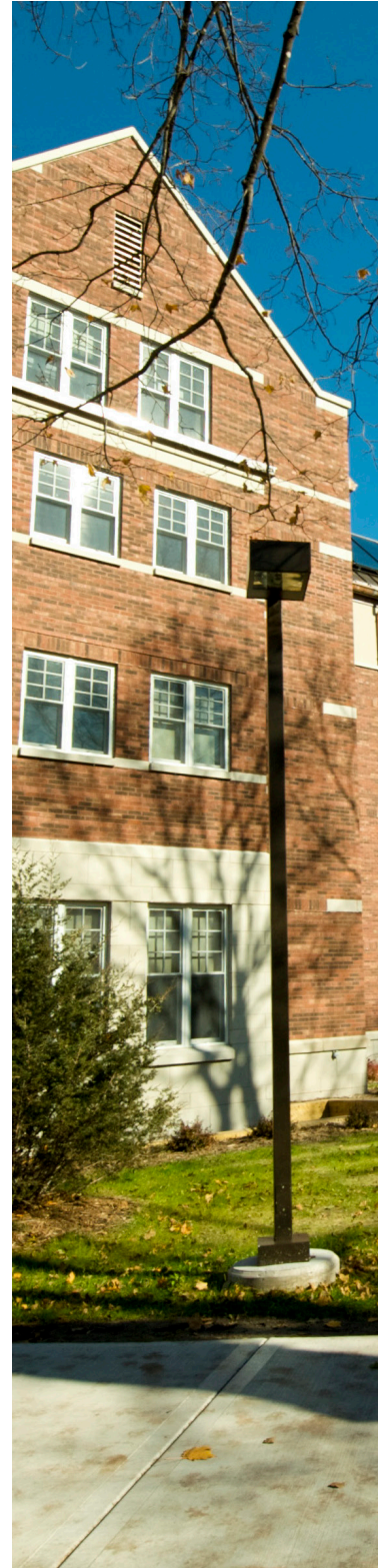
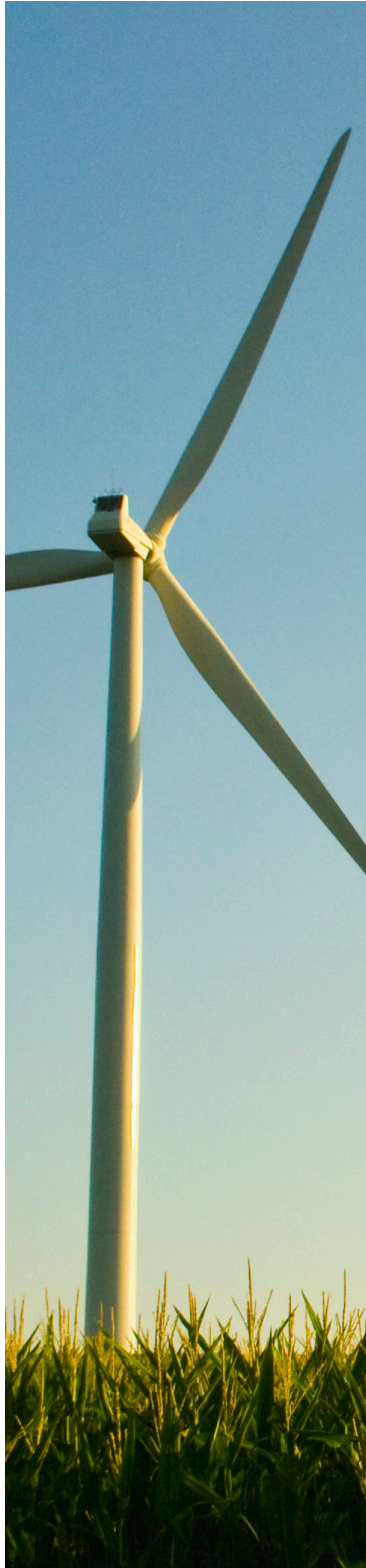
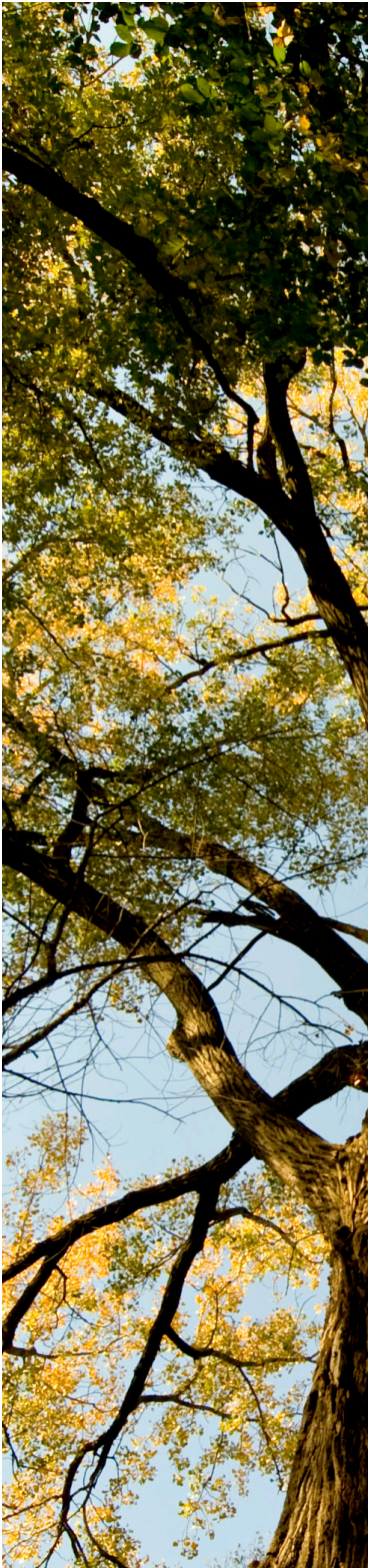




Climate Action Plan May 2011

Carleton Climate Action Plan Steering Committee

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I. Preface

Carleton has a long-standing reputation for leadership in environmental initiatives, from establishing the Cowling Arboretum in the 1920s to being the first college to construct a commercial-sized wind turbine in September 2004. Being a signatory to the American College and University Presidents' Climate Commitment furthers the dedication to environmental stewardship demonstrated by our predecessors and aligns Carleton with more than 670 other higher educational institutions.

Climate change, energy supply and demand, and related environmental issues are among the most pressing challenges of our time. Carleton's commitment to liberal arts undergraduate education allows us to prepare students to face these challenges from a variety of perspectives. Carleton faculty members have already begun introducing sustainability and climate change into the curriculum from scientific, economic, political, social, historical, and ethical perspectives, both in the classroom and through direct experience and observation within the campus environment. Furthermore, student interest in sustainability issues is strong and growing, as evidenced by Carleton's numerous environmental organizations and sustainability initiatives.

This Climate Action Plan knits educational opportunities together with tangible actions being implemented across Carleton's campus to reduce our carbon footprint.

With both short and long term goals, the Plan will affect many generations of Carls to come. It encourages involvement from all members of the Carleton campus—staff, students, and faculty—as well as collaborations with the Northfield community. Actions and initiatives can be monitored, refined, and improved with each iteration of the plan.

We are pleased to present this plan as a public statement of Carleton's commitment to a more sustainable future. We look forward to working with our peer institutions to reduce greenhouse gas emissions.



Steven Poskanzer
President

II. Executive Summary

Background

Carleton College is a recognized leader of higher education sustainability initiatives as evidenced by the College's Environmental Statement of Principles, Carbon Neutrality Value Statement, environmental studies major, two commercial-sized wind turbine projects, investments in central plant efficiency, and numerous ongoing campus sustainability initiatives. In 2007 President Oden reinforced Carleton's sustainability values by signing the American College and University Presidents' Climate Commitment (ACUPCC), which was renewed again by President Poskanzer in 2010. The ACUPCC requires each institution to implement two short-term tangible actions, perform a baseline greenhouse gas (GHG) emissions inventory, and develop a climate action plan outlining a series of actions that will achieve climate neutrality by a specific date in time. Furthermore, the climate action plan must include actions to make climate neutrality and sustainability part of the curriculum and educational experience for all students. Climate neutrality is defined as having net zero GHG emissions by reducing or avoiding GHG emissions as much as possible and using carbon offsets or other measures to mitigate the remainder.

Base Case Scenario, or Business-as-usual

The base case scenario in Carleton's Climate Action Plan uses the most recent GHG inventory, which was completed for the 2008 calendar year and reports 21,128 metric tons of CO₂e (MTCDE) emitted. Fifty percent of Carleton's total carbon footprint is comprised of GHG emissions from purchased electricity, and 36 percent is from natural gas burned on campus. Energy supply and demand are therefore a primary focus of Carleton's Climate Action Plan. Other Carleton GHG emissions are from transportation (ten percent) and waste (four percent). Carleton's GHG emissions inventory is offset (four percent) by carbon sequestration in the Arboretum. (See Figure V.1: Carleton College 2008 Greenhouse Gas Inventory on page 13.)

If Carleton does nothing to reduce its GHG emissions, current assumptions of campus square-footage and population growth are anticipated to result in a 45 percent increase to Carleton's carbon footprint by the year 2050. This is defined as the business-as-usual scenario. The Climate Action Plan outlines a series of recommendations to reduce Carleton's net GHG emissions to zero by the year 2050 through a combination of direct emissions reduction and carbon offsets. In addition to satisfying the requirements of the ACUPCC, the Climate Action Plan serves as a risk mitigation strategy against future energy price volatility and the potential for direct or indirect costs to Carleton due to future carbon regulations. Based on recent proposals in Congress, even a moderate form of carbon legislation could impose millions of dollars in financial exposure on Carleton over the 40-year life of this plan. (See Figure V.4: Range of Potential Financial Exposure Due to Future Greenhouse Gas Regulation on page 16.)

Evaluation Process

Carleton formed a Climate Action Plan Steering Committee in 2010 that worked with a team of experienced energy strategy and engineering consultants to evaluate carbon reduction strategies that would put the College on a path to achieve climate neutrality by the year 2050. Over two dozen carbon reduction strategies were evaluated for potential inclusion in the plan. (See Figure VI.1: Options Evaluated on page 17.)

Multiple carbon reduction strategies were quantified and compared based on two key metrics:

- Average annual metric tons of carbon dioxide equivalent (MTCDE) reduced
- Cost per average annual MTCDE reduced, including first cost plus net annual operating costs (or savings) from date of implementation through the year 2050

This quantitative comparison allowed the steering committee to quickly gauge which options were worth further exploration. The second wind turbine plus a group of energy conservation strategies showed a net financial savings to Carleton over the life of the plan and are recommended for near-term implementation (2010–2020). (See Figure VI.2: Levelized Cost Comparison on page 19.)

Summary of Recommendations

The steering committee created a diagram in the shape of a native prairie flower found in the Cowling Arboretum to represent the five categories of GHG emissions reduction strategies surrounding a core mission of education and outreach and supported by a foundation of reliable funding, implementation, and reporting methods. (See Figure VI.4: Greenhouse Gas Reduction Areas on page 21.)

GHG Reduction Wedge Diagram

The steering committee used both qualitative and quantitative evaluation criteria to identify GHG reduction strategies that appear to be a best fit for Carleton's operations and campus culture. Many are projected to result in low to no net cost over the life of the plan. Others require capital investment in fundamental utility plant modifications; these are reserved for a much later date and will be highly influenced by future technological, economic, and political factors. Quantified options were stacked in a wedge diagram to show how much each option reduces Carleton's business-as-usual GHG emissions growth relative to a straight-line path to climate neutrality by 2050. (See Figure VI.3: Carbon Reduction Wedge Diagram on page 20.)

Key interim milestones on the wedge diagram are as follows:

- **2010–2020:** Carleton will remain on or ahead of a straight-line path to climate neutrality by 2050 through implementation of strategies that result in a net savings to the College over the life of the plan such as the second wind turbine, a portfolio of energy conservation strategies (space utilization, green building standards, green IT, energy audits, building energy conservation measures, and behavior change initiatives), and a combined heat and power (CHP) boiler with a back-pressure turbine to replace boiler #1 at the end of its useful life. These strategies support an interim GHG emissions target of 17,000 MTCDE by 2020.
- **By 2025:** Carleton will need to implement a more aggressive carbon reduction strategy to remain on a straight-line path to climate neutrality by 2050. The Climate Action Plan recommends replacing wind turbine #1 at the end of its anticipated useful life (2024) and building a direct connection from the replacement turbine to Carleton's electrical grid. This strategy advances Carleton toward its second interim target of 14,000 MTCDE by 2025, but additional projects, reduced campus growth from the business-as-usual condition, and/or purchased offsets will be needed to reach this goal.
- **By 2030:** Carleton will need to implement other aggressive carbon reduction strategies in order to remain on a straight-line path to climate neutrality by 2050. The Climate Action Plan recommends replacing natural gas burned in central plant boilers with a non-carbon fuel such as biogas from a renewable fuel source. This strategy advances Carleton toward its third interim target of 11,000 MTCDE by 2030, but additional projects, reduced campus growth from the business-as-usual condition, and/or purchased offsets will be needed to reach this goal.
- **Beyond 2030:** Carleton will need to implement yet to-be-determined future technologies or supplement its plan by purchasing carbon offsets and renewable energy credits in order to achieve climate neutrality by the year 2050.

GHG Reduction Portfolio

The steering committee expanded the GHG reduction portfolio to include strategies shown in the wedge diagram (primarily energy supply and demand) plus some that were not quantified in this process but will help reduce Carleton's overall carbon footprint and create a more sustainable campus. The recommended actions are grouped into five categories—energy supply and demand, transportation, waste management, procurement, and land management.

Education and Outreach

The Carleton Climate Action Plan also outlines education and outreach opportunities focusing on current issues in environmentalism and sustainability. Recommended actions in this section address student experiences in the classroom; outside the classroom in extra-curricular, work-study positions, internships or off-campus studies; after graduation in graduate studies or “green collar” careers; participation in community outreach; and faculty research.

Funding, Implementation, Reporting

All of the cost projections in the Climate Action Report are estimates, since the projects listed have not yet been approved for implementation. All projects, especially large-scale initiatives, will involve detailed cost evaluation and identification of specific fund sources as part of the planning process. External funding assistance will be explored to offset first costs, including grants, incentives, and donations. Some projects such as energy conservation strategies are likely to provide annual savings to the College through reductions in energy demand and associated utility costs.

The first ten years of the Carleton Climate Action Plan include numerous low to no cost initiatives from the energy supply/demand, transportation, waste management, land management, procurement, and education/curriculum sections of the plan. Major facilities initiatives during this period include installing a second wind turbine, replacing boiler #1 with a combined heat and power system, and conducting campus-wide building energy audits and energy conservation measures. Once these projects are complete, they are expected to begin generating more in annual energy savings than the annual operating expenses required to support them and to pay back the total initial investment in six to ten years. A breakdown of projected costs can be found on page 48.

Project costs and paybacks beyond a ten-year timeframe are too far in the future to accurately predict. Carleton will continue to monitor renewable energy, substitute fuels, and other technologies as they advance and will modify the Climate Action Plan to reflect both technological and economic changes in these industries.

As a baseline for comparison, the cost of purchasing voluntary renewable energy credits (RECs) and/or carbon offsets currently is relatively inexpensive. In today's market, it could cost Carleton as little as \$65,000 per year to purchase sufficient RECs and offsets to achieve climate neutrality. Although this might appear to be an attractive short-term solution, it does not directly reduce Carleton's greenhouse gas emissions and potentially exposes the College to volatile and uncertain market prices, especially if carbon emissions are regulated in the future and offset prices rise dramatically. For example, the Climate Action Plan's economic model estimates that under moderate carbon emissions regulation coupled with moderate technological advances, the cost of purchasing offsets to achieve climate neutrality could reach nearly \$4 million per year by 2050. The committee felt that purchasing offsets should not be a substitute for implementing direct-reduction options, especially those that are practical ways to improve campus-wide energy efficiency. For these reasons, annual purchases of RECs and offsets are not recommended as a primary means for Carleton to achieve climate neutrality.

Implementation

A more detailed cost evaluation, sensitivity analysis, and financial plan will be conducted prior to implementing any Climate Action Plan recommendation that requires significant capital cost or changes to current operating procedures. Project management best practices will be applied to implementation of each individual project initiative. General support from the Carleton community and a broad distribution of responsibilities will be essential to transforming the plan from a written document into tangible actions. The sustainability office and student sustainability assistants will implement tactical aspects of recommended actions contained within the program. The steering committee can continue to guide progress from an advisory standpoint, and committee members will participate in sub-committee efforts as needed to advance specific recommended actions. Each initiative will be assigned a lead point-of-contact whose existing role at the College is consistent with the project in question.

Reporting

Carleton will provide internal updates and report to the campus community on a regular basis at a frequency depending on the recommended action, with a formal internal progress assessment in June 2012. An update to the Climate Action Plan will be posted publicly on the ACUPCC Web site after two years (June 2013), per the terms of the commitment. Carleton will continue to conduct an annual greenhouse gas emissions inventory and post it to the ACUPCC Web site. The College will update the internal climate action plan on an annual basis to report progress on recommended actions and make necessary modifications in response to changes in the internal or external political, economic, and technological landscape.

Conclusion

Carleton's 2011 Climate Action plan allows the College to implement practical solutions over the next decade while maintaining an open-minded vision for future years. Over time, the plan will be adapted in response to technological, political, economic, and social changes. Recommended actions in the plan will not only reduce Carleton's carbon footprint but also mitigate future financial risk due to energy price fluctuations or potential greenhouse gas legislation. The plan also will foster the development of education and outreach opportunities for Carleton's students both inside and outside the classroom.

III. Introduction and Purpose

Carleton College is a four-year liberal arts college located in Northfield, Minnesota, with a long-standing commitment to improving the energy efficiency of its campus and reducing its environmental impact. By signing the American College and University Presidents' Climate Commitment (ACUPCC), President Robert A. Oden (2002–2010) pledged that Carleton would join hundreds of other higher education institutions in a coordinated effort to reduce campus greenhouse gas emissions. Carleton's current president, Steven G. Poskanzer, renewed the commitment in 2010.

This Climate Action Plan is a significant step toward furthering Carleton's ongoing sustainability efforts while also fulfilling one of the primary requirements of the ACUPCC. The Climate Action Plan Steering Committee chose to expand the focus of this document from a greenhouse gas emissions reduction strategy to an overall sustainability strategic plan, allowing it to serve as a vehicle for prioritizing and tracking a broad network of campus-wide sustainability efforts. This plan will be updated annually to facilitate ongoing review, evaluation, integration of new ideas, and course correction as needed. It also will serve as a comprehensive internal sustainability reporting and project planning tool.

Formed in May 2010, the Climate Action Plan Steering Committee included a dedicated, cross-disciplinary group of faculty and staff members, students, and one Carleton trustee. The steering committee's work on the plan was supplemented by contributions from numerous additional campus collaborators who offered their specific expertise across multiple campus disciplines. The steering committee's process included systematic evaluation of multiple carbon-reduction solutions in search of those that were the most actionable, defensible, transparent, aligned with Carleton's mission and values, integrated within existing facilities and capital planning, flexible, and forward-looking. Through its evaluations, the steering committee concluded that:

- Even without a regulated price on GHG emissions, there are opportunities for Carleton to reduce its carbon emissions that will also save money for the College within a reasonably short payback period.
- Even without a regulated price on GHG emissions, decreasing Carleton's campus energy use and dependence on fossil fuels provides some amount of risk management against future increases in electricity and natural gas prices.
- It's very possible that there will eventually be a direct or indirect price on GHG emissions, and this evaluation will allow Carleton to be better prepared by having already implemented certain best practices and by knowing what technologies to watch for future development.
- Consumption of natural gas and purchased electricity account for 86 percent of Carleton's total greenhouse gas inventory meaning that reducing energy demand and developing renewable sources of supply must be the primary focus of Carleton's GHG reduction plan.
- Renewable energy from the second wind turbine and rigorous energy conservation efforts for both new and existing buildings will allow Carleton to remain on a straight-line path to zero carbon emissions in 2050 for the next 10–15 years. Further reductions beyond that point will require implementation of much more aggressive and capital-intensive changes to energy supply and demand and/or purchase of renewable energy credits and carbon offsets.



entrance to Carleton College

"We believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality."
- ACUPCC Text

- Although direct greenhouse gas emissions reductions are preferred by the Carleton community and offer a more stable risk management strategy, purchased renewable energy credits (RECs) and carbon offsets are currently very affordable and can be purchased from local sources. These instruments should be considered as part of the portfolio of options that will help Carleton achieve its emissions reductions targets.

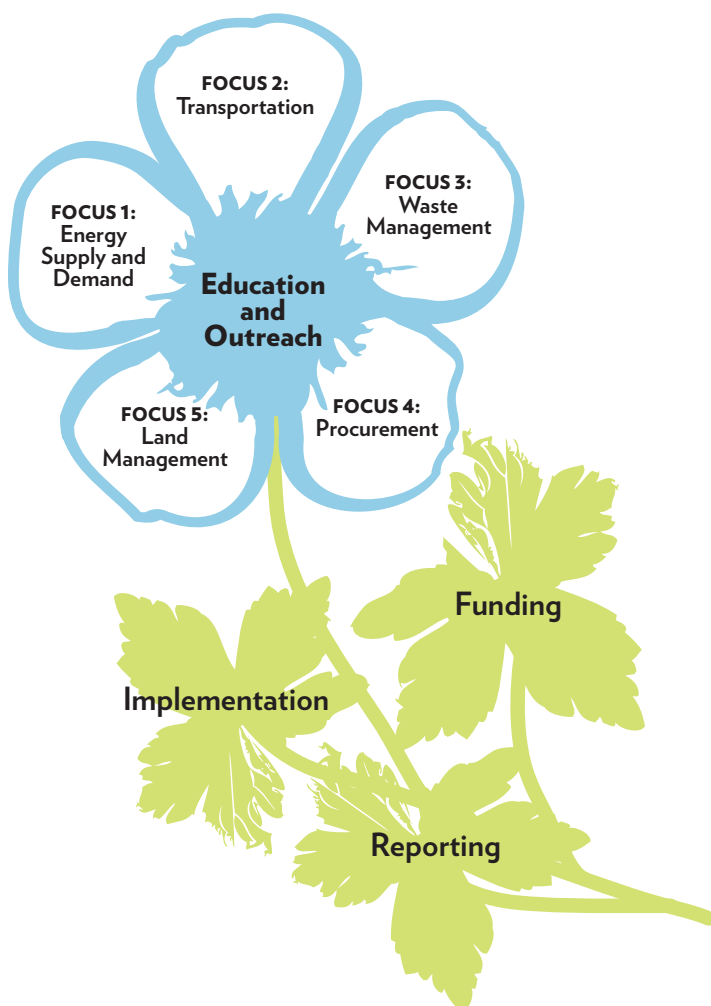
Carleton's Climate Action Plan presents a practical approach that reflects Carleton's current planning environment, ranging from the good fortune of our upcoming alumni-sponsored wind turbine to realistic challenges such as a conservative budget approach due to the current state of the U.S. economy. The plan is organized into five focus areas which directly influence greenhouse gas emissions. At the center, the College's mission of providing an exceptional undergraduate education is interwoven throughout the five carbon reduction focal points through opportunities for curriculum development, research, and campus/community outreach. A foundation of reliable reporting, implementation plans, and funding strategies supports the plan as represented in Figure III.1.

Although the steering committee acknowledges that this plan is only a starting point, it is intended to foster a focused awareness of campus-wide sustainability initiatives, inspire educational opportunities, and instill a widespread network of environmental best practices into our standard operating procedures. Carleton College is pleased to be among the growing number of American colleges and universities who are stepping forward as proactive leaders to create more sustainable campuses and actively address the threat of global climate change.



Carleton's wind turbine (#1)

FIGURE III.1: GREENHOUSE GAS REDUCTION AREAS



IV. Background

Carleton Environmental Principles

From the creation of the Cowling Arboretum in the 1920s to the installation of Carleton's first wind turbine in 2004, the College has demonstrated that commitment to the environment is a long-standing institutional value. Carleton continues to be a leader in sustainable practices through recent initiatives such as the implementation of campus-wide lighting system retrofits to reduce energy consumption, a student-run on-campus organic farm, the creation of a sustainable revolving fund, development of the environmental studies program, and the activities of numerous volunteer student groups devoted to environmentalism and sustainability.

The Carleton Environmental Statement of Principles, adopted in 2001, asserts that "Carleton College recognizes that it exists as part of interconnected human and natural communities that are impacted by personal and institutional choices" and that the College "will strive to be a model of stewardship for the environment by incorporating ideals of sustainability into the operations of the College and the daily life of individuals."¹

Carleton's Carbon Neutrality Value Statement, adopted in 2006, states, "Carleton College recognizes that global warming is one of the greatest local and global challenges of our time. The College values the goal of carbon neutrality as a priority for our community, recognizing that this goal merits the consideration of allocation of resources to research and implement technological and behavioral change. The College commits to developing a framework to reduce greenhouse gas emissions with the input of students and staff and faculty members. In doing so, Carleton reaffirms its commitment to sustainability as articulated in the Environmental Statement of Principles."

