicals, and refrigerants.

Scope 2 emissions include all indirect emissions associated with the energy the University purchases from the grid, including:

- The University's main and west campus energy usage;
- The electricity consumption of Queen's Biological Station; and
- The electricity, heating, and cooling in all leased spaces.

METHOD

The GHG quantification methodologies used in this report have been developed according to standard quantification approaches. Emission 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 consumption for fuels and energy. Throughout the year, invoices and metering data is collected and stored for all fuel combustion, electricity consumption, and heating of independent buildings. This information is then compiled and its 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 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.

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, and heating and cooling for office spaces come from Natural Resources Canada. For both emission factor sources, there is usually a two-year lag in the availability of these values. Thus, data from 2013 was used for this year's report, and the calculation will be updated when values for 2014 become available. This methodology is consistent with previous reports.

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 (25%) is used to heat other facilities including Kingston General Hospital and St. Mary's on the Lake Hospital. As such, some of the emissions produced by the University are not directly associated with its own facilities. Shown below are figures 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 adjusted emissions for the 2013 calendar year were **45,712 MT CO_2e**, and **47,724 MT CO_2e** in the 2014 calendar year. See Table 1 for a detailed breakdown of campus emissions over the past two years.

$MTCO_2e$ 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.

	2013 Total Emissions – including hospitals (MT CO_2e)	2013 Adjusted Emissions – Queen's only (MT CO_2e)	2014 Total Emissions – including hospitals (MT CO_2e)	2014 Adjusted Emissions – Queen's only (MT CO_2e)
Scope 1	48,201	36,575	48,823	38,414
Scope 2	9,136		9,310	
Total	57,337	45,712	58,084	47,724
Per Capita Emissions	1.60		1.70	
Emissions Per 1000 SF	6.02		6.21	

Table 1. Breakdown of 2013 and 2014 University emissions according to scope, population, and campus area

RESULTS BY SCOPE

Campus emissions are divided into two categories: Scope 1 and Scope 2. 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 come from the central heating plant (CHP) used to heat the campus in the winter. The CHP emissions represent 86% of Scope 1 emissions in 2013, and 88% in 2014. The next largest emissions source is from small scale heat production in buildings, comprising approximately 7% in both 2013 and 2014. The remaining emissions comprise of fuel combustion from the campus vehicle fleet, chemical emissions from laboratory chemicals, and fire suppression systems.

Scope 1 GHG Sources (adjusted)	2013 $MTCO_2e$	2014 $MTCO_2e$
Net CHP Emissions	31,328	33,688
Heat Generation in Buildings	3,433	3,879
Refrigerant Leakage	1,326	408
Fuel Combustion in Equipment	361	311
Laboratory Chemicals	77	77
Fire Suppression Systems	34	34
SF6 Leakage	16	16
Wood Combustion	2	2
Scope 1 Total	**36,575**	**38,414**

Table 2. Breakdown of Scope 1 emissions in 2013 and 2014

Scope 2 GHG Sources	2013 $MTCO_2e$	2014 $MTCO_2e$
Owned Offices – Net Grid	8,377	8,551
Leased Offices – Heating	163	163
Leased Offices – Grid Electricity	36	36
Leased Offices – Cooling	560	560
Scope 2 Total	**9,136**	**9,310**

Table 3. Breakdown of Scope 2 emissions in 2013 and 2014

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.

RESULTS IN CONTEXT

Total emissions have remained relatively stable since 2009, fluctuating each year, but never consistently reducing. In 2009, the total adjusted emissions were 48,126 MT CO_2e, as compared to the 45,712 MT CO_2e in 2013 and 47,724 MT CO_2e in 2014.

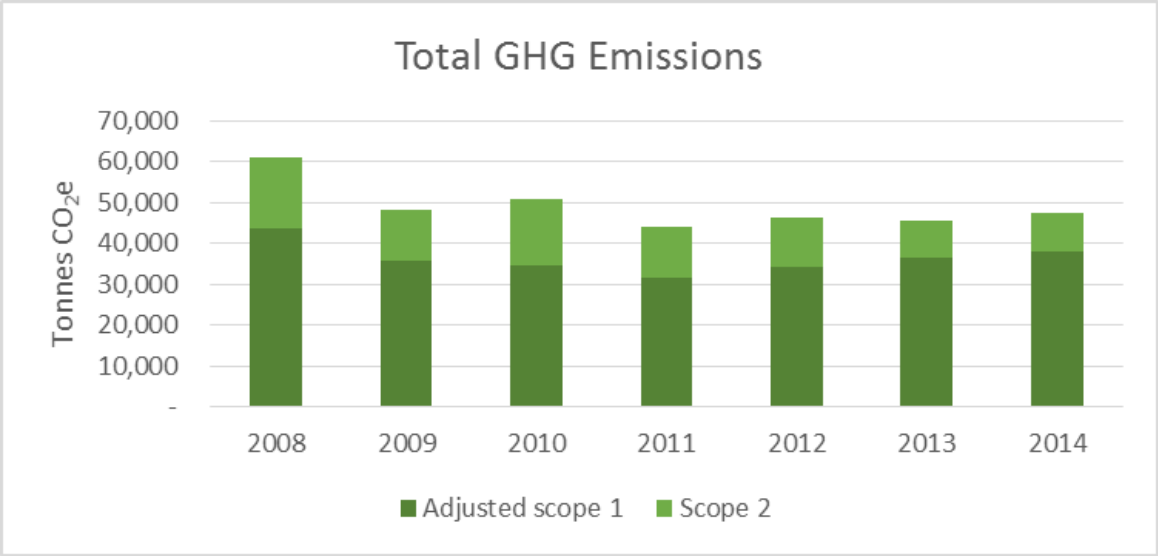

Figure 1. Total Queen's University GHG Emissions from 2008-2014

CHANGES IN SCOPE

Part of the reason for the observed 2014 increase in emissions for the campus is the addition of the Isabel Bader Centre for Performing Arts. The building is approximately 80,000 square feet, and started using electricity and natural gas in May 2014. Additionally, the Reactor Materials Testing Lab was added to the campus in 2013, and came onto the grid in June 2013.

