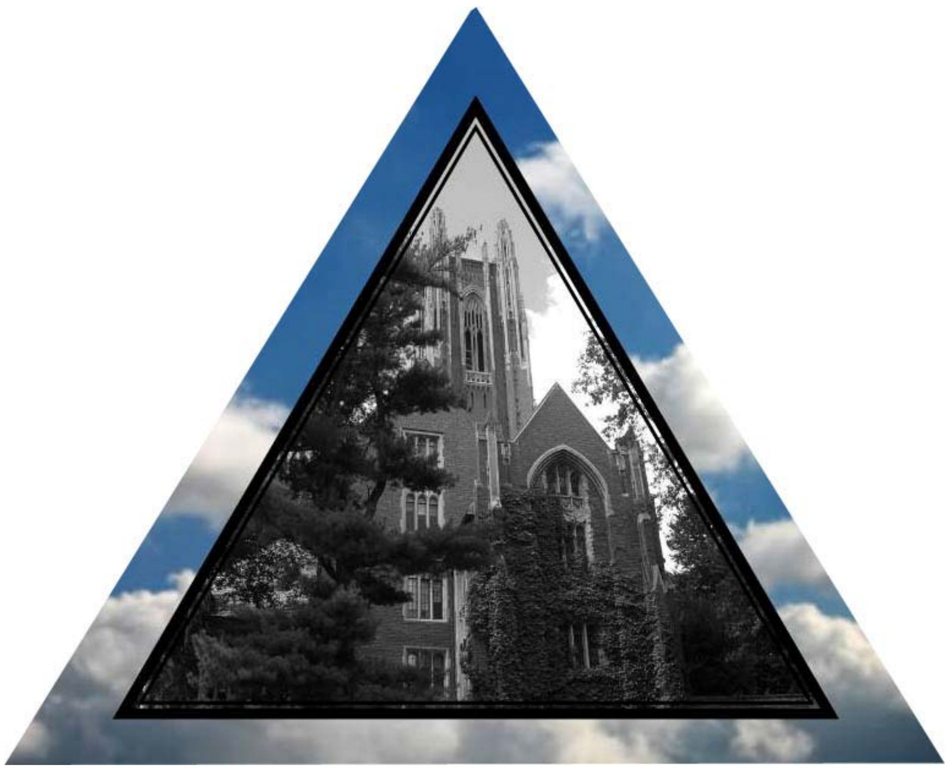
Climate For Change



Greenhouse Gas Audit
Wellesley College

Environmental Studies 300, Spring 2008

Authors:

Environmental Studies 300, Spring 2008

Dr. Elizabeth DeSombre	Professor, Advisor
Amy Harrington	Energy/Land Use Sector Coordinator
Alexander Jenko	Transportation/Waste Sector Coordinator
Samantha Jones	Overall Data and Graphics Editor
Monisha Khurana	Project Manager
Courtney Streett	Media and Publicity Contact
Amanda Tai	Ruhlman Presentation Coordinator
Margaret Weirich	Mitigation Manager
Anli Yang	Overall Text Editor

Acknowledgments:

Our class could not have completed this report without the tremendous help that we received from Wellesley College administrators, faculty, and staff. You have been an invaluable asset to us by graciously responding to last-minute emails, allowing us to utilize your resources, and letting us make makeshift offices (with doors as tables).

Thank you also to all of those whom attended our Ruhlman presentation-your support was truly appreciated. This includes Wellesley College President, H. Kim Bottomly, whose interest in our research is treasured.

Finally, we would like to extend our gratitude to Beth, who has led us on this journey and challenged us with this project over late nights and early mornings. We thank you for all of the celebrations, the 'innocuous' coffee, the extensions, and your guidance throughout this project.

We would like to thank the following individuals and committees:

Professor Elizabeth DeSombre, President H. Kim Bottomly, Patrick Willoughby, George Hagg, John Olmsted, Jennifer Desjarlais, Mike Dawley, Hearther Ayres, Tom Kane, Peter Eastment, Andy Evans, Larry Baldwin, Kevin Reardon, Jack Daigle, Jason LaPrade, Ann Hamilton, George Reebe, Officer William Bowman, Professor Nicholas Rodenhouse, Professor Stacy Sneeringer, Lisa Wiley, Ros White, Harry Clark, Suzanne Howard, Fran Adams, Mary Pat Navins, Jodi Colman, Phil Levine, Bridget Belgiovine, Avery Esdaile, Donna Ng, Amy Chandler-Nelson, Joe Leva, Pete Zuraw, Jennifer Thomas-Starck, Ellie Perkins, Professor Jay Turner, Professor Dan Brabander, The Environmental Studies Program, The Sustainability Committee, and The Ruhlman Committee

Table of Contents

List of Figures & Tables

List of Abbreviations/Acronyms

AASHE – Association for the Advancement of Sustainability in Higher Education

ACUPCC or PCC – American College and University Presidents Climate Commitment

BTU – British Thermal Unit; a unit of measurement for the amount of heat energy in fuels

CA-CP – Clean Air-Cool Planet; an environmental non-profit with a calculator that determines college carbon emissions

CFCs – Chlorofluorocarbons; an exclusively anthropogenic greenhouse gas and chemical compound that depletes ozone

CFL – Compact Fluorescent Lightbulb

CH_4 – Methane; a greenhouse gas

CHP – Combined heat and power, also known as cogeneration

CO_2 – Carbon Dioxide; a greenhouse gas

CO_2e – Carbon dioxide emissions equivalents; emissions from other greenhouse gases, such as CH_4 and N_2O are converted into CO_2e, which is the standard metric for greenhouse gas emissions, whether they come from CO_2 or other greenhouse gases.

CO_2MMBTU – Carbon dioxide per million British Thermal Units

Co-Gen – Co-generation plant

DEP – Department of Environmental Protection (state agency)

EPA – United States Environmental Protection Agency

ES – Environmental Studies (Program)

Gg – Gigagram; equal to one million tonnes of CO_2

GHG – Greenhouse gas

GIS – Geographic Information Systems

GWSA – Global Warming Solutions Act

H_2O – Water (vapor); the most abundant greenhouse in the atmosphere

HFCs – Hydro-fluorocarbons

HP – House President

IPCC – Intergovernmental Panel on Climate Change

IS – Information Services

LCA – Life Cycle Analysis

LED – Light-emitting diode

LEED – Leadership in Energy and Environmental Design; a third party certification program for the design, construction, and operation of green buildings.

MIT – Massachusetts Institute of Technology

MPG – Miles per gallon

$MTCO_2e$ or TCO_2e – (metric) tonnes of CO_2 equivalent

N_2O – Nitrous Oxide; a greenhouse gas

O_3 – Ozone; a greenhouse gas

OWB Shuttle – Olin/Wellesley/Babson Shuttle

PPMV – Parts per million by volume

RA – Resident Assistant

RD – Resident Director

ResStaff – Residential Life Staff, made up of House Presidents (HPs), Resident Assistants (RAs), and Resident Directors (RDs)

RGGI – Regional Greenhouse Gas Initiative

SAC – Sustainability Advisory Committee

SF_6 – Sulfur hexafluoride; a greenhouse gas

Short tons – British unit tons; equivalent to 0.907 metric tonnes

SUV – Sport Utility Vehicle

Tonnes– Metric tonnes; equivalent to 1000 kg, or 1.102 short tons

UNFCCC – United Nations Framework Convention on Climate Change

WEED – Wellesley Energy and Environmental Defense, Wellesley College's environmental student organization

WTE – Waste to energy; a method of waste treatment that creates energy in the form of heat or electricity from a source of waste

WVO – Waste vegetable oil; an alternative to diesel fuel

Executive Summary

Anthropogenic climate change presents one of the most important social, economic, and environmental challenges of our time. Because of the difficulties and opportunities presented by climate change, Wellesley must be a part of the solution. While the college has already taken on numerous greening initiatives, more can and should be done. This report quantifies the greenhouse gas emissions of Wellesley College and presents options for decreasing our negative impact on the global climate system. In addition, we evaluated the feasibility and desirability of having Wellesley sign onto and meet the requirements of the American College & University Presidents Climate Commitment (ACUPCC), a commitment to climate neutrality.