Carleton's Climate Action Plan represents yet another point on the continuum of our commitment to environmental awareness and actions toward a more sustainable future.

American College and University Presidents' Climate Commitment (ACUPCC)

In 2007 President Oden signed the American College and University Presidents' Climate Commitment (ACUPCC), pledging Carleton to develop a comprehensive plan and timeline to mitigate its contributions to climate change. Carleton's current president, Steven Poskanzer, reaffirmed that commitment in 2010. Carleton is now joined with more than 670 other colleges and universities whose presidents have pledged their institutions to reduce and offset greenhouse gas (GHG) emissions to become climate neutral as soon as possible. Carleton's model adopts the year 2050 as the target year to achieve a net zero carbon footprint.

The ACUPCC defines climate neutrality as "having no net greenhouse gas emissions, to be achieved by minimizing greenhouse gas emissions as much as possible and using carbon offsets or other measures to mitigate the remaining emissions." The ACUPCC Implementation Guide defines three categories of greenhouse gas (GHG) emissions for accounting and inventory reporting purposes:

- **Scope 1 GHG emissions** are direct emissions "owned and controlled" by Carleton College, including on-campus stationary combustion of fossil fuels, mobile combustion of fossil fuels by College-owned/controlled vehicles, and "fugitive emissions" from intentional or unintentional releases of greenhouse gases.

"Carleton College recognizes that it exists as part of interconnected communities that are impacted by personal and institutional choices. We are dedicated to investigating and promoting awareness of the current and future impacts of our actions in order to foster responsibility for these human and natural communities. Carleton strives to be a model of stewardship for the environment by incorporating ideals of sustainability into the operations of the college and the daily life of individuals."

—Carleton Environmental Statement of Principles, 2001



Cowling Arboretum

- **Scope 2 GHG emissions** are indirect emissions associated with purchased commodities such as electricity supplied by electric distribution companies serving the Carleton campus grid.
- **Scope 3 GHG emissions** are indirect GHG emissions associated with activities that are a direct consequence of Carleton's mission and operations but are from sources not owned or controlled by the College such as air travel for student study abroad programs or faculty/staff continuing education.

To achieve climate neutrality under the terms of the ACUPCC, all Scope 1 and 2 emissions and Scope 3 emissions from commuting plus air travel paid for by the College must be neutralized. Institutions who have signed the ACUPCC also pledge to eliminate contributions to global warming by taking the following actions (Carleton's actions are listed in bold after each item):²

- Establish an institutional structure to oversee the development and implementation of the schools program to comply with the ACUPCC. **Carleton's manager of campus energy and sustainability, the Environmental Advisory Committee, and the Climate Action Plan Steering Committee all contribute to this purpose.**
- Complete a greenhouse gas (GHG) emissions inventory within a year. **Carleton GHG inventories are posted on the ACUPCC Web site for 2007 and 2008. The 2009 and 2010 inventories are underway and will be posted online in spring term 2011.**
- Within two years, establish a climate action plan and set a target date and interim milestones for becoming climate neutral. **This document is Carleton's Climate Action Plan.**
- Take immediate steps to reduce greenhouse gas emissions by choosing from a list of tangible action options. **Carleton's tangible actions include LEED building standards for new construction, an Energy Star appliance purchasing policy, access to public transportation, a responsible investment committee, and the campus recycling/composting program.**
- Integrate sustainability into the curriculum and make it part of the educational experience. **The environmental studies program draws from a broad range of science and humanities disciplines.**
- Make their climate action plan, inventory, and progress reports publicly available. **Carleton reports are publicly posted on the ACUPCC Web site.**

2010 Planning Environment

To recognize the impacts of the external planning environment, the steering committee began with an overview of economic conditions, energy markets, and environmental policy. As scientific consensus has shown the necessity for reducing GHG to avoid the catastrophic effects of global warming, world leaders, the U.S. Congress, and state legislators have intensified efforts to develop policy responses in order to cap and regulate emissions of GHG.

International Forum

The international effort to address climate change formally began 18 years ago in Rio De Janeiro when the U.N. Framework Convention on Climate Change established a broad long-term objective calling for the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." In 1997 the Kyoto Protocol was adopted, establishing a

legally binding short-term emissions reduction commitment for the 161 countries that ratified the protocol covering the period 2008–2012. It also established a framework for countries to negotiate a second set of near-term GHG reduction commitments for the period 2013–2017 which led to the U.N. Climate Change Conference in Copenhagen in 2009. In Copenhagen attending world leaders, including the United States, agreed that “deep cuts in global emissions are required . . . so as to hold the increase in global temperature below 2 degrees Celsius. . . .” They adopted a three-page agreement, the Copenhagen Accord, in which both industrialized countries and major developing countries agreed to pledge to non-binding emission reduction targets. The accord represented the first time all of the world’s major economies had agreed to submit international climate pledges to the U.N.³

Federal Legislation

Since 2007 both the executive and legislative branches of the U.S. government have been very active in addressing climate change through legislative action, administrative rule-making and international engagement.⁴ Accordingly, there has been an expectation that federal market-based greenhouse gas legislation and/or GHG regulations would be on the horizon. In the current 111th Congress, the U.S. House of Representatives passed the American Clean Energy and Security Act of 2009 (H.R. 2454) on June 26, 2009. In the U.S. Senate six climate bills were either introduced or released as discussion drafts in 2009 and 2010, although Senate leadership did not bring comprehensive climate legislation to the floor for a vote in 2010.

While market-based cap and trade proposals are currently stalled in the U.S. Congress, the U.S. Environmental Protection Agency (EPA) has expressed its willingness to regulate GHG emissions under the Clean Air Act and is moving forward with GHG regulation. The EPA has adopted rules to limit GHG emissions from motor vehicles and to require suppliers of fossil fuels, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons of GHG emissions or more per year to submit annual emissions reports to EPA. Moreover, starting in January 2011 the EPA will also begin to regulate GHG emissions from large point sources through the adoption of the GHG Tailoring Rule.

State Initiatives

At the state level, Minnesota has been a leader in the development of policies to promote clean energy technologies and to address climate change. On May 25, 2007, Governor Tim Pawlenty signed the Next Generation Energy Act of 2007. The act includes requirements for Minnesotans to increase energy efficiency and renewable energy and to expand community-based clean energy development. The act also established a statewide goal to reduce GHG emissions to 15 percent below 2005 levels by 2015, with cumulative reductions of 30 percent by 2025 and 80 percent by 2050. Later in 2007 Minnesota joined nine Midwestern states and two Canadian provinces in signing the Midwestern Greenhouse Gas Reduction Accord. In signing the accord, Minnesota agreed to establish a program to reduce greenhouse gas emissions and to work with other states and provinces to adopt a regional cap and trade program to reduce emissions of greenhouse gases to 20 percent below 2005 levels by December 31, 2020, and to 80 percent below 2005 levels by December 31, 2050.

Colleges and Universities

The substantial efforts to address climate change at the international, federal, and state level reinforces the need for ground-up networks of coordinated efforts such as those being undertaken by Carleton College in conjunction with other colleges and universities through the ACUPCC. As of December 31, 2010, more than one third of the total U.S. collegiate student population—5.5 million students—were attending ACUPCC signatory institutions. More than 670 institutions had signed the agreement, 462 had completed greenhouse gas inventory reports, and 130 climate action plans had been submitted to the ACUPCC.⁵ Through Carleton’s commitment to the ACUPCC and development of this Climate Action Plan, the College is linked with a proactive

community of educational institutions in a joint effort to implement tangible carbon reduction milestones over a defined period of time.

Carleton College

As the economy emerges from a global recession, Carleton is witnessing dynamic changes within the sectors of the economy that supply its energy. Carleton, like many other institutions, remains cautious regarding current and projected budget expenditures. Carleton's initial Climate Action Plan therefore places upfront emphasis on practical and no or low net cost solutions. Through developing this plan, the steering committee recognized that current uncertainty about energy market supply and prices, advances in clean energy technologies, and evolving environmental regulations that address GHG emissions and climate change. These variables emphasize the importance of Carleton's focus on a diverse portfolio of technologies and strategies that can provide the most cost effective GHG reductions in the near term while maintaining the flexibility to incorporate more advanced, low- and non-carbon technologies and energy supplies in the future.

Notes

¹Environmental Statement of Principles; approved by the Environmental Advisory Committee, April 2001; endorsed by the Board of Trustees, Buildings and Grounds Committee, May 2001

²American Colleges and University Presidents' Climate Commitment, 2007

³As of May 2010, 99 parties (including the 27 member states of the European Union as a single party) had filed GHG emissions reduction submissions with the United Nations. In January 2010 the United States formally submitted its commitment to the United Nations promising to reduce greenhouse gas emissions by approximately 17 percent below 2005 levels by 2020, with the caveat that the target would be set "in light of enacted legislation."

⁴The Pew Center for Global Climate Change reports that in the period covering the 109th, 110th and 111th Congresses more than 350 bills, resolutions and amendments have been introduced specifically addressing greenhouse gas emissions and climate change. See www.pewclimate.org/federal/congress/110

⁵American Colleges and University Presidents' Climate Commitment, 2009 Annual Report

V. Base Case Scenario

2008 Greenhouse Gas Emissions Inventory

The first Carleton Greenhouse Gas (GHG) Emissions Inventory was conducted by students and facilities staff members in 2006. After President Oden signed the Presidents’ Climate Commitment in 2007, Carleton conducted its second GHG emissions inventory for the 2007 calendar year and is now using its 2008 inventory as the base case for this report at 21,122 MTCO₂e¹. Inventories for 2009 and 2010 are currently underway. Carleton intends to conduct future greenhouse gas emissions inventories on an annual basis and to utilize the most current available data in future Climate Action Plan updates.

The 2008 inventory shows that the largest contribution to Carleton’s carbon footprint is the energy demands of campus buildings and facilities. Scope 1 emissions from natural gas used to create heat, steam, and chilled water on site and Scope 2 emissions from electricity purchased from Xcel account for 86 percent of Carleton’s total 2008 greenhouse gas emissions. The inventory suggests that reducing total energy consumption and supplying cleaner energy to the campus distribution system must be a core component of Carleton’s Climate Action Plan.

Because Carleton is a primarily residential campus, transportation emissions are less of a concern than they would be at an urban university; Carleton’s transportation emissions include study abroad travel paid for by the College, staff and faculty commuting and conference attendance, and fuel for campus-owned vehicles. Waste accounts for another relatively small portion of Carleton’s greenhouse gas emissions. Carleton’s total greenhouse gas emissions inventory is offset slightly (4 percent) by the arboretum, which provides 903 metric tons of on site carbon sequestration each year.

Growth Assumptions: Business-as-usual

As a necessary first step in preparing the Climate Action Plan, the steering committee developed a base case, or business-as-usual (BAU) model, to forecast Carleton’s GHG emissions out to 2050. The three major building blocks used to develop the GHG forecast are projected growth in population (student, faculty and staff), campus building area in square feet, and primary energy use measured as energy use intensity (EUI).

The BAU model assumes that campus population (students, staff, faculty) will grow at an average annual rate of 0.2 percent per year, resulting in an increase from 2,678 in 2009 to 2,805 in 2050. This is consistent with historical averages. Campus building space, the primary driver of energy use and GHG emissions, is projected to increase at an annual growth rate of 0.7 percent per year between 2010 and 2050, which results in a net addition of 602,000 square feet of new building space. It is interesting to note that, on average, Carleton’s square footage growth has historically outpaced population growth.

With an increase in campus building space and population, demand for natural gas and electricity would be expected to create a corresponding increase in Carleton’s carbon footprint. As a result, the College’s GHG emissions are expected to increase 45 percent by 2050 from 21,122 MTCO₂e in 2008 to 30,604 MTCO₂e in 2050. Scope 2 emissions associated with purchased electricity are projected to remain the largest portion of Carleton’s BAU GHG emissions (53 percent) at 16,140 MTCO₂e in 2050. Natural gas consumption is projected to be the second highest contributor to Carleton’s GHG emissions (35 percent) growing from 7,182 MTCO₂e in 2008 to 10,773 MTCO₂e by 2050.

FIGURE V.1: 2008 EMISSIONS INVENTORY

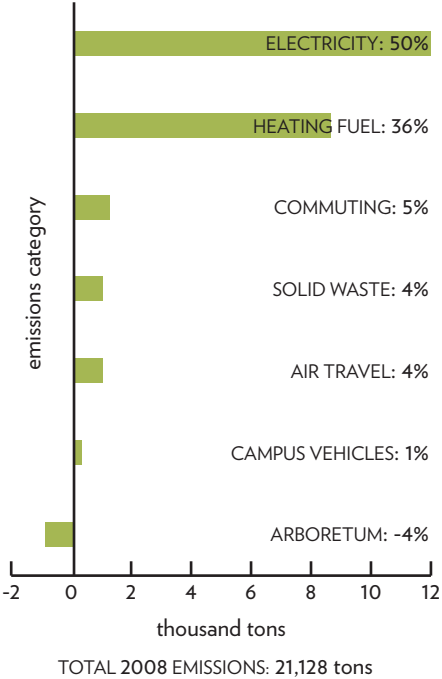
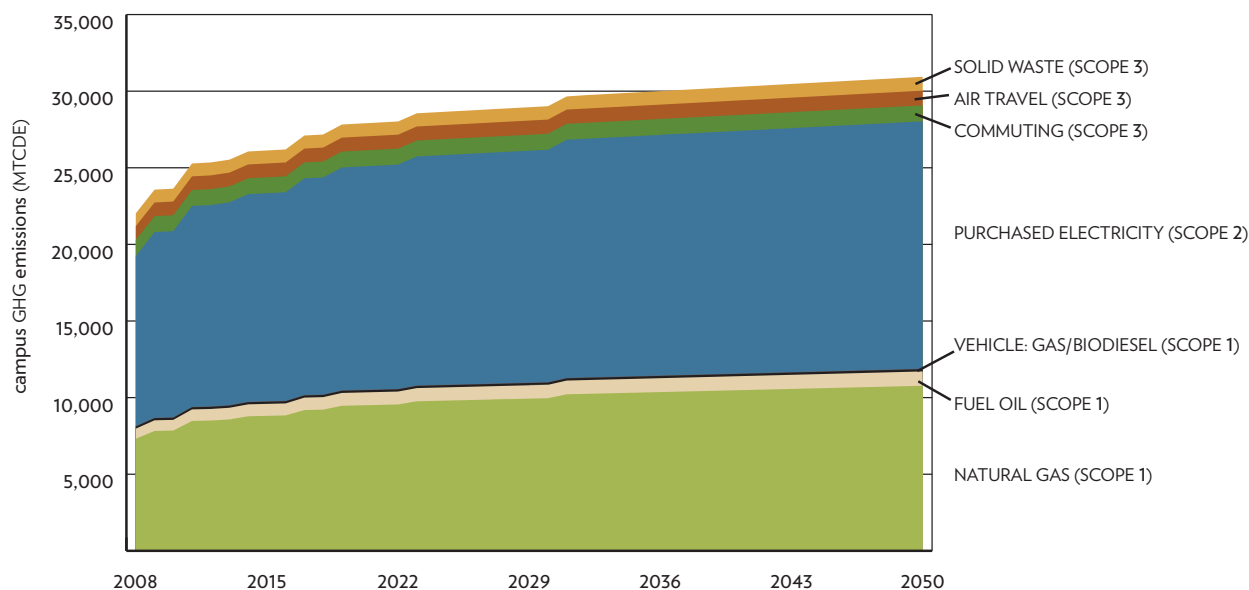


FIGURE V.2: EMISSIONS FORECAST

GHG emissions category	Primary forecast driver
Stationary combustion	Campus area (GSF) and primary energy use intensity
Purchased electricity	Campus area (GSF) and primary energy use intensity
Commuting	Campus population
Air travel	Campus population
Mobile combustion (fleet)	Campus area (GSF)
Mobile combustion (shuttle)	Campus population
Refrigerants and other chemicals	Campus area (GSF)
Solid waste	Campus population

FIGURE V.3: BUSINESS-AS-USUAL EMISSIONS GROWTH



Business Case for Carleton Climate Action Plan

The ACUPCC provides a framework and support for America's colleges and universities to be leaders by voluntarily reducing greenhouse gas emissions ahead of federal legislation. But reducing GHG emissions also makes sound business sense from a campus operations and risk management perspective. Many of the actions Carleton can take to reduce its carbon footprint also improve efficiency, reduce energy use, and save the College money in the operations and management of its central plant and energy supplies.

Energy Price Fluctuation

Carleton's annual budget for electricity and natural gas to provide heat, steam, and power to its 1.8 million sq. ft. campus can easily exceed \$1.5 million. In 2009 the total cost of natural gas delivered to Carleton was about \$870,000 and electricity purchases cost Carleton an additional \$842,000. While the current long-term outlook is for natural gas prices to remain stable at around \$5 to \$6 per MMBTU and then slowly rise by 0.2 percent per year through 2035², it is also true that since 2000 natural gas markets have been exposed to episodes of extreme price volatility due to factors such as weather, supply-demand balances, political events, and economic conditions. A 2007 Sebesta Blomberg report estimated that for every \$1 increase in the price of natural gas, Carleton's annual gas expenditures could increase by \$120,000. An increase of \$3 during Carleton's peak winter use (November–March) could add \$225,000 in costs for just those five months.³

Carleton also can expect upward pressure on the rates it pays for electricity service in the future. In its 2010 Integrated Resource Plan, Xcel projects that electricity rates of Xcel customers—including Carleton—could rise by an average of 5 percent per year through 2016.⁴ Based on 2009 electricity expenditures of \$842,000, a worst case scenario would see Carleton's electricity expenditures increase by 34 percent over the next six years and total \$1,123,610 by 2016.

In the face of price volatility and the likely future increase of energy costs, many actions and strategies the College adopts to reduce its carbon footprint also will provide energy savings that would reduce its exposure to energy price increases and volatility. The types of actions recommended in the Climate Action Plan would be prudent to undertake regardless of whether Carleton is a signatory to the ACUPCC.

Future Climate Legislation

The Climate Action Plan also can be regarded as an important risk management strategy in preparation for potential future climate legislation. If federal, regional, and/or state regulations are introduced to control GHG emissions through a market-based approach that puts a price on GHG emissions, such as a carbon tax or cap and trade program, Carleton would avoid resulting financial exposure by being proactive in taking concrete actions in the near term to reduce its GHG emissions.

There are two ways that greenhouse gas regulations could create a financial liability for Carleton. First, the College's central plant could qualify as a regulated source of GHG emissions, requiring Carleton to pay a fee for every metric ton of greenhouse gas generated (direct financial liability). A second and more likely type of financial exposure would be increased costs embedded in Carleton's supply chain as suppliers pass on costs incurred for their own GHG emissions (indirect financial liability). Depending on the future price that federal regulations impose on GHG emissions, the direct or indirect costs of compliance could be hundreds of thousands to millions of dollars per year.

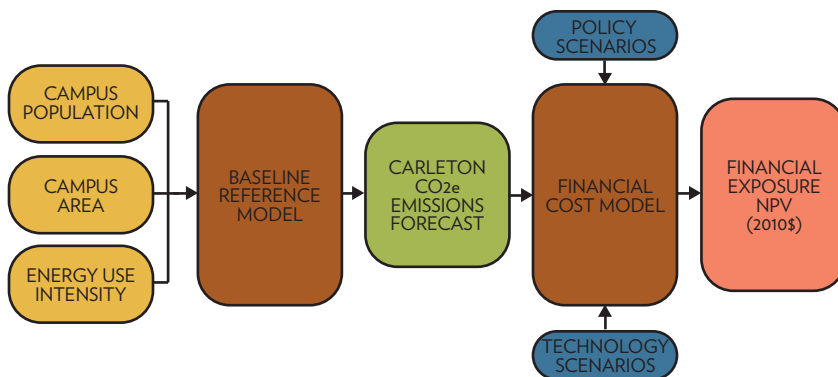
Financial Model

The Climate Action Plan consulting team developed a financial model that evaluates the net present value of potential costs Carleton could face under future climate change regulations. Based on Carleton's business-as-usual (BAU) greenhouse gas emission projection, the model estimates costs under three different potential forms of regulation and three technology assumptions, producing nine different carbon price forecasts. (See Figure V.5 on page 16.)

Figure V.4 illustrates how the elements of this model fit together. The model provides a flexible framework to:

- Forecast future campus GHG emissions under the BAU campus growth model.
- Identify which of those future GHG emissions might be subject to a compliance cost associated with putting a price on carbon.
- Assign a price to GHG emissions.
- Calculate the potential financial cost to Carleton of future GHG regulations.

FIGURE V.4: FINANCIAL MODEL SCHEMATIC



This model is not intended to represent a specific piece of legislation; rather it is intended to capture a range of financial exposure possible under a varied range of market-based legislative scenarios, technology assumptions, and associated GHG prices. Depending on the policy and technology assumptions selected, the model estimates the quantity of Carleton's GHG emissions that would be subject to a compliance cost and calculates the range of the College's financial exposure as the sum of the net present value (2010\$) of annual compliance costs through the planning period 2010 to 2050.

Model Results

Given the assumption that both building space and population on Carleton's campus will grow between 2009 to 2050, the base case model projects emissions of GHG to increase from 21,122 MTCO₂e in 2008 to 30,604 MTCO₂e by 2050. Carleton's net financial exposure over the period 2010–2050 is estimated to range from a low of \$5 million to a high of \$57 million (2010\$), based on the entire range of policy and technology assumptions. Figure V.5 identifies the potential financial exposure Carleton could face under a range of policy and technology assumptions embedded in the model.

Greenhouse gas emissions associated with Carleton's primary energy use (electricity and natural gas) poses the greatest financial risk to the College. Carleton's purchase of electricity accounts for 56 percent of the financial exposure while procurement of natural gas for the central plant makes up almost 40 percent of Carleton's estimated exposure to financial risk.

Notes

¹MTCO₂e stands for Metric Tons of Carbon Dioxide Equivalent and is the standard unit of measurement for greenhouse gas emissions accounting and carbon trading instruments.

