Introduction
Ontario Regulation 397/11 under the Green Energy Act 2009 requires public agencies—municipalities, municipal service boards, school boards, universities, colleges and hospitals—to report on their energy consumption and greenhouse gas (GHG) emissions annually beginning in 2013 and to develop and implement energy Conservation and Demand Management (CDM) plans starting in 2014.

Requirements of the Plan:

Section 1: Annual Energy Consumption FY 2012-13
See Appendix A
- 2012 Reg 397/11 Campus Data
- Queen’s Carbon Footprint Report.

Section 2: Energy Conservation Goals
Queen’s is currently in the process of several energy conservation efforts, including a campus wide ASHRAE Level 1 Audit in partnership with an Energy Savings Company. As such, at this time setting specific targets before the results and opportunities are quantified will be avoided. Instead these targets will be updated within an amendment to the plan when appropriate. Queen’s current goals and targets are summarized below.

- Reduce energy use intensity [GJ/m²] levels.
- Reduce overall energy use from current levels
- Reduce water use intensity [m³/m²] and consumption from current levels.

Section 3: Proposed Measures
With the scope and timeframe of a 5 year plan, evolving technology and changing needs and use of buildings on campus. Proposed measures and the business case to support them will be reviewed annually. With that, the following list of measures has been identified by Queen’s PPS staff and external consultants. Criteria for review and evaluation will be based on access to capital, significance of energy and cost savings, GHG impacts and technical feasibility.

The measure types are categorized by the following, Technical, Behavioural, and Organizational

Technical measures
1. Electrical Demand Management - Demand management during the summer to reduce electrical demand on the provincial grid. The current provincial cost structure incentivizes demand management on peak power days for the Ontario electrical grid. Currently accomplished via conservation efforts but may be expanded via off peak storage technology or expanded use of embedded generation.

   - Estimated Cost¹: $45,000
   - Estimated Savings²: $500,000 + annually
   - Duration of project impact: Annual

2. Expansion of Real Time Utility Metering - Install steam meters and integrate with existing electricity data collection database. Install hardware to communicate and integrate LDC gas and water meters to existing
electricity data collection database. Use data to monitor system status for leaks and losses, energy management, Preventative Maintenance work, improvements of business operations and provide data to implement occupant awareness.

- Estimated Cost\(^1\): $750,000
- Estimated Savings\(^2\): $50,000 - $125,000 annually
- Duration of project impact: Continuous

3. **Lighting Retrofits** – In existing buildings convert aging fixtures and technology to LED and high efficiency Florescent lamps, install occupancy sensors, daylight harvesting with photocells and lighting controls where appropriate.

- Estimated Cost\(^1\): $2,750,000
- Estimated Savings\(^2\): $320,000 annually
- Duration of project impact: Continuous over lifespan of building

4. **Equipment Purchasing program** – Implement process ensure lowest lifecycle costing for all equipment retrofits/replacements and minor construction projects to ensure energy efficient equipment is selected for systems and design

- Estimated Cost\(^1\): $15,000 plus 5% premium over lowest cost option
- Estimated Savings\(^2\): 20% in annual operating costs
- Duration of project impact: Lifespan of equipment

5. **Building Audits** - ASHRAE Level 1 and 2 building Audits to identify efficiency and conservation projects. Queen’s is currently partnered with Honeywell Inc. acting as an ESCO. The scope will include water conservation, HVAC upgrades, fume hood replacements, envelope upgrades, Controls and BAS optimization, heat recovery opportunities. This project is currently in the initial Audit stages and will evolve into a major capital investment in campus wide energy conservation and deferred maintenance.

- Estimated Cost\(^1\): $280,000 +
- Estimated Savings\(^2\): $35,000 + annually
- Duration of project impact: Ongoing continuous

6. **Back Pressure Turbine in CHP** – Install a backpressure turbine to utilize the pressure difference between CHP generation pressure and steam system distribution pressure. The turbine would operate year round offsetting electrical consumption in the plant.

- Estimated Cost\(^1\): $1.9 Mil
- Estimated Savings\(^2\): $217,000 annually
- Duration of project impact: Ongoing for lifespan of equipment

7. **Building Re-commissioning** – Retro commissioning is the optimization of existing building automation, controls, HVAC balancing and scheduling functions. As building age and undergo renovations the functionality of equipment can be compromised and schedules and operating parameters no longer reflect the ideal scenarios.
- Estimated Cost\(^1\): $3.50/m^2
- Estimated Savings\(^2\): $2.00 – $4.00/m^2 annually
- Duration of project impact: 5 + years

8. **Installation of Dedicated Heating Plant at West Campus** – Separation of the west campus from the main campus steam system for elimination of line losses and capital cost avoidance for major deferred maintenance requirements on the distribution network.

