Climate Action Plan
Building a Sustainable Future

January 2016
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Message from the Principal

The global climate is changing, and so must we. The decisions we take today, as consumers and citizens, will help determine how livable our planet will be tomorrow and in the decades to come.

The challenge of climate change applies equally to communities of individuals and to institutions such as universities and colleges. For its part, Queen’s University is committed to fostering environmental sustainability in all facets of its operations, teaching, research and student life. In February 2010, Queen’s formalized this commitment as a signatory to the University and College Presidents Climate Change Statement of Action for Canada. This pledge calls upon the university to engage in activities aimed at reducing greenhouse gas (GHG) emissions and enhancing research and teaching on climate change and sustainability. A core element of this pledge includes the development of this document, a comprehensive Climate Action Plan (CAP), which I am pleased to present, on behalf of Queen’s.

Queen’s has taken steps to identify our GHG emissions, using a baseline of 2008. We have identified near- and long-term reduction targets, are developing strategies to achieve these targets, and have been consulting and working closely with our community and our stakeholders.

I wish to acknowledge the important work carried out by the original working group, which has led to the development of this document. I also thank those student groups who have contributed to this effort and to the progress we have achieved to date. The possible strategies for action identified by the working group are set out in the appendix of this report.

The Queen’s Climate Action Plan calls for the university to work towards reducing its GHG levels by 35 per cent from 2008 levels by 2020, and by 70 per cent by 2030. We recognize that achieving success will not be easy and may well require adjustments in either timing or strategy over time. Still, I am happy to confirm that we are well on our way to achieving our target for 2020.
A new working group will be reviewing what has been proposed to date and will be responsible for developing Queen's GHG reduction strategies going forward.

Queen's draws upon the remarkable strengths and talents within our university to meet the modern challenge of achieving environmental sustainability. We rely upon the commitment of all members of our community – staff, faculty and students. One such example is an international research project based at Queen's that focuses on developing new clean energy technologies. The project recently received a $4-million grant from the Natural Sciences and Engineering Research Council of Canada.

Queen's is also embarking on a comprehensive energy conservation program to help reduce energy consumption and costs, and mitigate campus GHG emissions. The university has partnered with Honeywell, an Energy Savings Company (ESCo), to deliver this project.

Our approach is not confined to following a number of rigidly defined steps and actions. Rather, reflecting the dynamic, constantly evolving world in which we live, we will explore a range of possible actions that can lead to the attainment of our emission reduction targets. As circumstances and opportunities evolve, Queen's is open to new ideas and will remain agile and adaptive in pursuing our goal.

Reducing GHG emissions and achieving carbon neutrality can only happen through a collaborative and concerted effort that involves everyone within our university family. At Queen's, environmental sustainability is and must be everyone's priority.

Over a history spanning close to 175 years, Queen's University has built a tradition of excellence in learning while playing a vital role in contributing to the betterment of the community, nation and world. In championing climate action, we are committed to demonstrate leadership in meeting the challenge of building a future based on environmental sustainability.

Dr. Daniel Woolf
Principal and Vice-Chancellor
Queen's University
Executive Summary

The Queen’s University Climate Action Plan (CAP) has been developed in response to the defining challenge of our age – climate change. The main contributor to climate change is increasing concentrations of greenhouse gases (GHGs) in the atmosphere. Burning fossil fuels and changes in land use, including deforestation, land degradation and agricultural activities, are all sources of GHGs. A unique feature of climate change is that it has global implications, with negative impacts on the environment, economy and society.

In February 2010, Principal Woolf signed the University and College Presidents’ Climate Change Statement of Action for Canada. This pledge commits Queen’s University to engage in activities aimed at reducing GHG emissions. It also requires development of a comprehensive CAP.

The CAP development process was designed to achieve four main goals:

• Produce a plan that met the requirements and was in line with the spirit of the pledge.

• Leverage expertise within the university from the academic, staff and student communities to determine how Queen’s could and should meet the commitment.

• Ensure that the Queen’s broader stakeholders were appropriately consulted.

• Ensure alignment with other significant strategic planning initiatives (for example, the Campus Master Plan, the Strategic Research Plan and the Academic Plan).

These four goals were achieved through the creation of an advisory committee, targeted working groups, and a stakeholder engagement plan. The objective of this part of the planning process was to establish the mechanisms and overall approach to effectively engage key stakeholders and communicate the CAP, its development and launch. The main Stakeholder Engagement and Communications Activities included the hosting of a Community Forum in March 2012, a CAP Community Survey in October 2012, and ongoing awareness-building through a variety of communications channels.
GHG Inventory, Projections and Reduction Targets

Queen's first conducted a GHG inventory in 2008 in order to establish a baseline from which to measure future emissions reductions. Total emissions from the inventory were 57,716 Metric Tonne Carbon Dioxide Equivalent (MTCO2e) with Scope 1 emissions of approximately 43,500 MTCO2e and Scope 2 emissions of approximately 14,200 tonnes CO2e.

Scope 1 emissions at Queen's come primarily from heat generation, with the major source from natural gas consumption in the Central Heating Plant (CHP). Most of Queen's Scope 2 emissions are from grid electricity generated for use in buildings owned by the university.

Queen's has already launched some GHG reduction strategies, and has reduced its GHG emissions by approximately 17 per cent over the period from 2008 (baseline) to 2014. This reduction, achieved since 2008, can largely be attributed to installation of a new, higher-efficiency boiler in the CHP (2.5 per cent efficiency gain), conversion to natural gas only as a heating fuel, and a reduction in the Ontario grid emission factor.

To better understand the full range of possible future scenarios, including the absence of GH reduction strategies in support of the CAP, two “business-as-usual” cases have been modelled for Queen's emissions:

- **Low Grid Emissions Factor (Low Grid EF):** This projection is based on using an optimistic forecast of a reduction in GHG intensity of electricity generation in the future. These are based on provincial projections assuming the elimination of coal and adoption of other clean energy initiatives.

- **High Grid Emission Factor (High Grid EF):** This projection reflects a more conservative projection for grid emission factors that assumes the current provincial government is unable to deliver on all of its intended targets.

**QUEEN’S UNIVERSITY WILL AIM TO BECOME CARBON NEUTRAL BY 2040 AND REACH MILESTONE TARGETS IN 2020 AND 2030.**

Targets for GHG reductions were set using the following principles:

1. Targets need to reflect what Queen's should do in order to address climate change.

2. Targets should be technically viable and, at least for the near term, should not rely on technologies that have not been commercialized and/or demonstrated as successful.

3. Targets should be set using a timeline that is achievable.
GHG Reduction Strategies

Scope 1 and 2 GHGs can be reduced through actions in three main areas: reducing point-of-use energy consumption, addressing efficiency and the fuels used to generate steam at the Central Heating Plant, and adopting other renewable energy generation approaches. Several possible GHG reduction strategies were developed by the Climate Action Plan Advisory Committee and working groups, and are presented in the appendix.