²DOE-EIA 2010 Annual Energy Outlook

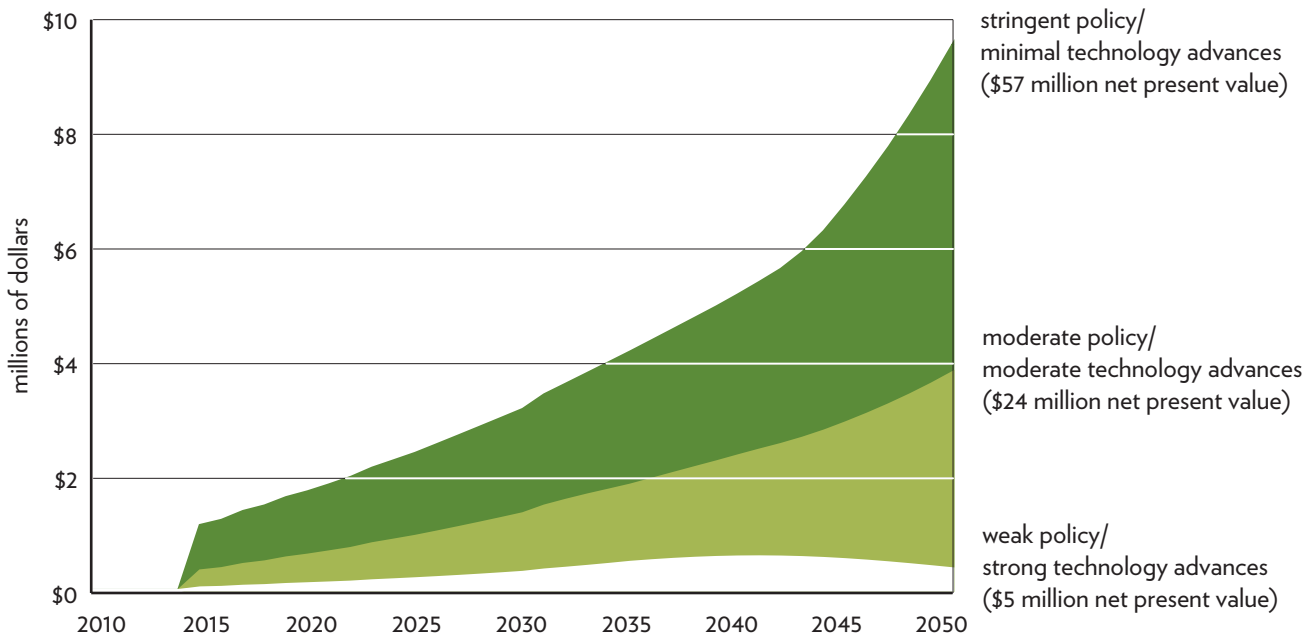
³Sebesta Blomberg, Energy Performance Assessment Report, March 6, 2007, pg. 12

⁴Xcel Energy, 2010 Resource Plan, pg. 1–8

FIGURE V.5 POTENTIAL TECHNOLOGICAL/LEGISLATIVE SCENARIOS

		LEGISLATIVE SCENARIO		
		WEAK	MODERATE	STRINGENT
TECHNOLOGY SCENARIO	STRONG ADVANCES	\$5 million	\$13 million	\$20 million
	MODERATE ADVANCES	\$9 million	\$24 million	\$42 million
	MINIMAL ADVANCES	\$12 million	\$35 million	\$57 million

FIGURE V.6: RANGE OF POTENTIAL FINANCIAL EXPOSURE DUE TO FUTURE GREENHOUSE GAS REGULATION



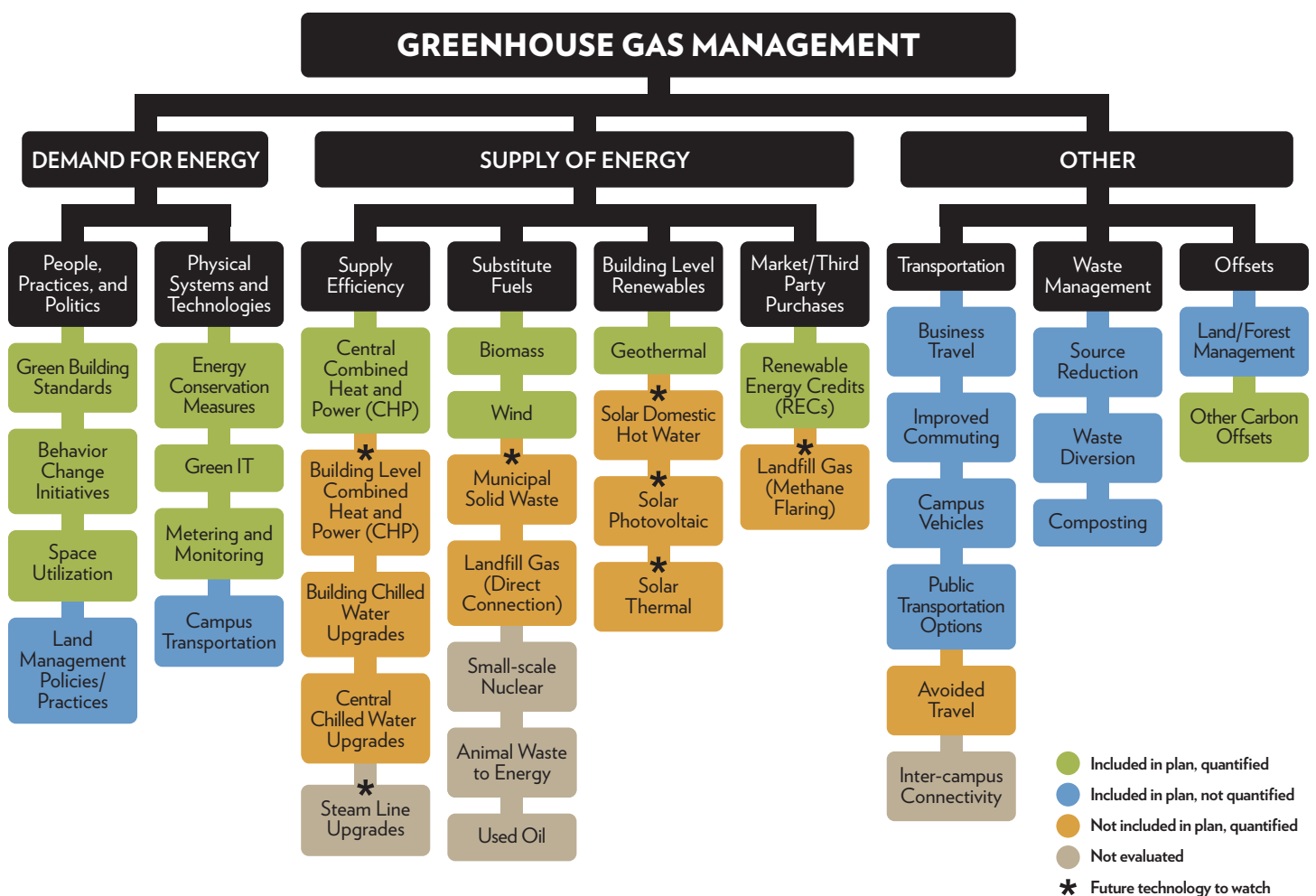
VI. Evaluation Process

Options Evaluated

The steering committee evaluated approximately two dozen GHG emissions mitigation options as shown in Figure VI.1. Those that appear in green represent options that were quantitatively evaluated for relative cost and carbon reduction impacts and included as recommended actions within the carbon reduction portfolio. Blue options are addressed in this plan but were not quantified as part of this study. Yellow options were quantified but determined to be infeasible or to have an unfavorable ratio of cost to carbon reduction potential. Gray options were not evaluated as part of this study.

Evaluation Criteria

FIGURE VI.1: OPTIONS EVALUATED



The steering committee began by identifying criteria to help guide the evaluation of various carbon mitigation strategies. Solutions were compared by quantitative metrics such as first cost, operating cost, net annual cost/savings per metric ton of carbon reduced, and decrease in campus energy in kBtu per square foot or kBtu per person. The committee also developed qualitative evaluation criteria to highlight solutions

that are creative, can become integrated within the campus identity, will foster student leadership development, can improve current asset utilization, and are “leading, not bleeding-edge” solutions. The committee also preferred options that provide renewable energy sources, create opportunities for local economic development, provide direct greenhouse gas reductions (in lieu of purchased RECs or offsets) and emphasize education/behavior change initiatives. The near-term (one to ten year) recommendations in this report were initially favored as a result of the quantitative comparisons, but each one also meets many of the qualitative criteria listed above.

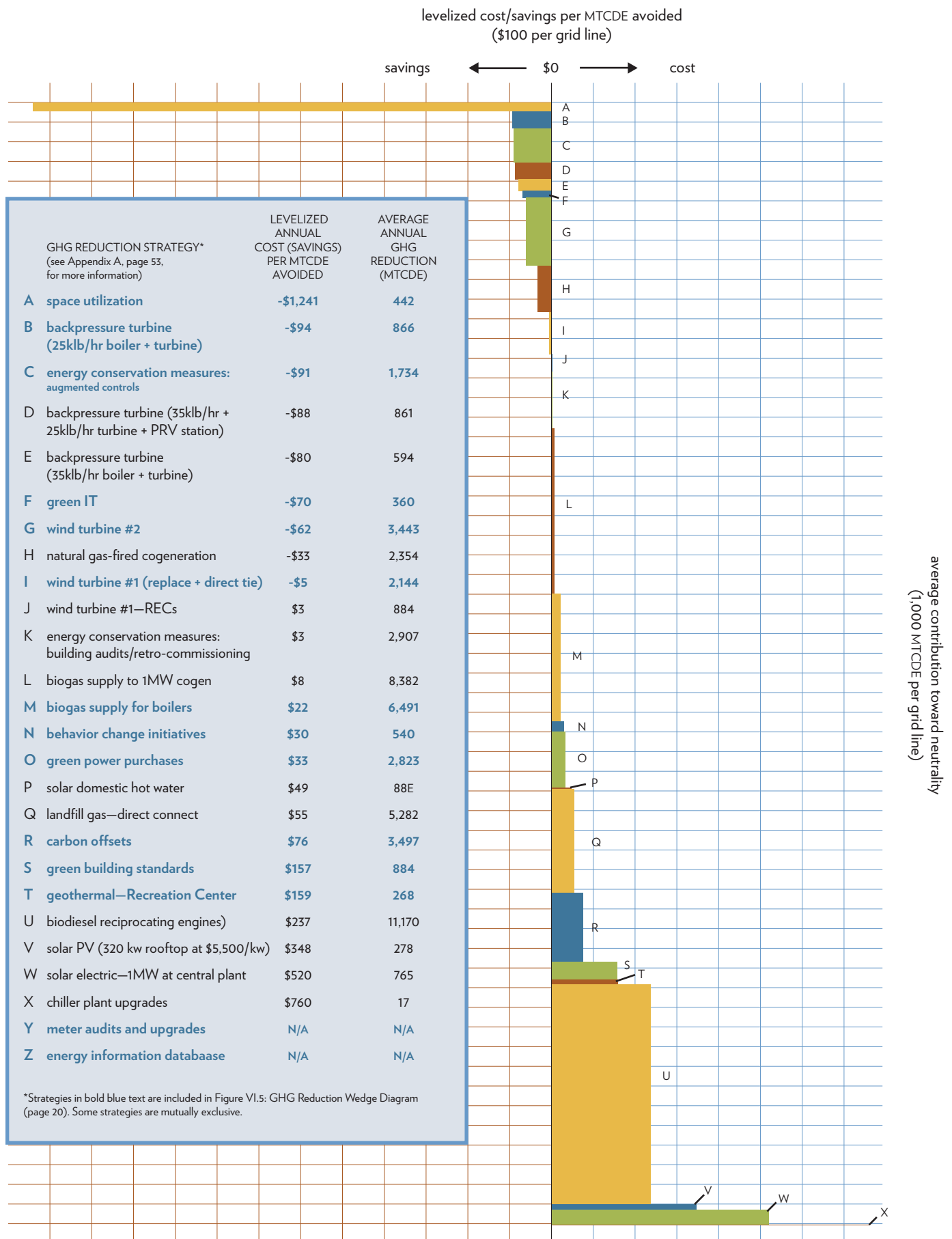
Quantitative Cost / Carbon Comparison

Carleton’s consulting team provided engineering calculations and financial analysis for each GHG mitigation strategy selected by the steering committee (shown in Figure VI.1). The results of this analysis are summarized in the form of a levelized cost chart (Figure V.2) that shows the total cost of each option (in 2010\$) per metric ton of carbon abated. Total cost includes both the first cost of implementation (or the incremental cost increase over an in-kind equipment replacement) plus annual operating expenses over the life of the option spanning from its projected start date through the year 2050. Strategies that fall to the left of the line are projected to generate net savings to Carleton over the Climate Action Plan timeframe (2010–2050) while those to the right of the line would incur a net cost. The vertical axis represents average annual metric tons of carbon avoided over the life of each option. Many options are scalable, but the steering committee and consulting team established practical parameters to support the calculations used in this analysis.

This visual graphic allowed the steering committee to quickly identify the options that were worth further exploration by focusing on those that are expected to result in net savings or low cost to the College over the life of the plan while providing significant annual GHG emission reductions. Primary conclusions drawn from the levelized cost chart include:

- Carleton’s second wind turbine and an aggressive energy conservation program are projected to have a significant impact on reducing GHG emissions while posing a net savings over the life of the plan. They should be prioritized within Carleton’s near-term portfolio of GHG reduction options.
- A backpressure turbine combined heat and power solution appears to be a relatively cost-effective replacement for Carleton’s oldest existing boiler (boiler #1).
- Carbon offsets and renewable energy credits (RECs) emerged as a very cost-effective way to achieve scalable—and potentially significant—net reductions to Carleton’s carbon footprint. Although the Committee does not view these purchased instruments as a long-term solution, they pose an interesting opportunity for Carleton to accelerate carbon reductions and partner with local sources to achieve interim milestones.
- Despite the popularity and high visibility of solar renewable energy projects, within Carleton’s campus environment these technologies currently represent a very high cost option for a relatively meager reduction to the College’s carbon footprint. They are flagged as a “technology to watch” for advancements over time but were not considered as a feasible short-term solution within this plan.
- Although a relatively high cost item today, biogas fuel supply for boilers has a significant potential to reduce Carleton’s annual GHG emissions and was flagged as a technology to watch for advancements and financial incentives that may make it more economical and practical to implement in the future.

FIGURE VI.2: LEVELIZED COST COMPARISON



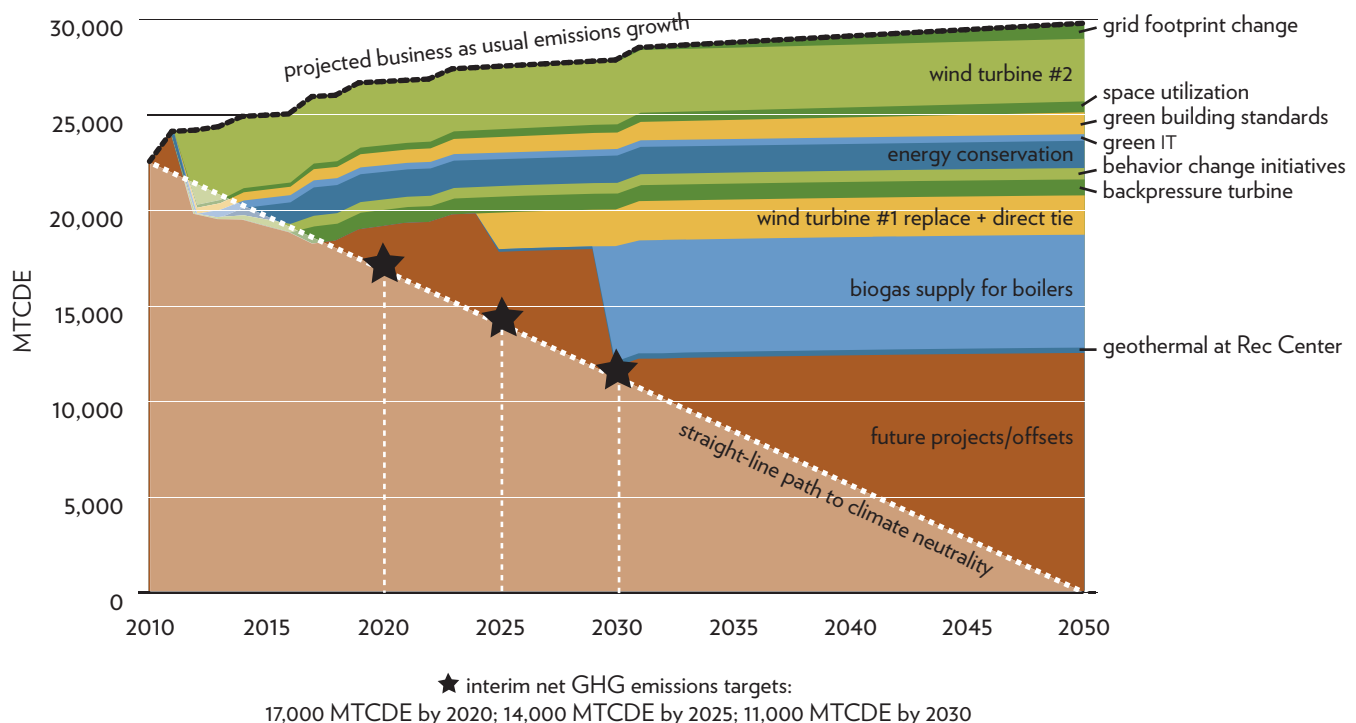
Carbon Reduction Wedge Diagram

The wedge diagram shown in Figure VI.3 is a common tool for representing GHG emissions reductions over time. While the leveled cost comparison (Figure VI.2) shows all of the options that the steering committee quantitatively evaluated, the wedge chart shows only those options that the committee is recommending for inclusion in Carleton's Climate Action Plan. The top line in the wedge diagram represents Carleton's calculated GHG emissions growth in a business-as-usual condition without any actions taken to reduce the College's carbon footprint. The lower boundary represents a straight-line path to climate neutrality by the year 2050. In between, a portfolio of recommended GHG reduction strategies are represented by colored wedges sized according to their relative impact on reducing Carleton's carbon emissions. Primary conclusions represented by the wedge diagram include:

- The steering committee identified three interim targets, which are based on a straight-line path to climate neutrality by 2050 and aligned with specific recommended actions. However, the brown section between the straight-line path to climate neutrality and the estimated potential of these options shows that additional projects, reduced campus growth, and/or purchased offsets will be needed to reach these goals.
- The diagram focuses on energy supply and demand strategies as the primary component of Carleton's GHG emissions reduction plan. These are the options that will yield the largest GHG reductions and have potential to provide notable returns on investment.
- Within the energy supply/demand category, the steering committee elected to include all options that are expected to result in net savings to Carleton over time. These are grouped as the first phase of recommended actions entitled "Common Sense Conservation" in Section VII (Energy Supply/Demand, page 22).
- The plan also anticipates implementation of a combined heat and power solution (a backpressure turbine) to replace the oldest of three existing boilers upon its retirement. This option is further outlined in Section VII (Repair and Replacement, page 29).

This practical scenario—implemented in a timeframe that aligns with Carleton's existing facilities planning framework—allows the College to remain on a straight-line path to net zero carbon emissions for the next decade without radical changes to campus infrastructure. This is the primary interim milestone within Carleton's Climate Action Plan.

FIGURE VI.3: CARBON REDUCTION WEDGE DIAGRAM



- The plan presumes Carleton will replace wind turbine #1 at the end of its useful life and build a direct transmission line connecting the replacement turbine directly to the campus electrical grid. This will significantly advance Carleton toward its second interim target.
- One of the most effective GHG reduction strategies evaluated is to provide biogas supply for Carleton’s boilers as a substitute fuel. This is the most aggressive recommendation in the plan, and it helps Carleton reach its third interim target in 2030.
- Although waste management, transportation, and procurement are also key elements of Carleton’s overall GHG emissions reduction plan, it was not possible to quantify these recommendations during the course of this study, so they are not represented as specific layers within the wedge diagram.

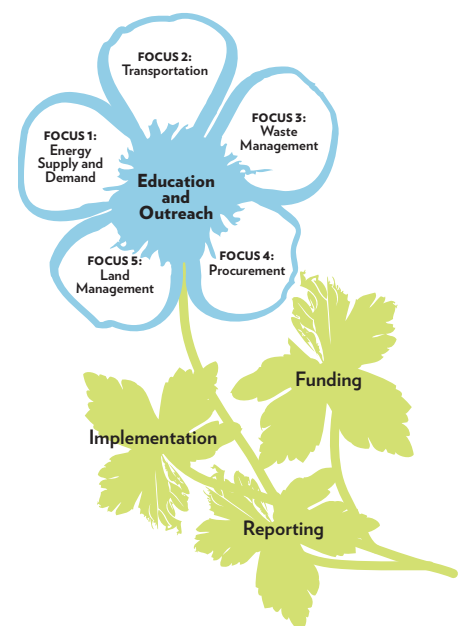
This practical scenario—implemented in a timeframe that aligns with Carleton’s existing facilities planning framework—allows the College to remain on a straight-line path to climate neutrality for the next decade. Solutions beyond 2020 include more capital-intensive, ambitious projects and technologies to watch such as solar power, geothermal energy, and renewable fuels. These solutions will be strongly influenced by technological, economic, political, and social developments over time. The ‘Future Projects/Offsets’ wedge represents yet-to-be-determined solutions which will be needed to meet our interim goals and to reach climate neutrality by 2050.

Purchased carbon offsets or renewable energy credits (RECs) are included in Carleton’s initial wedge diagram as infill to reach interim reduction targets and remain within the realm of possible carbon reduction strategies. They could be used either to accelerate Carleton’s carbon reduction efforts or to remain on a straight-line path to climate neutrality if options outlined in the diagram prove less effective than anticipated. Local opportunities to purchase RECs or carbon offsets from Midwestern tribes, farmer cooperatives, or nearby landfills could provide interesting opportunities for local partnerships and educational outreach activity at a reasonable and scalable cost.

Climate Action Plan Summary

Carleton’s Climate Action Plan expands the wedge diagram in Figure VI.3 into a more comprehensive set of recommendations that form an overall sustainability strategic plan. Section VII outlines a GHG reduction portfolio that defines five focus areas including the energy supply/demand GHG reduction strategies shown in Figure VI.3 plus recommendations to reduce greenhouse gas emissions from transportation, waste management, land management and procurement. Within each GHG reduction focus area, the steering committee developed a list of specific and tangible recommended actions. Section VIII describes education, research, and outreach opportunities that are woven throughout the plan, generated as a result of recommended GHG reduction activities and expected to influence best practices for Carleton’s future sustainability initiatives. These opportunities link the nuts and bolts of GHG reduction to Carleton’s core educational mission and values. The plan rests on a foundation of diverse funding strategies, clearly defined implementation efforts, and consistent reporting methods.

FIGURE VI.4: GREENHOUSE GAS REDUCTION AREAS

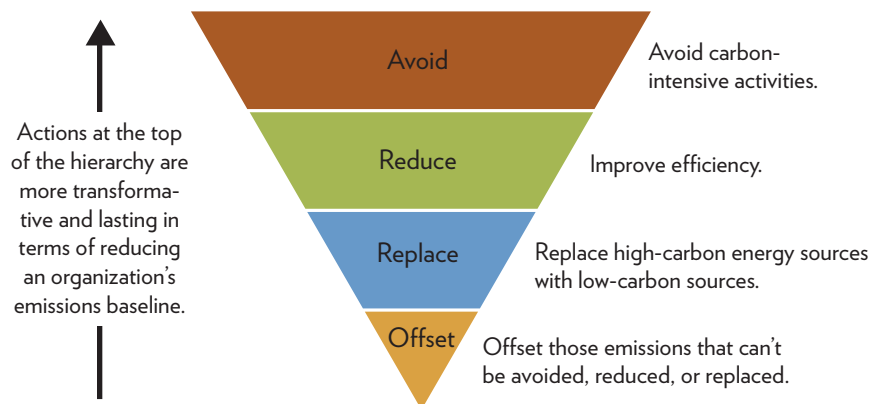


The flower used in Figure VI.4 is a *Geranium Maculatum*, which is a native plant commonly found in the Cowling Arboretum.

VII. GHG Reduction Portfolio

Each recommendation in the GHG reduction portfolio aligns with one or more levels of the ACUPCC GHG mitigation hierarchy illustrated in Figure VII.1 below. Avoiding carbon intensive activities is the most effective path to climate neutrality, followed by reducing emissions through thoughtful conservation techniques. Replacing high-carbon energy sources with low-carbon substitutes further minimizes emissions. Offsets are recognized by the ACUPCC as an acceptable way to address remaining emissions that cannot be eliminated through direct carbon reduction strategies.

FIGURE VII.1: ACUPCC CARBON MITIGATION HIERARCHY



Focus #1: Energy Supply/Demand

Energy supply and demand are the primary components of any carbon reduction plan. To facilitate a strategic and well-timed approach to energy solutions, Carleton should pursue options that include modifications that make sense within the College's current energy infrastructure system and align with planned repair/replacement expectations; Carleton also should remain aware of energy industry technological advancements that may make sense for the College in the future. The steering committee grouped energy supply and demand options into four implementation phases:

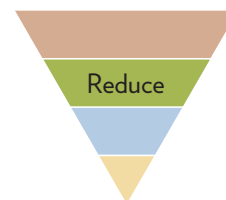
- **Phase 1:** common sense conservation (1–5 years)
- **Phase 2:** repair and replacement (5–15 years)
- **Phase 3:** technologies to watch (10+ years)
- **Phase 4:** offsets (1–40 years)

Phase 1: Common Sense Conservation (1–5 Years)

The first phase of energy supply and demand recommendations include actions that have little to no net cumulative cost over the course of the Climate Action Plan. By reducing existing carbon emissions through conservation practices and avoiding addition of future emissions, these options provide a prudent yet significant starting point for Carleton's overall GHG emissions mitigation plan.

ENERGY INFORMATION DATABASE

Reliable energy data collection is critical to understanding the true impact of any energy conservation project. Carleton currently has electrical sub-meters on each primary campus building, but the steam sub-meter installations are not yet complete. The steering committee recommends that one of the first Climate Action Plan initiatives be to confirm that all meters are fully functional, add steam sub-meters to primary campus buildings where needed, and develop a central energy information database where both central plant and individual building energy data can be compiled, sorted, displayed, and exported into specific data subsets. Ideally, the database would be



easily accessible via a Web interface, allowing Carleton faculty and staff members and students to view and export real-time energy data. Well-developed reporting capabilities would provide Carleton with valuable tools to support strategic planning efforts, raise energy use awareness on campus, illustrate results from on-campus behavior change initiatives, and participate in energy conservation competitions.

The initial cost of developing an energy information database could vary widely depending on whether an in-house solution can be built in partnership with Carleton’s Information Technology Services (ITS) department or if the data collection and reporting system will need to be outsourced to an external vendor. Either way, a functional energy information database is an essential prerequisite to other recommended actions within this portfolio.

FIGURE VII.2: ENERGY INFORMATION DATABASE	
Capital cost ¹	\$50,000 implemented over two years to expand existing software or implement a new database software solution \$60,000 implemented over three years to repair and expand sub-metering system
Annual operating cost ¹	\$10,000 per year in IT maintenance, data hosting, and software licensing
Start date	2011
Useful life	Life of plan
Source	Carleton

SPACE UTILIZATION

The goal of this strategy is to build 10 percent less new square footage than what is projected in the business-as-usual model (see Chapter V: Base Case Scenario). Reducing campus square footage produces a resulting decrease in energy use intensity (EUI) measured in kBtu per square foot. This strategy requires thoughtful awareness of whether new space is truly necessary at the time of each new construction request and a thorough evaluation of whether current available space can be repurposed, retrofitted, or replaced to achieve the desired function in lieu of building new space. It is also important to evaluate during building design phases how much new square footage is directly serving the intended functions vs. circulation space or architectural features. Improved space utilization also can be achieved by choosing not to replace buildings that are demolished or by replacing them with buildings of a smaller square footage and/or lower EUI.