Since 1994, Wellesley's total greenhouse gas emissions have remained relatively constant over time. Including all the factors considered in this report, the college emitted a total of 48,350 tonnes of CO_2e and, according to the boundaries set by the ACUPCC, 38,563 tonnes of CO_2e in 2007. The largest source of these greenhouse gas emissions, accounting for 64% of total emissions, is the cogeneration plant. Therefore, the trajectory of campus greenhouse gas emissions has and will continue to be tied closely tied to energy production and consumption. Wellesley's next largest source of emissions, accounting for almost all of our remaining emissions, is our transportation sector. Most of these transportation emissions come from student travel to and from home at the beginning and end of each semester. The next biggest component of transportation emissions comes from academic reimbursed travel, such as conference and research travel conducted by Wellesley professors and students. Any emissions from Wellesley waste generation and disposal or land use account for less than 1% of our total emissions. (Please note that some waste-related emissions are counted within the transportation sector.)

This report outlines a variety of options to reduce the College's carbon footprint at the administrative level. There is, however, a select group of recommended mitigation strategies that have been deemed most reasonable for campus implementation and worth the initial investments of time and money. These options include hiring a Sustainability Coordinator, implementing greener purchasing policies, continuing renovations with a focus on energy efficiency, and various individual actions. Offsets will also be a necessary tool for achieving carbon neutrality under the ACUPCC. Comprehensive mitigation strategies will require administrative action as well as support from the college as a whole.

Committing Wellesley to the ACUPCC is an important step toward decreasing our greenhouse gas emissions. While the commitment to carbon neutrality outlined in the ACUPCC is incomplete, we feel it is a worthy commitment to make. A demonstrated commitment to addressing the climate change challenge will bring Wellesley many benefits, including energy cost savings, a smaller chance of catastrophic environmental change, and a higher green status with which to compete with other schools for both new students and alumni contributions. It must be remembered, however, that there is no reason to limit ourselves to only meeting the requirements of the ACUPCC; we can also go above and beyond them.

Background

1.

Introduction

Anthropogenic climate change presents us with one of the most challenging social, economic, and environmental challenges of our time. Wellesley must be a part of the solution and reduce its greenhouse gas emissions because of the gravity of the problem, because Wellesley contributes to the problem by being responsible for greenhouse gas emissions, and because Wellesley is in a position to make a positive difference. Colleges and universities across the nation are committing to addressing climate change, and Wellesley can lead by making a firm commitment to decrease its carbon footprint.

The background portion of this report (Chapters 1-6) give an overview of climate change science, the regulatory context of climate change, Wellesley's greening background, and the potential benefits to Wellesley of making a strong commitment to fight climate change. In order to reduce our emissions, however, we must ascertain the sources and quantities of these emissions. This greenhouse gas audit quantifies Wellesley's greenhouse gas emissions. Chapter 7 gives an overview of our overall emissions and audit procedures, while Chapters 8-11 break down our emissions by sector: Energy, Transportation, Waste, and Land Use.

Wellesley's first greenhouse gas emissions audit was undertaken and completed by the ES 300 class of Spring 2003. Our audit seeks to build their techniques and findings. Using the 2003 report as a starting point, we refine measurements, include more information than was previously available, and paint a much more comprehensive picture of Wellesley's greenhouse gas emissions than could previously have been done.

In addition to quantifying Wellesley's greenhouse gas emissions, we seek to evaluate the feasibility and desirability of signing onto and meeting the requirements of the American College & University Presidents Climate Commitment (ACUPCC), a commitment to carbon neutrality. We evaluate, first, whether or not Wellesley College is capable of meeting such a commitment. We decide that Wellesley can, indeed, meet the requirements of the ACUPCC.

We then looked to answer the question of whether or not such a commitment is something the college *should* do. We decid that, overall, Wellesley should take on the ACUPCC.

Using the tools learned from quantifying our carbon footprint, we also are able to present a set of mitigation options (Chapter 12) to decrease Wellesley's greenhouse gas emissions. These options vary widely in terms of financial cost, implementation difficulty, and carbon savings. The options encompass both institutional and individual actions. We have evaluated each based on numerous criteria, and, where we could, quantified the costs and benefits of each option.

Our goal is to present a comprehensive picture of how Wellesley can make a positive difference with respect to climate change. By quantifying our emissions, understanding the processes that produce these emissions, and charting our mitigation options, we can best understand where to make efficient reductions. We hope this report will be used as a reference by students, faculty, staff, and administrators working to reduce our greenhouse gas emissions.

2.

The Basics of Climate Change

Before we can assess Wellesley's contribution to climate change, we must first understand how climate change works. The sun supplies the Earth with energy in the form of electromagnetic radiation, forms of which include visible light, ultra-violet (UV) radiation, and infrared radiation. Most of the energy coming from the sun is in the form of short wavelength visible light. About one-third of the energy hits the planet and is reflected directly back into space. The remaining two-thirds is absorbed by the earth and atmosphere, and distributed across the earth's surface from the equator to the poles via atmospheric and oceanic circulation,[1] but the Earth radiates energy back into space as longer wavelength, infrared rays.[2] Figure 2.1 below illustrates the basic greenhouse effect.

The presence of greenhouse gases (GHGs) in the atmosphere prevents some of this energy from radiating back, making this planet inhabitable for life. Without the the heat trapped by the greenhouse effect, the earth's average surface temperature would be a frigid -19°C, instead of the comfortable 14°C it is now.[3] Human activities, however, have intensified the greenhouse effect through the additional input of greenhouse gases into the atmosphere, leading to anthropogenic climate change, or what is called global warming.

The atmosphere is composed of 78% nitrogen and 21% oxygen. These gases do not contribute to the greenhouse effect. Other gases, including the greenhouse gases, make up

---

1 Australian Bureau of Meteorology. *The Greenhouse Effect and Climate Change.* http://www.bom.gov.au/info/GreenhouseEffectAndClimateChange.pdf

2 National Oceanic and Atmospheric Administration. *Greenhouse Gases and Aerosols.* http://www.research.noaa.gov/climate/t_greenhouse.html

3 IPCC. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA), 99.

the remaining one percent of the atmosphere.[4] The primary greenhouse gases are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrous oxide (N_2O) and fluorinated gases such as halocarbons (CFCs), hydroflurocarbons (HFCs) and sulfur hexafluoride (SF_6).[5] Because of their molecular structure, these greenhouse gases absorb the infrared rays that are radiated back from the Earth's surface.[6]