ACTIONS TO DATE

Operations

Queen’s has undertaken a number of important initiatives that promise to make valuable contributions to the overall strategy for reaching GHG reduction targets, and to provide leadership in teaching, research and student engagement that support the sharing of knowledge and best practices about climate change. These include the following actions:

• In an effort to become less reliant on the combustion of fossil fuels, including oil and diesel, Queen’s installed a new steam boiler in 2010. The new boiler gains 2.4 per cent efficiency when converting energy from the fuel source to steam and runs on natural gas. In addition, the boiler was designed to be the new “workhorse” for campus steam production, meaning it carries the majority of the campus heating load. The efficiency gain translates into less fuel consumption.

• Queen’s has embarked on a comprehensive energy conservation program to help reduce energy consumption and costs, and mitigate campus GHG emissions. The university has partnered with Honeywell, an Energy Savings Company (ESCo), to deliver this project through an energy performance contract. This will support the implementation of efficient solutions designed to upgrade facilities and reduce operating costs, and is paid for by guaranteed energy savings. The project will achieve GHG reductions of 2,800 metric tonnes annually.
• The university is in a provincial demand management program intended to reduce peak energy loads. As part of the program, air conditioning systems are shut down in a number of campus buildings on roughly 10 afternoons over the summer months. These shutdowns are timed to coincide with the expected peaks in provincial electricity demand. Reductions during these peak demand times reduce the reliance on this fossil fuel-based electricity production. The estimated financial savings due to this demand management was approximately $1.3 million in 2014 for Queen’s.

• An active lighting retrofit program has been operating on campus since 2008. Led by the campus energy manager, the program examines existing lighting throughout the buildings and updates the systems with newer versions. To date, more than 20 buildings have undergone lighting retrofits with another 40 buildings at various stages of design and development. The cumulative impact of the completed projects to date is an annual reduction in energy consumption of approximately 1.4 million kWh, resulting in a carbon emission reduction of 132 metric tonnes.

• Through its mainstream recycling programs, Queen’s is committed to reducing, reusing and recycling waste material generated by its operations. In 2012, Queen’s added single-use coffee cups and Styrofoam to the cans, glass and plastic stream in an effort to remove these ubiquitous items from the waste stream and improve campus waste diversion. It is expected that a significant portion of the 1.1 million coffee cups disposed of annually on campus will now be recycled. In 2014-15, the university’s waste diversion rate was approximately 41 per cent.

• Queen’s has partnered with the City of Kingston Transpass program to improve the accessibility of Kingston transit for staff and faculty. Benefits include discounted monthly passes, payroll deduction payments, unlimited monthly bus rides, and a more environmentally friendly way to commute. Queen’s has 250 riders signed up for the program, resulting in a carbon impact of approximately 300 MT.
Teaching

The academic mission of the university is intrinsic to the CAP. Research and teaching allow a university to contribute to reducing climate change in a manner that is greater than its own GHG inventory.

In the realm of curriculum, Queen’s created the School of Environmental Studies in 1995. This focused school and around 30 other distinct programs at Queen’s provide students with the opportunity to encounter learning opportunities in roughly 175 individual courses spread across most of the faculties.

The academic direction at Queen’s University is informed by the Queen’s University Academic Plan 2011. The plan is supported by four core pillars:

- The Student Learning Experience
- Disciplinarity and Interdisciplinarity
- Reaching Beyond: Globalism, Diversity and Inclusion at Queen’s
- Health, Wellness and Community

Queen’s University provides students with an opportunity to learn and discover general principles of sustainability, and to gain knowledge of issues related to climate change across multiple faculties and schools. These include: the School of Environmental Studies; Collaborative Master’s Program in Applied Sustainability; School of Business; School of Urban and Regional Planning; and, the Field School in Sustainability Leadership.

Research

Queen’s research advances the science, policy and technological developments that the world uses to mitigate and adapt to climate change.

Queen’s faculty are contributing in a variety of areas, including ecosystem management, renewable energy sources, energy systems and design, materials science and civil engineering. The breadth of the research is significant, from localized climate change impacts to future technological solutions and much in between. Notable examples include:

- The Queen’s Centre for Energy and Power Electronics Research (ePOWER) brings together academic and industrial researchers to develop a broad range of applications and expertise. These include power transmission, alternative energy, power consumption, and power application-specific integrated circuits. Fundamental and applied research conducted at ePOWER is resulting in the development of new energy-efficient and environmentally friendly electronic technologies.
- Queen’s-RMC Fuel Cell Research Centre (FCRC) is a prime example of leading research that can offer a technological solution to addressing climate change. Nearly 50 researchers are conducting research directed at improving materials, design and manufacturing processes while reducing costs, all of which are critical to the commercialization of fuel cell applications.
The Solar Calorimetry Lab (SCL) was established within the National Research Council of Canada in 1977 and subsequently moved to Queen's University in 1985. Current research topics include the design, analysis and modelling of thermal systems in the heating, ventilation and air conditions (HVAC) and solar fields.

The Queen's Institute for Energy and Environmental Policy (QIEEP) promotes the meeting of like minds; it offers a crossroads where the best academic research intersects with the challenges of policy makers and industry.

The Paleoecological Environmental Assessment and Research Laboratory (PEARL) includes a group of about 30 research scientists, post-doctoral fellows, graduate students and other scientists dedicated to using paleolimnological techniques to provide historical perspectives to environmental change. Such data are required to define natural environmental variability, to generate and test hypotheses, and to evaluate computer models that are now being used for the study of environmental change.

Queen's Facility for Biogeochemical Research on Environmental Change and the Cryosphere (FABRECC) carries out research directed at improving understanding of critical processes in these biogeochemical cycles, how they are being altered by human activity, and how terrestrial ecosystems might be more effectively managed to help mitigate human impacts while still providing critical ecosystem services.

Proposed Climate Change Research Enhancements include maintaining a public list related to climate change research, identifying opportunities for student involvement in the quantification of Scope 3 elements identified in the CAP, and recognizing exemplary climate change work by students and faculty members.

Student Leadership

In addition to academic work, Queen's University offers abundant extracurricular student engagement opportunities on issues of climate change and sustainability. Notable examples include:

- AMS Commission of the Environment and Sustainability (CES), which supports environmental consciousness on campus and advocates for sustainable improvements at Queen's.

- Queen's Solar Design Team, best known for designing a series of award-winning solar cars and racing them in international competitions.

- Earth Centre, an entirely student-run shop specializing in green products.

- Queen's Backing Action on Climate Change (QBACC), a campus club that mobilizes and organizes environmentally minded students at Queen's.
Implementation

The principal will appoint a vice-principal to chair a working group that will operationalize the plan. Members of the working group will have a good understanding of the commitments made in 2010, as well as the financial implications of operationalizing the plan.