Successful implementation of space utilization guidelines depends on effective measurement and tracking methods. Carleton’s ITS department currently is working on ways to evaluate and report on campus space utilization metrics by using existing scheduling and building information data pulled from Carleton’s internal data warehouse. The College should be able to use this data to continually monitor space usage and develop policies and metrics to help guide facilities planning efforts for the long term.

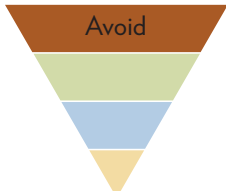


FIGURE VII.3: SPACE UTILIZATION

Capital cost¹	\$0
Annual operating savings¹	\$6 per GSF avoided, average \$3,000 per year (assumes 10 percent reduction in projected growth)
Change in demand	530 MWh saved over life of plan 4,700 MMBTU saved over life of plan
Annual GHG emission reductions by 2050	Scope 1 emissions: 270 MTCDE Scope 2 emissions: 300 MTCDE
Annual energy savings	\$47,000 per year average over the life of the plan
Start date	2011
Useful life	Life of plan
Source	AEI/Carleton

GREEN BUILDING STANDARDS

To make a more substantial impact on the energy consumption of buildings, the steering committee recommends including an additional energy efficiency standard to supplement the existing LEED silver designation. This could be done by simply increasing the minimum number of points achieved for LEED energy conservation credit (EAc.1) or by setting an overall minimum building EUI requirement. Energy guidelines would be based on benchmarks from other similar institutions and would vary by building type. The committee also recommends the LEED existing buildings rating system be evaluated as a potential guideline for renovations on the Carleton campus that don't fall under the LEED new construction guidelines. Furthermore, each new building or major renovation project should include installation of steam and electrical energy sub-meters as a standard practice. This will assure that continued energy savings and building performance can be monitored and evaluated over time.

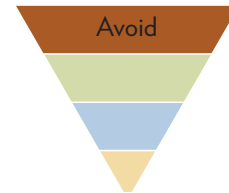
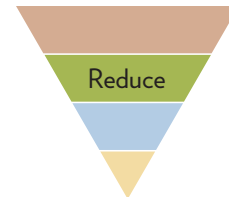


FIGURE VII.4: GREEN BUILDING STANDARDS

Capital cost¹	\$15 per GSF incremental building cost (5 percent of assumed \$300 per GSF construction cost)
Change in demand	Assumed 20 percent better than current energy use intensity (EUI) for both electricity and natural gas
Annual GHG emission reductions by 2050	Scope 1 emissions: 530 MTCDE Scope 2 emissions: 610 MTCDE
Annual energy savings¹	\$93,000 per year average over the life of the plan
Start date	2012
Useful life	Life of plan (business-as-usual growth assumptions)
Source	AEI/Carleton

BUILDING ENERGY CONSERVATION MEASURES (ECM)

The first logical step in addressing campus energy supply and demand is to confirm that existing building envelopes and systems are operating at peak performance for their current class and vintage. A comprehensive energy conservation program would begin with energy audits of all primary buildings to assess campus-wide energy conservation opportunities, followed by the creation of implementation plans tailored to each building. This is the most significant component of Carleton's recommended short-term (1–5 year) Climate Action Plan initiatives. Specific information on energy conservation measure is provided in Appendix B (page 55).



Building energy audits could begin as soon as FY 2012 and are eligible for external incentives and funding sources, including most notably the Xcel Energy Joint Energy Efficiency Program. Implementation of energy conservation measures would begin with buildings that are older or are identified as particularly high energy consumers. Energy Star's portfolio manager tool will be considered as a means to benchmark building energy use and energy conservation programs.

In order to most effectively and efficiently evaluate the specific energy needs of different types of buildings, the energy audit program is divided into two separate categories: individual residential and administrative houses (i.e. Hill House, Strong House, etc) and primary academic/administrative and residential campus buildings which are served by the main campus utility system (i.e. Leighton Hall, Hulings Hall, Musser Hall, etc.).

- **Category #1—Individual Houses:** The individual houses encompass approximately 12 percent of total campus gross square footage. Energy audits for these buildings would follow the format commonly used in standard residential audit programs and could provide accessible opportunities for sustainability assistants and other interested students to participate in the audit program as a hands-on learning experience. Once the energy audits have been performed, a plan will be developed to complete energy efficiency improvements, incorporating student involvement wherever possible. Potential external resources and partnerships that Carleton will explore include collaboration with Xcel Energy, St. Paul-based Cooperative Energy Futures, and Northfield's Home Matters program.
- **Category #2—Primary Campus Buildings:** Most of Carleton's energy demand is consumed by larger campus buildings. These buildings and their mechanical/electrical systems are more complex than the individual houses and therefore will require engineering expertise. For these buildings, the steering committee proposes contracting a professional engineering firm with proven experience in assisting higher education institutions to conduct comprehensive building energy audits leading to prioritized recommendations for energy conservation upgrades. Category #2 audits could be performed in groups by building type (i.e. residences, science buildings, standard administrative/classroom buildings, etc.) and spread over a period of five or more years. Evaluations would be based on a standard ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) Level 2 audit, which exceeds a Level 1 visual inspection but is less expensive than a Level 3 survey, which includes in-depth computer simulation and more complex analyses of building systems.

Based on these audits, an energy conservation action plan would be tailored to each building with actions phased according to prioritized needs and available funds. Ideally, each building would designate an energy conservation task force leader who would work with the facilities office to develop a comprehensive plan for energy conservation upgrades and ongoing building management. The implementation phase is likely to include retro-commissioning of primary building systems which would help to calibrate, update, and optimize individual system components. Buildings that require major mechanical or electrical renovations would qualify as building renovations and fall under the green building standards outlined above.

To estimate potential energy savings from building energy conservation measures, the Climate Action Plan model focused on primary campus buildings, using baseline energy assumptions from the Department of Energy’s Commercial Building Energy Consumption Survey (CBECS). Since Carleton’s building-specific energy data is incomplete, CBECS was used as a baseline and calibrated to total campus EUI. The costs and energy savings from retro-commissioning, building system upgrades, and lighting upgrades were estimated through data that Affiliated Engineering, Inc. (AEI) compiled from previous higher education projects. These estimates should be evaluated more thoroughly as the audits are implemented to accurately examine building-specific costs and savings. (See Appendix B on page 55 for further details about energy conservation measures.)

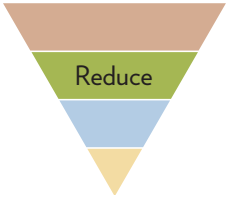
FIGURE VII.5: BUILDING ENERGY CONSERVATION MEASURES (ECM)

Capital cost¹	ECM program could include a combination of: • Energy audits: \$775,000 over five years to audit 85 percent of all campus buildings • Augmented HVAC/lighting controls: \$960,000 over five years to address 50–65 percent of all campus buildings • Retro-commissioning + augmented HVAC/lighting controls: up to \$7 million over five years to address 85 percent of all campus buildings (some of this cost could be incorporated into planned building renovation projects)
Change in demand	Electricity reduction: 1,500–2,530 MWh per year (upon project completion) Natural gas reduction: 11,500–26,700 MMbtu per year (upon project completion)
Annual GHG emission reductions	Scope 1 emissions: 671–1,517 MTCDE Scope 2 emissions: 1,099–1,446 MTCDE
Annual energy savings¹	\$164,000–\$323,000, depending on level of implementation
Start date	2012
Useful life	Life of plan
Source	AEI

GREEN INFORMATION TECHNOLOGY

Information technology (IT) will play an ever-increasing role in campus energy usage. A review of IT policies and operation modes is fundamental to Carleton’s energy conservation measures to assure this area of significant energy demand is operating as efficiently as possible. For the purposes of the Climate Action Plan model, the “Green IT” wedge in the carbon abatement portfolio used Energy Star calculations to project carbon reduction assuming that 75 percent of Carleton-owned computers go into sleep mode after 10–15 minutes of inactivity and are turned off overnight. Ideally, this energy-saving feature would be controlled from a centralized location and would apply to all Carleton-owned and controlled computers on our network (estimated to be 1,000 desktops and 500 laptop notebooks). The steering committee recommends that a more detailed sustainability plan be developed with ITS to explore the feasibility of energy conservation strategies, such as:

- More aggressive use of power management software
- Nightly printer power-down



- Evaluation of evolving data center best practices that accommodate higher room temperatures, thereby decreasing year-round air conditioning demand
- Utilizing data center waste heat as an energy input elsewhere
- Audit and/or funding through Xcel Energy Data Center Efficiency Program
- Nightly energy saving modes for voice over IP communications systems

FIGURE VII.6: GREEN INFORMATION TECHNOLOGY

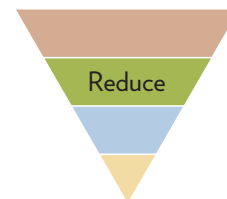
Capital cost¹	unknown software purchase/programming fees
Annual operating cost¹	\$15,000 per year: \$10 per computer for licensing for power management software for 1,500 College-owned computers
Change in demand	Electricity reduction: 600,000 kWh per year
Annual GHG emission reductions by 2050	Scope 2 emissions: 343 MTCDE
Annual energy savings¹	\$37,000 per year average over the life of the plan
Start date	2012
Useful life	Life of plan
Source	AEI/EPA Energy Star computer management calculator

BEHAVIOR CHANGE INITIATIVES

What if everyone took shorter showers and remembered to turn off electronics and lights that are not in use? What would happen if every college student gave up his or her mini fridge? If 500 students unplugged their mini fridges (which generally use approximately 400 kWh per year) Carleton would save more than 200,000 kWh per year of electricity—approximately 1.3 percent of total campus electricity usage.

The Climate Action Plan model assumes that activities like these along with other campus education and awareness campaigns would permanently reduce electricity usage by approximately five percent. Campus events and competitions will help raise awareness by outlining defined periods of activity when specific actions can be measured and successes communicated in a way that fosters sustained behavior changes. Furthermore, an annual survey could be used to gauge the awareness and self-reported actions of the Carleton community. Regularly scheduled surveys would provide another means to analyze the effectiveness of behavior change initiatives.

The Climate Action Plan model includes the cost of creating a staff position—potentially a fifth-year Carleton intern—dedicated to developing and running a coordinated, comprehensive sustainability outreach program. Responsibilities of this position would include planning and leading behavior change initiatives, campus sustainability events, New Student Week activities, and environmental awareness campaigns; participating in national energy and waste reduction competitions; conducting annual greenhouse gas inventories; and coordinating external sustainability reporting efforts. The steering committee also suggests that Carleton develop a consolidated, well-recognized branding program to unite all sustainability outreach activities under a single banner and increase the visibility of these programs.



students participating in the “Dorm Wars” energy conservation competition

FIGURE VII.7: BEHAVIOR CHANGE INITIATIVES

Annual operating cost¹	\$55,000 for staff position (less if fifth-year intern) \$20,000 for program budget
Change in demand	Electricity reduction: 877,000 kWh per year upon achievement of goal (1 percent reduction in electricity per year, increasing over 5 years, to hold constant at 5 percent)
Annual GHG emission reductions by 2050	Scope 2 emissions: 595 MTCDE
Annual energy savings¹	\$53,000 per year upon achievement of five percent reduction target
Start date	2012
Useful life	Life of plan
Source	AEI/Carleton

WIND TURBINE #2

The second wind turbine will be a 1.6 MW–2.0 MW capacity model that will connect directly to Carleton’s electrical grid. It is expected to serve 30 to 35 percent of the annual campus electrical demand, resulting in significant annual energy cost savings. Thanks to a generous donation covering 100 percent of the initial cost of the turbine’s purchase and installation, the levelized cost comparison shows that this GHG mitigation strategy results in a net savings to the College. This project is one of Carleton’s most visible and notable impacts on reducing our carbon footprint and will hopefully serve as a catalyst for future renewable energy initiatives. The Climate Action Plan cost model assumes in-kind replacement of the second wind turbine at the end of its useful life, allowing this carbon reduction strategy to continue throughout the life of the plan.

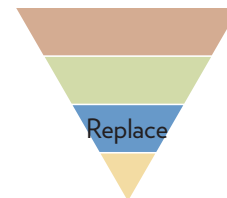


FIGURE VII.8: WIND TURBINE #2

Capital cost¹	• \$0 initial installation (provided by gift) • \$2.9 million for in-kind replacement after 20–30 years
Annual operating cost¹	\$109,000, increasing annually per changes in the consumer price index
Change in demand	Electricity production: 4,200,000 kWh
Annual GHG emission reductions by 2050	Scope 2 emissions: 3,378 MTCDE
Annual energy savings¹	\$247,000
Start date	2011
Useful life	20–30 years
Source	AEI/Carleton



proposed location for wind turbine #2, just east of campus

Phase 2: Repair and Replacement (5–15 Years)

The second phase of energy supply and demand recommendations focuses on opportunities to incorporate more energy efficient technologies into planned repair and replacement events. These recommendations are tailored specifically to meet the anticipated needs of Carleton’s central plant.

BACKPRESSURE STEAM TURBINE

Boiler #1 was installed in 1954 and is the oldest of Carleton’s three boilers. Excellent maintenance practices have allowed this boiler to operate well beyond its theoretical useful life, but it is likely to be the next piece of major equipment due for replacement within the next five to ten years. The Climate Action Plan consulting team evaluated multiple options for replacing boiler #1 and presented them for discussion with Carleton facilities staff. The group concluded that a combined heat and power (CHP) co-generation solution is preferred, specifically one that incorporates a backpressure turbine to generate electricity as a by-product of steam production. The current 35,000 pph boiler delivers steam to the central distribution system at 100 psi. The Climate Action Plan model assumes it would be replaced with a 600 psi high-pressure boiler that would generate 400 kw of electricity via the pressure drop from 600 to 100 psi. Not only did this solution appear to offer the best return on investment, but it also maintains future flexibility to substitute renewable fuels for natural gas should Carleton decide to incorporate this into its carbon reduction portfolio as described in Phase 3 (technologies to watch). A more detailed discussion of the boiler #1 replacement evaluation can be found in Appendix C (page 58).

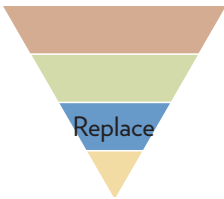


FIGURE VII.9: CHP BOILER WITH BACKPRESSURE STEAM TURBINE

Capital cost ¹	\$500,000 for initial cost of backpressure steam turbine \$100,000 increased incremental cost for 600 psi boiler
Change in demand	Increased gas consumption: 30,100 therms per year (600 psi boiler is about 3 percent less efficient than 150 psi boiler) Electricity production: 1,760,000 kWh
Annual GHG emission reudctions by 2050	Scope 1 emissions: -170 MTCDE Scope 2 emissions: 1,000 MTCDE
Annual energy savings ¹	\$88,000
Start date	2016
Useful life	35 years
Source	AEI



boiler #1

WIND TURBINE #1 REPLACEMENT AND DIRECT TIE

Carleton’s first turbine was installed prior to campus-wide utility upgrades and was therefore not compatible with the voltage of our campus electricity grid at that time. Although the current power purchase agreement was typical for its time, it does not provide any renewable energy credits to Carleton. Xcel pays Carleton for electricity produced by the turbine, but they also keep the associated RECs. Carleton’s power purchase agreement with Xcel is in place for the 20-year design life of the wind turbine, which means that it will expire in 2024. The Climate Action Plan model assumes full replacement of this turbine at the end of its useful life with the addition of a direct connection to Carleton’s electrical grid. Because the new turbine (wind turbine #2) also will be providing direct wind electricity, Carleton should be able to use 60 percent of the annual energy production of the new wind turbine #1 directly. The remaining 40 percent would be sold to Xcel, presuming power purchase arrangement contracts with public utilities are still standard practice for renewable energy sources in 2024. Excess energy could potentially be stored and used later should battery technology advance to a point in which it is both economical and space-efficient by that time.

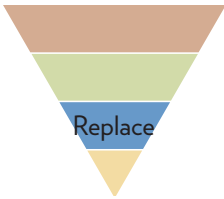


FIGURE VII.10: WIND TURBINE #1 REPLACEMENT AND DIRECT TIE

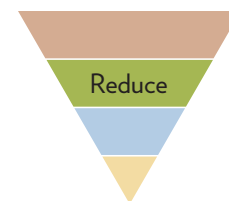
Capital cost¹	\$2.9 million to decommission existing turbine and replace in-kind \$500,000 for new transmission line to Carleton grid (if replaced in current location)
Annual operating cost/savings¹	• \$110,000 in operating costs • \$56,000 annual income from Xcel at \$33 per MWh for 32 percent excess electricity production sent to public grid
Change in demand	Electricity production: 3,600,000 kWh <i>Assume Carleton would use 68% of annual production</i>
Annual GHG emission reductions by 2050	Scope 2 emissions: 2,144 MTCDE
Annual energy savings¹	\$220,000
Start date	2024
Useful life	20–30 years
Source	Energy Strategies/Carleton



wind turbine #1

STEAM DISTRIBUTION SYSTEM UPGRADES

Prior studies have suggested that Carleton examine its central steam distribution system to reduce demand on the system by operating farther-reaching buildings independently (i.e. Recreation Center, Goodhue Hall) and/or reducing system steam pressure to reduce overall losses. These solutions have not yet been widely endorsed by Carleton's operations staff but warrant further examination. If future renewable energy solutions such as ground source heating and cooling allow buildings at the outer reaches of Carleton's steam distribution system to operate independently, there would be some consequential benefit to the efficiency of the central steam distribution system as a whole. This option was not explored in great detail as part of the current Climate Action Plan evaluation efforts but presents an opportunity for further study. Other more common energy efficiency measures such as steam trap audits and replacements involve far less capital cost and can be implemented in the near term.



Phase 3: Technologies to Watch (10+ Years)

Over time, technologies that currently are not suitable to Carleton's financial and operational environment may become more feasible due to changes in energy rates, GHG emissions regulations, available incentive programs, and/or technological advancements. These changes could result in shorter paybacks and greater incentive for Carleton to consider incorporating them into its GHG reduction portfolio. The Climate Action Plan model includes the following GHG reduction strategies as potential considerations in the 10 to 20 year timeframe:

BIOFUELS

Various conventional fossil fuels can be substituted with renewable sources of bio-based energy. Figure VII.11 shows the various sources of substitute fuels and the conventional fuel sources they replace. It is important to understand that there is not a one-size-fits-all renewable fuel that can serve all fuel needs.

Currently, barriers to implementing large-scale adoption of biofuels tend to be initial cost, fuel reactor space and site requirements, resource availability, material storage, and material handling requirements. Furthermore, not all biofuels have the same energy content as their conventional counterparts, so a much larger material mass is required

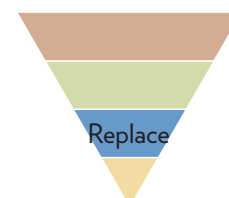
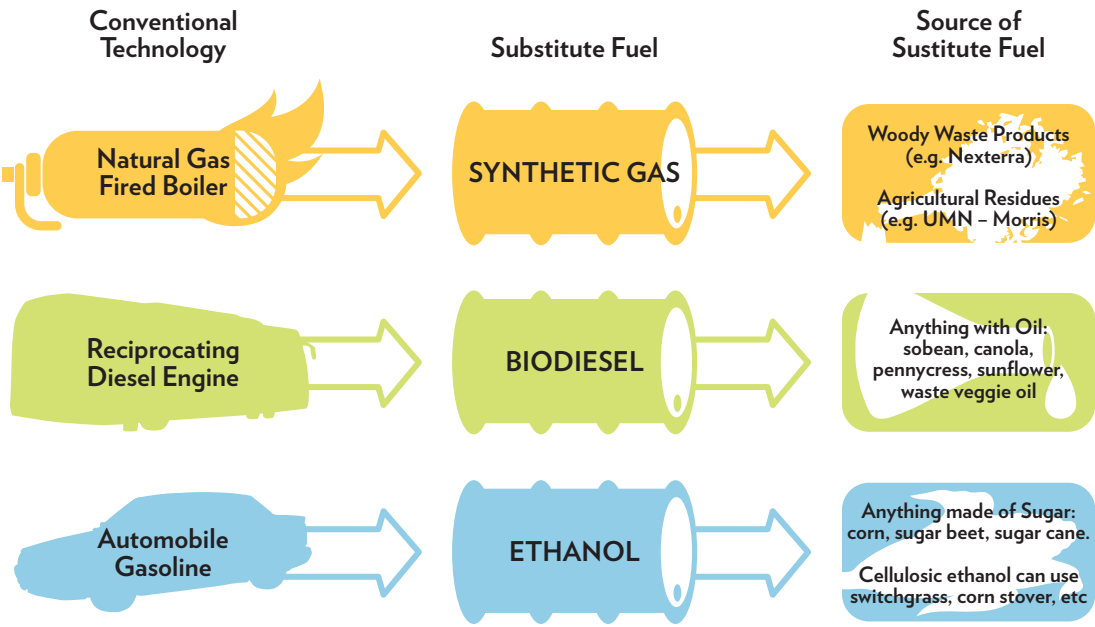


FIGURE V.11: SUBSTITUTE FUELS



to produce equivalent amounts of energy. Renewable fuels also must be evaluated based on their total net environmental impact. In the case of fuels such as corn-based ethanol, the benefits of using a renewable fuel are greatly discounted by the negative environmental impacts of growing, transporting, and processing corn as fuel, in addition to the potential tension implicit in using a food source as fuel.

Renewable fuels are an area of dynamically evolving research and development, and revolutionary technological advancements may soon be on the horizon. Researchers are studying the fuel potential of common, indigenous plant materials such as switchgrass and pennycress that are native to the Midwest and easy to grow with limited use of fertilizers and pesticides. These types of materials may eventually present an exciting opportunity for Carleton to partner with local farmers to produce renewable fuels for use in College boilers, generators, or campus vehicles. The Climate Action Plan model includes a potential option to use biogas derived from waste wood as a fuel for the boilers. A detailed description of current substitute fuel technologies is contained in Appendix D.

FIGURE VII.11: BIOGAS SUPPLY FOR BOILERS

Capital cost ¹	\$7.5 million for biomass gasification system
Annual operating cost ¹	\$105,000
Change in demand	Natural gas avoided: 108,600 MMBtu
Annual GHG emission reductions by 2050	Scope 1 emissions: 6,200 MTCDE
Biomass supply	8,400 tons of green wood per year
Annual energy savings ¹	\$684,000
Start date	2030
Useful life	30 years
Source	Energy Strategies/Carleton

GROUND SOURCE HEATING/COOLING (GEOTHERMAL ENERGY)

Ground-source heating and cooling utilizes the earth’s near-constant temperatures to match the heating and cooling load of buildings. However, despite reducing natural gas consumption, geothermal heat pumps increase electricity demand. Wentz Engineering, Inc. conducted a 2009 study to determine the simple payback period associated with implementing ground source heating/cooling at the Gould Library, the Recreation Center, and the Center for Mathematics and Computing. These sites were selected due to their adjacency to available open land for installation of geothermal wells and their relatively balanced heating and cooling loads compared to other buildings on campus.

On-site conductivity measurements revealed that Carleton’s soil conditions have particularly high subsurface conductivity, which makes this area well suited to geothermal options. In lieu of on-site conductivity measurements, the Wentz study utilized more conservative conductivity values in its calculations, which were based on empirical data for similar geological conditions. As a result, the costs and payback durations estimated in the 2009 study were not particularly favorable. However, the Climate Action Plan consulting team recommends recalculating these studies based on actual measured conductivity and the current, decreasing cost of geothermal wells. Payback calculations are likely to be more favorable, making this option more attractive. In particular, if a geothermal heating and cooling system proves to be feasible for the Recreation Center, the building could be removed from the central steam distribution system, potentially increasing the system’s overall efficiency.

Calculations in the Climate Action Plan model utilize life cycle analysis costs for geothermal energy in the Recreation Center based on the 2009 Wentz study. These costs include not only the addition of sufficient geothermal wells to serve the heating and/or cooling demands but also the cost of building distribution line upgrades that would be required to circulate hot or chilled water through retrofitted buildings.