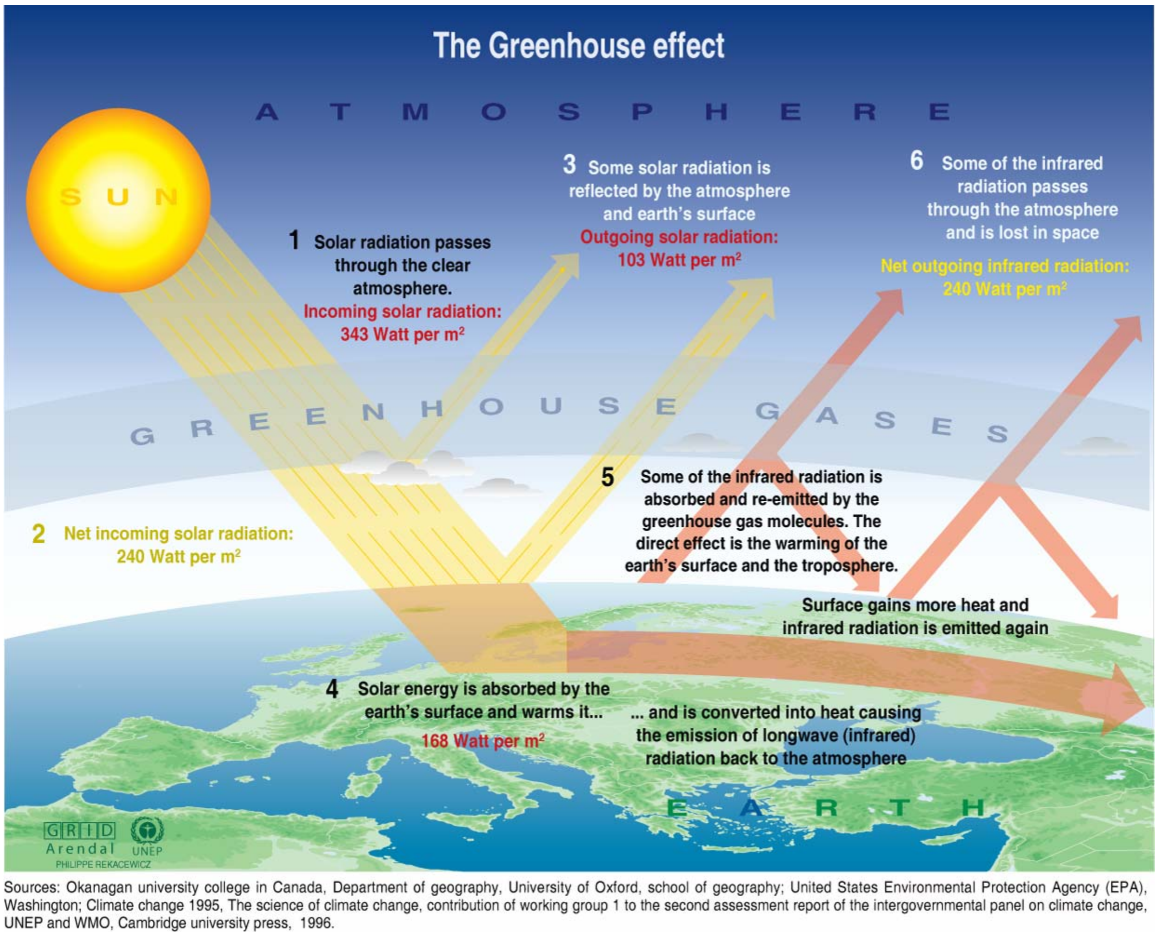


Figure 2.1: Greenhouse Effect[7]

Each greenhouse gas has a different effect and magnitude in the atmosphere. The Intergovernmental Panel on Climate Change (IPCC) has assigned a global warming potential to each of these gases in order to compare the magnitude of their contribution to the greenhouse effect, based upon their relative residence times and abundances in the

---

4 National Oceanic and Atmospheric Administration. *Greenhouse Gases and Aerosols.* http://www.research.noaa.gov/climate/t_greenhouse.html

5 U.S. Environmental Protection Agency. *Greenhouse Gas Emissions.* http://www.epa.gov/climatechange/emissions/index.html#ggo

6 Randy Russell, University Corporation for Atmospheric Research (UCAR). *The Greenhouse Effect & Greenhouse Gases* http://www.windows.ucar.edu/tour/link=/earth/climate/greenhouse_effect_gases.html&edu=high

7 Philippe Rekacewicz, UNEP/GRID-Arendal, "The Greenhouse Effect," *Vital Climate Graphics*, UNEP, http://maps.grida.no/go/graphic/greenhouse_effect

atmosphere.[8] Water vapor has a very short residence time in the atmosphere, but is the most abundant greenhouse gas and is responsible for 66-85% of the natural greenhouse effect.[9] Carbon dioxide is the second most abundant and important greenhouse gas contributing to the natural greenhouse effect, even though it has the weakest ability to trap heat.[10] It is used as a baseline to compare other greenhouse gases, and has been assigned global warming potential of 1 by the IPCC. The other greenhouse gases are much more potent and tend to have much longer residence times in the atmosphere as well as a greater ability to trap heat because of their molecular structure, but they exist naturally in smaller quantities. Because of anthropogenic inputs, carbon dioxide is the most important greenhouse gas in terms of a human impact on the climate.

There is increasing evidence that humans are playing a role in climate change and intensifying the greenhouse effect. Anthropogenic activities contribute carbon dioxide and other greenhouse gases into the atmosphere. These activities include fossil fuel combustion, deforestation, agriculture, and industrial processes.[11] In fossil fuel combustion, carbon-based fossil fuels such as coal, oil, and natural gas are being burned to generate energy and releasing carbon dioxide into the atmosphere. Land use changes such as deforestation decrease the number of trees and other plants available to sequester carbon dioxide.

The amount of carbon dioxide in the earth's atmosphere has been increasing over the past 150 years, since the Industrial Revolution. There is a correlation between increased fossil fuel usage and the increase in carbon dioxide in the atmosphere. In addition, surface temperatures of the earth have increased 0.74°C from 1906-2006, and 11 out of the 12 warmest years in that time period occurred between 1995 and 2006.[12] Vostok Ice Core data in Figure 2.2 shows a correlations between temperature and carbon dioxide (CO_2) concentrations in the atmosphere. The Keeling Curve in Figure 2.3 shows the increase in carbon dioxide in the atmosphere since 1960.

---

[8] Randy Russell, University Corporation for Atmospheric Research (UCAR). *The Greenhouse Effect & Greenhouse Gases* http://www.windows.ucar.edu/tour/link=/earth/climate/greenhouse_effect_gases.html&edu=high

[9] Randy Russell, University Corporation for Atmospheric Research (UCAR). *The Greenhouse Effect & Greenhouse Gases* http://www.windows.ucar.edu/tour/link=/earth/climate/greenhouse_effect_gases.html&edu=high

[10] Randy Russell, University Corporation for Atmospheric Research (UCAR). *The Greenhouse Effect & Greenhouse Gases* http://www.windows.ucar.edu/tour/link=/earth/climate/greenhouse_effect_gases.html&edu=high

[11] Pew Center on Global Climate Change, *Climate Change 101: The Science and Impacts*, http://www.pewclimate.org/docUploads/101_Science_Impacts.pdf

[12] IPCC. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA), 103.