- Estimated Cost\(^1\): $ 5.0 Mil
- Estimated Savings\(^2\): 125,000 annually, 3.0 Mil DM cost avoidance on distribution network
- Duration of project impact: Continuous.

**Behavioural Measures:**
1. **Energy Dashboard and Mobile Device APP.** - Develop an energy dashboard and mobile device application with real-time building energy use and historical data that is available to the Queen’s Community

- Estimated Cost\(^1\): $60,000
- Estimated Savings\(^2\): TBD
- Duration of project impact: Ongoing

2. **Queen’s Community Engagement** - Fund Sustainability outreach, awareness and engagement activities on campus for staff, faculty and students to foster energy conservation.

- Estimated Cost\(^1\): $10,000
- Estimated Savings\(^2\): $10,000 annually
- Duration of project impact: Annual energy impact with ongoing cultural change

**Organizational Measures:**
1. **Lifecycle Costing Capital Projects** – Expand current process of lifecycle costing to all energy intensive equipment and systems to ensure energy and water efficiency are the primary drivers of equipment selection and design for all major construction and renovation capital projects. Close the link between operational and capital budgets to ensure integral components are excluded from value engineering efforts.

- Estimated Cost\(^1\): 2\% of Capital Cost
- Estimated Savings\(^2\): 10 – 20\% Annual Operational Savings
- Duration of project impact: Continuous over lifespan of building

2. **Construction Standards** - Update internal construction standards document to reflect best practices for design, construction and equipment selection.

- Estimated Cost\(^1\): 2\% of Capital Cost
3. **Energy Intensity Targets** - For all major construction and renovation projects develop and maintain energy intensity standards for construction types. Use in charge to architect.

- Estimated Cost$^1$: $10,000
- Estimated Savings$^2$: 10 – 20% Annual Operating Savings
- Duration of project impact: Continuous over lifespan of building

4. **Improved Cost Allocation** – Utilize the expanded and automated metering system and database to expand the current budget model to provide building level cost allocations for all utilities. (i.e. steam, electricity, water, gas etc.)

- Estimated Cost$^1$: $50,000
- Estimated Savings$^2$: $50,000 – $75,000 annually
- Duration of project impact: Duration of budget model

5. **Deferred Maintenance Funding** – Many DM projects will inherently have an energy savings component, examples of this include West Campus Steam Line removal, Lighting Retrofit work, Windows and Doors (i.e. Envelope Upgrades), Motors, Fans, and Pump Retrofits, Steam to Hot Water Conversions, Roof Replacements with Increased Insulation.

- Estimated Cost$^1$: 1.0M +
- Estimated Savings$^2$: 10 – 20% of annual operational cost
- Duration of project impact: Continuous

**Notes:**

1. The costs provided are estimates and are based on case studies, consultant reports and previously project experiences. The costs, as estimates are subject to changes and unforeseen conditions which are common when project details and project scope is further investigated and defined. They are also subject to inflation, and potential errors and omissions.

2. The estimate savings similarly are based on previous project experience, consultant reports, and case studies. Actual utility and cost savings will be derived from detailed business case development and project exploration and details. The savings, as estimates are subject to changes and unforeseen conditions which are common when project details and project scope is further investigated and defined. They are also subject to inflation, and potential errors and omissions.
Section 4: Renewable Energy Generation Facilities

Goodwin Hall Solar PV System

In June 2002 a 20 kilowatt solar array was installed on Goodwin Hall. It was constructed as a learning, teaching, and research tool for Applied Science students, and it generates enough power to run five family homes. The array feeds its power into Walter Light Hall, Goodwin Hall, and the Integrated Learning Centre (Beamish Munro Hall). The system produces approximately 18,000 kWh of electricity annually.

Section 5: Confirmation of Approval by Senior Management:

To: Ontario Minister of Energy

Queen’s University’s commitment to CDM will continue and this document will serve as a guide in that process over the next 5 years. The plan and details will be revised and updated to reflect opportunities and priorities for conservation and energy efficiency within the Universities operations.