Heating Degree Days

The emissions associated with heating in 2014 were significantly higher than in 2013, comprising 34,761 MT CO_2e in 2013 vs 37,567 MT CO_2e in 2014. This is partly due to the significantly colder winter in 2014, which can be demonstrated by the number of heating degree days (HDD). HDD are a form of measurement to indicate how cold the days are over a period of time, with a greater HDD value resulting in the need to heat a building. Thus, the greater number of HDD over a period of time, the greater the expected emissions produced due to heating. One HDD is equivalent to one degree below 18°C, which has been set as the baseline temperature. As a result, if the temperature is -10°C, the HDD value for that day would be 28. At Queen's, the impact of a single HDD on campus is on average approximately 8.5 MT CO_2e, as opposed to a cooling degree day which is 7.5 MT CO_2e.
To explain the increased emissions in 2014, there were 3,788 HDD in 2013 and 4,277 HDD in 2014, a difference of 489 HDD. The 2014 HDD value was greater than any since Queen's started collected GHG emissions information.

Grid Emission Factors

Every year, Environment Canada produces a National Inventory Report outlining all of Canada's emissions. This report publishes the provincial grid emissions factors, which is a calculation of emission intensity of electricity production (in g CO_2e/kWh). This accounts for losses in transmission and distribution, as well as the increasing use of renewable energy sources in Ontario. However, there is a delay of two years in the availability of the grid emission factors, resulting in the use of the 2013 factors for both the 2013 and 2014 emissions depicted in this report. For more information, see the 2014 National Inventory Report. The grid emission factor was reduced from 0.11 in 2012 to 0.08 in 2013. As such, the electricity associated emissions have decreased significantly in the following two years.

Oil Usage

There was a significant increase in the amount of oil used in the Central Heating Plant boilers this past year. In 2014, just over 1 million litres of oil was used, the greatest volume since 2008, producing 3,128 MT of CO_2e emissions. For comparison, only 64,000 L of oil was used in 2013, producing 200 MT CO_2e emissions. The primary reason for this increased use of oil, which is associated with much higher GHG emissions than natural gas, was the increased cost of natural gas and decreased cost of oil.

CONCLUSION

The main factor affecting the increase in emissions in 2014 as compared to 2012 and 2013 was the increased use of the central heating plant. The winter temperatures were colder than previous years, and the CHP utilized a significantly greater amount of oil. There was a substantial decrease in electricity associated emissions, due to the reduced grid emission factors, reflecting the cleaner production of electricity in Ontario.

	Scope 1 (adjusted)	Scope 2	Total
2008	45,532	14,182	59,714
2009	35,675	12,451	48,126
2010	34,700	15,973	50,673
2011	31,710	12,221	43,931
2012	33,077	12,305	45,382
2013	36,575	9,136	45,711
2014	38,414	9,310	47,724

Table 4. Scope 1 and 2 emissions from 2008-2014

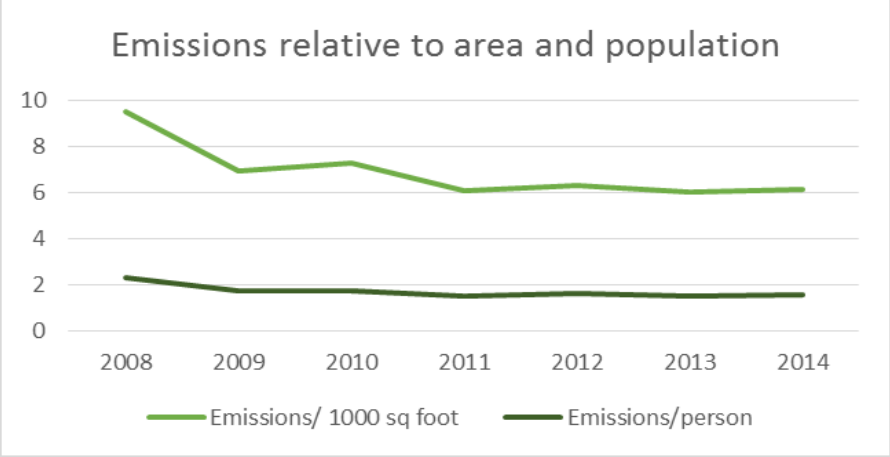

Figure 2. GHG emissions relative to student, staff, and faculty population and area of campus.

As can be seen (Figure 2), the GHG emissions relative to area and population have remained relatively stable since 2011. This indicates that there has been little overall improvement in GHG emissions. However, relative to the increase in surface area and population, regardless of the greater gross 2014 emissions, emissions have not increased.

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