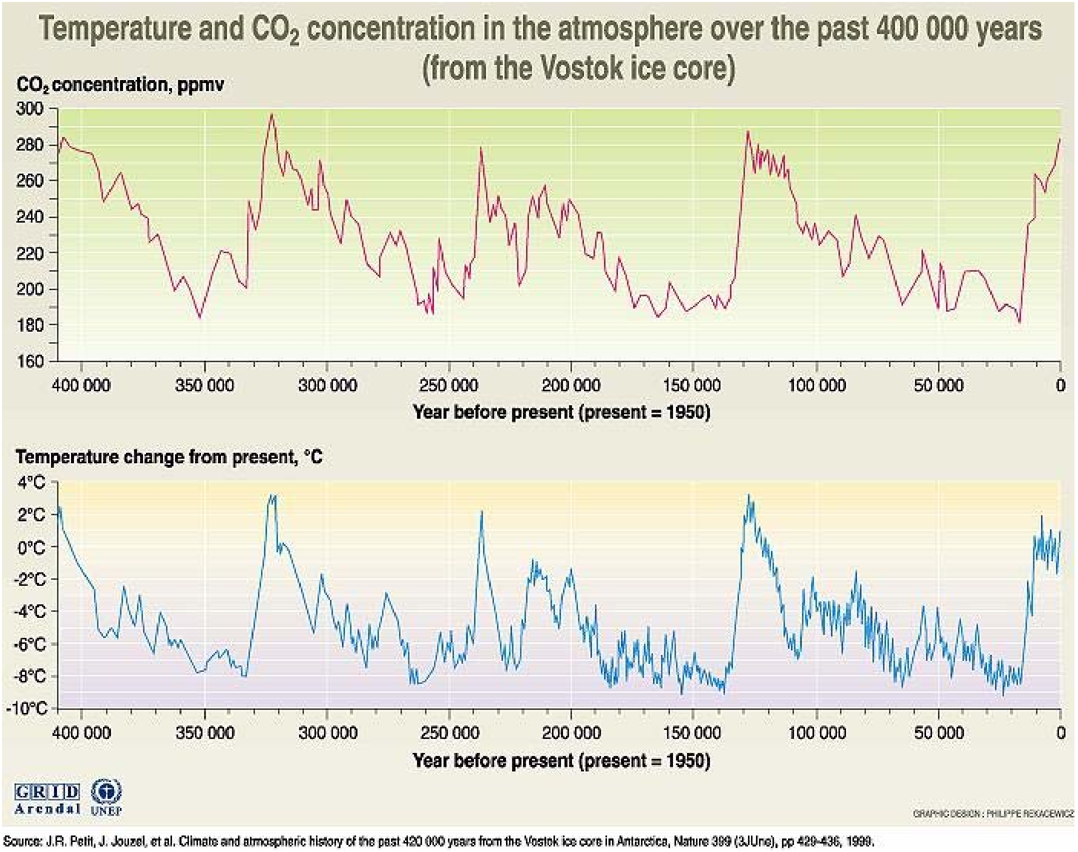


Figure 2.2: Vostok ice core data.[13]

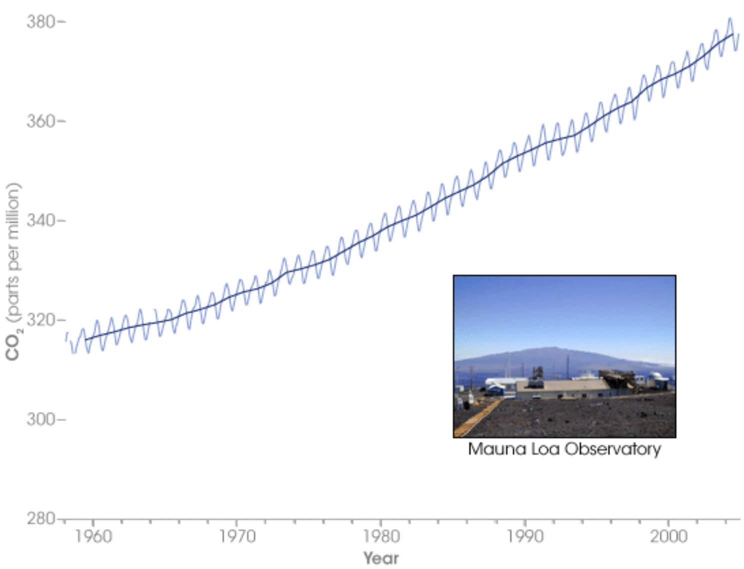


Figure 2.3: The Keeling Curve.[14]

---

[13] Takle, Eugene. 2005 *Atmospheric Composition, Carbon Dioxide.* http://www.geology.iastate.edu/gccourse/chem/gases/gases_lecture_new.html (Fig. 5)

[14] Simmon, Robert. *The Keeling Curve.* http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=16954

Climate change is a phenomenon that self-perpetuates through certain positive feedback loops. For instance, as the atmosphere warms, the concentration of water vapor increases (because the warmer it is, the more water evaporates), and warmer air can hold more water. [15] With more water vapor in the atmosphere, increased amounts of radiation are trapped and warm the earth. Another example occurs when warmer temperatures lead to ice melting, which then causes more energy—heat—to be absorbed by the ground and water (ground and water absorb more heat than ice, which is more reflective, does). More heat causes more ice to melt. A third example is that as the temperature increases, permafrost melts, which releases methane (a GHG) into the atmosphere causing further warming.[16]

Climate change involves a complex set of processes, and there are uncertainties about the science and magnititude of the factors that interplay to cause climate change. The concept of radiative forcing compares the relative strengths of various factors in contributing to climate change. As Figure 5 shows, there is uncertainty in how much certain climate components are contributing to climate change.[17] Some of the other uncertainties include the effects of clouds and aerosols. Since clouds have high albedo (reflectivity), they reflect sunlight and send the energy back into space. They are also composed of water vapor and absorb infrared radiation, so their net effect is uncertain.[18] There still remains a lot of uncertainty in the effect of clouds. Furthermore, darker particles such as soot contribute to warming, as they absorb heat from the sun.[19]

Much of the ambiguity that surrounds the issue of climate change is related to the potential effects and timescale of these effects, as models are being used to determine the potential extent and consequences of climate change. The effects of climate change are both many and wide-reaching. The effects of climate change are both hard to quantify and dependent on geographic location. Weather patterns will change. Even at the 2000 levels of emissions, scientists predict that global temperature will rise at a rate of 0.1° C per decade.[20] Sea levels will rise both through melting of glaciers and through thermal expansion, and

---

[15] University of California, San Diego. *The Greenhouse Effect.* http://earthguide.ucsd.edu/globalchange/greenhouse_effect/01.html

[16] Sample, Ian. "Warming hits 'tipping point.'" *The Guardian*, August 11, 2005.

[17] IPCC. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA), 205

[18] University of California, San Diego. *The Greenhouse Effect.* http://earthguide.ucsd.edu/globalchange/greenhouse_effect/01.html

[19] Hansen, James et. al. *Global Warming in the 21st Century: An Alternative Scenario.* Goddard Institute for Space Studies. http://www.giss.nasa.gov/research/features/altscenario/