Based on this understanding, the working group will develop a list of actionable items that will help the university work towards its stated targets. The working group will be made up of one academic administrator recommended by the provost, one academic administrator recommended by the VPR, as well as AVP Facilities, Sustainability Office, Campus Planning, Communications and student representation. The working group will call in other subject matter experts as required.
Introduction

1.1 VISION FOR CLIMATE ACTION

Climate change is widely recognized as the defining challenge of this century at a global, regional and local scale. The dimensions of climate change are broad and have profound implications for all life on Earth.

The impacts of climate change are felt in many ways. These include changing air temperature, the amount and seasonality of precipitation, the intensity and frequency of extreme weather events such as droughts, storms, heat waves and cold spells, changing sea levels, ocean acidity and changes in the structure and function of ecosystems.

Because we depend on stable ecosystems for our life support, these ecosystem impacts will directly affect all life. The main contributor to climate change is increasing concentrations of greenhouse gases (GHGs) in the atmosphere. Burning fossil fuels and changes in land use, including deforestation, land degradation and agricultural activities, are all sources of GHGs. A unique feature of climate change is that it has global implications, with negative impacts on the environment, economy and society.

While climate change is a global phenomenon, taking responsibility for action rests not only with governments and international bodies but with individuals and their communities. It is in this context of a locally inspired response to climate change that the Queen’s University Climate Action Plan (CAP) has been developed. This plan challenges the university in several ways:

• To take responsibility for not only being part of the problem, but being part of the solution through action, research, education and innovation.

• To develop and implement effective carbon reduction strategies.

• To continue to engage its core functions of teaching and research to increase the awareness of the science of climate change, the impact of climate on all aspects of society and the urgency and need to take significant action to mitigate and adapt to climate change.

• To effectively communicate its strategies, policies, teaching and research to motivate others around the world to join us in solving humanity’s foremost challenge.
1.2 CAP OVERVIEW AND DEVELOPMENT PROCESS

1.2.1 Overview

In February 2010, Principal Woolf signed the University and College Presidents’ Climate Change Statement of Action for Canada. This pledge commits the university to engage in activities aimed at reducing GHG. It also requires development of a comprehensive CAP.

The Queen's CAP has been designed to meet the requirements of the pledge and consists of the following components:

- A summary of the current campus GHG emissions and GHG emission projections, incorporating planned growth and business as usual scenarios (see Section 2).
- Milestone targets for GHG reductions (Section 2.3).
- Progress to date, including teaching, research and student leadership (Section 3).
- Possible strategies and actions to reduce the university's GHG emissions.

1.2.2 CAP Development

The CAP development process was designed to achieve four main goals:

- Produce a plan that met the requirements and was in line with the spirit of the pledge.
- Leverage expertise within the university from the academic, staff and student communities to determine how Queen's could and should meet the commitment.
- Ensure that the Queen's broader stakeholders were appropriately consulted.
- Ensure alignment with other significant strategic planning initiatives (for example, the Campus Master Plan, the Strategic Research Plan and the Academic Plan).

These four goals were achieved through the creation of an advisory committee, targeted working groups, and a stakeholder engagement plan as described below.

1.2.2.1 CAP Advisory Committee and Working Groups

CAP development was overseen by the CAP Advisory Committee. The role of the committee was to work collaboratively on evaluating, planning and developing the CAP. The 22-member committee included students, staff and faculty, representing a wide range of Queen's community.

1.2.2.2 Stakeholder Engagement and Communication Process

Queen's stakeholders have played an essential part in the CAP development process. Through engagement and open communication, the CAP benefits from buy-in and accountability of the university community and thus integration with other university processes. A CAP Stakeholder Engagement and Communications Plan (SE&C) was developed to complement and to help foster the broader sustainability goals.

The objective of this part of the CAP planning process was to establish the mechanisms and overall approach to effectively engage key stakeholders and communicate the development of the CAP.

Stakeholder Engagement and Communications Activities encompassed a number of elements including a community forum which brought together some 65 Queen's stakeholders to contribute ideas and help set priorities for moving forward.

A CAP Community Survey was completed involving Queen's stakeholders. It provided the CAP Advisory Committee with useful feedback on medium- and long-term priorities for GHG reduction strategies and climate change curriculum and research integration.

The SE&C Working Group also generated a number of communications products intended to inform Queen's stakeholders about CAP developments and to update them on pertinent information.
2. GHG Emissions Inventory, Projections and Reduction Targets

2.1 GHG INVENTORY

2.1.1 GHG INVENTORY SCOPE

Queen’s GHG inventory includes facilities that are within the university’s operational control and located within the province of Ontario. This approach has the effect of including both owned and leased facilities, but excluding facilities such as student rental homes and the Bader International Study Centre at Herstmonceux, England.

The GHG emission sources included in the inventory cover all Scope 1 and Scope 2 emissions as defined by the World Resources Institute’s (WRI) Greenhouse Gas Protocol.

Scope 1 includes all direct emissions that are owned or controlled by the university, including:

- Stationary combustion from 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 campuses and Queen’s Biological Station electricity consumption.
- The electricity, heating and cooling in all leased spaces.

In the future, Queen’s could consider including Scope 3 emissions in its inventory from emissions associated with employee travel, waste disposal, water use and commuting. Scope 3 emissions would be tracked in a separate inventory, subject to individual targets associated with each type of emission.
2.1.2 ESTABLISHING THE BASELINE (2008)

Queen's first conducted a GHG inventory in 2008 in order to establish a baseline from which to measure future emissions reductions. Total emissions from the inventory were 57,716 Metric Tonne Carbon Dioxide Equivalent (MTCO2e) with Scope 1 emissions of approximately 43,500 MTCO2e and Scope 2 emissions of approximately 14,200 tonnes CO2e. This gives a breakdown of 75 per cent attributable to direct (Scope 1) sources and 25 per cent to indirect (Scope 2) sources.

Scope 1 emissions at Queen's come primarily from heat generation, with the major source from natural gas consumption in the Central Heating Plant (CHP).

As shown in Figure 1, in 2008, the CHP represented over 60 per cent of total Scope 1 emissions. Energy generation from Queen's cogeneration plant emitted approximately 30 per cent of the university's GHGs. The third-largest source is heat generation in buildings, comprising 5 per cent of total emissions. The remaining emissions come from minor sources such as refrigerant leakage and fuel combustion in equipment.

Most of Queen's Scope 2 emissions are from grid electricity generated for use in buildings owned by the university, as seen in Figure 2. Other minor sources include heating leased offices, grid electricity generation for leased offices, and cooling leased offices.
Scope 3 Emissions

To date, Queen's has not quantified Scope 3 emissions as part of its GHG inventory. Scope 3 emissions can be quantified in future inventories.

