QUEEN'S UNIVERSITY GREENHOUSE GAS EMISSIONS INVENTORY SUMMARY 2015

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 sixth GHG Inventory Report published, and contains data from January 1, 2015 until December 31, 2015.

The emissions data is separated by years and the year over year total emissions is compared from 2008 until 2015 (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 electricity 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

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 2014 was used for this year's report, and the calculation will be updated when values for 2015 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 (20%) 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 2015 calendar year were **43,678 MT CO_2e**. See Table 1 for a summary of 2015 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.

	2015 Total Emissions – including hospitals (MT CO_2e)	2015 Adjusted Emissions – Queen's only (MT CO_2e)
Scope 1	46,289	37,815
Scope 2	5,863	
Total	52,152	43,678
Per Capita Emissions	1.42	
Emissions Per 1000 SF	5.83	

Table 1. Breakdown of 2015 University emissions by 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 87% in 2015. The next largest emissions source is from the standalone heat generation in buildings, that are not connected to the CHP, comprising approximately 10% in 2015. 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)	2015 MTCO_2e
Net CHP Emissions	33,009
Heat Generation in Buildings	3,640
Refrigerant Leakage	820
Fuel Combustion in Equipment	273
Laboratory Chemicals	23
Fire Suppression Systems	34
SF6 Leakage	16
Wood Combustion	2
Scope 1 Total	37,815

Table 2. Breakdown of Scope 1 emissions in 2015

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	2015 MTCO$_2$e
Owned Offices – Net Grid	5,260
Leased Offices – Heating	90
Leased Offices – Grid Electricity	20
Leased Offices – Cooling	494
Scope 2 Total	5,863

Table 3. Breakdown of Scope 2 emissions in 2015

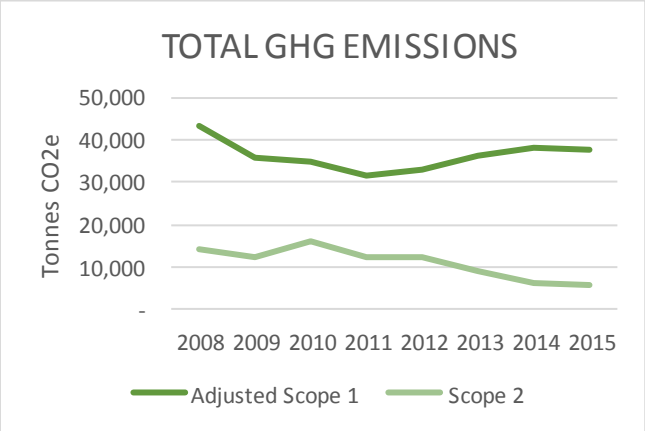

Figure 1. Total Queen's University GHG Emissions from 2008-2015

Upward Trends

Two new residence buildings (Brant House and Smith House) were built and became operational in 2015. New campus buildings do contribute to an increase in GHG emissions. However, even with this impact, Queen's total emissions are still decreasing overall.

Using their square footage to calculate an estimate of their GHG emissions, Brant House emits approximately 560 MT CO_2e and Smith House approximately 530 MT CO_2e.

RESULTS IN CONTEXT

Total emissions have remained relatively stable since 2009, fluctuating annually but showing an overall downward trend. This is reflected in the 2% decrease in emissions from last year. In 2014, the total adjusted emissions were 44,433 MT CO_2e, as compared to the 43, 678 MT CO_2e in 2015.

These decreases can be likely attributed to the change in the provincial grid emission factor, fewer heating degree days (HDD), and the decreased use of oil. These reduction trends are offset somewhat by an increase in campus square footage by the onboarding of two new residence buildings.

Reduction Trends

Heating Degree Days

Heating Degree Days (HDD) are a form of measurement designed to indicate the energy demand required to heat a building. The greater the number of HDD over a period of time, the greater the required energy is to heat a building. 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. There were 4184 HDD in 2015. This was a decrease from last year where there were 4,277 HDD in 2014. The impact of 93 fewer HDD than the previous year is approximately equivalent to 790 MT CO_2e.

Heating Fuel

The university's emissions also decreased due to the impact of burning less oil at the Central Heating Plant (CHP). In 2015 111,000 liters of oil was consumed compared to 2014's consumption of 1 M liters. There is an approximate 30% reduction in carbon emissions per gigajoule of energy when burning natural gas versus oil. Fuel choice at the plant matters, as using natural gas leads to far less emissions.

Grid Emission Factor

As mentioned earlier, the provincial grid emission factor has continued to decrease, impacting last year's GHG inventory as well as the current year's GHG inventory. The provincial grid continues to get cleaner and uses more carbon-neutral sources (such as nuclear, hydro, wind, and solar), this has a direct impact on the emissions of our university. There was a reduction in the value from 2013 to 2014 of roughly 38%. This reduction translates directly into a carbon reduction for Queen's, however is partially offset by steady incremental increases to campus electricity consumption.

CONCLUSION

Although the scope for the GHG inventory increased from 2014 to 2015 with the addition of two new residence buildings, there was nevertheless a decrease in campus emissions. Driving this trend was the reduced heating demand at the CHP, as indicated by fewer Heating Degree Days in 2015 and the reduction in oil consumption. The downward trend can also be attributed to the lower Provincial Grid Emission Factor.

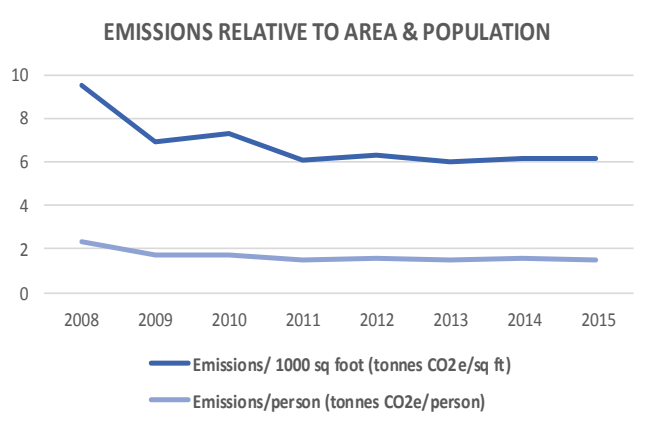

Figure 2. GHG emissions relative to student, staff, and faculty population and area of campus.

	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	6,019	44,433
2015	37,815	5,863	43,678

Table 4. Scope 1 and 2 emissions from 2008-2015

Although the gross carbon footprint has decreased, as can be seen (Figure 2), the GHG emissions relative to area and population have remained relatively stable since 2011. This would suggest that despite the positive effects of outside forces such as HDD values and grid emission factors, our energy consumption continues to grow. More effort to internally reduce emission will be necessary to achieve our carbon footprint reduction goals.

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