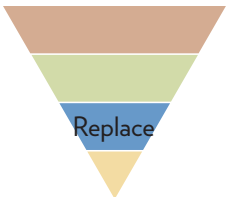


FIGURE VII.12: GROUND SOURCE HEATING/COOLING—RECREATION CENTER

Capital cost¹	\$865,000 for purchase and installation \$260,000 for heat pump replacements in years 15 and 30
Annual operating cost (until 2050)	\$9,000
Change in demand	Natural gas avoided: 79,000 therms Electricity produced: 344,000 kWh
Annual GHG emission reductions by 2050	Scope 1 emissions: -400 MTCDE Scope 2 emissions: 200 MTCDE
Annual energy savings¹	\$29,000
Start date	2030
Useful life	Wells: 50 or more years; heat pumps: 15 years
Source	Wentz/AEI



Recreation Center

SOLAR PHOTOVOLTAIC (PV) AND SOLAR DOMESTIC HOT WATER

The Climate Action Plan engineering team (AEI) used a prior solar thermal study by Wentz Engineering, Inc. to evaluate solar preheated domestic hot water and swimming pool water; they also used new analyses by the Climate Action Plan consulting team of solar photovoltaic (PV) to produce grid-connected electricity. Figure VII.13 shows buildings in orange that were modeled to produce electricity from rooftop PV panels and buildings in green that were modeled to pre-heat domestic hot water.

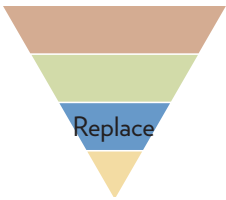
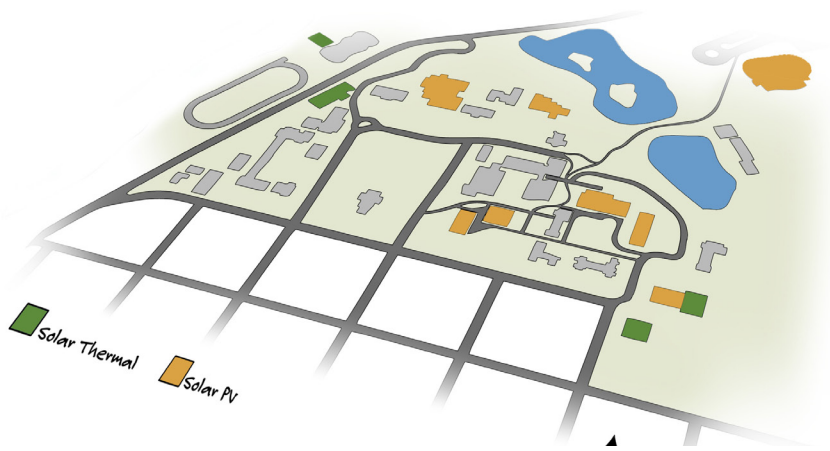


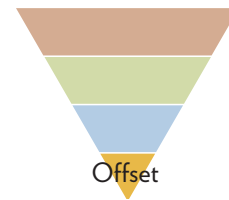
FIGURE VII.13 ROOFTOP SOLAR STUDY AREA



Solar PV systems were modeled to cover eight campus buildings with a total of 320 kW of capacity. Although this technology currently does not show a substantial enough GHG reduction potential to justify its high cost, solar technology is rapidly advancing. Production efficiency rates are expected to increase, and costs are expected to become more economical over time. Therefore, the current Climate Action Plan does not include a specific solar solution as a recommended action but lists solar power as a technology to watch. If opportunities arise to incorporate solar energy into new construction, they will be considered within the context of Carleton's green building standards.

Phase 4: Renewable Energy Credits (RECs) and Carbon Offsets (1–40 Years)

The ACUPCC acknowledges that it will be very difficult for institutions to achieve climate neutrality without offsets and other environmental financial instruments, acknowledging that “. . . the short-term use of high quality offsets can be an effective way to drive real reductions in GHG emissions now and can serve as a useful tool for internalizing the costs of GHG emissions and accelerating innovation on campuses to reduce GHG emissions more quickly. As such, the ACUPCC supports investment in offsets as an effective way to help create a GHG-free future.”² The ACUPCC recommends that institutions acquire offsets only when direct reduction activities already have been initiated.



Carbon offsets and renewable energy credits (RECs) are environmental financial instruments that allow companies and institutions to reduce their greenhouse gas (GHG) emissions liability by purchasing the emission reductions made by another entity. There is a distinct difference between the two:

- Carbon offsets represent a real reduction, sequestration, destruction, or avoidance of greenhouse gas (GHG) emissions that can be measured and quantified, and they originate from projects or activities outside the boundary of a regulatory program or an entity's own carbon footprint.³ Each carbon offset purchased represents the equivalent of one ton of carbon dioxide (CO₂e) emissions avoided and can be used to reduce Scope 1 and Scope 3 GHG emissions.
- Renewable energy credits (RECs) are measured in terms of electricity production; each REC represents one MWh of electricity produced from renewable energy resources. RECs can be purchased from certified producers of renewable electricity including independent providers and public utilities such as Xcel Energy. RECs can only be used to reduce Scope 2 GHG emissions.

RECs and carbon offsets are currently available at very inexpensive rates. Local sources of RECs could present partnership opportunities with Midwest tribes and farmer cooperatives that currently are producing electricity from renewable sources and selling

the RECs to other entities. At \$0.75 per MWh, Carleton could completely displace its current Scope 2 emissions from purchased electricity for approximately \$12,000 per year. Carleton could purchase carbon offsets from recognized organizations such as the Nature Conservancy, or the College could develop community programs such as a partnership with the Rice County landfill to instigate a methane flaring project.⁴ In 2009 U.S.-based carbon offsets sold for an average price of \$5.30 per MTCO₂e⁵; based on this pricing, Carleton could offset its Scope 1 and Scope 3 emissions (per the 2008 inventory) for approximately \$53,000 per year. Although this is a relatively inexpensive way to become climate neutral right away, the volatility of this market does not make it a viable long-term solution—if carbon regulation legislation is enacted, the price of offsetting Carleton’s GHG emissions could increase exponentially.

Although carbon offsets are a relatively inexpensive way to become climate neutral right away, the volatility of this market does not make it a viable long-term solution.

RECOMMENDED ACTIONS: FOCUS #1—ENERGY SUPPLY/DEMAND

1. Develop a consolidated energy information database to include—at minimum—central plant and per-building steam production, steam use, and electrical demand data. Format the database such that faculty and staff members and students have Web or network access to view and export data subsets.
2. Utilize the energy information database to develop a regular reporting system to keep the campus community apprised of energy usage per building and the progress of energy conservation/reduction measures.
3. Develop space utilization guidelines to define a comprehensive needs assessment process prior to implementing plans for new square footage, including a set of recommended square footage guidelines for new spaces by type.
4. Add requirements to Carleton’s current LEED silver new construction standard that provide further guidance for the energy management component of the LEED building rating system.
5. Evaluate LEED existing building standards as a starting point for developing green building design guidelines for interior renovation projects.
6. Conduct energy audits for all individual houses and primary campus buildings, engaging student participation wherever possible and professional engineering assistance as needed.
7. Based on building energy audits, incorporate appropriate energy conservation projects into annual facilities budget and work plans. Projects that fall within a five-year payback timeframe should be prioritized, and those with paybacks of ten years or less should be strongly considered.
8. Work with information technology services to develop a green IT energy reduction plan, implement appropriate metrics to measure progress, and incorporate IT energy reporting into campus-wide energy conservation reports.
9. Complete installation of wind turbine #2 as a direct source of renewable energy.
10. Add a fifth-year intern or other staff position to work with the manager of campus energy and sustainability, under the guidance of the Environmental Advisory Committee, to implement a comprehensive sustainability campus outreach program.
11. Consider implementing a coordinated branding program to unite Carleton’s campus-wide sustainability efforts and increase visibility.
12. Develop a detailed replacement plan for boiler #1 utilizing a combined heat and power solution—a boiler with the addition of a backpressure turbine.
13. Rerun prior geothermal studies utilizing measured conductivity values in lieu of empirical values and update Recreation Center, Gould Library, and Center for Mathematics and Computing payback estimates accordingly.
14. Replace wind turbine #1 at the end of its useful life (appx. 2024); add direct interconnection to Carleton’s electrical grid.
15. Evaluate annual financial commitment required to offset Carleton’s entire carbon footprint as a baseline for comparison against the capital cost of direct GHG reduction strategies.

Focus #2: Transportation

Because Carleton is a residential campus in a small town with many staff and faculty members living nearby, transportation emissions comprise a relatively small proportion of the College's overall carbon footprint. However, the reduction of vehicle use and associated emissions is an area of past success and continuous improvement, playing a key role in Carleton's overall sustainability profile. The Philosophy Statement on Transportation at Carleton by the Task Force on Vehicles and Parking supports the College's sustainability objectives:

"Carleton, at its core, is a residential campus designed to utilize foot and bike traffic to navigate the campus. The small size of our campus makes it easy to navigate to anywhere on campus without utilizing an automobile. With that in mind, the College is asking everyone within our community—students, faculty and staff members, alumni, parents, and friends—to make informed choices on the types of transportation they utilize to travel to, from, and around Carleton. Making an informed decision regarding personal and community transportation choices also helps those in the Carleton community be wise stewards of our environment and economic resources, from a personal and institutional standpoint. . . ."⁶

With this in mind, the Carleton Transportation Web site will be redesigned in spring 2011 with the goal of unifying the transportation options available to students, faculty and staff members, and visitors. In addition, shifting the reservation process to the College's event management software has resulted in better utilization of vehicles and passenger counts and a total reduction of six fleet vehicles since 2008. Beyond campus borders, the Northfield Grass Roots Transit Initiative (a subcommittee of the Northfield Environmental Quality Commission), includes representation by Carleton staff members and students; the group evaluates and promotes transit solutions benefiting the broader Northfield community.

Operations/Maintenance Fleet

The operations fleet was not examined as part of the Climate Action Plan, but it is noted as an area for future evaluation. Currently, Carleton has one maintenance truck fueled by 100 percent ethanol, but the net environmental benefit of this fuel type is questionable, as noted in the previous biofuels section (page 30). Most Carleton vehicles are fueled by diesel or gasoline, which makes them prime candidates for substitute fuel demonstration projects. Carleton students have expressed interest in exploring the possibility of implementing a small-scale biodiesel fuel reactor and have submitted a proposal to the Sustainable Revolving Fund committee.

Campus Options

Through its Residential Life Strategic Plan, Carleton continues to increase both the quantity and variety of on-campus student housing options. This reduces the number of students who opt for off-campus housing and might therefore be more inclined to have their own personal vehicles. Campus and local transportation options have meanwhile increased in recent years, providing students with a wide range of public transit opportunities both in Northfield and to/from Minneapolis and St. Paul. Many students come to Carleton from locations that have limited public transit options and where small families often have multiple vehicles; their time at Carleton provides students with the opportunity to become familiar with the benefits of public transit in a comfortable and well-served environment. Reducing or eliminating student "approved use" vehicle permits would encourage students to explore public transit opportunities, and special programs could be arranged through Campus Services for those with specific needs for regular vehicular travel. A complete description of available public transportation programs is outlined in Appendix E (page 61); options include:

- WeCar vehicle sharing program
- Local car rentals
- Metro Express bus



Bicycles are a primary mode of transportation on Carleton's campus.



Carleton offers the WeCar vehicle sharing program.

- LOCAL bus
- Campus fleet vehicles
- Taxi vouchers and transit bus tokens
- Bicycles
- Car and vanpools

Commuting

Staff and faculty members are the primary group of regular commuters to campus. Many who live in Northfield are able to walk or bike to work. Others take advantage of carpool and vanpool resources which are outlined on the Carleton maps and transportation Web site. Carpool program participants are eligible for a designated parking space for the shared vehicle. A “live local” program could increase the number of staff and faculty members who choose to live in Northfield and can therefore walk or bike to work, and walk/bike to work contests could further reduce Carleton’s vehicle emissions. Commuting is one of the most difficult metrics to track, but an annual or biannual survey would help Carleton tailor the accuracy of its annual greenhouse gas emissions inventories. Furthermore, those who receive Carleton parking permits could be asked to specify their commute mileage and commuting habits to help tally total commuting contributions to Carleton’s Scope 3 emissions.

Long-Distance Travel

Long-distance travel related to work or school at Carleton is common. In 2010, a significant number of Carleton faculty and staff members traveled to conferences worldwide, and more than 70 percent of Carleton students study off campus at least once. Carleton values these experiences, and they contribute to the College’s core mission. Therefore, Carleton does not wish to reduce travel that provides development opportunities to staff and faculty members or enhances the educational experience of students. This is one area where Carleton’s options are limited to offsetting the associated environmental impacts.

RECOMMENDED ACTIONS: FOCUS #2—TRANSPORTATION

1. Consider undertaking substitute fuel demonstration projects to evaluate possibilities for improving the overall energy profile of the campus vehicle fleet.
2. Evaluate current College-owned vehicles for potential opportunities to purchase vehicles with lower emissions.
3. Consider eliminating all “approved use” student vehicle permits to encourage use of public transit options. (Retain current policy for student “dead storage” parking permits.) Design custom programs for students who have specific travel needs that require frequent vehicular travel off-campus.
4. Conduct an annual commuting survey to understand staff and faculty commuting habits and further increase the accuracy of Carleton’s greenhouse gas emissions inventory.
5. Encourage faculty and staff members to walk, bike, or carpool to campus.
6. Consider implementing employee benefits that set aside pre-tax dollars for carpool and public transit commuting options.
7. Consider a “live local” program to encourage staff and faculty members to live in the Northfield area.
8. Engage a task force to study the cost, impact, and sources of purchased carbon offsets equal to some or all faculty, staff, and student long-distance travel funded by the College.

Focus #3: Waste Management

Carleton initially implemented a recycling program in the mid-1980s and introduced composting around 2005. In August 2010 the College strengthened these programs by switching its waste hauling contract to a smaller local vendor who can take more types of recycling and accommodates a more comprehensive range of compost materials. Carleton is a member of Minnesota Waste Wise, a statewide non-profit organization

that organizes conferences, provides resources, and consults on strategies to reduce waste, conserve resources, and save energy. Carleton students have been highly involved in both outreach/education campaigns and implementation of new waste reduction initiatives. Carleton is actively seeking to increase the accuracy of its waste monitoring and reporting methods by engaging in conversations with its waste hauler, working with Minnesota Waste Wise to evaluate reporting best practices, and reaching out to other higher education institutions to gain insight in this area.

- **Reduce.** Carleton is actively striving to reduce paper consumption by increasing online resources for announcements, forms, and resources. The custodial department alone saw a significant reduction in paper use upon implementation of e-mail announcements to its employees. In fall 2010 student sustainability assistants (STAs) launched a Trayless Tuesdays initiative in one of two campus dining halls, resulting in a 20 percent reduction in food waste on those days. Sustainability assistants also worked with custodial staff members to initiate a pilot program to expand composting to residence hall bathrooms. The program was so successful that it is scheduled to be expanded to other residence halls in 2011.
- **Reuse.** Carleton retains unused appliances, furniture, and equipment that can be reused entirely or dismantled for parts. Office administrators hold an office supply exchange at which departments can trade unused office supplies in lieu of ordering new items. The Carleton ACT (Acting in the Community Together) organization sponsors an annual “Lighten-Up” garage sale for students, faculty and staff members, and community members to donate unwanted items for sale with profits benefitting a local charity; this is one way Carleton reduces bulk waste generated during student move-out periods at the end of each year.
- **Recycle.** Carleton’s current waste hauler now accepts all recyclable plastic containers. In addition, the custodial department requires that all replacement carpet be 100 percent recyclable. This effort could be further advanced by using companies that lease flooring materials, provide service agreements to replace worn areas in lieu of entire rooms, and take responsibility for recycling the full content of the materials they provide—a “cradle-to-cradle” approach to manufacturing.



“Lighten-Up” garage sale in West Gymnasium, sponsored by Acting in the Community Together (ACT)

RECOMMENDED ACTIONS: FOCUS #3—WASTE MANAGEMENT

1. Work with waste hauler to commence a monthly recycling and compost reporting system.
2. Partner with Minnesota Waste Wise to conduct annual or biannual waste management audits.
3. Improve and expand communication and education about what is recyclable, compostable, and waste. Work with food service provider to label café items accordingly.
4. Consider expanding composting to administrative and academic buildings in addition to residence halls.
5. Expand residence hall bathroom composting program to include all on-campus residence halls with the eventual inclusion of all primary campus buildings.
6. Institute a campus-wide IT policy that all standard office and computer lab printer defaults are set to duplex mode.
7. Reduce the number of plastic bag inserts in Carleton office waste baskets by reducing the number of waste baskets in each office and reusing or eliminating plastic inserts.
8. Establish a Web-based inventory system for excess office supplies and office furniture so requests can be filled with a reused item rather than a new purchase whenever possible.
9. Work with students, the Environmental Advisory Committee, and Carleton’s waste hauler to evaluate whether Carleton should participate in the nationwide higher education Recyclemania competition which is listed as a “tangible action” in the ACUPCC. (www.recyclemania.org).

Focus #4: Land Management

Cowling Arboretum

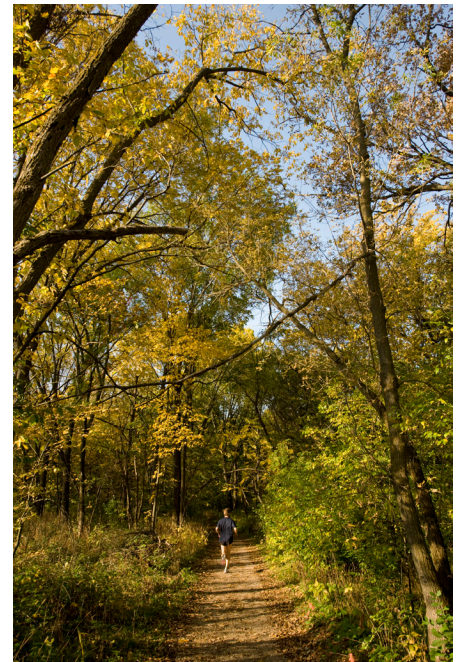
The Cowling Arboretum is Carleton's only source of self-generated GHG reductions. The amount of CO₂ sequestered by the arboretum currently contributes a four percent reduction to the College's overall carbon footprint. Carleton's Arboretum Plan provides detailed guidelines for arboretum land management and planting practices. The following items specifically link Arboretum management to campus sustainability efforts.

- **Conversion of former agricultural lands to native plant communities.** Grasslands sequester more carbon than agricultural land, while forests sequester six to seven times more carbon than crops. While a portion of the arboretum will remain in agricultural use for the near future, eventually the majority of that area will be converted to native forest or grassland cover and will contribute to Carleton's goal of carbon neutrality. New plantings would be selected primarily from a list of Rice, Dakota, and Goodhue county plant species originally native to the region and arranged in associations typically found in the native plant communities of the area.
- **Disposal of waste wood.** Much of Carleton's arboretum waste wood formerly was burned in piles, but it is now disposed of in more environmentally-friendly ways. Many large trees are removed as part of Carleton's restoration programs, to route a trail, or for safety reasons. These trees typically contain valuable lumber are now provided to the art department as part of the sculpture program. Wood that is not suitable for lumber is processed into firewood for campus fire rings or provided to local residents to use in home wood burning stoves or fireplaces. A large portion of Carleton's waste wood (slash from large trees and brush from invasive species removal) is diverted to energy production through a partnership with the St. Paul Energy District. The wood is chipped on site by a procurement contractor and shipped via semi-truck to St. Paul. Currently the arboretum produces 12 semi-truck loads of chipped wood annually.
- **Herbicides.** Many plant species cannot easily be controlled without using chemical herbicides. While large amounts of labor could be utilized for some of these control efforts, the arboretum budget would not allow this strategy. Herbicides are chosen for their minimal impact to the environment and are applied through techniques that minimize collateral impacts, targeting the problem species as closely as possible.

The arboretum is heavily utilized by students and the local community. It is one of Carleton's most cherished assets and offers numerous opportunities for education, outreach, and promoting Carleton's environmental values. If at any point in the future the College wished to expand the arboretum, such an expansion would further increase Carleton's ability to sequester carbon and would reduce the College's net carbon footprint. In the current market, nearby agricultural land is estimated to sell for approximately \$5,000 per acre for the land, plus \$1,000 per acre to replant and manage new areas. Each additional acre has the potential to sequester 10 to 47 metric tons of CO₂ per year, pending vegetation type and growth rate.

Campus Landscaping

The campus landscape is arranged and maintained in a manner that is both consistent with local and regional design aesthetics and responsive to normal usage and constituent expectations. While Carleton has no established limitations regarding the use of non-native plant material, responsible and sustainable landscaping practices favor the predominant use of fully hardy species that are native and/or adapted to the region. Campus plant materials are primarily species native to southeastern Minnesota as defined in *Vascular Plants of Minnesota*⁷. Non-native material is used in a limited and judicious manner if comparable native species do not exist or are not available in an acceptable size, form, or quantity. For example, mowed bluegrass sod is used as groundcover in some locations. Non-native plants with invasive qualities are avoided.



Cowling Arboretum

Many of Carleton's landscaping practices are sustainable, and continue to evolve with campus development and improvement projects. Permeable paving has been installed at new parking and plaza areas, and the College is working to improve storm water management. This year, the grounds department also restricted the use of leaf blowers to eliminate noise and dust and to reduce gasoline consumption.

A new landscape design is currently being planned for a quadrangle between the Language and Dining Center and Carleton's new LEED-gold residence Halls, Cassat Hall and Memorial Hall. Furthermore, Carleton's trustees have recommended that certain parking areas be moved from the campus center to its edges, thereby limiting the visual presence of automobiles in the heart of campus and encouraging foot traffic. These and other future landscaping plans continue to increase sustainable practices on Carleton's campus. There are no specific grounds practices included in the current Climate Action Plan model, but an inventory of the current non-arboretum vegetation types could potentially be quantified to account for additional carbon sequestration.

Agricultural Land

Approximately 80 acres of College land currently is being leased to a neighboring farmer and used for agriculture; the tenant farmer utilizes conservation tillage best practices, including installation of grass waterways to reduce erosion as outlined in the U.S. Department of Agriculture standards and uses integrated pest management methods to reduce the use of herbicides and pesticides. A portion of Carleton's agricultural land is reserved for the Carleton student organic farm, which sells summer produce to the College's food service provider. Additionally, portions of the arboretum are cultivated on occasion during the soil preparation phase of a restoration planting in order to reduce weed problems; planting these fields with an agricultural crop for one or two years can help reduce the need to mow or use herbicides as the new planting is established.



Carleton utilizes native plants in landscape designs, including a section of native grasses and wildflowers between the Recreation Center and Lyman Lakes.

RECOMMENDED ACTIONS: FOCUS #4—LAND MANAGEMENT

1. Conduct evaluations of arboretum carbon sequestration with each update to the Carleton Greenhouse Gas Inventory, coordinating with student class projects whenever possible.
2. Include carbon sequestration potential as an evaluation criterion for any future opportunities to expand arboretum acreage.
3. Support the proposed reduction of vehicular parking within the campus center.
4. Continue replacement of existing impervious surfaces with permeable paving, formally establishing this as a campus-wide grounds policy.
5. Consider establishment of a policy requiring that any addition of exterior hardscape (sidewalks, plazas, driveways, etc.) be accompanied by an equivalent reduction to hardscape in other areas (no net loss of green space).
6. Develop a campus landscape map by zone that can be used by students to calculate carbon sequestration of the landscaped area using methods previously applied to the arboretum.
7. Evaluate sustainable alternatives (prairie plantings or other types of perennial plants) to ornamental turf grass that reduce mowing and watering requirements and increase carbon sequestration.
8. Evaluate pesticide and fertilizer use, pest management systems, and storm water management in a format consistent with how these elements are evaluated in the AASHE STARS rating system. Develop percent reduction targets where possible.

Focus #5: Procurement

Although procurement is not quantified in Carleton's carbon reduction portfolio, there are various ways to incorporate sustainability into the way purchasing dollars are spent. Carleton has a number of existing green purchasing practices including the following:

- Compact fluorescent (CFL) light bulbs and responsible disposal practices
- Recycled content paper
- Green cleaning products
- Recycled paper towels
- Energy Star appliances
- Recommendations for green purchases

Whenever possible, Carleton selects third-party vendors that are environmentally conscious. Most notably, Carleton's current food service provider is a company that bases its business on sustainable principles. They focus on socially responsible food production practices and provide 30 percent local food in their dining menus, including some food produced by the on-campus student organic farm.

Because procurement is woven throughout the campus organization, it offers vast opportunities for increasing Carleton's sustainability profile through short-term, achievable changes. These efforts could begin by simply raising the visibility of existing sustainable purchasing practices and evaluating current preferred vendor lists to determine which vendors can be identified as having sustainable business practices or providing "green" products. Further research can be done to find providers who take a "cradle-to-cradle" approach to manufacturing, making them responsible not only for creation of goods but for recycling or composting them upon disposal. A prime example of cradle-to-cradle manufacturing practices is carpet vendors who lease carpet and then take back the product at the end of its useful life to recycle all components. Procurement is an area of further exploration and one that could incorporate a high degree of student research and participation.



Carleton now uses compact fluorescent lightbulbs instead of regular incandescent lightbulbs in campus buildings.