[20] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

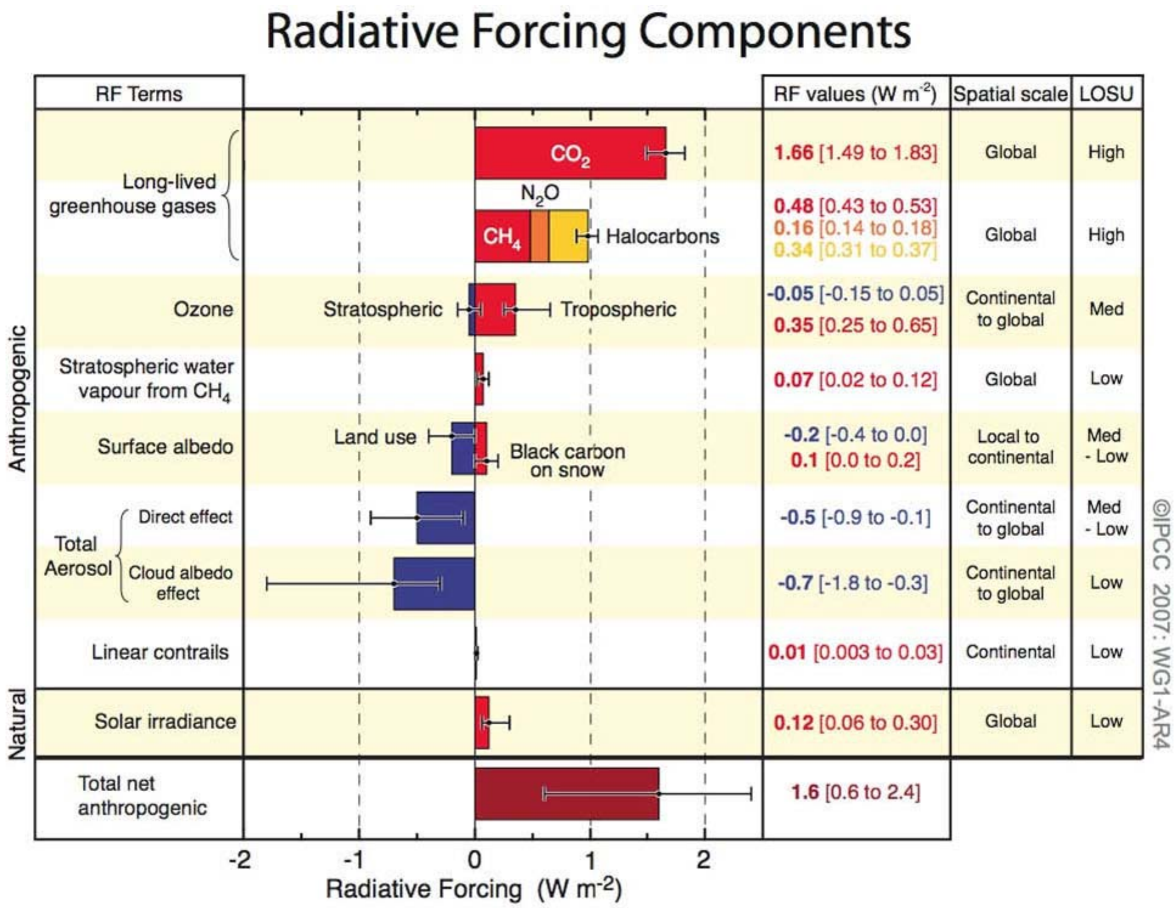


Figure 2.4: Radiative Forcing and the uncertainty involved in determining the effects of specific factors[21]

people with coast front property may seek to move to areas less prone to damage to avoid rising insurance costs.[22] The warmer weather will lead to increased precipitation in some areas, and extended droughts in others; droughts in especially vulnerable areas may dramatically increase the risk of forest fires.[23] Though people tend to associate higher temperatures with climate change, some areas, such as the United Kingdom, will probably experience a cooling trend. Warmer water may lead to a longer hurricane season and to more intense tropical storms.[24]

---

[21] (IPCC. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA), 205)

[22] "Issues: Global Warming". National Resources Defense Council. Accessed Feb. 10, 2007. http://www.nrdc.org/globalWarming/fcons.asp

[23] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[24] "Issues: Global Warming". National Resources Defense Council. Accessed Feb. 10, 2007. http://www.nrdc.org/globalWarming/fcons.asp

A variety of economic and social problems will rise out of the changing weather patterns. One of the most affected areas is agribusiness; scientists predict that changing weather patterns will affect an already unstable industry. Bouts of warmer weather may lengthen the growing season, whereas lessened precipitation may parch crops in other areas. The primary concern is that the destabilized climate may create food shortages that could leave many people hungry.[25] Infectious diseases will spread; malaria, for example, will become more common farther north due to the increased breeding range for the mosquitoes that carry it.[26] Rising sea levels and an increased risk of storms may cause those who are in dangerous areas to emigrate to places less prone to damage.[27] Migratory patterns of many species may change—they may end up flying to different places or at different times of the year—due to the changes in temperature. Species may go extinct because of the temperature changes, and many ecosystems may greatly diminish in size or disappear altogether.[28] Coral reefs are one notable example because they can only survive within a narrow temperature range. As the temperature rises the pH of ocean water may go up, causing a mild form of carbonic acid to saturate the water. This acidic ocean may harm coral reefs, thus destroying one of the richest and most biodiverse ecosystems on our planet.[29]

The United States, China, and the European Union together emit roughly 50% of the world's greenhouse gases, with China having just surpassed the U.S. in terms of yearly total GHG emissions.[30] The U.S. still surpasses China in per capita emissions and historical total emissions, however. Overall, industrialized countries currently emit far more GHGs than non-industrialized countries, due to extensive combustion of fossil fuels and agricultural techniques. As one of the largest GHG emitters in the world, the United States needs to look critically at how it is emitting GHGs. In the United States, anthropogenic CO_2 emissions come primarily from fossil fuel combustion, electricity generation, and transportation.

Carbon dioxide is by far the most prolific greenhouse gas, accounting for roughly 77% of greenhouse gas emissions emitted in the U.S., where CO_2 emissions have been increasing by about 1% every year since 1996.[31] Currently, 14% of all CO_2 in our

---

25 "Agriculture and Climate Change: FAO's Role". Updated Dec. 5, 1997. Accessed Feb. 11, 2007. Food and Agriculture Organization of the United Nations. http://www.fao.org/NEWS/1997/971201-e.htm

26 "Issues: Global Warming". National Resources Defense Council. Accessed Feb. 10, 2007. http://www.nrdc.org/globalWarming/fcons.asp

27 "Ecomigration: Global Warming Will Increase Environmental Refugees". Mongabay.com. Updated Nov. 28, 2007. Accessed Feb. 10, 2008. http://news.mongabay.com/2007/1128-ecomigration.html

28 Roach, John. "By 2050 Warming to Doom Million Species". National Geographic News. Updated July 12, 2004. Accessed Feb. 11, 2008. http://news.nationalgeographic.com/news/2004/01/0107_040107_extinction.html

29 Pew Center on Climate Change. *Press Release: Global Warming Expected to Further Degrade Coral Reef Systems.* Accessed April 7, 2008. http://www.pewclimate.org/press_room/global_warming_reefs.cfm

30 Netherlands Environmental Assessment Agency. *China Now No. 1 in CO2 Emissions; USA in Second Position.* Accessed April 7, 2008. http://www.mnp.nl/en/dossiers/Climatechange/moreinfo/Chinanowno1inCO2emissionsUSAinsecondposition.html

31 EPA, 2008: Executive Overview. *U.S. Inventory of Greenhouse Gas Emissions and Sinks.* *http://www.epa.gov/climatechange/emissions/usinventoryreport.html*

atmosphere has been produced by humans,[32] Methane emissions come from livestock, landfills, and natural gas systems, and nitrous oxide emissions come primarily from agricultural soil management, mobile combustion, and nitric acid production.[33] In 2006, for example, 81% of N_2O emissions came from agricultural soil. In 2006, amongst implied sectors industry was responsible for the most GHG emissions, followed by transportation, commercial, residential, and agricultural sectors.[34] Carbon dioxide comprises the great majority of anthropogenic GHG emissions, while CH_4 is 20 times more effective per molecule than CO_2 at trapping heat in the atmosphere while N_2O is approximately 300 times more powerful than CO_2.[35] With the immense emissions occurring presently, scientists predict that global warming will have pronounced effects on our planet. The effects of global warming should lead policymakers to rethink the way they approach environmental issues.

Responding to Skeptics

There are people who believe that anthropogenic climate change does not exist, and try to find alternative explanations for the evidence of climate change. Some scientists exploit uncertainties to further their claim that climate change is not an important issue to address. Many of these skeptics, however, have some sort of vested interest in proving that climate change is not important. They are often funded by lobbyists and groups such as oil companies that are trying to prove that climate change is non-existent and has been exaggerated by scientists and the media.[36] Furthermore, governmental organizations such as the Environmental Protection Agency (EPA), and international groups such as the Intergovernmental Panel on Climate Change (IPCC), strongly believe that anthropogenic climate change is a pressing issue to address. While there still remains much we are not completely certain about, there is a lot that we do know about the increasing human impact on the climate system.

---

32 Carbon Dioxide Information Analysis Center. *Frequently Asked Global Change Questions.* http://cdiac.ornl.gov/faq.html#Q7 Accessed April 7, 2008.