Table 1: Potential Scope 3 Emissions at Queen’s

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste</td>
<td>Organic waste decomposes in landfill to generate methane, a greenhouse gas. Reducing waste reduces GHG emissions.</td>
</tr>
<tr>
<td>Water</td>
<td>Water treatment requires energy and is a source of GHGs. Reducing water use reduces GHG emissions.</td>
</tr>
<tr>
<td>Employee Travel</td>
<td>Travel requires fossil fuel combustion and therefore is a source of GHG emissions. Efforts can be made to encourage video or voice conferencing when possible, and to use less GHG intensive modes (i.e. rail vs. car).</td>
</tr>
<tr>
<td>Commuting</td>
<td>Student, staff and faculty commuting to and from Queen’s generates emissions.</td>
</tr>
</tbody>
</table>
2.1.3 GHG EMISSIONS 2008-2015: AT A GLANCE

Queen's has already launched some GHG reduction strategies, and has reduced its GHG emissions approximately 17 per cent over the period from 2008 (baseline) to 2014. Campus GHG emissions from 2008-2014 are provided in Figure 3.

Queen's Annual Carbon Footprint

![Graph showing Queen's Annual Carbon Footprint from 2008 to 2014]

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Adjusted Emissions</td>
<td>57,716</td>
<td>48,126</td>
<td>50,672</td>
<td>43,931</td>
<td>45,383</td>
<td>45,711</td>
<td>47,694</td>
</tr>
<tr>
<td>Scope 2</td>
<td>14,182</td>
<td>12,451</td>
<td>15,973</td>
<td>12,221</td>
<td>12,305</td>
<td>9,136</td>
<td>9,310</td>
</tr>
<tr>
<td>Scope 1 – Adjusted</td>
<td>43,532</td>
<td>35,675</td>
<td>34,700</td>
<td>31,710</td>
<td>33,077</td>
<td>36,575</td>
<td>38,384</td>
</tr>
</tbody>
</table>

Figure 3: Queen's Campus GHG Emissions, 2008-2014

This reduction achieved since 2008 can largely be attributed to installation of a new, higher-efficiency boiler in the CHP (2.5 per cent efficiency gain), conversion to natural gas only as a heating fuel (near elimination of burning fuel oil #6 beginning in 2009-2010 with an attributable GHG reduction of roughly 4,000 tonnes CO2e), and a reduction in the Ontario grid emission factor. In addition, a combination of other energy-saving activities described in the table below helped with the GHG emissions reduction.

<table>
<thead>
<tr>
<th>Peak load AC shutdowns</th>
<th>Hourly scheduling for HVAC systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision cooling</td>
<td>Precinct cooling</td>
</tr>
<tr>
<td>Residence Energy Challenge</td>
<td>Building level utility data tracking</td>
</tr>
<tr>
<td>Lighting upgrades</td>
<td>Occupancy sensors</td>
</tr>
<tr>
<td>Lighting controls</td>
<td>Demand response program for Co-gen</td>
</tr>
<tr>
<td>Construction guidelines for energy efficiency</td>
<td>Energy Awareness Campaigns for Lighting and Computer Use</td>
</tr>
<tr>
<td>Lifecycle cost analysis</td>
<td>Heat recovery systems in HVAC</td>
</tr>
</tbody>
</table>

It is important to note that Queen’s Scope 1 emissions profile has changed since 2008. In that year the university was generating a considerable amount of energy from the cogeneration plant in addition to the CHP. Since 2009, the cogeneration plant has been used significantly less and the CHP has provided almost all of the university’s heat. The CHP now represents about 90 per cent of Queen’s Scope 1 emissions.
BUSINESS-AS-USUAL (BAU) EMISSION PROJECTIONS

GHG emissions have been projected until 2050. Increases in GHG emissions are projected to be linked to new building construction and their associated heating and electricity requirements for operation. New construction at the university has been estimated based on the near-term buildings already approved and an analysis of potential future construction scenarios. This includes a realistic estimation of potential growth for the university in order to ensure that the CAP and its targets account for the impact of campus growth on GHG emissions.

To better understand the full range of possible future scenarios, including the absence of GH reduction strategies in support of the CAP, two “business-as-usual” cases have been modelled for Queen’s emissions:

• **Low Grid Emissions Factor (Low Grid EF):** This projection is based on using an optimistic forecast of a reduction in GHG intensity of electricity generation in the future. These are based on provincial projections, assuming the elimination of coal and adoption of other clean energy initiatives.

• **High Grid Emission Factor (High Grid EF):** This projection reflects a more conservative projection for grid emission factors that assumes the current provincial government is unable to deliver on all of its intended targets. This projection has been provided by the Delphi Group.

It is important to note that this possible range is entirely based on provincial initiatives and will impact our GHG emissions despite Queen’s GHG reduction strategies. As the following graph projects, rising utility costs are anticipated over the coming decades.

![Projected Business-As-Usual GHG Emissions, High and Low Grid EF](image)

As with any projections that are dependent on uncertain future activities, there are multiple scenarios that could be explored. For the purposes of the CAP, the most important conclusion to be drawn from the two scenarios presented, and other possible scenarios, is that without GHG reduction strategies in support of the CAP, Queen’s inventory may rise and eventually surpass emissions from the 2008 baseline year.
2.3 TARGETS

Queen’s University will aim to become carbon neutral by 2040 and reach milestone targets in 2020 and 2030.

Targets for GHG reductions were identified using the following principles:

1. Targets need to reflect what Queen’s should do in order to address climate change. The United Nations Intergovernmental Panel on Climate Change (IPCC) estimates that GHGs in developed countries will need to be reduced by 25-40 per cent below 1990 levels by 2020 and 50-80 per cent by 2050 in order to avoid a temperature rise of >2°C. A temperature rise above 2°C is predicted to lead to drastic and uncontrollable changes to the climate with devastating effects.

2. Targets should be technically viable. Especially in the near term, targets should not rely on technologies that have not been commercialized and/or demonstrated as successful. Further into the future, it is expected that more GHG reduction technologies will become available.

3. Targets should be set using a timeline that is achievable. Feasibility studies and planning/approval cycles may be necessary for some actions, and the targets should allow for this to occur.

No inventory was done at the university in 1990; therefore, it is not accurate or practical to set targets based on the baseline year assessed by the IPCC. It was determined that the first principle would be best met by creating targets that led to deep reductions within the IPCC’s timeframe, i.e. by 2050.

Potential GHG reduction strategies were assessed by the CAP Advisory Committee for technical viability, resource implications and speed of implementation. Potential strategies were recommended in order that early-stage projects would provide for significant reductions while, at the same time, offering lower initial capital investment. Furthermore, early-stage projects are directed towards energy conservation that will provide for utility budget savings. The potential strategies are listed in the appendix.

Table 1 outlines the university’s reduction targets and Figure 5 graphs the reductions vs. the BAU scenarios:

<table>
<thead>
<tr>
<th>Year</th>
<th>Target Reduction</th>
<th>Reduction From Baseline (tCO2e)</th>
<th>Reduction from Forecasted BAU Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low Grid EF</td>
</tr>
<tr>
<td>2020</td>
<td>35%</td>
<td>20,200</td>
<td>10,711</td>
</tr>
<tr>
<td>2030</td>
<td>70%</td>
<td>40,400</td>
<td>34,059</td>
</tr>
<tr>
<td>2040</td>
<td>100% – climate neutrality</td>
<td>57,716</td>
<td>51,982</td>
</tr>
</tbody>
</table>

Figure 5: GHG Reductions Targets Compared to BAU Scenarios
3. Actions to Date

Queen's has been actively engaged on a number of fronts, including in operations, teaching, research and student engagement.