______________________________
John Witjes
Engineering and Operations Director
## Energy Consumption and Greenhouse Gas Emissions Reporting - for 2012

**Confirm consecutive 12-mth period**  
(mth-yr to mth-yr)  
January 2012 - December 2012

**Sector**  
Universities

**Agency Sub-sector**

**Organization Name**  
Queen's University at Kingston

<table>
<thead>
<tr>
<th>Operation Name</th>
<th>Operation Type</th>
<th>Total Floor Area</th>
<th>Unit</th>
<th>Avg hrs/wk</th>
<th>Electricity</th>
<th>Natural Gas</th>
<th>Fuel Oil 1 &amp; 2</th>
<th>Fuel Oil 4 &amp; 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus Total</td>
<td>Classrooms and related facilities</td>
<td>7,257,410</td>
<td>Square feet</td>
<td>60</td>
<td>102,882,227 kWh</td>
<td>574,003 Giga Joule</td>
<td>31,325 Litre</td>
<td>16,510 Litre</td>
</tr>
</tbody>
</table>
Summary
Queen’s University completes annual GHG inventories as part of the ongoing commitment to reduce GHG emissions and address climate change as per the University and College Presidents’ Climate Change Statement of Action for Canada signed in 2010. This is the fourth inventory report. This inventory report accounts for GHG emissions from the 2011 and 2012 fiscal years (May 1 to April 30). The inventory provides a measure of progress, yields trends, and identifies areas for improvement, all of which are crucial to establishing action plans to further reduce GHG emissions.

Scope
Consistent with the previous reports, these GHG inventories include facilities under the university's operational control and located within the province of Ontario. This approach includes both owned and leased facilities, but excludes student rental homes, satellite offices outside of Ontario, and the Bader International Study Centre at Herstmonceux.

The inventory comprises of Scope 1 and Scope 2 GHG emissions. Scope 1 refers to all direct emissions owned or controlled by the university, including:

- Stationary combustion from the boilers, cogeneration plant, generators, furnaces, and kitchen equipment
- Mobile combustion from various fleet vehicles and ground maintenance equipment
- Fugitive emissions from electrical switches, fire suppression equipment, lab chemicals, and refrigerants.

Scope 2 includes all indirect emissions from the university’s purchased energy, including:

- The university’s main and west campus, and the electricity consumption of Queen’s Biological Station
- 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. These reports are based on a combination of invoices, meter reading and steam generation records. Assumptions and best estimates are used for unknown values, which account for a small proportion.

Emissions associated with steam production, including all fuel combustion, electricity consumption and independent heating of buildings are all calculated using data reported via metering and/or invoicing. These calculations represent approximately 96% of emission sources on campus.
The remaining 4% of emission sources that rely to some degree on assumption-based calculations include elements like fugitive emissions, leased space and some small fuel-consuming equipment. As such, assumption-based emission calculations are small and only marginally impact the campus inventory.

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 2010 was used for this year’s report, and the calculation will be updated when values for 2011 and 2012 become available. This methodology is consistent with previous reports.

**Results: 2011 and 2012**

Scope 1 and Scope 2 emissions have been calculated to provide a total carbon footprint for Queen’s University in 2011 and 2012. As with previous inventories, two final numbers have been calculated: a total emissions value and an adjusted emissions value. This distinction provides a more accurate account of Queen’s University’s GHG emissions by considering that a significant portion of the emissions from steam generation is used by nearby independent hospital facilities. Thus, the adjusted emissions reflect the carbon footprint for Queen’s only, excluding emissions associated with the hospitals.

Total emissions for the fiscal year 2011 were **54,774 MTCO₂e**, and the total adjusted emissions were **43,931 MTCO₂e**. Total emissions for the fiscal year 2012 were **56,920 MTCO₂e**, and the total adjusted emissions were **45,382 MTCO₂e**. Emissions are also tracked against campus space (per 1000 SF) and per capita using student head counts information and staff numbers. Table 1 presents a breakdown of the total adjusted emissions.

<table>
<thead>
<tr>
<th></th>
<th>2011 Total Emissions - with hospitals (MTCO₂e)</th>
<th>2011 Adjusted Emissions – Queen’s only (MTCO₂e)</th>
<th>2012 Total Emissions - with hospitals (MTCO₂e)</th>
<th>2012 Adjusted Emissions – Queen’s only (MTCO₂e)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope 1</strong></td>
<td>42,553</td>
<td>31,710</td>
<td>44,615</td>
<td>33,077</td>
</tr>
<tr>
<td><strong>Scope 2</strong></td>
<td>12,221</td>
<td></td>
<td>12,305</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54,774</strong></td>
<td><strong>43,931</strong></td>
<td><strong>56,920</strong></td>
<td><strong>45,382</strong></td>
</tr>
<tr>
<td><strong>Per Capita Emissions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emissions Per 1000 SF</strong></td>
<td>5.93</td>
<td></td>
<td></td>
<td>6.00</td>
</tr>
</tbody>
</table>