33 EPA, 2008: Executive Summary. *U.S. Inventory of Greenhouse Gas Emissions and Sinks. http://www.epa.gov/climatechange/emissions/usinventoryreport.html*

34 EPA, 2008: Executive Summary. *U.S. Inventory of Greenhouse Gas Emissions and Sinks. http://www.epa.gov/climatechange/emissions/usinventoryreport.html*

35 EPA, 2008: Executive Summary. *U.S. Inventory of Greenhouse Gas Emissions and Sinks. http://www.epa.gov/climatechange/emissions/usinventoryreport.html*

36 Exxon Still Funding Climate Change Deniers. http://www.greenpeace.org/usa/news/exxonsecrets-2007

3.

Regulatory Context

Greenhouse gas emissions do not pose a stationary or directional problem. Carbon dioxide emissions, no matter where they come from, have the same effect on the global system. This characteristic provides both difficulties and advantages for addressing climate change. Thus a necessary response is collective action at an international level is needed.

The United Nations Framework Convention on Climate Change (UNFCCC), created in 1992, has since been ratified by 192 countries from Asia, Africa, Europe, North America and South America.[37] The objective of the convention is "to achieve stabilization of atmospheric concentrations of greenhouse gases at levels that would prevent dangerous anthropogenic interference with the climate system."[38] To achieve these goals, the Kyoto Protocol to the UNFCC was created in 1997 to commit developed, industrialized countries to reduce their greenhouse gas emissions by a global average of at least 5% of 1990 levels by 2012. To reach that goal, different countries have varying commitments under the protocol. Developing countries, such as China and India, are required to monitor and report greenhouse gas emissions, but are not obligated to reduce these emissions.

In 2001, President George W. Bush announced his opposition to the Kyoto Protocol, citing the fact that it does not include obligations for developing countries and that it could hurt the U.S. economy.[39] Before the Kyoto Protocol could enter into force, 55 developed countries accounting for at least 55% of developed world 1990 global emissions had to sign and ratify the Protocol. After ratification by Russia in 2004, the Kyoto Protocol entered into force in 2005. The United States and Kazakhstan are the two signatory nations to the UNFCCC that have not yet ratified the protocol to date. It is particularly significant that the United States has not ratified the protocol because the United States, consisting of

---

[37] United Nations Framework Convention on Climate Change, "Status of Ratification." August 22, 2007. http://unfccc.int/files/essential_background/convention/status_of_ratification/application/pdf/unfccc_conv_rat.pdf.

[38] United Nations Framework Convention on Climate Change, "Article 2." http://unfccc.int/resource/docs/convkp/conveng.pdf.

[39] The White House Office of the Press Secretary, "Text of a Letter from the President to Senators Hagel, Helm, Craig, and Roberts." March 13, 2001. http://www.whitehouse.gov/news/releases/2001/03/20010314.html.

less than 5% of the world's population,[40] accounts for approximately 25% of total emissions worldwide. [41] This amount has increased over time, accounting for approximately 6,229,040 million tones of CO_2 greenhouse gas emissions in 1990, the base year of the Kyoto Protocol, and 7,241,482.1 Gg CO_2 in 2005.[42] These emissions will continue increasing in the future, if no changes are made to U.S. policy and practice.

Although the United States has not ratified the Kyoto Protocol, other regulatory efforts to reduce greenhouse gas emissions have recently emerged in the country. The Regional Greenhouse Gas Initiative (RGGI) is a regional carbon dioxide emissions cap-and-trade program with nine member states: Maine, New Hampshire, Vermont, Connecticut, New York, New Jersey, Delaware, Massachusetts, and Maryland. While the program currently focuses on reducing carbon dioxide emissions from power plants, it may be expanded into other kinds of sources and to a variety of greenhouse gases.[43]

The Global Warming Solutions Act (GWSA), passed by the California Legislature in 2006, is a state-level greenhouse gas emissions reduction scheme. This law caps California's greenhouse gas emissions and requires reductions of 25% of 1990 levels by the year 2020.[44] In March 2008, the Massachusetts state Senate passed a Global Warming Solutions Act pledging to reduce emissions of greenhouse gases by 20 percent below 1990 levels by 2020 and 80 percent by 2050. The bill has yet to be passed in the state's House of Representatives.[45] Other states are looking into passing GWSAs in the near future.

In the absence of a strong government climate change policy, higher education institutions have voluntarily taken initiative in reducing greenhouse gases. Five hundred and forty-five colleges and universities, including 46 in Massachusetts alone, have signed the American College & University Presidents Climate Commitment (ACUPCC), a pledge to become carbon neutral. Many of these institutions are comparable to Wellesley College in general location and size, including Dickinson College and Middlebury College.[46] In addition to signing the ACUPCC, Dickinson College in Carlisle, Pennsylvania, has named "sustainability" one of the five "Dickinson Dispositions" that it hopes to instill in all

40 U.S. Census Bureau, "U.S. and World Population Clocks – POPClocks,"http://www.census.gov/main/www/popclock.html, May 7, 2008.

41 Energy Information Administration, United States Department of Energy, "Emissions of Greenhouse Gases Report." http://www.eia.doe.gov/oiaf/1605/ggrpt/.

42 United Nations Framework Convention on Climate Change Secretariat, "Greenhouse Gas Total without LULUCF." http://unfccc.int/ghg_emissions_data/ghg_data_from_unfccc/time_series_annex_i/items/3814.php.

43 Regional Greenhouse Gas Initiative, "About RGGI." http://www.rggi.org/about.htm.

44 Office of the Governor, "Gov. Schwarzenegger Signs Landmark Legislation to Reduce Greenhouse Gas Emissions." September 27, 2006. http://gov.ca.gov/index.php?/press-release/4111/

45 "Environment Massachusetts praises the Senate for passing the Global Warming Solutions Act." *Global Warming Solutions News*. http://www.environmentmassachusetts.org/news-releases/global-warming-solutions/global-warming-solutions-news/environment-massachusetts-praises-the-senate-for-passing-the-global-warming-solutions-act

46 *Campus Sustainability Profiles*. Association for the Advancement of Sustainability in Higher Education (AASHE). http://www.aashe.org/resources/profiles/profiles.php

students.[47] In 2004, the Board of Trustees of Middlebury College in Middlebury, Vermont voted to reduce greenhouse gas emissions 8% below 1990 levels by 2012. Soon afterwards, the vote was amended and the college has pledged to become carbon neutral by 2016. In order to support this goal, a new biomass heating system to reduce college's use of #6 fuel oil, a large source of the college's greenhouse gas emissions, will be implemented in the fall of 2008.[48]

Colby College has recently taken on the ACUPCC as well. Colby College, located in Waterville, Maine, defines sustainability as a core value of the institution and has integrated it into its mission statement. This commitment is supported by Colby's voluntary regional agreements with the Maine Green Power Connection, the Green Campus Consortium of Maine, and the Governor's Carbon Challenge. In addition, Colby has a policy that all new construction projects be LEED certified,[49] a label given by the U.S. Green Buildings Council based on a building's environmental sustainability throughout its life cycle.

Many other institutions of higher education that to date have not signed the ACUPCC have nonetheless established their own policies for the reduction of greenhouse gas emissions and overall sustainability. The Presidents Climate Commitment will be explained in greater detail in the next section.

---

[47] *Dickinson College 2007 Campus Sustainability Achievement Award Application*. Association for the Advancement of Sustainability in Higher Education (AASHE).
http://www.aashe.org/resources/profiles/dickinson.php

[48] *New Target- Carbon Neutrality by 2016*. Middlebury College.
http://www.middlebury.edu/administration/enviro/initiatives/climate/New+Target+-+Carbon+Neutral+by+2016.htm

[49] *Colby College 2006 Campus Sustainability Achievement Award Application*. Association for the Advancement of Sustainability in Higher Education (AASHE). http://www.aashe.org/resources/profiles/colby2006.php

4.