OPERATIONS

3.1 New Boiler (2010)

Queen's relies on the Central Heating Plant (CHP) and steam distribution system to provide most of the heating requirements for space conditioning and domestic hot water for campus buildings. The plant comprises three steam boilers and two cogeneration units (systems able to simultaneously produce electricity and steam). The multiple boilers are in place to provide redundancy in the case of maintenance issues. All in, the system produces about 700 million lbs. of steam, equalling about 550,000 gigajoules of energy, or the equivalent of heating nearly 4,600 Canadian homes. This energy production is reliant on the combustion of fossil fuels, including natural gas, oil and diesel.

The size and scale of the campus heating system means that even small changes offer broad impacts, as was the case in 2010 when a new steam boiler came online.

The new boiler gains 2.4 per cent efficiency when converting energy from the fuel source to steam and runs on natural gas. In addition, the boiler was designed to be the new “workhorse” for campus steam production, meaning that it carries the majority of the campus heating load. The efficiency gain translates into less fuel consumption. The natural gas fuel source translates into lower oil consumption, which the previous boiler required, and it is less carbon intensive.

OBJECTIVE

Replace an aging boiler with more modern and efficient equipment.

RESULT

After the new boiler was installed, the campus GHG inventories demonstrate a reduction in carbon emissions associated with the CHP by about 7,800 metric tonnes. Removing seasonal temperature impacts of the total reduction, approximately 5,500 tonnes can be attributed directly to the fuel switching and efficient gains of the new boiler.
3.2 ENERGY SERVICES COMPANY (ESCO)

Queen’s is embarking on a comprehensive energy conservation program to help reduce energy consumption and costs, and mitigate campus GHG emissions. The university has partnered with Honeywell, an ESCo, to deliver this project.

The project will be delivered as an energy performance contract, a program whereby the implementation of energy efficient solutions designed to upgrade facilities and reduce operating costs is paid for by guaranteed energy savings. Implemented energy conservation measures are designed to improve on existing systems to reduce the consumption of electricity, natural gas and water. The savings that the upgrades generate fund the work over the length of the contract, often spanning several years.

The identified savings that result from project implementation are guaranteed by the ESCo, meaning the ESCo will cover any savings shortfalls and correct the situation causing the shortfall. With the performance contract financing model, organizations can improve their facilities, manage rising energy costs, and reduce environmental impact without raising operating budgets.

A number of projects have been selected with a capital cost of $10.7 million, which will generate guaranteed annual savings of $946,000 and a GHG reduction of 2,800 metric tonnes.

OBJECTIVE

Reduce campus energy consumption and costs, and mitigate carbon emissions.

RESULT

The project is expected to be completed in August 2017 and will involve more than 170 individual energy conservation measures in 66 campus buildings. These include installation of low-flow fixtures to reduce water usage, upgraded lighting and building climate controls to reduce energy consumption, as well as recovery systems and improvements to building envelopes. At a high level, the program is currently targeting an annual carbon reduction of about 2,800 MT – the equivalent of taking 944 mid-sized cars off of Canadian roads. This project will contribute to an overall reduction of 26 per cent since 2008, when Queen’s started its GHG inventory.

3.3 DEMAND MANAGEMENT

The provincial electricity grid is managed in order to maintain base load energy consumption and peak energy demands on a daily basis. Base loads tend to be covered by electricity generation from nuclear and hydro, which both have reduced carbon emission impacts, whereas peak loads require dispatch production, which is often fossil fuel-based and has larger carbon impacts. Reducing these peak demands thereby reduces the reliance on this fossil fuel-based electricity production.
The university is in a provincial demand management program intended to reduce peak loads. As part of the program, air conditioning systems are shut down in a number of campus buildings on roughly 10 afternoons over the summer months. These shutdowns are timed to coincide with the expected peaks in provincial electricity demand. As Queen's reduces its energy demand at these times, so too are other participating institutions. These combined efforts work to decrease the overall peak demand within the province, allowing the electricity grid to become less reliant on fossil fuel generation.

**OBJECTIVE**

Contribute to a provincial effort to reduce peak energy demand and avoid associated costs within the utility budget.

**RESULT**

The shutdowns of the air conditioning systems contribute to roughly 4.18 MW of energy reduction, which is associated with significant financial benefits. Queen's, like other large electricity customers, pays what is called a Global Adjustment fee, which is a charge intended to recover costs associated with renewable power generation and other power contracts. The fee is based on a proportion of total provincial demand during the five peak demand hours from the previous year. The estimated financial savings due to this demand management was approximately $1.3 million in 2014.

3.4 LIGHTING RETROFITS

Lighting technology is always changing and improving, with increasing gains in light output and efficiency.

An active lighting retrofit program has been operating on campus since 2008. Led by the campus energy manager, the program examines existing lighting throughout the buildings and updates the systems with newer versions. The scope of the work varies depending upon the application and can include lamp-for-lamp swaps, ballast upgrades, complete redesigns and use-of-control systems like occupancy sensors and programming software.

**OBJECTIVE**

Improve the quality of campus lighting and conserve energy consumption.

**RESULT**

To date, more than 20 buildings have undergone lighting retrofits with another 40 buildings at various stages of design and development. The cumulative impact of the completed projects to date is an annual reduction in energy consumption of approximately 1.4 million kWh, resulting in a carbon emission reduction of 132 metric tonnes.
3.5 MAINSTREAM RECYCLING PROGRAMS

The principles of waste reduction and diversion continue to drive the university’s waste and recycling programming. Queen’s is committed to reducing, reusing and recycling waste material generated by its operations. This is accomplished through a variety of collection activities, including mixed recycling, mixed paper recycling, and scrap metal. In 2012, Queen’s added single-use coffee cups and Styrofoam to the cans, glass and plastic stream in an effort to remove these ubiquitous items from the waste stream and improve campus waste diversion. It is expected that a significant portion of the 1.1 million coffee cups disposed of annually on campus will now be recycled.

OBJECTIVE

To increase the amount and types of recyclable material the university diverts from landfill through recycling programs and education.

RESULT

In 2014-15, the university’s waste diversion rate was approximately 41 per cent. The Sustainability Office continues to create awareness of waste reduction and recycling while making waste reduction and recycling more accessible to the campus community. This year’s activities and innovations, such as the new Waste Watcher Recycling Stations, waste and recycling videos, and improved posters are three examples of the office’s continuing efforts.

3.6 TRANSPASS PROGRAM

Queen’s has partnered with the City of Kingston Transpass program to improve the accessibility of Kingston transit for faculty and staff. Benefits include discounted monthly passes, payroll deduction payments, unlimited monthly bus rides, and a more environmentally friendly way to commute.