*Table 1. Total and adjusted 2011 and 2012 emissions.*

MTCO₂e is a metric tonne of carbon dioxide equivalent, which is a unit of measure representing a GHG’s standardized atmospheric impact.
Results by Scope

The Central Power Plant (CPP), which provides steam heating to most of the buildings on Main and West Campus is the primary source of Scope 1 emissions, accounting for 88% in 2011 and closer to 90% in 2012. Specifically, the emissions are linked to the combustion of fuels at the CPP to produce steam. The next largest emission source, at about 7% in for both reporting years, comes from heat generation for the small number of campus buildings that are not part of the central steam distribution system. The remaining emission sources in Scope 1, include fleet vehicles and fugitive emissions from chemicals contained in equipment or laboratories that have global warming potential (GWP) attributes.

For Scope 2 emission sources, electricity consumption dominates the profile, representing roughly 93% of the total in both reporting years. Electricity consumption is a measure of the energy in kilowatt hours required to power equipment and systems on campus, including heating, cooling and ventilation systems, lighting, research equipment, and plug loads. The remaining portion represents energy used to heat and power our leased satellite offices around the province.

Results Examined in Context

The total adjusted GHG emissions from 2010 to 2012 have decreased. Emissions decreased by 6700 MTCO₂e from 2010 to 2011 and increased by 1452 MTCO₂e from 2011 to 2012, providing a net decrease over the 2 years.

The two years covered in this report have seen the university largely remain static in terms of growth via additional buildings and operating space. The exception to this was the opening of the New Medical Building, which came online in the fall of 2011. Because of the relative static growth, other external influences played a greater role in determining emission levels. The two primary influencers are the shifts in the provincial grid emission factors and differing seasonal temperatures from year to year.

Grid Emission Factors

Environment Canada publishes the annual National Inventory Report which details Canada’s annual GHG emissions. Among a variety of calculation factors, the report includes provincial grid emission factors. These emission factors, a calculation of emission intensity (g CO₂ eq / kWh), now account for losses in the transmission and distribution system, resulting in a more accurate reflection of consumption intensity rather than generation intensity. The grid emission factors lag two years, as such, the data in this report is based on the 2011 grid emission factor. For more information, emission factors are available on Environment Canada’s website for the National Inventory Report.

Ontario’s continued focus on cleaner (in terms of GHG emissions) sources of energy, combined with a drop in provincial demand for electricity, has resulted in reduced grid emission factors. There was a 26% decrease from the 2010 to 2011. Since grid factors are used in the GHG emission calculation, this translated into a significant reduction for the university’s emissions as well. From 2010 to 2011, the campus electricity consumption increased by about 1.5%, yet Scope 2
emissions decreased by 23%. The message here is that while electricity conservation is important in its own right, in terms of absolute emission impact, the activities happening on a provincial level are far more profound and can wildly swing our campus emissions.

**Heating and Cooling Degree Days**

Temperatures for 2011 were milder in the winter and cooler during the summer compared to 2010. In 2011 there were 680 fewer heating degree days and 80 fewer cooling degree days (see bottom right box for definition). The impact of a single heating degree day on campus is roughly 8.5 MTCO$_2$e – and a cooling degree day is 7.5 MTCO$_2$e. The reduced fuel and electricity requirements for heating and air conditioning resulted in fewer GHG emissions. Although there are other factors at play, this significant change in weather year to year contributed to an overall reduction in energy consumption and its associated emissions related to space conditioning.

Although not as drastic as the changes in the previous two years, 2012 nevertheless had a different heating and cooling profile compared to 2011. In general, 2012 experienced a colder winter and warmer summer than did 2011, with 368 more heating degree days and 61 more cooling degree days. These changes resulted in a larger energy demand associated with space conditioning, thereby putting upward pressure on GHG emissions for 2012.

**Changes in Scope**

During the 2011 reporting period the New Medical building became operational. New and additional operational space carries with it an increased energy demand, which puts upward pressure on GHG emissions. Although energy data is not available for building level resolution, based on other metrics a building like this would account for increased emissions of approximately 1000 MTCO$_2$e per year. The impact of the new building was offset by the impact of milder temperatures in 2011 but would account for some of the increase in 2012.