American College and University Presidents Climate Commitment

The American College and University Presidents Climate Commitment is an agreement by which institutions of higher education to commit to reduce their environmental footprint. Endorsement of climate change initiatives by institutional presidents and leaders is crucial to the attitude of entire campuses towards such programs. Colleges and universities have unique opportunities to fight climate change, as entities on the forefront of scientific research that could aid in climate change mitigation. In addition, many of tomorrow's environmental leaders are now attending colleges and universities, and it is critical that they expand their skills and knowledge.

The Presidents Climate Commitment presents to its signatory colleges and universities a set of steps to follow in order to become carbon neutral. Carbon neutrality is the idea of reducing an individual's or institution's greenhouse gas emissions to zero.[50] There are three sections of steps that the institutions are committing to when signing the Presidents Climate Commitment.

[50] Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. vii.

The ACUPCC also offers an Implementation Guide,[51] which serves as a handbook for implementation. The guide offers better-defined obligations, explains the technical issues that may involved in implementation, and lays out the conditions for keeping an institution in “good standing” with the Commitment.[52] It gives more detail and direction to help signatories fulfill the terms of the Commitment.

The elements of the Presidents Climate Commitment, as enumerated in the Implementation Guide, are as follows:

- Establish an institutional structure.
- Measure GHG emissions.
- Map out tangible actions.
- Establish a climate action plan.
- Reporting Requirements.[53]

These elements fall into the three categories of steps listed in the body of the Presidents Climate Commitment itself. (See appendix for full text of the ACUPCC.)

The first step is for the institution to develop a comprehensive plan working towards climate neutrality. Within two months of signing, the institution must create structures that will aid in development of that plan. In the year after signing the document, the institution is required to complete the inventory of the institution’s greenhouse gas emissions, which must be updated each year. Within two years of signing the document, an action plan for achieving climate neutrality at an institution must be drawn up.

There are specific requirements for this action plan. Target dates for achieving carbon neutrality must be clearly stated. Goals must be set along these target dates in order to reach carbon neutrality in a timely manner. The college will involve and inform the entire campus regarding the process of becoming carbon neutral. Research and other efforts to advance carbon neutrality must be expanded throughout the institution. In order to track progress regarding an institution’s action plan, tracking mechanisms have to be put in place and enforced.

After the action plan is created, the next step for the institutions is to include two or more actions in its efforts to reduce greenhouse gases. The Presidents Climate Commitment lays out seven different options for institutions to initiate. The options are: the purchasing of energy-efficient appliances, creating a way to offset air travel done through the school, purchasing at least 15% of the school’s electricity from renewable energy sources, partaking

---

[51] Julian Dautremont-Smith, *Implementation Guide: Information and Resources for Participating Institutions* (American College & University Presidents Climate Commitment, 2007).

[52] Julian Dautremont-Smith, *Implementation Guide: Information and Resources for Participating Institutions* (American College & University Presidents Climate Commitment, 2007), 3.

[53] Julian Dautremont-Smith, *Implementation Guide: Information and Resources for Participating Institutions* (American College & University Presidents Climate Commitment, 2007), 3-4.

in the national RecycleMania competition by implementing 3 or more methods to reducing waste, and creating a policy to make all new buildings built to LEED Silver standards.[54]

The third and final step is to publicize the institution's efforts to become carbon neutral. In order to publicize, the institution must make reports available to the public through the Association for the Advancement of Sustainability in Higher Education (AASHE).

One important feature of the Presidents Climate Commitment is its true effort to hold its signatories accountable. It achieves accountability through laying out an implementation timeline, by requiring a level of transparency from the schools, and by laying out conditions for "good standing" status. If a school fails to fulfill its commitments to agreement, it will be noted as being not in good standing on the ACUPCC's website. Those institutions in good standing will also be noted on the website.[55]

A number of schools have already signed onto the Presidents Climate Commitment. Competition from other schools has encouraged the popularity of signing the document. There are 545 schools that have made the commitment.[56] According to AASHE, the breakdown of signatory schools is as follows:

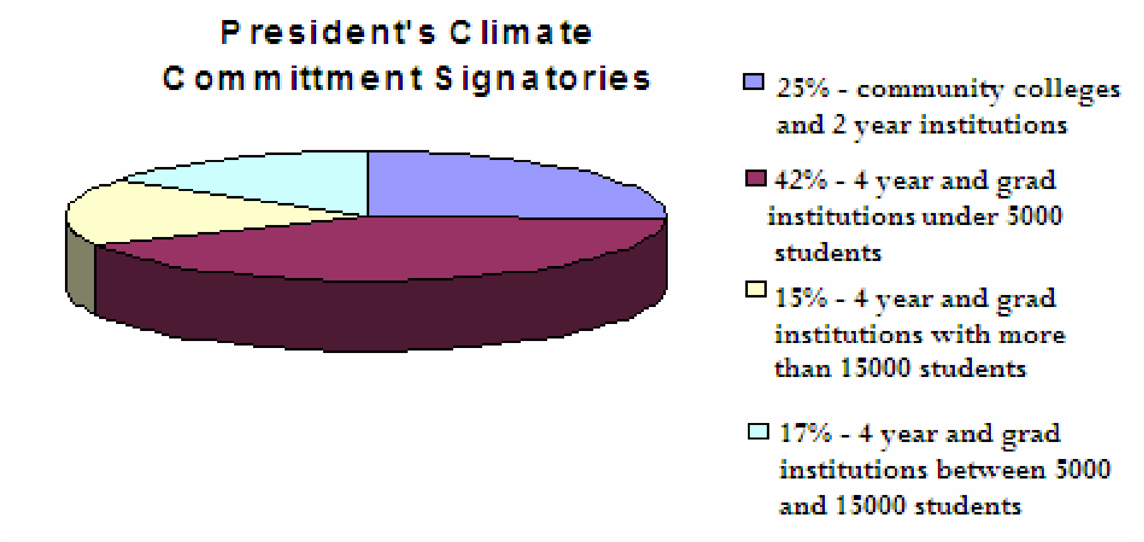


Figure 4.1: ACUPCC Signatories

Many institutions comparable to Wellesley College have committed to the ACUPCC. Forty percent of the top 50 liberal arts colleges, as ranked by *US News & World Report*, have made

[54] Presidents Climate Commitment, *Presidents Climate Commitment,* http://www.presidentsclimatecommitment.org/html/commitment.php

[55] Julian Dautremont-Smith, *Implementation Guide: Information and Resources for Participating Institutions* (American College & University Presidents Climate Commitment, 2007), 28.

[56] Presidents Climate Commitment, *Presidents Climate Commitment,* http://www.presidentsclimatecommitment.org/html/commitment.php

the commitment.[57] Comparable schools such as Wesleyan, Bates, Bowdoin, Brandeis, Emerson, Simmons, Smith, Bryn Mawr, and Middlebury are all signatories.

[57] Dautremont-Smith, Julian, *Statistics about Presidents Climate Commitment Signatories.* http://www.aashe.net/staffblog/campus-operations/energy-climate/statistics-about-presidents-climate-commitment-signatories

5.

Wellesley's Greening Efforts (So Far)

Though Wellesley College has not committed to a policy of climate neutrality, it has taken actions to reduce its greenhouse gas emissions. Through administrative, academic and student-level activities, Wellesley has been increasing environmental awareness and adopting greener practices. Over the years, the setting within which Wellesley staff, faculty, and students have been working for environmental change has also become increasingly receptive.

Institutional

In 2005, then-President Diana Chapman Walsh created the Sustainability Advisory Committee. Currently members of the committee include key Wellesley staff from the President's Office, the Physical Plant, Dining Services, Purchasing, and ResStaff; Environmental Studies and other faculty; and student representatives from the leadership of WEED and House Presidents' Council. Through its various members' combined influences, the Committee is able to launch environmental initiatives, host environmental events, and institute environmental policy changes. The Sustainability Committee also serves as a brainstorming body for changes to be instituted within various other administrative, academic, and as a forum for student involvement. In recent years, the committee has also been invaluable in assisting the academic and student efforts to combat climate change and institute other environmental change.