OBJECTIVE

Make low-emission transport more appealing.

Increase accessibility and use of Kingston Transit for Queen’s commuters.

RESULT

Queen’s has 250 riders signed up for the program, resulting in a discounted transit price of $53/month and a carbon impact of approximately 300 MT.

3.7 TEACHING

The academic mission of the university is intrinsic to the Climate Action Plan. Research and teaching allow a university to contribute to reducing climate change in a manner that can be greater than its own GHG inventory. In the realm of curriculum, Queen’s created the School of Environmental Studies in 1995. This focused school and around 30 other distinct programs at Queen’s provide students with the opportunity to encounter learning opportunities in roughly 175 individual courses spread across most of the faculties.
The academic direction at Queen's University is informed by the Queen's University Academic Plan 2011. The plan is supported by four core pillars:

- The Student Learning Experience
- Disciplinarity and Interdisciplinarity
- Reaching Beyond: Globalism, Diversity and Inclusion at Queen's
- Health, Wellness and Community

Queen's University provides students with an opportunity to learn and discover general principles of sustainability and gain knowledge of issues related to climate change across multiple faculties and schools. These include:

- The School of Environmental Studies focuses on environmental chemistry and toxicology; ecosystem and human health; and society, culture, environmental planning and management, and economic sustainability.

- The Collaborative Master's Program in Applied Sustainability, offers a collaborative program with faculty members from six programs in the Faculty of Engineering and Applied Science: Chemical Engineering, Civil Engineering, Electrical and Computer Engineering, Geological Sciences and Geological Engineering, Mechanical and Materials Engineering and Mining Engineering.

- The Smith School of Business, one of the world's premier business schools, uses innovative approaches to team-based and experiential learning to provide opportunities to link commerce with the principles of sustainability.

- The School of Urban and Regional Planning offers specialized courses in environmental policy, environmental services, environmental planning and management, and environmental assessment.

- The Field School in Sustainability Leadership program is run at the Bader International Study Centre of Queen's University and consists of two core courses: ENSC 390 Sustainability, which provides a foundation in the concepts surrounding sustainability, and ENSC 310 Environmental Policy, which focuses on local and global examples of sustainable and unsustainable policies, and analyzes the consequences of these policies.

- Academic Student Engagement Enhancements expose students to a variety of curriculum and research initiatives enabling them to learn about and develop the necessary tools and understanding to address the challenges of climate change.

3.8 STUDENT LEADERSHIP

In addition to academic work, Queen's University offers abundant extracurricular student engagement opportunities on issues of climate change and sustainability. At the same time, the university also encourages student participation on committees (Queen's Sustainability Advisory Committee and the Queen's Climate Action Plan Advisory Committee) and in procurement processes on projects like the Queen's Solar PV Project.
The information presented below has been compiled from student group websites:

- The AMS Commission of the Environment & Sustainability (CES) supports environmental consciousness on campus and advocates for sustainable improvements within the AMS at Queen’s. Within the CES, there are working groups that focus on particular initiatives or services, including running a bicycle repair shop, carrying out free energy-saving retrofits in the student village and conducting sustainability-related educational campaigns on campus.

- The Queen’s Solar Design Team, best known for designing a series of award-winning solar cars and racing them in international competitions, is now focusing its attention and expertise on designing and building net-zero energy homes.

- The Earth Centre is an entirely student-run shop specializing in green products. It offers Queen’s students, faculty and community members a chance to engage in every-day activities to reduce their environmental footprint via green consumerism and provides shoppers with environmentally preferable common products.

- Queen’s Backing Action on Climate Change (QBACC) is a campus club that mobilizes and organizes environmentally minded students at Queen’s University. The club is designed to encourage progressive, climate change action at Queen’s University and in the City of Kingston. QBACC is about making real change happen now, at a local, provincial and federal level.

- Non-academic opportunities to engage students in climate change activities include messaging during orientation week, sustainability events and encouraging the inclusion of sustainability content in existing student-run conferences.

3.9 RESEARCH

Queen’s research advances the science, policy and technological developments that the world uses to mitigate and adapt to climate change.

Queen’s faculty are contributing in a variety of areas, including ecosystem management, renewable energy sources, energy systems and design, materials science and civil engineering. The breadth of the research is significant, from localized climate change impacts to future technological solutions and much in between – the university’s research engagement is comprehensive.

Notable examples include:

- The Queen’s Centre for Energy and Power Electronics Research (ePOWER) brings together academic and industrial researchers to develop a broad range of applications and expertise. These include power transmission, alternative energy, power consumption, and power application-specific integrated circuits. Fundamental and applied research conducted at ePOWER is resulting in the development of new energy-efficient and environmentally friendly electronic technologies.
Queen's-RMC Fuel Cell Research Centre (FCRC) is a prime example of leading research that can offer a technological solution to addressing climate change. Nearly 50 researchers are conducting research directed at improving materials, design and manufacturing processes while reducing costs, all of which are critical to the commercialization of fuel cell applications.

The Solar Calorimetry Lab (SCL) was established within the National Research Council of Canada in 1977 and subsequently moved to Queen's University in 1985. Current research topics include the design, analysis and modelling of thermal systems in the heating, ventilation and air conditions (HVAC) and solar fields.

The Queen's Institute for Energy and Environmental Policy (QIEEP) promotes the meeting of like minds; it offers a crossroads where the best academic research intersects with the challenges of policy makers and industry.

The Paleoecological Environmental Assessment and Research Laboratory (PEARL) includes a group of about 30 research scientists, post-doctoral fellows, graduate students and other scientists dedicated to using paleolimnological techniques to provide historical perspectives to environmental change. Such data are required to define natural environmental variability, to generate and test hypotheses, and to evaluate computer models that are now being used for the study of environmental change.

Queen's Facility for Biogeochemical Research on Environmental Change and the Cryosphere (FABRECC) carries out research directed at improving understanding of critical processes in these biogeochemical cycles, how they are being altered by human activity, and how terrestrial ecosystems might be more effectively managed to help mitigate human impacts while still providing critical ecosystem services.

Proposed Climate Change Research Enhancements include maintaining a public list related to climate change research, identifying opportunities for student involvement in the quantification of Scope 3 elements identified in the CAP, and recognizing exemplary climate change work by students and faculty members.

The Engineered Nickel Catalysts for Electrochemical Clean Energy (Ni Electro Can) research team, an international research project based at Queen's University that is focused on developing new clean energy technologies chemistry, is looking to develop the next generation of nickel-based materials, giving Canada's energy sector a competitive advantage.
Implementation

The principal will appoint a vice-principal to chair a working group that will operationalize the plan. Members of the working group will have a good understanding of the commitments made in 2010, as well as the financial implications of operationalizing the plan.