RECOMMENDED ACTIONS: FOCUS #5—PROCUREMENT

1. Increase visibility of existing Carleton green purchasing policies by linking them to the sustainability Web site.
2. Review the existing preferred vendors list and identify vendors that engage in sustainable practices.
3. Institute an education campaign regarding proper disposal of CFL light bulbs.
4. Continue monitoring advancements in LED lighting technology for the next phase of campus light fixture upgrades.
5. Evaluate ways to report on and monitor green purchasing practices in order to understand the impacts of our purchasing dollars on Carleton's overall sustainability profile.
6. Evaluate and implement floor system vendors (carpet, tile, etc.) who employ a "cradle to cradle" approach to manufacturing. Research and implement other products where "cradle-to-cradle" options are available.
7. Evaluate ways to increase green IT purchasing policies. Explore EPEAT certification and other similar programs.
8. Monitor and shape the profile of food purchasing practices, encouraging Carleton's food service provider to increase percentages of local, organic, and sustainable food purchases.
9. Explore opportunities to reduce packaging through purchasing decisions that take this into account.

Notes

¹2010 pricing/rates

²The American College and College Presidents' Climate Commitment, *Investing in Carbon Offsets: Guidelines for ACUPCC Institutions* (November 2008, v1.0), page 10

³The American College and College Presidents' Climate Commitment document, *Investing in Carbon Offsets: Guidelines for ACUPCC Institutions* (November 2008, v1.0), defines a carbon offset as a reduction or removal of carbon dioxide equivalent (CO₂e) greenhouse gas (GHG) emissions that is used to counterbalance or compensate for (offset) emissions from other activities; offset projects reducing GHG emissions outside of an entity's boundary generate credits that can be purchased by that entity to meet its own targets for reducing GHG emissions within its boundary.

⁴Methane flaring is the process of burning methane gas emitted by landfills to prevent this harmful greenhouse gas from entering Earth's atmosphere. The process qualifies as a mitigation of greenhouse gas.

⁵Ecosystem Marketplace and New Carbon Finance, *State of the Voluntary Carbon Markets, 2010*

⁶Philosophy Statement on Transportation at Carleton, apps.carleton.edu/campus/services/statement/

⁷Ownby and Morley, *Vascular Plants of Minnesota*, University of Minnesota Press, 1991

VIII. Education and Outreach

The Climate Action Plan provides a wealth of education and outreach opportunities through actions on campus and connections with ACUPCC peer institutions. The steering committee identified numerous opportunities to integrate sustainability topics into existing Carleton academic initiatives such as the environmental studies program, Perlman Center for Learning and Teaching, the spatial analysis/GIS lab, and the Quantitative Inquiry, Reasoning, and Knowledge (QuIRK) initiative. Academic courses and classroom activities are the primary place to engage students with the theory, application, and research that support Carleton's Climate Action Plan and guide the development of future best practices. Sustainability initiatives provide an opportunity for students to apply classroom knowledge to complex, real-world problems, using quantitative data analysis to draw conclusions within the context of related economic, social, political, and ethical issues. Sustainability is a topic that is common to the world at-large, supporting Carleton's mission to develop "... qualities of mind and character that prepare its graduates to become citizens and leaders, capable of finding inventive solutions to local, national, and global challenges."

Inside the Classroom

As an ACUPCC signatory, Carleton must incorporate the study of sustainability issues into courses across the curriculum, thereby preparing students with a fundamental level of environmental literacy. Carleton's environmental studies program brings together faculty members and students from a broad range of academic departments and backgrounds to address the scientific, economic, ethical, social, political, historical, and aesthetic dimensions of environmental issues related to climate change. Environmental studies became a major at Carleton in 2009. Students in this interdisciplinary major take courses in laboratory science, quantitative analysis, global change biology, American environmental history, environmental economics and policy, and topic-focused electives. Courses across disciplines increase students' exposure to sustainability issues through case studies, civic engagement, research projects, and assigned texts. In addition, students complete a team-based research project during their senior year, culminating in a scholarly research paper and presentation to the environmental studies community. Throughout its curriculum, the environmental studies major emphasizes:

- Critical thinking and information literacy
- Communication and collaborative work
- Problem-oriented service learning and civic engagement projects
- Place-based learning
- Internships and other work experiences
- Off-campus studies programs

Carleton faculty members have already begun to incorporate the Carleton Climate Action Plan into their classrooms. For example, students in a fall 2010 ecology course reviewed the literature on ecosystem carbon storage and calculated the carbon storage values for the Cowling Arboretum that will be included in the 2009 and 2010 greenhouse gas emissions inventories. In a winter 2011 economics course, students performed a sensitivity analysis of the cost-benefit calculations for carbon mitigation alternatives presented in the 2011 Climate Action Plan. Opportunities exist to explore the topic of emissions reduction from a scientific, political, cultural, and historical perspective and to use aspects of the ACUPCC as a case study to analyze the environmental mission of the College.



Sustainability issues can be incorporated into Carleton classes.



students on a class field trip to the Cowling Arboretum

RECOMMENDED ACTIONS: INSIDE THE CLASSROOM

1. Research and compile grant opportunities for curriculum/course development and class projects. Visibly publicize these opportunities within the Carleton academic community.
2. Develop online teaching resources in collaboration with the Perlman Center for Learning and Teaching that include examples of course syllabi, activities, and assignments to help faculty members who want to incorporate sustainability into their courses. Develop a fifth-year internship position (which could be combined with the position recommended on page 34) to assist with these efforts. Include an online database of past and potential project ideas.
3. Make the Climate Action Plan and associated data available for review and use in courses.
4. Develop a course designation for sustainability consistent with the requirements of the AASHE STARS rating system.
5. Explore the possibility of an environmental literacy core course requirement.
6. Find opportunities to integrate existing academic initiatives such as QUIRK, VIZ, and the Carleton GIS lab into campus-wide sustainability initiatives and Climate Action Plan objectives.

Outside the classroom

Carleton's learning environment extends beyond the traditional classroom. Campus organizations, work-study positions, research, community service, internships, and off-campus study programs all provide learning opportunities in which students create connections to the greater community both on and off campus and around the world, encouraging them to broaden their sustainability education as both students and citizens.

Campus Organizations

Campus organizations and committees allow students to have an active role in campus decision-making on sustainability issues. For instance, the Environmental Advisory Committee and the Carleton Student Association jointly created the Sustainability Revolving Fund to provide money to implement student-led projects on campus, reducing the College's greenhouse gas emissions and creating utility savings with which to refill the fund over time. The Cole Student Naturalist Program employs students to teach the community about the natural history, ecology, and management of the arboretum. The student organization SOPE (Students Organized for Protection of the Environment) is involved in environmental awareness and activism at Carleton. Appendix F (page 61) contains descriptions of the following student groups related to environmental or sustainability initiatives.

CARLETON-FOCUSED

- Environmental Advisory Committee
- Residential Life Sustainability Committee
- Student Sustainability Assistants
- Students Organized for the Protection of the Environment (SOPE)
- Food Truth
- Farm Club
- Yellow Bike Club

FOCUSING OUTSIDE OF CARLETON

- Minnesota Public Interest Research Group (MPIRG)
- Engineers Without Borders

OUTDOOR APPRECIATION

- Carleton Association of Nature and Outdoor Enthusiasts (CANOE)
- Cole Student Naturalist Program



students examine marine wildlife on a Carleton off-campus seminar in Australia

"[Carleton develops] qualities of mind and character that prepare its graduates to become citizens and leaders, capable of finding inventive solutions to local, national, and global challenges."
—A Statement on Carleton's Mission, Values, and Goals

SERVICE-ORIENTED

- Arbor
- Kids For Conservation (KFC)
- Adopt-A-Highway
- Adopt-A-River

INTEREST HOUSES

- Wellstone House of Organization and Activism (WHOA)
- Sustainable Living Houses (Farm and Parr)

Work-study Opportunities

Carleton employs student sustainability assistants (STAs) to work with campus offices to promote sustainability across campus. STAs have developed and implemented several sustainability initiatives such as trayless dining, the installation of low-flow showerheads, and a campus composting program. STAs also are involved with maintaining Carleton's sustainability Web site and the Shrinking Footprints blog that is used to inform the community about campus green initiatives and to seek input on how to make Carleton more sustainable. STAs already have started planning an update to the sustainability Web site that will include a dynamic interface to the Climate Action Plan.

Campus Events

Carleton sponsors one major sustainability initiative per term organized by the STAs and/or student groups. New Student Week activities help orient incoming freshmen to standard campus sustainability protocols such as recycling and composting and introduce them to student organizations with a sustainability or environmental emphasis. The winter term Green Wars competition raises awareness about energy usage in residence halls and encourages energy conservation. Spring term Earth Week activities raise awareness of environmental issues and initiatives. In addition to these major events, student organizations sponsor and promote a variety of one-time sustainability events throughout the year.



Eat the Lawn is a student organic farm in the center of campus; the project was started to highlight the benefit and beauty of edible landscaping.

RECOMMENDED ACTIONS: OUTSIDE THE CLASSROOM

1. Foster opportunities for campus groups to collaborate on co-sponsored environment/sustainability projects and events.
2. Re-establish the "green network" communication newsletter to update all campus groups focused on the environment and sustainability about related projects and events, solicit volunteers, and share information.
3. Provide competitive awards for students pursuing summer research positions, community service projects, or internships related to sustainability.
4. Encourage the development of off-campus study programs that address sustainability as a global issue and highlight past trips on the Carleton sustainability Web site.
5. Encourage increased project partnership between academic civic engagement and sustainability efforts at Carleton.
6. Explore expanding New Student Week activities to include a mandatory sustainability awareness session fostering sustainable literacy and highlighting sustainability policies, Climate Action Plan initiatives, and environmental student groups.
7. Create opportunities for STAs and environmental studies majors to collaborate and exchange ideas with students in similar programs at other schools.
8. Develop a database of practicum opportunities which are integrated with the environmental studies program.

After the Classroom

Notable growth in the green-collar job sector demonstrates that sustainability is becoming a driving force within the current job market. Closer partnership between Carleton's sustainability office, the environmental studies department, and the Career Center will provide students with the resources to explore internships, graduate programs, and job opportunities in this fast-growing sector of the economy. A designated sustainability resource library in the environmental studies department or the Career Center would assist students in exploring these opportunities. Resource materials also could be compiled online at the Carleton sustainability Web site.

RECOMMENDED ACTIONS: AFTER THE CLASSROOM

1. Connect the Career Center, environmental studies department, and sustainability office in a partnership to create a consolidated green-collar jobs and internships resource database.
2. Organize a series of speakers—including alumni—who are currently working in green-collar professions to visit Carleton and offer career guidance to students aspiring to work in environmental and sustainability-related occupations.
3. Partner with the Career Center to create a database of graduate study programs with an emphasis on sustainability and environmental issues.

Campus and Community Engagement

Carleton strives to provide educational opportunities not only for students, but also for faculty and staff members and the greater community. The newly created staff position of manager of campus energy and sustainability creates a bridge between groups on and off campus that are involved in sustainability issues. The Carleton academic civic engagement (ACE) office promotes the integration of student learning with the needs of local schools, businesses, and organizations. Invited speakers, weekly convocations, and faculty and staff reading groups also provide connections within the greater Carleton community. The Carleton campus provides numerous opportunities for campus speakers to bring new ideas to campus and expand on existing areas of interest.

Increased presence in the local and regional media has helped Carleton keep the community informed about major sustainability initiatives such as the second wind turbine. This not only allows Carleton to be recognized as a leader in sustainable thinking and practice but also opens the door to opportunities for collaboration and idea exchange with the external community.

RECOMMENDED ACTIONS: CAMPUS/COMMUNITY ENGAGEMENT

1. Collaborate with campus organizations to organize a sustainability seminar series that invites speakers to campus (convocation, guest lecturers, Headly House visitors, etc.).
2. Evaluate opportunities for community interaction and education in collaboration with Carleton sustainability research and facilities projects.
3. Coordinate with external relations division to continue providing updates to the community about Carleton's sustainability efforts and carbon reduction progress.
4. Explore opportunities for partnering with other community groups such as St. Olaf College, the Northfield Public School District, the Northfield Environmental Quality Commission, Northfield Home Matters, and others to expand individual sustainability projects into community-wide collaborations.
5. Create a reading/discussion group through the Perlman Center for Learning and Teaching with a focus on sustainability.
6. Develop action guides for College departments and offices to help the campus community adopt widespread sustainability best practices, and create opportunities to engage staff and faculty members in sustainability competitions or events.
7. Establish environmental and sustainability networks and/or organizations for faculty and staff members and include Carleton sustainability practices as a topic in new employee orientation.

Research

Promoting research on sustainability issues is a primary component of the ACUPCC. Carleton faculty members in several departments engage in research related to environmental issues and sustainability education. Research on sustainability is particularly accessible to students and frequently involves faculty-student collaborations. The environmental studies department provides a network of faculty members focused on sustainability research and creates opportunities for interdisciplinary collaboration. A coordinated effort to communicate this research to the greater community would further increase the visibility of Carleton's environmental education programs.

RECOMMENDED ACTIONS: RESEARCH

1. Create a Web site to acknowledge faculty research on sustainability issues and disseminate information to the greater community.
2. Collect and publicize opportunities for sustainability research funding.
3. Provide funding to faculty and students to attend meetings and workshops on the study of the environment.

IX. Funding, Implementation, and Reporting

Funding

One of the steering committee's primary objectives was to craft a plan that is actionable in the near-term through prioritization of low or no net cost carbon reduction strategies and capital improvements that align with existing facilities department planning efforts. Of the five GHG reduction focus areas, most recommended actions in transportation, waste management, land management, and procurement have no or low initial cost and can be integrated within existing operations budgets. Recommended actions in the education and outreach section also primarily consist of low or no initial cost opportunities that can be integrated into existing Carleton programs. It is understandable that the largest funding needs serve large-scale facilities projects in the energy supply and demand focus area, which is where the most aggressive GHG reductions must be achieved. Capital improvement projects that are expected to achieve a simple payback within one to five years will be strongly recommended and prioritized. Those with expected simple payback of six to ten years will be strongly considered, especially if they offer additional academic or operations benefits.

Although the Climate Action Plan provides a strategic overview and a method for prioritizing these initiatives, the anticipated project costs and payback periods used in this report are rough estimates based on benchmarks from other similar projects, cost per square foot, and best guess assumptions. Each recommendation that involves notable capital expenditure beyond existing operating budgets requires further research prior to implementation, including a more thorough cost-benefit analysis, a project feasibility study, and a detailed funding/financial plan.

External fund sources for sustainability efforts remain available despite the current economic downturn and will be researched and explored as Carleton implements each recommended action. Carleton's sustainability office will work with the Office of Corporate and Foundation Relations to develop a list of resources that offer environmental grants and incentives so that they may be monitored regularly for opportunities that align with current phases of Carleton's Climate Action Plan. The facilities department already is working with Carleton's Xcel Energy representative to capture opportunities for the College to utilize existing incentives for energy audits and energy conservation measures through the Xcel Joint Energy Efficiency Program.

Carleton has already implemented projects with funds from two sustainable revolving funds: one fund is available to the Carleton community and the other is built into the annual facilities operating budget. These funds establish a framework for supplementing up-front costs for projects that are expected to generate simple payback within six years. Generated savings from these projects through energy or resource conservation then replenish the fund for subsequent projects. By doing more to publicize these funding opportunities and successful project outcomes, Carleton could generate greater participation and growth in this area.

Grants for curriculum development and educational opportunities may provide additional sources of funding for recommended actions within the education and outreach section of this plan. Furthermore, the plan itself provides a framework for applying donations from alumni who request that their donations go toward Carleton's sustainability efforts. We hope that widespread communication about the Climate Action Plan will increase the visibility of Carleton's GHG reduction efforts and therefore encourage future donations like the gift that is funding the installation of the second wind turbine.

Capital improvement projects that are expected to achieve a simple payback within one to five years will be strongly recommended and prioritized. Those with expected simple payback of six to ten years will be strongly considered, especially if they offer additional academic or operations benefits.

10-Year Look-Ahead

The first ten years of the Carleton Climate Action Plan include numerous low to no cost initiatives from the energy supply/demand, transportation, waste management, land management, procurement, and education/curriculum sections of the plan. Major facilities initiatives during this period include installing a second wind turbine, replacing boiler #1 with a combined heat and power system, and conducting campus-wide building energy audits and energy conservation measures. Once these projects are complete, they are expected to begin generating more in annual energy savings than the annual operating expenses required to support them and to pay back the total initial investment in six to ten years. A breakdown of projected costs follows.

The sample cash flow in this plan focuses on the cost projections over the next one to ten years, noting that other strategies are too far in the future to accurately project.

Low/No Cost Initiatives

For \$45,000 to \$120,000 per year (2010 pricing), Carleton could implement various low to no cost actions including:

- Low-cost energy supply and demand recommended actions, i.e.:
 - Building sub-meter audits and upgrades to capture accurate, consistent, and comprehensive campus energy data
 - Implementation of a compiled energy information database to improve energy tracking and reporting capabilities
 - Collaboration with Carleton's Information Technology Services (ITS) department to develop a documented green IT program
 - An added staff or fifth-year intern position to focus on outreach and behavior change initiatives
 - Establishment of space utilization guidelines and green building standards
- All transportation recommended actions (page 36)
- All waste management recommended actions (page 37)
- All land management recommended actions (page 39)
- All procurement recommended actions (page 40)
- All education and curriculum recommended actions (pages 42–46)

Major Facilities Initiatives

Projects with a higher capital investment that will have a more significant impact on reducing Carleton's greenhouse gas inventory include:

- **WIND TURBINE #2:** This project is currently underway thanks to a generous donation from a Carleton alumnus. It is expected to be installed in fall 2011 and begin generating electricity for the campus grid by the end of this year.
- **BOILER #1 REPLACEMENT:** For \$500,000 to \$600,000, Carleton could augment replacement of the nearly 60-year-old boiler #1 from an in-kind replacement to a combined heat and power system with addition of a backpressure turbine. This cost would be evaluated relative to other facilities needs at the time of implementation.
- **BUILDING ENERGY AUDITS / ENERGY CONSERVATION PROJECTS:** For \$155,000 to \$655,000 per year (2010 pricing) spread over a period of six years, Carleton could implement campus wide building energy audits and energy conservation projects. As stated earlier in the plan, projects with a one to five year simple payback would be strongly recommended and prioritized. Projects with a six to ten year simple payback would also be considered, especially if they have additional educational or operations benefits. The range of annual expenditures for building energy audits and energy conservation measures could be tailored to align with predetermined facilities projects and/or to spread costs over a longer period of time. Energy conservation projects will be prioritized based on anticipated payback potential and evaluated within the context of the College's facilities plan, financial plan, and strategic priorities as they evolve over the next decade.

As these projects are completed, annual energy cost reductions (including power offset by the wind turbine) could increase to \$250,000 to \$590,000 per year. The wind turbine

and energy conservation measures will generate the most notable savings by reducing the campus energy demand and purchased electricity costs. Project costs and paybacks beyond a ten-year timeframe are too far in the future to accurately predict. Carleton will continue to monitor renewable energy, substitute fuels and other technologies as they advance and will modify the Climate Action Plan to reflect both technological and economic changes in these industries.

Cost Savings

Throughout the next decade, annual energy cost avoidance (including power offset by the wind turbines) could increase from \$250,000 to \$590,000 per year. The wind turbines and energy conservation measures will generate the most notable savings by reducing the campus energy demand and utility costs.

Project costs and paybacks beyond a ten-year timeframe are too far in the future to accurately predict. Carleton will continue to monitor renewable energy, substitute fuels and other technologies as they advance and will modify the Climate Action Plan to reflect both technological and economic changes in these industries.

Implementation

Process

The recommendations proposed in the Climate Action Plan vary widely in their complexity, and implementation practices would vary accordingly. For more complex facilities projects and task force-based initiatives, a project leader would be named from the Carleton community (faculty, staff, or student) who has existing knowledge and involvement with the topic at hand. Project leaders would begin by identifying a team; defining roles and responsibilities; performing a detailed evaluation of cost, time, and other resource requirements; developing a communication plan; and presenting the detailed proposal for review or approval by primary stakeholders. Each project team would be required up front to establish a consistent methodology for tracking and reporting progress over time.

Management/Resources

With more than 75 recommended actions outlined in the Climate Action Plan, effective overall program management and resourcing are key considerations. The manager of campus energy and sustainability will maintain primary responsibility for the plan with strategic-level guidance from the Climate Action Plan steering committee and the Environmental Advisory Committee. Energy supply and demand projects will be led by the facilities department with assistance from student sustainability assistants and the proposed fifth-year intern. Significant actions or expenditures will be presented for approval to the Buildings and Grounds Committee and the Board of Trustees as appropriate. Transportation, waste management, and procurement are woven throughout campus life—all three focus areas are well-suited to significant student participation and leadership. Responsibility for implementing land management recommendations will remain primarily with the arboretum director and the grounds superintendent. Education and outreach recommendations will be fueled by faculty members—especially from the environmental studies department—in partnership with campus resources such as the Perlman Center for Learning and Teaching and the Career Center.

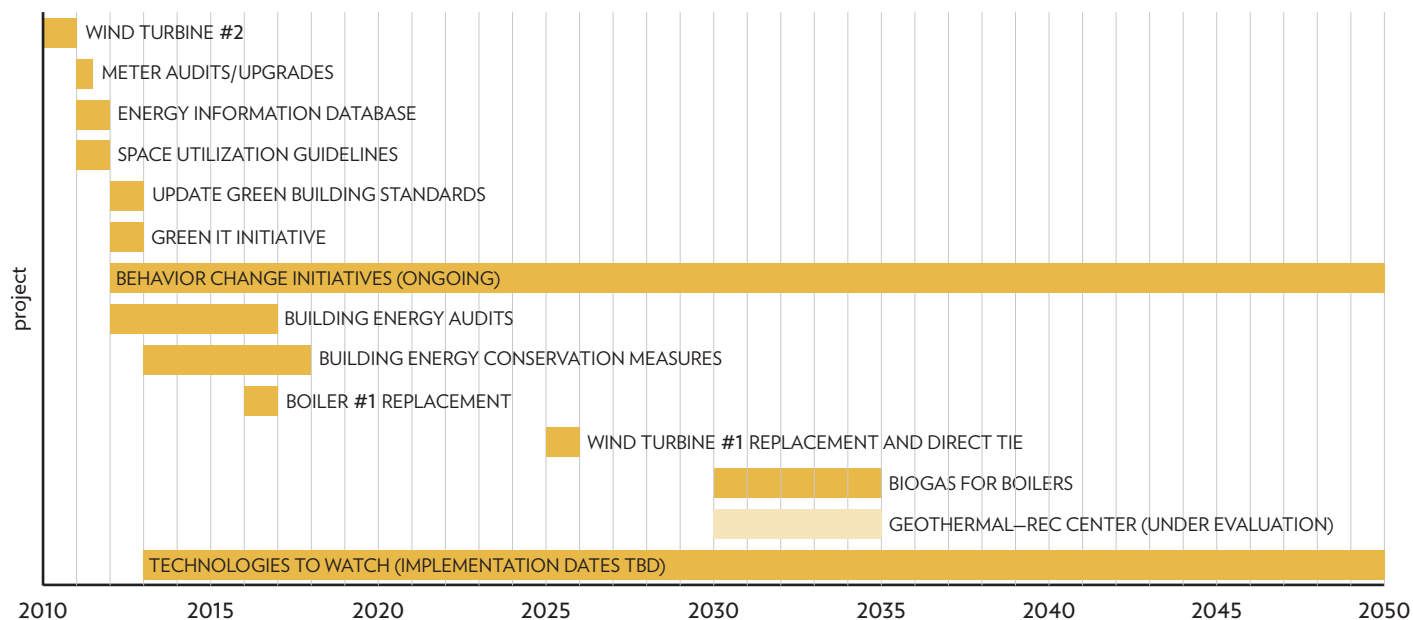
The Climate Action Plan Steering Committee could remain intact, meeting at periodic intervals to evaluate progress and guide future direction of the plan. Subcommittees will be formed as needed to implement specific actions recommended within the report.

Schedule

The pace of implementing recommended actions outlined in the Climate Action Plan depends heavily on how many resources are committed to these efforts.

Recommendations in the waste management, transportation, land management, and procurement focus areas are anticipated to be implemented over the next three years, paving the way for a new set of initiatives in the next formal Climate Action Plan progress update. Energy supply and demand initiatives will begin by establishing a comprehensive energy information database and implementing energy conservation programs over the next six years. Wind turbine #2 (2011), boiler #1 replacement (2017), and direct connection of wind turbine #1 to the campus grid (2025) serve as major stepping stones along the timeline toward aggressive reduction in Carleton's use of fossil fuels as the College approaches the mid-point of our forty-year implementation period. Education and outreach recommendations will develop over time and will be strongly influenced by the future direction of the environmental studies program.

FIGURE IX.1: TIMELINE



Communications

The steering committee emphasizes the importance of consistent and transparent communication on any changes to the plan and progress on its primary initiatives. Those who should remain informed include the Carleton campus community, the Board of Trustees, alumni, ACUPCC, and other external sustainability reporting agencies. Hopefully Carleton could also involve the Northfield and Rice County communities in efforts that could be expanded beyond campus borders. Eventually the committee envisions incorporating the Climate Action Plan into a dynamic Web-based interface that will allow widespread distribution and real-time information. In the meantime, the steering committee will report on major achievements or advancements through a variety of available communication formats, including campus correspondence, alumni publications, and news feeds from higher education associations. The committee will partner with the external relations division to identify effective communication outlets for each intended audience at major milestone or reporting intervals.