**Energy Efficiency**

Energy efficiency upgrades and initiatives continue to play a role in helping to reduce GHG emissions. The ongoing lighting retrofit program tackled a variety of large and small projects across five buildings. The retrofits, which include a variety of strategies including lamp efficiency upgrades, ballast swapping and de-lamping have provided for an annual consumption reduction of approximately 520,000 kWh’s. This reduction translates into roughly 60 MTCO$_2$e per year in avoided GHG emissions.

In addition to lighting retrofits, the university has also been very successful with newer demand management programs. In particular, our participation in peak shaving opportunities as identified by Ontario’s Independent Electricity System Operator (IESO) has resulted in reduced energy consumption during peak summer periods. These energy curtailment activities focus on shutting down campus chillers at specific and targeted times of the day. Seven chillers are included in the program and their shutdowns allowed the university to shave about 2500 kW of power demand. This reduction is roughly equivalent to 7 MTCO$_2$e based on the standard grid emission factor. Because these targeted reductions occur at
the margin, meaning the grid is more reliant on heavier fossil fuels to produce power, the actual avoided emissions are higher.

Conclusion
There were two main factors affecting the 2011 and 2012 emission count: the provincial grid emission factors and the variation in seasonal temperatures as measured by heating and cooling degree days. To a lesser extent, the increase to campus space and the ongoing energy efficiency programs have also impacted campus emissions. Some of these had the effect of increasing emissions while others decreased them. Overall, the university’s energy consumption marginally increased from 2010 due to the addition of buildings to the campus. The impact of this increased energy consumption however, is entirely negated by the provincial shift to cleaner sources of fuel, which reduced emissions substantially for both the province and the university. Additionally, seasonal temperature changes to date have also diminished internal impacts; in some cases increasing emissions and in others decreasing them. Irrespective of external factors, Queen’s must strive to maintain this positive result with continued efforts and dedication to reduce emissions.

The campus year over year analysis reveals a continued downward trend, despite a slight increase in the past fiscal year. From the last report year in 2010 there has been a 10% reduction in emissions, resulting in nearly 5300 MTCO\(\text{e}\) fewer emissions to 2012. Since the baseline year in 2008 emissions have dropped by nearly 22%, which represents an absolute decrease in campus GHG emissions of roughly 12,300 MTCO\(\text{e}\).

<table>
<thead>
<tr>
<th>Year</th>
<th>Scope 1 (MTCO(\text{e}))</th>
<th>Scope 2 (MTCO(\text{e}))</th>
<th>Adjusted Total (MTCO(\text{e}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>43,532</td>
<td>14,182</td>
<td>57,716</td>
</tr>
<tr>
<td>2009</td>
<td>35,675</td>
<td>12,451</td>
<td>48,126</td>
</tr>
<tr>
<td>2010</td>
<td>34,700</td>
<td>15,973</td>
<td>50,672</td>
</tr>
<tr>
<td>2011</td>
<td>31,710</td>
<td>12,221</td>
<td>43,931</td>
</tr>
<tr>
<td>2012</td>
<td>33,077</td>
<td>12,305</td>
<td>45,382</td>
</tr>
</tbody>
</table>

Table 3. Year to year campus GHG emissions.

![Annual Campus GHG Emissions](image)

Figure 1. The year over year trend of total and adjusted GHG emissions in MTCO\(\text{e}\).

The inventory also calculates emissions per capita (total staff and student population) and per 1,000 square feet of building space. These metrics allow for an assessment of reduction progress independent of the population and space...
variables, which can impact emissions from year to year. The downward trend apparent from the absolute campus emissions also carries into a downward trend in these per capita and space emission metrics.

The university’s emission metrics compare favorably to the average figures for the Master’s and Doctorate granting institutions reporting under the American College & University Presidents’ Climate Commitment (ACUPCC). The ACUPCC is similar to the pledge signed by Queen’s and commits its signatories to reducing their institutional GHG emissions. Their website offers detailed information about each member’s carbon footprint. The Queen’s emission metrics of 6.00 MTCO$_2$e per 1000 SF and 1.66 MTCO$_2$e per capita are significantly less than the combined average of 11.26 and 4.07 respectively as reported by ACUPCC institutions.

Completion of the 2011 & 2012 GHG inventory enables Queen’s to track its progress on emission reductions and devise further improvements in order to fulfill obligations made under the University and College Presidents’ Climate Change Statement of Action for Canada, specifically to the Climate Action Plan (CAP).

Sustainability Office, Physical Plant Services
http://www.queensu.ca/sustainability
Sustainability Manager