Based on this understanding, the working group will develop a list of actionable items that will help the university achieve its stated targets. The working group will be made up of one academic administrator recommended by provost, one academic administrator recommended by VPR, as well as AVP Facilities, Sustainability Office, Campus Planning, Communications and student representation. The working group will call in other subject matter experts as required.
Acknowledgements

Queen’s University would like to thank all those whose efforts have contributed to the creation of the Climate Action Plan. Contributors to this project included members of the Climate Action Plan Advisory Committee, with representatives drawn from Queen’s faculty and staff, as well as the City of Kingston.

We would also like to thank members of the Queen’s community who provided inventive ideas and feedback on the plan’s direction via direct email, the community forum and the Climate Action Plan survey. Finally, we wish to thank members of the Vice-Principals’ Operations Committee for their contributions and leadership during the plan’s development.

The Delphi Group assisted in the development of the Climate Action Plan.
Appendix

1. GHG REDUCTION STRATEGIES

The possible GHG reduction strategies in this appendix were developed by the original CAP Advisory Committee and working groups as part of the consultative process explained in this report. While these strategies will inform Queen's planning going forward, they represent only some of the options that will be considered by the new working group for possible future action.

1.1 STRATEGY DEVELOPMENT PROCESS

Ideas for GHG reduction strategies were gathered by Delphi and the Climate Action Plan Advisory Committee from the following sources:

- Identified internally through the Sustainability Office and university operations.
- Best practices at other universities.
- Renewable energy and energy efficiency experts.

Evaluation criteria were developed in order to prioritize the longlist of GHG reduction strategies initially identified. These criteria reflected the factors considered to be most important to the university and its stakeholders. The evaluation criteria were presented at the first community forum in order to gain feedback. A relative weighting was then assigned to the criteria according to this feedback. This filtering process, based on the evaluation criteria, generated a shortlist of viable projects. The shortlist was then further reviewed by a group of Physical Plant Services building operators and engineers. The secondary review was to ensure the feasibility of shortlisted projects within a campus-specific context.
The evaluation criteria and Physical Plant Services review were implemented in the first round of strategy assessment and a group of the best-ranked strategies was chosen. However, a gap was identified between the strategies chosen and the reductions required to meet the 2020 GHG reduction target. To address this gap, the GHG Reduction Strategy working group has recommended further investigation of strategies to reduce the GHG impact of the Central Heating Plant. It is expected that new sources of energy to heat the university will be required to meet the 2030 and 2040 reduction targets, and further study is needed to assess the technical viability and cost for a large-scale project.

2. EXISTING AND NEAR-TERM ACTIONS (2012-2020)

Queen’s has committed to reduce GHG emissions in 2020 by 35 per cent from the 2008 baseline. Given the uncertainty in the Ontario grid emission factor, this could represent a reduction anywhere from approximately 10,000 to just over 18,000 tonnes of carbon dioxide equivalent (tCO2e) from the BAU scenario. Recommended reduction strategies to meet this target focus on establishing more rigorous energy standards for new buildings, improving existing building energy performance and exploring the development of a renewable energy project.

Based on the initial evaluation, all of the projects identified for near-term action are believed to offer a viable path forward for achieving the 2020 reduction targets. However, the reduction strategy path is not intended to be prescriptive. As further development and implementation of the strategies occur, the plan will remain flexible in order to respond to new and emerging reduction options. Such options may offer greater benefits to Queen’s and therefore could replace one of the currently identified projects. Accordingly, recognizing that the CAP is a “living document,” the list of existing and near-term projects will be revised and updated over time.

Due to the uncertainty regarding the grid emission factors and the corresponding range of actual reductions necessary to achieve the 2020 target, the reduction potentials of the identified near-term strategies are presented as a range. As such, a number of different scenarios could develop in reaching the 2020 target. It may be that implementing the campus-wide energy performance update will be enough to achieve the campus goal. Conversely, all of the projects may need to be implemented in order to achieve, and potentially exceed, the 2020 reduction target. Ultimately, resources and opportunity will determine what specific projects are implemented in order to meet the 2020 reduction goal.
## 2.1 OPERATIONS

Identified projects to meet 2020 targets are as follows:

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
<th>GHG Reduction (tCO$_2$e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy standards</td>
<td>Adopt new energy intensity standards for campus operations, including new building performance, fleet vehicles, etc.</td>
<td>3000$^1$</td>
</tr>
<tr>
<td>Building energy efficiency</td>
<td>Partner with an Energy Service Company (ESCO) to implement a series of energy savings projects across campus.</td>
<td>4000-9000$^2$</td>
</tr>
<tr>
<td>Renewable energy project</td>
<td>Replace the West Campus heating line with a geothermal system.</td>
<td>700</td>
</tr>
<tr>
<td>Renewable fuel CHP pilot project</td>
<td>Use biogas or wood pellets.</td>
<td>4000-8000</td>
</tr>
</tbody>
</table>

### 2.1.2 ENERGY CONSUMPTION

#### Reducing Energy Consumption

The goal of reducing energy consumption at the point of use is to use less energy for existing activities and within existing infrastructure. Related strategies target heating and electrical energy consumption and opportunities for efficiency improvements within building operations.

Improvements in energy consumption will be driven by energy standards and operating policy.

### 2.1.3 ENERGY STANDARDS

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>GHG Reduction (tCO$_2$e)</th>
<th>Key Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel efficiency policy for campus fleet</td>
<td>End-of-life vehicles must be replaced with best-in-class fuel-efficient vehicles. Where a business case can be made, adoption of hybrid and electric vehicles is encouraged.</td>
<td>85</td>
<td>Strategic Procurement Services, VPOC, Sustainability Office</td>
</tr>
<tr>
<td>Adopt improved energy intensity standards</td>
<td>Energy intensity standards are set for new buildings on campus. Set standards guided by third-party certification bodies such as LEED, Green Globe, BREEAM etc.</td>
<td>3000</td>
<td>Physical Plant Services, Sustainability Office, VPOC</td>
</tr>
<tr>
<td>Air Conditioning (AC) Policy</td>
<td>Campus-wide set point of 26°C Fans operated at reduced capacities and runtimes.</td>
<td>100</td>
<td>Physical Plant Services, Sustainability Office, VPOC</td>
</tr>
</tbody>
</table>

$^1$ Estimated as the difference between new builds using new and existing standards

$^2$ Up to 20-25 percent of energy use within buildings can be reduced
2.1.4 BUILDING ENERGY USE REDUCTIONS

Via an Energy Performance Contract, it is proposed that a series of building envelope improvements and energy efficiency projects will be launched with an energy audit. The energy audit will allow the university to strategically identify and implement projects to minimize capital cost and maximize operational cost savings, while achieving GHG reductions. The scope of work and reduction potential are outlined below.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>GHG Reduction (tCO₂e)</th>
<th>Key Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Performance Contract</td>
<td>An energy audit will be completed for all buildings on campus. Via an</td>
<td>4000-9000</td>
<td>Physical Plant Services,</td>
</tr>
<tr>
<td>activities including:</td>
<td>energy performance contract a series of energy savings projects will be</td>
<td></td>
<td>Sustainability Office</td>
</tr>
<tr>
<td>• Fan scheduling policies</td>
<td>implemented.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Occupancy and Photo Sensor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology “campus-wide”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CO₂ monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Additional Lighting Retrofits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Efficient Hot Water Generation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(on-demand)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Heat Recovery Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fume hoods (VAV)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.1.5 CENTRAL HEATING PLANT

Addressing the Central Heating Plant

Queen's currently generates heat in the Central Heating Plant via high-efficiency boilers and, to a lesser degree, through a cogeneration system. Heat is transferred to campus buildings as steam through a series of buried lines. There are options to reduce emissions, including enhanced heat recovery for further improving heat generation efficiency, and by integrating renewable fuels to the supply mix.