The steering committee will work to identify an effective way to receive ongoing feedback from the campus community. This could be through a new page on the sustainability Web site; social media formats; presentations to Carleton faculty, student, and staff groups; or campus gatherings such as the Climate Action Plan town hall meeting in September 2010.



September 2010 Climate Action Plan town hall meeting

Reporting

The steering committee identified the following three defined reporting points:

- Submit final Climate Action Plan to the ACUPCC in June 2011 following approval from Board of Trustees.
- Provide an internal progress report after one year (June 2012) to keep the Carleton community apprised of progress on recommended actions within the Climate Action Plan since its official publication date.
- Provide ACUPCC progress reports every two years starting in June 2013.

Carleton also intends to submit an annual greenhouse gas inventory to the ACUPCC, post the inventory on the College's sustainability Web site, and update Carleton's ACUPCC online profile as required to represent any major changes. Carleton plans to identify and implement standardized forms of benchmarking for each GHG reduction focus area and continue participating in external sustainability rating/ranking systems, especially those with broad participation by other ACUPCC schools. The steering committee hopes to investigate online formats for reporting on and updating Climate Action Plan recommended actions. This would allow these efforts to be consolidated into a dynamic resource that can be actively updated and accessed by a broader audience. The steering committee also will develop a regular internal reporting mechanism to keep Carleton students and staff and faculty members apprised of current campus energy use and progress on energy conservation efforts.

X. Conclusion

Carleton's 2011 Climate Action Plan offers a strong set of near-term recommendations including energy conservation measures and the addition of a directly connected wind turbine that will keep the College on a straight-line path to climate neutrality for the next decade. This approach allows Carleton to implement practical solutions over the next decade while maintaining an open-minded vision for future years. Over time, the Climate Action plan will be adapted in response to technological, political, economic, and social changes in both internal and external environments. The initial Climate Action Plan establishes tangible near-term targets and gives the College the flexibility to respond to changes in both internal and external environments. It also provides a framework for continuing evaluation and updates as well as a basis for reporting and tracking mechanisms. The resources, evaluation process, and people that came together to create this preliminary Climate Action Plan provide a strong foundation that will help Carleton advance its sustainability objectives well into the future.



Former President Robert Oden (2002–2010) with Carleton's first wind turbine

XI. Acknowledgements

Climate Action Plan Signatories

President Robert Oden (2002–2010)

President Steven Poskanzer (2010–Present)

Climate Action Plan Steering Committee

Nancy Braker, Director of Cowling Arboretum, Lecturer in Biology

Don Frost, Trustee

Daniel Hernandez, Assistant Professor of Biology

Mark Kanazawa, Director of Environmental Studies

Patricia Langer, Budget Analyst

Martha Larson, Manager of Campus Energy and Sustainability

Ray McGaughy '11, student

Fred Rogers, Vice President and Treasurer

Kimberly Smith, Associate Professor of Political Science and Environmental Studies

Steven Spehn, Director of Facilities and Capital Planning

Aaron Swoboda, Assistant Professor of Environmental Studies and Economics

Lynne Wilmot, Planned Giving Officer

Climate Action Plan Consulting Team

Fred Betz, Affiliated Engineers, Inc.

Jeff Burks, Energy Strategies

Justin Farr, Energy Strategies

Jeannette LeBoyer, Affiliated Engineers, Inc.

Robert McKenna, Energy Strategies

Campus Contributors

Kathryn Beckers, Maintenance Administrative Assistant

Kayla Berger, Publications Production Assistant and Writer/Editor

Julia Burmesch, Director of Campus Services

Kirk Campbell, Director of Maintenance and Custodial Services

Steven Caton, Maintenance Storekeeper

Joel Cooper, Director of Information Technology Services

Denise Dube, Senior Accountant–Facilities

Kerry Dwyer, Master Electrician

Dennis Easley, Superintendent of Grounds

Mark Gleason, Director of Corporate and Foundation Relations

Richard Goerwitz, Database Administrator and Integrator/Data Warehouse Archite

Gloria Heinz, Facilities Communications Specialist

Randie Johnson, Purchasing and Risk Manager

Julie Latham, Enterprise Applications and Data Warehouse Administrator

Karen Lawson, Custodial Services Supervisor

Erin Lewis '13, student

John Matthews, Facilities Project Manager/Owner's Representative

Gregory McCracken, Facilities Project and Safety Coordinator

Lynn Nichols, Custodial Administrative Assistant

Jonathon Reese, Graphic Designer

Patti Sabrowski, Custodial Services Supervisor

Don Smith, Senior Climate Control

Nina Whitney '12, student

Referenced Studies

Sebesta Blomberg

Sightlines, LLC

Wentz Associates, Inc.

Appendix A: Table of Values (supplements Figure VI.2: Levelized Cost Comparison, page 19)

GHG REDUCTION STRATEGY ¹	ESTIMATED CAPITAL COST ²	AVG ANNUAL OPERATING COST ²	AVG ANNUAL ELECTRICITY SAVINGS (MWh)	AVG ANNUAL GAS SAVINGS (MMbtu)	AVG ANNUAL ENERGY SAVINGS ²	NET ANNUAL COST ²	PAGE REFERENCE
A. Space utilization	–	-\$3,000	400	3,515	\$47,000	(-\$50,000)	p. 23–24
B. Backpressure turbine (25k pph + turbine)³	\$600,000	–	1,760	-3,010	\$88,000	(-\$88,000)	p. 29, 57
C. ECM: augmented controls⁴	\$960,000	–	1,500	11,500	\$164,000	(-\$164,000)	p. 25–26, 54–56
D. Backpressure turbine (35k pph + turbine + PRV) ³	\$700,000	–	1,760	3,100	\$127,000	(-\$127,000)	p. 57
E. Backpressure turbine (35k pph + turbine) ³	\$800,000	–	1,310	3,100	\$99,000	(-\$99,000)	p. 57
F. Green IT	TBD	\$15,000	600	–	\$37,000	(-\$22,000)	p. 26–27
G. Wind turbine #2⁵	–	\$109,000	2,378	–	\$247,000	(-\$138,000)	p. 28
H. Natural gas-fired cogeneration	\$2,132,523	\$71,000	7,490	80,000	\$961,000	(-\$890,000)	p. 57
I. Wind turbine #1 replace + direct tie	\$3,400,000	\$54,000	3,600	–	\$220,000	(-\$166,000)	p. 29–30
J. Wind turbine #1—RECs	–	TBD	–	–	–	TBD	–
K. ECM: building audits + retro-commissioning ⁴	\$7,677,000	–	2,530	26,700	\$323,000	(-\$323,000)	p. 25–26, 54–56
L. Biogas supply to 1MW cogen	\$9,500,000	\$161,000	8,079	59,068	\$865,000	(-\$704,000)	p. 57
M. Biogas supply for biolers	\$7,500,000	\$105,000	–	108,600	\$684,000	(-\$579,000)	p. 30–31, 58–59
N. Behavior change initiatives	–	\$75,000	877	–	\$53,000	\$22,000	p. 27–28
O. Green power purchases	–	\$0.75/MWh	–	–	–	TBD	p. 33–34
P. Solar domestic hot water	\$209,000	\$2,000	–	1,500	\$8,000	(-\$6,000)	p. 32–33
Q. Landfill gas—direct connect	\$7,100,000	\$200,000	–	90,213	\$568,000	(-\$368,000)	p. 58–59
R. Carbon offsets⁶	–	\$5.31/MTCDE	–	–	–	TBD	p. 33–34
S. Green building standards⁷	–	–	798	7,030	\$93,000	(-\$93,000)	p. 24
T. Geothermal—Recreation Center⁸	\$866,000	\$9,000	-344	7,900	\$29,000	(-\$20,000)	p. 32
U. Biodiesel reciprocating engines	\$2,000,000	\$25,000	15,346	79,927	\$1,440,000	(-\$1,415,000)	p. 57
V. Solar PV (320kw rooftop at \$5,500/kw)	\$3,553,000	–	463	–	\$28,000	(-\$28,000)	p. 32–33
W. Solar electric (1 MW at central plant)	\$3,750,000	\$166,000	1,291	–	\$79,000	\$87,000	p. 32–33
X. Chiller plant upgrades	\$300,000	–	–	284	\$2,000	(-\$2,000)	–
Y. Meter audits and upgrades	\$60,000	–	–	–	–	–	p. 22–23
Z. Energy information database	\$50,000	\$10,000	–	–	–	\$10,000	p. 22–23

NOTES

¹Strategies in bold green text are included in Figure VI.5: GHG Reduction Wedge Diagram (page 20)

²Capital and operating costs and savings are in 2010 prices and do not include escalation; energy savings are calculated using 2010 rates

³Backpressure turbine capital costs are incremental over the cost of an in-kind boiler replacement

⁴ECM—energy conservation measures; augmented controls is a subset of audits and re-commissioning (these two options are mutually exclusive)

⁵Capital cost for wind turbine #2 is covered by a gift

⁶Need for purchased RECs and offsets amounts will depend on the status of Carleton's progress status at each interim milestone

⁷Model assumes \$15 per GSF increase in capital costs to implement green building standards; in practice, these costs would be incorporated into project budgets

⁸Geothermal: Rec Center may yield better financial results with revised calculations to account for measured conductivity results in lieu of empirical values

SOURCE: Energy Strategies file "Carleton CAP Model r9 2011_01_10.xlsx"

Appendix B: Building Energy Conservation Measures (ECM)

Building energy conservation measures (ECM) are some of the most effective near-term GHG reduction strategies included in the Climate Action Plan. They also are one of the most complex options to distill into a quantified format such as the leveled cost comparison (Figure VI.2) and the wedge diagram (Figure VI.3). This appendix outlines the intended ECM implementation process in greater detail and clarifies the assumptions and limitations of the model results.

Model vs. Actual Implementation

The Climate Action Plan model quantified two types of ECM and treated them as two separate but mutually exclusive GHG mitigation strategies. The more moderate strategy, ECM: augmented controls, limits the energy conservation project scope to installing more advanced controls on existing lighting and HVAC systems. The more aggressive strategy, ECM: audits and retro-commissioning, includes added control of existing systems plus energy audits, retro-commissioning, and other more extensive upgrades to the HVAC and electrical systems themselves. There is an exponentially higher cost to this second strategy, but more aggressive energy conservation projects are expected to produce higher energy savings as a result.

The steering committee chose to include the moderate option in Carleton's plan since its lower first cost and shorter payback period support the committee's general objective to recommend that more affordable strategies be implemented in the near-term period (2010–2020). In reality, Carleton's energy conservation project portfolio is anticipated to include a combination of energy audits, advanced controls, retro-commissioning, and electrical/HVAC system upgrades that draw from both options.

The steering committee proposed starting with a methodical approach to energy audits in all buildings which will allow Carleton to inventory and prioritize a wide range of potential improvements. Recommended projects will focus on buildings that are known to be high energy consumers and modifications that will result in short-term paybacks. Projects with a one to five year simple payback will be strongly recommended and prioritized. Those with a six to ten year simple payback will be strongly considered, especially if they are expected to provide additional operations or academic benefits. Because of the way the Climate Action Plan model was structured, the steering committee was not able to show this combined ECM approach in the wedge diagram; therefore, this appendix presents the details of a more realistic approach to actual project implementation.

Step #1: Energy Audits

The steering committee recommends that the energy audit process consist of a consistent, two-pronged approach:

Category #1: Individual Houses

One energy audit program will target Carleton's residential houses, using processes similar to a standard home energy audit. This program will be designed to provide a hands-on learning opportunity for students who want to participate in walk-through audits of residential houses to analyze and implement simple measures to reduce building energy load. ECM in Carleton's individual houses may include but are not limited to:

- Analysis of utility data (if applicable)
- Sealing air leaks and envelope
- Inspection of appliances and heating/cooling systems
- Upgrading lighting systems
- Checking thermostat set points and controls
- Outreach/educating tenants

Because houses constitute a very small portion of total campus energy demand (approximately eight percent) the potential retrofit costs and energy savings from these buildings were not significant enough to be included in the Climate Action Plan model. Energy conservation initiatives in Carleton's residential buildings may be eligible for incentives through utility-sponsored retrofit programs that offset a portion of the costs. Carleton will explore opportunities to incorporate student involvement and partnerships with local entities such as Xcel Energy, Northfield's Home Matters, or Saint Paul-based Cooperative Energy Futures to include educational components as a co-benefit to potential financial incentives and/or energy audit assistance.

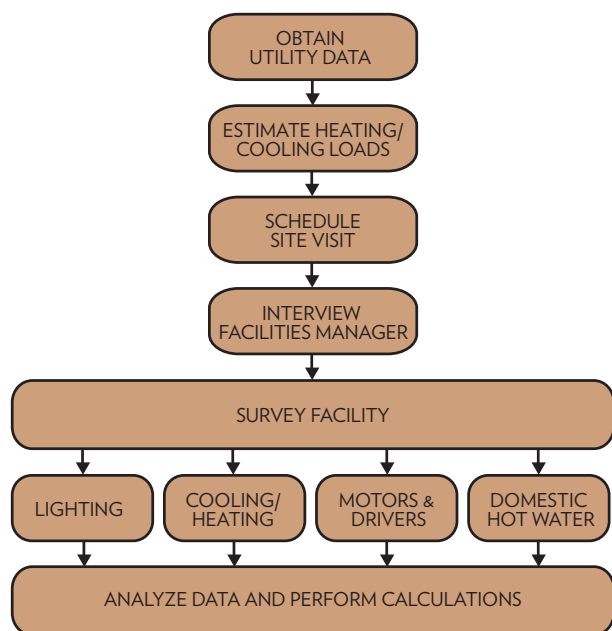
Category #2: Primary Campus Buildings

The other primary component of Carleton's proposed building ECM focuses on primary buildings, including campus residence halls, academic/administration buildings, and recreational facilities. The steering committee recommends a strategic and systematic approach to energy audits for these buildings:

- **Schedule of energy audits:** Buildings will be prioritized according to age and comparative energy use. Parallel efforts to increase the number of meters across campus also will help hone the prioritization process by identifying buildings with the highest energy consumption per square foot or by building type. Older and more energy-intensive buildings will be audited first utilizing a standard approach outlined by ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers).
- **Energy audit process:** ASHRAE defines three levels of building audits. Level 1 involves a walk-through audit that visually inspects the building for energy efficiency opportunities. Level 2 is likely to be the most appropriate choice for Carleton's building energy audits; this audit examines building energy data and engineering plans/schedules for a more in-depth analysis of building performance. It also includes interviews with building operators and occasionally incorporates a

computer simulation to calibrate building energy use and analyze energy conservation measures. Level 3 audits typically include advanced building simulation. They are more expensive and likely to be more than what is required for Carleton to develop a strong ECM implementation plan.

FIGURE B.1: ASHRAE LEVEL 2 BUILDING AUDIT PROCESS



Step #2: ECM Implementation

ECM: Augmented Controls

As a conservative starting point, the Climate Action Plan recommends implementation of a basic level of ECM limited to HVAC and lighting controls strategies on existing building systems. Carleton may be able to streamline energy use by fine-tuning HVAC control systems that currently are in the building's mechanical system. While certain systems such as direct digital controls or variable air volume mechanical systems allow a greater degree of control, they also require a greater investment. Until that investment is made, this energy conservation measure will help optimize building performance, going hand in hand with a systematic approach to verifying building performance through building audits. Carleton will use audit results to evaluate which buildings may benefit from further action such as retro-commissioning or more aggressive ECM.

ECM: Audits and Retro-commissioning

This option includes augmented controls plus more aggressive energy conservation projects such as retro-commissioning, a systematic, documented process that identifies potential operational and maintenance improvements in existing buildings and restores them to optimal performance based on original design intentions. This approach stresses the need not only to analyze energy conservation opportunities (via building audits) and increase the level of control over building systems but also to optimize building system performance. Retro-commissioning efforts can include (but are not limited to):

- Reviewing building maintenance and operating schedules and analyzing utility data
- Sealing air leaks to tighten the envelope of the building with infrared thermography
- Calibrating indoor and outdoor building sensors to be in accordance to original design specifications
- Inspecting damper and valve controls
- Evaluating HVAC equipment for life expectancy
- Evaluating lighting for efficiency opportunities
- Running through sequences of operation through the control systems with building operator or controls contractor using building-specific functional performance tests
- Providing engineering design services and overseeing implementation of construction if required
- Third-party testing, adjusting, and balancing of HVAC system components including:
 - Air system flow rates
 - Water system flow rates
 - Temperatures of heating and cooling delivery system
 - Positions and functioning of flow-control devices
 - Control settings and operation
 - Fan and pump speeds and pressures
 - Cleaning of system components
 - Examination of potential obstruction of terminal units

Model Assumptions

The Climate Action Plan model included the following assumptions for purposes of quantifying the two proposed levels of ECM. In a more realistic scenario, the Climate Action Plan would include an option that combines elements of both approaches tailored to the specific needs of each building. However, due to time constraints, the Climate Action Plan model is not based on in-depth analyses of specific buildings; instead, the plan includes a high-level square footage-based estimate of energy costs and savings due to building energy audits and retro-commissioning activities. Since comprehensive building level utility data was not available, Carleton's Climate Action Plan consulting team used the Commercial Building Energy Consumption Survey (CBECS) database from the U.S. Energy Information Administration (EIA) to estimate building energy use intensity by building type as shown in Figure B.2 (page 56). Project costs and energy savings were estimated by the Climate Action Plan engineering consultants (AEI) utilizing their experience on previous higher education projects.

ECM: Augmented Controls

The scheduling, setback, and lighting controls upgrades affect a smaller proportion of building square footage than the more aggressive auditing and retro-commissioning option.

COSTS

- Scheduling and setbacks: \$0.15/GSF for 65% of all campus buildings (including academic/administrative, athletic, residential, and student life)
- Lighting control upgrades: \$1.00/GSF for 50% of campus buildings (including academic/administrative, athletic, and residential)

FIGURE B.2: CBECS BUILDING ENERGY USE ESTIMATES

BUILDING CATEGORY	GROSS SQUARE FOOTAGE	CBECS CATEGORY ¹	KBTU/SF (PER CBECS OR AEI)	KBTU TOTAL	ELECTRICITY—26% OF TOTAL ² (KBTU)	NATURAL GAS—74% OF TOTAL (KBTU)
Academic/administrative	697,288	education	92	63,871,581	16,776,816	47,094,756
Athletic	235,158	N/A (AEI average)	110	25,867,380	6,794,450	19,072,930
Garage	7,195	warehouse	46	328,812	86,367	242,444
Houses	218,329	lodging	90	19,671,443	5,166,996	14,504,447
Residence hall	439,484	lodging	90	39,597,508	10,400,872	29,196,637
Science/research	183,421	N/A (AEI average)	200	26,684,200	9,635,648	27,048,552
Student life	28,213	public assembly	102	2,877,726	755,877	2,121,849
Support	13,800	warehouse	46	630,660	165,652	465,008
TOTAL	1,823,000	weighted EUI	104	189,529,310	49,782,678	139,746,631
NOTES ¹CBECS database: www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003html/c10.html ²Electricity and natural gas consumption were broken out using percentages from the Sightlines energy consumption information for Carleton campus-wide.						

- $(65\% \times \$0.015/\text{GSF} \times 1,823,000 \text{ GSF}) + (50\% \times \$1.00/\text{GSF} \times 1,555,000 \text{ GSF}) = \$960,000$

ELECTRICITY SAVINGS

- 1,500,000 kWh/year (upon project completion)
- 10 percent reduction in electricity consumption from lighting and HVAC control for buildings modeled
- Nine percent reduction in electricity consumption from HVAC/building system upgrades for buildings modeled

NATURAL GAS SAVINGS

- 115,000 therms/year (upon project completion)
- 12 percent reduction in natural gas consumption from modifications to scheduling and setbacks upgrades for buildings modeled

ECM: Audits and Retro-commissioning

Project costs and energy savings for this more extensive ECM option were estimated by the Climate Action Plan engineering consultants (AEI), utilizing their experience on previous higher education projects. To be conservative, the Climate Action Plan model assumes energy conservation measures will only be applicable to 85 percent of all primary campus buildings.

PHASE 1: BUILDING ENERGY AUDITS FOR 85 PERCENT OF BUILDINGS

- \$0.50/GSF for 85% of all campus buildings
- $85\% \times 1,823,000 \text{ GSF} \times \$0.50/\text{GSF} = \$775,000$

PHASE 2: RETRO-COMMISSIONING AND BUILDING/LIGHTING UPGRADES FOR 85 PERCENT OF BUILDINGS

- \$4.50/GSF for 85% of all campus buildings (\$3.00/GSF for retro-commissioning/building upgrades; \$1.50/GSF for lighting upgrades)

- $85\% \times 1,823,000 \text{ GSF} \times 4.50/\text{GSF} = \$6,973,000$

ELECTRICITY SAVINGS

- 2,530,000 kWh/year (cumulative over five years)
- 10 percent reduction in electricity consumption from lighting
- 10 percent reduction in electricity consumption from HVAC/building system upgrades

NATURAL GAS SAVINGS

- 267,000 therms/year (cumulative over five years)
- 22 percent reduction in natural gas consumption from HVAC/building system upgrades

These numbers provide a high-level estimate of energy savings potential. As the audits are implemented, these estimates must be evaluated more thoroughly to accurately examine building-specific costs and savings.

Funding Opportunities

A variety of funding and incentives are currently available for energy audits and ECM through Xcel Energy. Carleton's facilities office has already begun working with an Xcel representative to explore the Xcel Joint Energy Efficiency Program which helps customers compile a database of potential projects that may be eligible for pre-approval of energy audit discounts or financial assistance for energy conservation projects. Carleton intends to fully explore these and other potential funding sources in the planning process of a comprehensive ECM program during the first five to seven years of Climate Action Plan implementation.

Appendix C: Boiler #1 Replacement Evaluation

Carleton's oldest boiler—boiler #1—is a 35,000 pph unit installed in 1954 and due for replacement within the next five to ten years. It serves primarily as a backup boiler and a supplement to the largest 50,000 pph boiler (boiler #3) during peak heating seasons. The steering committee saw the upcoming replacement of boiler #1 as an opportunity to integrate a sustainable solution into Carleton's planned maintenance requirements. This evaluation focused on three combined heat and power (CHP) solutions that allow either electricity to be created as the by-product of steam production or vice versa. Below is a summary of the considerations that led the committee to select a boiler with a backpressure turbine as the most feasible CHP replacement for boiler #1.

Option #1: Backpressure Turbine Cogeneration—Recommended Option

Boiler #1 could be replaced with a high-pressure boiler coupled with a backpressure steam turbine (BST) in lieu of a standard boiler. A backpressure steam turbine is a commercially available technology that utilizes thermal energy in the form of steam to generate mechanical energy to drive a generator. The BST analyzed in this model would use a boiler to generate steam at around 600 psig. In the process of reducing this steam pressure to 100 psig for use on the campus grid, the BST would produce electrical energy via the 500 psig pressure drop. This evaluation assumes the system would generate 25,000 pph of steam at 100 psig as well as 400 kW of electrical power as a by-product, thereby reducing both Carleton's scope 1 (natural gas) and scope 2 (electricity) greenhouse gas emissions.

To address concerns that a 25,000 pph boiler may not meet the future projected steam load of campus, the team also analyzed installing a larger boiler (35,000 pph) with either a similar sized turbine (35,000 pph) or a smaller turbine (25,000 pph). The 35,000 pph boiler and 35,000 pph turbine system has a higher capital cost because of its higher capacity but less generation potential because the turbine doesn't operate as efficiently during part-load conditions. With that in mind, the team considered coupling a larger 35,000 pph boiler with a smaller 25,000 pph turbine. This system would need a 10,000 pph pressure reduction valve station which adds to initial capital costs but maintains the power production potential. Because the Climate Action Plan includes energy reduction goals targeted to reduce steam demand, the committee chose to recommend a smaller system, but at the time of boiler replacement, a more detailed analysis of campus steam load should be performed to size the system properly.

Option #2: Natural Gas Turbine Cogeneration

Boiler #1 could be replaced with a natural gas turbine cogeneration unit. This option was first suggested in a Carleton

utility master plan study dated 2007. The unit would be sized to produce 1 MW of electricity with the cogeneration of 4,500 pph of steam. Its main function would be to produce electricity with steam as a byproduct. While Carleton would reduce its purchased electricity demand, the central plant would still be expending conventional energy in the form of natural gas. Compared to option #1, this system produces more electricity and less steam. Because this system produces electricity using natural gas (which is cleaner than coal), the GHG reductions are more significant than in option #1. However, the final payback is smaller than option #1 because electricity prices are lower than the equivalent energy content of natural gas. With Carleton's second wind turbine and the potential direct connection of the first wind turbine, Carleton has less need for a cogeneration unit whose primary function is electricity production.

Option #3: Biodiesel Reciprocating Engine

Heat recovery equipment could be added to one of the existing 2.5 MW diesel generators used for backup power to provide electricity to the campus grid. The Climate Action Plan model assumed the diesel engine would operate at approximately 75 percent of peak power to maintain peak electrical efficiency and to minimize generator wear and tear. Based on the provided electric and steam load profiles, the diesel cogeneration system would be able to produce 61 million pounds of 100 psig steam per year (534,000 therms), or 51 percent of the total campus steam demand. Furthermore, 15.3 million kWh of electricity would be produced per year or approximately 94 percent of the total campus electricity demand.

This option initially looked very attractive using biodiesel fuel as a substitute for conventional diesel. It was one of the few carbon abatement solutions that drastically reduced Carleton's greenhouse gas emissions by retro-fitting equipment the College already owns. However, Carleton staff members were concerned that the diesel generators (installed in 2009) were not meant to run most of the year and would not last their intended useful life if used in this way. The steering committee also was concerned about using biodiesel as a resource. Although it is considered to be a more renewable resource than conventional diesel, biodiesel is not an emission-free resource when emissions due to raw material production are taken into account. Furthermore, the intense material supply and material handling requirements of a biodiesel option seemed less attractive than a natural gas cogeneration option. However, the steering committee deemed biodiesel a technology to watch, and the College may wish to explore it as an option as developments in biofuel technology advance in the future.

Option #4: Biogas 1MW Cogeneration

This option combines the system described in Option #2 with a biogas fuel supply in lieu of natural gas as described in Appendix D.

Appendix D: Substitute Fuels

The following summary of substitute fuel technologies is provided as a reference for how these fuels work and an indication of how evaluation of various substitute fuels played into the Climate Action Plan. It is important to understand that there are specific renewable fuels that can substitute for each conventional fuel as illustrated in Figure D.1. They are not interchangeable, so there is not a one-size-fits-all solution to address all conventional fuel types with a single type of renewable material.

Biomass Gasification

This energy production system uses woody biomass products such as construction waste or pulp mill waste. It gasifies the material using pyrolysis (at high temperatures with low levels of oxygen) and uses this gas as a substitute fuel in place of natural gas. This type of system is currently being employed at the St. Paul District Energy Plant and could be even more attractive if local sources such as arboretum waste wood or wood from local tree trimmers and construction companies could be used. Depending on how it is configured, a biomass gasification system could be used at the fuel source to create steam or in a cogeneration system that produces either steam with electricity as the byproduct or electricity with steam as the byproduct.

Landfill Gas and Municipal Solid Waste

Most people understand that recycling or reusing is more beneficial than simply throwing things away, and yet we still throw away a lot of material that goes directly into a landfill. While landfills have negative environmental attributes, they also provide an opportunity to harness the inherent energy in our waste to create power. Waste can be made into energy in a number of ways, the most common being direct combustion and methane capture.

For purposes of the Climate Action Plan, the steering committee and the consulting team explored the opportunities associated with the landfill closest to the College; the Rice County landfill is located approximately seven miles away from the Carleton campus and offers an opportunity to utilize waste methane that would otherwise be expelled into the atmosphere. In conventional landfill systems, as more waste is piled high, methane is created from the decomposition of materials in anaerobic conditions. Since methane has a global warming potential 23 times stronger than carbon dioxide, it makes sense to look for alternatives to simply releasing that methane into the atmosphere. As a combustible gas, methane can be gathered at the landfill and either flared off or used to generate electricity or produce heat. While methane flaring also releases that potential

FIGURE D.1: SUBSTITUTE FUELS

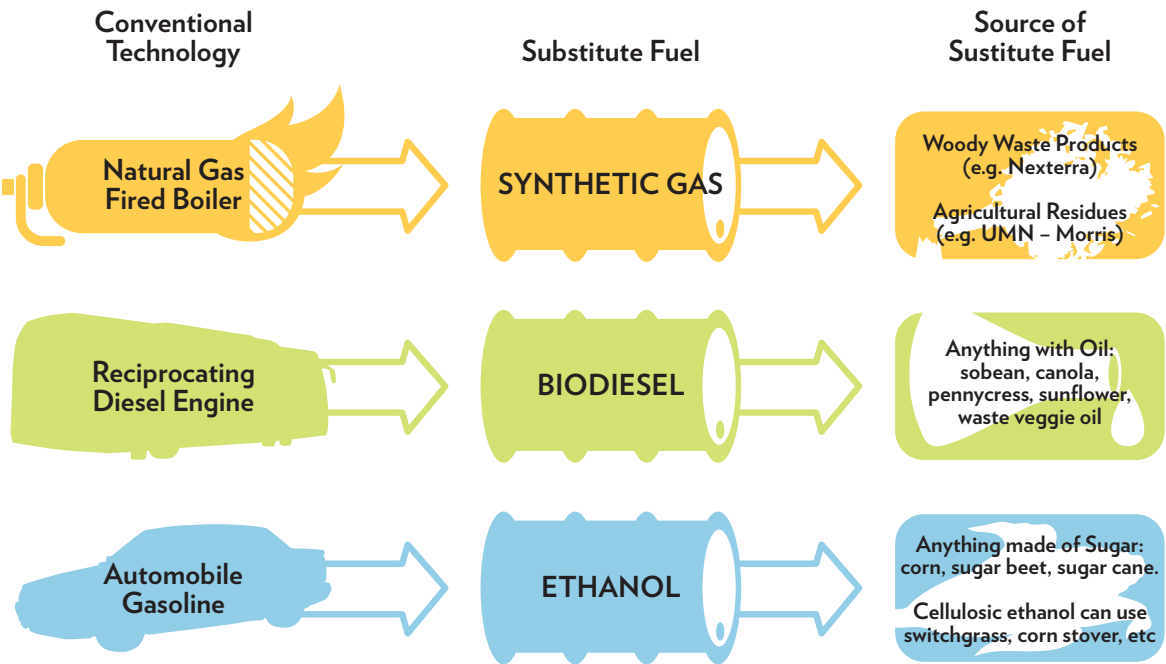
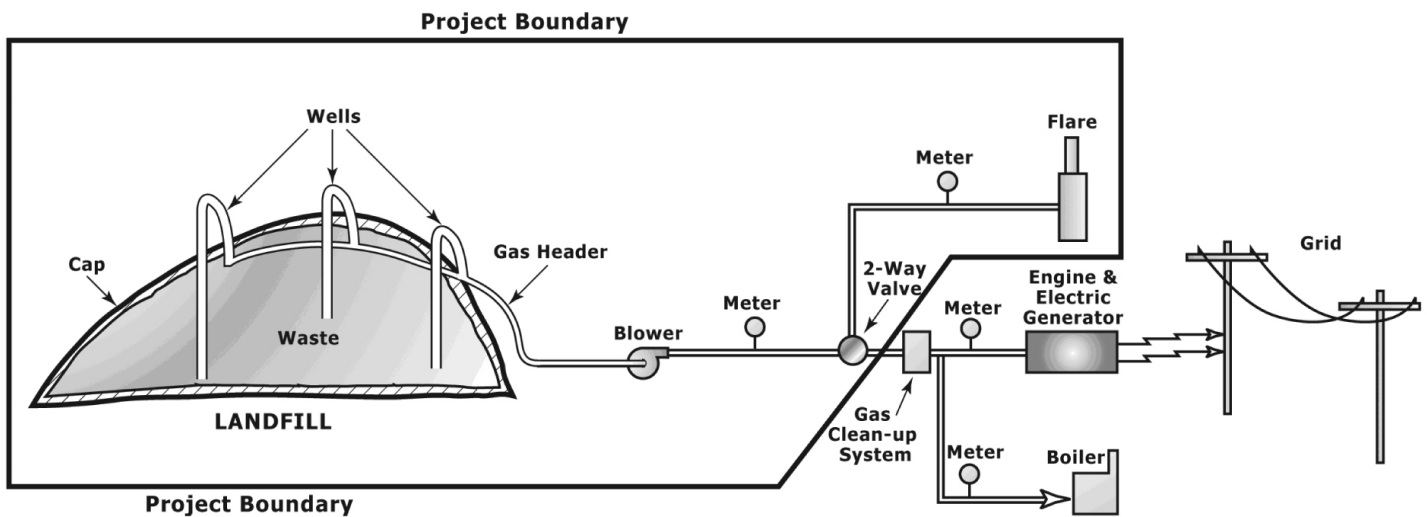


FIGURE D.2: LANDFILL METHANE COLLECTION AND COMBUSTION



Source: EPA Climate Leaders Landfill Methane Collection and Combustion (2008), www.epa.gov/climateleaders/documents/resources/draft_LandfillOffset_protocol.pdf

energy into the atmosphere, it has a lesser global warming impact because the methane is transformed to carbon dioxide during the combustion process. Figure D.2 depicts a landfill gas system that utilizes methane either as a flare or a source of energy for a generator or a boiler.

Biodiesel

This fuel can be used as a substitute for anything that runs on diesel. Biodiesel is made through the process of chemical reaction of lipids with an alcohol (transesterification). The process is commercially available and highly scalable, and, like most processes, economies of scale work to the financial advantage of biodiesel production. The potential feedstock for biodiesel includes soybean, canola, waste vegetable oil, animal fat, and some algae. A number of institutions utilize waste oil from kitchen operations to produce small amounts of biodiesel in fleet operations. Currently there is a biodiesel mandate on #2 diesel fuel that requires a five percent blend with biodiesel.

Ethanol

This fuel—in contrast to transesterification of biodiesel—is the fermentation of plant sugars to form an alcohol that can be used as a gasoline substitute. In the United States, the most common plant from which to make ethanol is corn; however, the corn-based ethanol industry is under critique because of the high energy inputs needed for an ethanol output. Other plants, such as sugarcane or sugarbeets, have a better energy balance than corn, but these plants are respectively either not grown regionally or are not in commercial production. Because of the high-energy inputs of corn-based ethanol and the controversy over using food for fuel, ethanol may not offer a golden ticket to a renewable replacement of gasoline. Research currently is underway to commercialize cellulosic ethanol—which has a better energy balance and more diverse feedstock than corn-based ethanol—but at this point, there are no commercially available methodologies to produce large-scale amounts of ethanol.

Appendix E: Sustainable Campus Transportation Options

- **WeCar** is a car-sharing program available to students and faculty and staff members as a personal transportation option. A Prius hybrid and a Nissan Cube are available to members and rented hourly, daily, or overnight. WeCar offers members the convenience of car ownership without the hassle and expense. Initiated in September 2009, membership exceeded 110 by November 2010. Initially subsidized by the College, the program is on track to be fully supported by member fees. Membership is open to students between the ages of 18 and 20 if they submit a signed parent/guardian consent form.
- **Local car rentals** are available through the Enterprise Rent-A- Car location a short walk from campus. A custom Web link directs members of the campus community (age 21 and older) to Carleton's Enterprise account. Carleton's affordable business rental rates are available to students and faculty and staff members.
- **Metro Express bus service** to and from the Twin Cities runs daily, 365 days a year. The College has a designated bus stop in front of Willis Hall that serves as a shelter during inclement weather. The most popular destinations are the Minneapolis–St. Paul International Airport and the Mall of America, en route to the downtowns of Minneapolis and St. Paul. The College works closely with the bus company to ensure additional buses are put into service at the start and end of academic terms in order to accommodate the high volume of student travelers going to and from the airport.
- **Local bus service** is free for Carleton and St. Olaf students four nights a week plus Sunday afternoons. Paid for by both colleges and their student governments, the bus circulates between both colleges and popular local retail and restaurant locations that are difficult to walk to. Ridership in 2010 was 29 percent higher than 2009, a result of student employees marketing to students through the information desk at Sayles-Hill and on Facebook.
- **Campus fleet vehicles** are available to College-recognized student organizations and to faculty and staff members when conducting official College business. Shifting the reservation process to the College's event management software resulted in better utilization of vehicles and passenger counts and a total reduction of six fleet vehicles since 2008. The current fleet is composed of 12 hybrid or flex-fuel vehicles and one standard fuel cargo van—specifically, four Toyota Prius hybrids (MPG city/hwy 48/45), one Ford Fusion hybrid (MPG city/hwy 41/36), seven Dodge Grand Caravan flex-fuel minivans (MPG city/hwy 17/24), and one Ford Windstar standard fuel cargo minivan (MPG city/hwy 16/21).
- **Taxi vouchers and Northfield Transit bus tokens** are funded by the College and are available to students participating in community-based work-study and academic civic engagement projects in the broader Northfield community, eliminating another reason for students to need a personal vehicle.
- **Bicycle options** include the Green Bike and Yellow Bike student organizations that provide free short term bicycle use for students.
- **Carpool and vanpool** resources are available on the maps and transportation Web site. Participants are eligible for a designated parking space for the shared vehicle.
- **The transportation Web site** will be redesigned in spring 2011 with the goal of unifying the transportation options available to students, faculty and staff members, and visitors.
- **Northfield Grass Roots Transit Initiative** (a subcommittee of the Northfield Environmental Quality Commission) includes representation by Carleton staff members and students. The group evaluates and promotes transit solutions benefiting the broader Northfield community.

Appendix F: Sustainability/Environmental Student Groups

Carleton-Focused

Environmental Advisory Committee

Formed in 2001, this committee is “dedicated to upholding the Environmental Statement of Principles and the Carbon Neutrality Value Statements at Carleton College, ensuring that these visions and ideals are incorporated into all aspects of College function.” The committee is chaired by the manager of campus energy and sustainability and is responsible for instituting and advising campus sustainability initiatives. The committee produces an annual report in the spring of each year to compile past achievements and future years’ objectives.

Residential Life Sustainability Committee

This group of RAs focuses on sustainability objectives within the residence hall environment. They support and develop communication and education campaigns and behavior change initiatives based on their intimate knowledge of the residence hall environment and its areas of opportunity.

Sustainability Assistants (STAs)

STAs assist with facilities and residential life sustainability initiatives—including both staff- and student-led projects—through a work-study position. STAs maintain the Carleton sustainability Web site and regularly update the “Shrinking Footprints” blog. They also serve as a resource to other students on topics related to sustainability at Carleton.

Students Organized for the Protection of the Environment (SOPE)

This student organization is dedicated to promoting environmental awareness and activism on campus and in the community. Students meet weekly to discuss environmental issues on campus and to work on specific projects. Ongoing projects include planning and promoting Green Wars (an inter-dorm energy saving contest) every February, hosting Earth Week activities, and maintaining the Green Bikes program. Past projects have included starting the Adopt-A-River program; bringing environmental speakers to campus; starting and encouraging a composting program at Carleton; sending representatives to local, regional, and national conferences; and encouraging the College to purchase its first wind turbine. SOPE primarily works on Carleton-related issues.

Food Truth

Members of Food Truth raise food consciousness by examining the environmental, political, social, and ethical impacts of what people eat. The group organizes events, speakers, community dinners, films, workshops, and field trips to encourage discussion and advocacy around food-related issues. Past projects have

included meatless/trayless challenges in the dining halls; visits to farms; analyzing the dining halls’ environmental impact using the Real Food Calculator; discussions on topics such as migrant workers and fair labor, the farm bill, and cheese-making; sending delegates to local and regional conferences; and sharing and teaching food preparation through potlucks. Food Truth also includes the Carleton chapter of Slow Food U.S.A.

Farm Club

Farm Club members help run Carleton’s student organic farm, which sells produce to the dining halls and provides food for the residents of Farm House. Students oversee all aspects of the farm—planning, planting, weeding, harvesting, and coordination with Carleton’s food service vendor. Farm Club also helps to run Eat The Lawn, a small on-campus garden started in 2009 as a project on edible landscaping.

Yellow Bike Club

The Yellow Bike Club repairs old bikes, paints them yellow, and puts them around campus. Everybody is encouraged to use the bikes on campus (not off campus). The club also collaborates with SOPE to fix up bikes for the Green Bikes program, in which students can check out a bike to ride anywhere on campus or in Northfield. Club members also help people repair their personal bikes.

Focusing Outside of Carleton

Minnesota Public Interest Research Group (MPIRG)

MPIRG is a statewide, non-profit, nonpartisan student activism organization that works on social justice and environmental issues through grassroots political work. MPIRG is open to all students and advocates educated activism. Task forces at Carleton’s chapter for the 2010–11 academic year include social justice, environment, and democracy. In recent years, the environment task force has worked on green transportation issues, a local organic foods campaign, and implementing composting on campus and in Northfield.

Engineers Without Borders

The mission of the Carleton chapter of Engineers Without Borders is to partner with developing communities around the world in order to improve their quality of life. The group works to implement engineering projects that are both environmentally and economically sustainable. Past projects have included building high altitude greenhouses and irrigation in Ccapacmachay, Peru; constructing a biodiesel reactor to convert waste vegetable oil into usable biodiesel fuel; and participating in Northfield community outreach through the Tackling Obstacles and Raising College Hopes (TORCH) program.

Outdoor Appreciation

Carleton Association of Nature and Outdoor Enthusiasts (CANOE)

CANOE organizes and runs a wide variety of student-led trips and activities to help Carleton students learn about and experience the outdoors; the group believes that the enjoyment of outdoors leads to respect for nature and engenders ecological thought and concern. CANOE lends a variety of outdoor equipment for independent student use free of charge and has an interest house (Chaney).

Cole Student Naturalist Program

This program is not a student organization—it is a work-study opportunity for two or three students from each class. The students are trained in natural history and nature interpretation and then given the opportunity to lead field trips and participate in other educational events for Carleton and the Northfield community. First-year students are recruited for the program at the end of each winter term, based not only on their knowledge of natural history (birds, plants, geology) but also on their enthusiasm for learning about the natural world and sharing it with others. In addition to the paid student naturalists, volunteers are welcome to the program.

Service-Oriented

Arbor

Members of Arbor learn about the environment and help with the restoration and management of the Cowling Arboretum and McKnight Prairie. Group activities include collecting prairie and forest seeds and nuts, removing brush and trash, and planting and protecting native tree seedlings. Group members also have the opportunity to undertake Independent projects.

Kids For Conservation (KFC)

Student volunteers in KFC work with elementary school children to teach environmental awareness. The group's ultimate goal is to encourage students to make responsible decisions about the environment. Lesson plans are designed by Carleton students and taught in teams of approximately four. Each group teaches interactive lessons that range from 30 minutes to one hour in the same classroom for four to six weeks each term.

Adopt-A-Highway

Operated in conjunction with the volunteer network at St. Olaf College, Adopt-A-Highway sends volunteers to spend part of a weekend afternoon cleaning up a designated five-mile stretch of Highway 3. Transportation and equipment are provided.

Adopt-A-River

Because Northfield's Cannon River flows through a residential area and picks up a large amount of trash along the way, Adopt-A-River organizes volunteers to help clean up the trash in and along the river.

Interest Houses

Wellstone House of Organization and Activism (WHOA)

Residents in this house foster activism on campus and encourage students to connect with communities outside Carleton by sponsoring events, delegations, and dinners and building links between Northfield, St. Olaf, and Carleton.

Sustainable Living House (Farm and Parr)

The residents of Farm and Parr Houses foster awareness and appreciation of sustainable agriculture and sustainable living by assisting Farm Club with planting and tending the student organic garden, offering educational programs focusing on sustainable living, and hosting communal dinners.

Appendix G: Glossary

AASHE—Association for Advancement of Sustainability in Higher Education

AASHE STARS—Association for Advancement of Sustainability in Higher Education sustainability rating program

ACUPCC—American College and University Presidents' Climate Commitment

Allowance—a permit to emit a specified volume of an air pollutant, issued under air quality regulations that allow emissions trading (*see cap-and-trade*)

Backpressure steam turbine—a technology that utilizes thermal energy in the form of steam to generate mechanical energy to drive a generator

Biodiesel—a substitute fuel for conventional diesel that is created from plants with high oil content, such as soybeans, canola, and sunflower, and/or from waste vegetable oil from food production operations

Biomass gasification—the process of manufacturing a natural gas substitute from the combustion of biomass at low oxygen levels, also known as synthetic gas

Business-as-usual (BAU)—the expected course of operations at Carleton College based on known and planned policies and programs that can reasonably be anticipated; for the Climate Action Plan model, the BAU scenario incorporates projected student population, growth in building square footage, and primary energy use over a 40 year time horizon to estimate Carleton's GHG emissions absent any proactive mitigation efforts

Cap-and-trade—a program in which the government sets an overall emission target, or “cap,” for facilities that it specifies to be regulated; once the cap (the sum of all allowed emissions from all regulated facilities) has been set, tradable emissions allowances (rights to emit) are distributed (either auctioned, or freely allocated, or some combination of these), and each allowance authorizes the release of a specified amount of greenhouse gas emissions, generally one metric ton of carbon dioxide equivalent (CO₂e)

Carbon allowance—a permit to emit one metric ton of CO₂e under a cap-and-trade regulatory scheme

Carbon dioxide equivalent (CO₂e)—a metric used to compare the amounts and effects of emissions of different greenhouse gases, determined by multiplying the emissions of a gas (by mass) by the gas's global warming potential (GWP)

Carbon footprint of the grid—the carbon intensity of the electricity that is delivered to an end user within a specific regional public electric system (grid), measured by the taking the total MTCO₂e emitted by electric generating plants and dividing by the number of megawatt hours of electricity generated by all power plants within the specified electricity system

Carbon offsets—*see offsets*

Carbon sequestration—removal of atmospheric CO₂, either through biological processes (i.e., plants and trees) or through geological processes such as storage of CO₂ in underground reservoirs

Carbon tax—an emission tax on each unit of CO₂ equivalent emitted from a regulated source of GHG or a surcharge on the carbon content of oil, coal, and gas that discourages the use of fossil fuels and aims to reduce carbon dioxide emissions

Cogeneration—the use of a heat engine or a power station to simultaneously generate both electricity and useful heat

Combined heat and power (CHP)—*see cogeneration*

Cradle-to-cradle—a concept that refers to the cyclical nature of processes or materials wherein they are recycled or returned to a usable form rather than being discarded in a landfill as expressed in the opposing phrase, “cradle-to-grave”

Energy use intensity (EUI)—a metric used to measure and compare the amount of energy used between buildings, derived by summing the total BTUs of primary energy used by a building (i.e., natural gas, electricity, or other primary energy fuels such as propane and heating fuel) and dividing the total by the gross square footage of the building

Environmental literacy—a basic understanding of the principles and vocabulary of sustainability and environmental issues.

Gas-turbine cogeneration—the simultaneous production of steam heat and electricity through a natural gas-fired turbine

Geothermal energy—*see ground source heating and cooling*

GHG—greenhouse gas

Global warming potential (GWP)—a system of comparing the warming effects of different gases over a specified time horizon; The GWP-weighted emissions of direct greenhouse gases are presented in terms of equivalent emissions of CO₂ (the cumulative warming effect of a mass unit of CO₂ is assigned the value of 1, and effects of emissions of non-CO₂ greenhouse gases are estimated as multiples; for example, over the next 100 years, a gram of methane in the atmosphere is currently estimated as having 23 times the warming effect as a gram of carbon dioxide)

Gross square feet (GSF)—unit of measurement of building space that includes all spaces within the exterior walls

Grid footprint change—the change in carbon intensity of the electricity supplied to Carleton by its electricity provider, Xcel, as a result of changing the fuel mix used to generate electricity to no- and low-carbon fuels and renewable energy sources

Greenhouse gas (GHG)—gaseous constituents of the atmosphere that absorb and emit radiation at specific wavelengths such that a greenhouse effect is created, including water vapor, carbon dioxide, nitrous oxide, methane, and ozone

Ground source heating/cooling (geothermal)—the use of earth's near constant temperature to condition indoor spaces, using a heat exchanger to extract heat from the ground in winter and cooling in summer

kBtu—thousand British thermal units (BTU).

Methane flaring—destruction of fugitive methane gas from landfills or oil and gas production operations by converting it into carbon dioxide—a greenhouse gas with significantly less global warming potential—prior to emitting it into the atmosphere

MTCDE (metric ton of carbon dioxide equivalent)—unit of measurement that compares the emissions of various greenhouse gases against the standard of one unit of carbon dioxide based upon global warming potential

MTC02e (metric ton of carbon dioxide equivalent)—*see MTCDE*

Net square feet (NSF)—unit of measurement of building space that excludes the footprint of exterior walls, interior walls and partitions, lavatories, mechanical space, elevators, and stairways

Offset—a tradeable energy commodity representing one metric ton of carbon dioxide equivalent (MTCDE) abated or sequestered

Pollution allowance—*see allowance*

Reciprocating engine—a heat engine that generates steam through the movement of pistons that run a generator to produce electricity

Renewable energy credit (REC)—a tradeable energy commodity representing one megawatt of electricity generated by an eligible renewable resource facility

Retro-commissioning—a whole-building approach to tuning up and recalibrating building systems to restore them to their original design; over time most building systems drift away from their design performance targets

Simple payback—the amount of time it takes for savings resulting from project implementation to equal initial project costs; this method does not factor in the time value of money or operating and maintenance costs