A significant portion of the emission reductions between 2008 and 2010 resulted from the elimination of fuel oil #6. In order to preserve these reductions, a natural gas-only policy will need to be set that will require that other fuels can only be used as backups.

To further address the emissions associated with the CHP, options for enhanced heat recovery and power solutions will need to be explored. A pilot project to test the use of a renewable fuel could also be explored.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>GHG Reduction (tCO₂e)</th>
<th>Key Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas-only policy</td>
<td>The CHP has dual fuel boilers that allow PPS to operate reliably with fuel</td>
<td>Result of current practice</td>
<td>Physical Plant Services,</td>
</tr>
<tr>
<td></td>
<td>back-ups. Natural gas, diesel, and # 6 fuel oil are the three main fuels</td>
<td></td>
<td>Sustainability Office, VPOC</td>
</tr>
<tr>
<td></td>
<td>available for use. Currently, there are economic benefits to using natural</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>gas, but that may change in the future. Instituting a policy of burning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>natural gas only (subject to operational requirements) would avoid the</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>production of GHG gases from diesel and # 6 fuel oil.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condensing economizers (heat</td>
<td>Condensing economizers can recover waste heat and reuse the energy to</td>
<td>2300</td>
<td>Physical Plant Services,</td>
</tr>
<tr>
<td>recovery)</td>
<td>preheat the boiler feed water for Boilers #6 and #7.</td>
<td></td>
<td>Sustainability Office</td>
</tr>
<tr>
<td>Small boiler biogas pilot</td>
<td>End-of-life boiler is replaced with a regular boiler that is run using</td>
<td>8000</td>
<td>Physical Plant Services,</td>
</tr>
<tr>
<td></td>
<td>biogas.</td>
<td></td>
<td>Sustainability Office</td>
</tr>
<tr>
<td>Small boiler wood pellet pilot</td>
<td>End-of-life boiler is replaced with a boiler that can use wood pellet fuel.</td>
<td>7500</td>
<td>Physical Plant Services,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sustainability Office</td>
</tr>
<tr>
<td>Stand-alone bio-fuelled heating</td>
<td>West Campus heating line is removed from the central system, thereby</td>
<td>8000</td>
<td>Physical Plant Services,</td>
</tr>
<tr>
<td>plant for West Campus</td>
<td>eliminating a large and inefficient heating load. Heating is replaced with</td>
<td></td>
<td>Sustainability Office</td>
</tr>
<tr>
<td></td>
<td>a stand-alone and bio-fuelled system servicing only the West Campus.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.1.6 RENEWABLE ENERGY

Renewable Energy Generation

Renewable fuels can be integrated into both heating and electricity demands at the university. Examples of renewable energy generation considered for campus include solar photovoltaic (PV) panels, solar thermal and geothermal. Investment in energy conservation and efficiency tends to provide greater results in emission reductions. However, renewable energy generation can contribute to offsetting more emission-intensive sources currently being used on campus.

Although not likely essential to achieve the necessary 2020 GHG reduction targets, the development of a renewable energy project may be a worthwhile pursuit to demonstrate innovation and leadership, as well as provide for excellent learning and research opportunities for students. However, given the relatively high costs for reductions, these projects should only be implemented should funding become available. Three renewable energy projects have been considered during the development of the CAP. Of these, the geothermal system for West Campus is the most viable in the near term, given current conditions. The heating line extending to West Campus has accrued significant deferred maintenance and a capital expenditure will be required in the timeframe to either fix the line or invest in a new form of heating.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>GHG Reduction (tCO2e)</th>
<th>Key Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow geothermal</td>
<td>Replace the line out to West Campus with a geothermal system.</td>
<td>720</td>
<td>Physical Plant Services, Sustainability Office</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Install solar PV systems on campus rooftops with a 750 kW capacity.</td>
<td>90</td>
<td>Physical Plant Services, Sustainability Office</td>
</tr>
<tr>
<td>Solar thermal for DHW</td>
<td>Implement solar thermal collectors on roof tops (where possible) or ground mount systems for specific building domestic hot water production. Student residence and athletic facilities are potential sites for consideration.</td>
<td>300</td>
<td>Physical Plant Services, Sustainability Office</td>
</tr>
</tbody>
</table>

3. MEDIUM AND LONG-TERM STRATEGIES (2020 – 2040)

Emission reduction projects in the medium and long term should focus on the decarbonization of Queen's sources of energy. In essence, this strategy involves targeting the Central Heating Plant, which is the largest source of Queen's GHG emissions. On an annual basis, the plant represents between 75 per cent and 80 per cent of the university's carbon impact. To address this issue, several options have been identified:

- Biofuels, derived from agricultural, commercial, industrial and/or domestic waste. These are considered to be close to carbon-neutral, after factoring in additional potential transportation impacts.

- Biomass, such as plant material and animal waste, which also represents a low-carbon alternative to conventional fuel sources.

- Renewable electricity generation (wind, solar, etc.).

These can be used to meet a 70 per cent reduction by 2030 and contribute towards carbon neutrality in 2040. It is likely that there will be some technical limitation in physically achieving carbon neutrality in 2040. It is highly unlikely that energy generation to meet all of the university's demand can be accomplished without some level of GHG emissions, however reduced from today's standards. Therefore, in order to meet the 2040 target, Queen's may need to explore sources of offsets, or off-campus GHG reduction projects. Roughly 10 per cent of the reductions necessary to achieve climate neutrality have been attributed to the purchase of carbon offsets, which could occur towards the later stages of the plan.

Medium- and long-term actions should be revisited as new and further options become available.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>GHG Reduction (tCO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas or biomass for heating</td>
<td>Building off of the pilot, all campus heating requirements would be met with bio-energy.</td>
<td>20,000 – 40,000</td>
</tr>
<tr>
<td>Renewable electricity generation (large scale)</td>
<td>Large-scale renewable electricity generation (for example, wind) would be implemented by Queen's or purchased to provide an amount of electricity equivalent to university usage.</td>
<td>14,000</td>
</tr>
<tr>
<td>Offsets</td>
<td>Offsets would be purchased to cover technically limited GHG reductions.</td>
<td>3,000 – 5,000</td>
</tr>
</tbody>
</table>