In a recent report, co-chairs Patrick Willoughby and Kate Salop enumerated many of the changes made on campus.[58] In the realm of landscape, renovation of the campus has

---

58 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008).

removed 5.7 acres of parking lots and roads. An estimated 4,000 trees, 14,000 shrubs, and tens of thousands of herbaceous perennials have been planted to date.[59] An emphasis on having a predominantly pedestrian campus has also reduced the amount of space and roads available for automobiles.[60]

The fact that Wellesley generates its own electricity at the cogeneration plant reduces the college's potential greenhouse gas emissions. In 2007, Wellesley generated 29,417,856 kWh or 2,941.79 MWh of electricity, releasing 6,876 tonnes of CO_2e in the process.[61] If Wellesley were to purchase this amount of electricity from the town, it can be estimated that the amount of electricity purchased would result in 13,147 tonnes of CO_2e.[62] In addition, line loss between the generation site and the college is estimated at approximately 7%.[63] Thus, Wellesley already saves approximately 6,271 tonnes of CO_2e because electricity is produced at the cogeneration plant.

Renovations have resulted in substantial water savings, energy-efficiency increases, and waste reduction. Low-flow versions showerheads and dining services devices, better leak detection in pipes, and new chill water towers have been installed in renovations of various buildings.[64] Aggressive energy management, installation of more efficient lighting, upgraded heating and cooling systems have all resulted in energy savings.[65] Wellesley went, in the single year from 2005 to 2006, from having 1% of its solid waste stream being recycled to 10% of it being recycled.[66]

Dining Services and Purchasing Departments have adopted more sustainable policies, buying more local and organic produce, purchasing energy-star rated appliances, and installing vending misers.[67]

Printing Services has independently adopted more environmentally-friendly practices. Paper with 30% post-consumer recycled content is the standard offering, with 100% recycled paper available upon request. Dual-sided copying is encouraged, and all of the

59 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 5-10.

60 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 27.

61 George Hagg, Personal Communication. "Campus Carbon Calculator v5.0." Clean Air, Cool Planet, 2006.

62 "Campus Carbon Calculator v5.0." Clean Air, Cool Planet, 2006. Calculated in "input" worksheet in the purchased electricity column, with the state MA and the region NPCC New England.

63 "Transmission and Distribution Technologies." Technology Options for the Near and Long Term, U.S. Climate Change Technology Program (November 2003). http://climatetechnology.gov/library/2003/tech-options/tech-options-1-3-2.pdf

64 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 12-14, 28-29.

65 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 20-26.

66 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 16.

67 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 29-30.

equipment used is set to "sleep" mode whenever not in use and powered off when the department closes.[68] More innovations are planned in all realms of the school's operations.

Academic

Wellesley offers a number of academic courses that encourage or allow students to work for more environmental practices on campus. One is this course itself, ES 300: Environmental Decisionmaking. The capstone course for the Environmental Studies major, ES 300, is an interdisciplinary seminar that focuses on a different issue of environmental concern in the community each year. The result of our study is a comprehensive report and policy recommendations. Past classes have recommended green, LEED-certified renovations to the Wellesley Greenhouses and a LEED-certified residence hall; assessed the campus' ability to sequester carbon through its land use policies; and performed the original audit of the college's greenhouse gas emissions.[69]

Another such course that engages students in examining what Wellesley can do about its ecological footprint is ES/ECON 228: Environmental and Resource Economics. Along with teaching students how to think about broader environmental problems and solutions within a neo-classical economics framework, the course involves a semester-long project in which students evaluate the economic costs and benefits (and make a recommendation based upon them) of possible Wellesley environmental policy changes, many of which have been framed partially by their impact on Wellesley's greenhouse gas emissions.[70]

Environmental Policy, POL2-312S, specifically requires that students work to institute an environmental policy change on Wellesley's campus, as part of a semester long project. Past projects have installed sensors in lights and vending machines in order to conserve energy, instituted policies that discourage the use of disposable dishware in the dining halls,[71] and encouraged the use of reusable hot and cold beverage containers.

Student Involvement

In addition to the courses Wellesley offers that allow students to engage in climate change action on campus, there are also other avenues for student involvement. Wellesley has clubs, businesses, and media outlets that contribute to raising awareness about climate change and taking action.

---

68 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 31.

69 Environmental Studies Program, *Environmental Studies – es300 Projects*, http://www.wellesley.edu/EnvironmentalStudies/Research/es300.html

70 Stacy Sneeringer, *Economics 228 Homepage,* http://www.wellesley.edu/Economics/Sneeringer/econ_228/index.html

71 Environmental Studies Program, *Environmental Studies – Course Projects,* http://www.wellesley.edu/EnvironmentalStudies/Research/course.html

Wellesley Energy & Environmental Defense (WEED) was created in 2002-2003. Many of its projects have to do with reducing Wellesley's greenhouse gas emissions. Its recycling efforts (WEED coordinated before recycling institutionalization), events, and educational campaigns have contributed to greater environmental awareness on campus. WEED works with the Sustainability Committee to coordinate events to encourage conservation and environmental policy changes on campus.

On January 31, 2008, Wellesley Focus the Nation (a subcommittee of WEED) hosted acclaimed writer and environmentalist Bill McKibben in the school's most prestigious yearly lecture. McKibben spoke to the Wellesley community about climate change and the urgent need for action. The lecture was recorded for use as a free podcast on iTunesU, and faculty were encouraged to bring their classes to the lecture and spend some time in their individual classes talking about climate change.

In the 2008-2009 academic year, Wellesley will have its first sustainable living space. It will be housed in Simpson West, and its members will seek to reduce their greenhouse gas emissions at Wellesley in a variety of ways, mainly through food choices. Members will be off the school's meal plan, cooking food for themselves, and getting their food from more locally grown and organic sources, which expend less greenhouse gas emissions in their acquisition.

Another group, Wellesley Women for Sustainable Farms and Produce, participates in sustainable farming practices, and seeks to encourage the use of more local, organic produce in our campus dining halls, restaurants, and co-ops. The co-ops on campus that provide food for the community, El Table in Green Hall, and the Hoop in the LuLu Chow Wang Campus center, have been adopting more and more sustainable practices. Increasingly, they have used more locally available products and produce in their kitchens and generally encourage individual sustainability.

The Wellesley News (the school's weekly newspaper) and WZLY (the campus radio station) have increasingly featured environmental efforts (whether institutional, academic, student, or a combination of those) in their publications and programming.

6.

Benefits to Wellesley of Committing to Address Climate Change

Although Wellesley will not experience some of the most dramatic consequences of climate change like rising sea levels and melting permafrost, it may still see serious effects. Invasive species normally killed during the harsh New England winters could gain a foothold in this ecosystem with warming weather and could devour the college's beautiful landscaping and replace its native animal life. As North Atlantic hurricanes increase in intensity beyond levels of normal fluctuation, Boston has the potential to become a hurricane-prone city.[72] Even though the college is not at an environmental "hot spot," it will still see the negative environmental effects of climate change.

The benefits of taking action against climate change, however, are much broader than merely limiting the direct environmental consequences to Wellesley's campus. Strategically reducing GHG emissions will bring the college economic benefits in the long-term. Increasing efficiency and decreasing waste of energy will decrease the college's greenhouse gas emissions, and also lower the college's energy costs. The initial costs of many large technological innovations, such as installing solar panels and wind turbines, are already partially offset by government subsidies and tax incentives and can provide public relations benefits as well. Reducing wasted energy in the future with immediate expenses like compact fluorescent light bulbs or low-flow shower heads will both lower emissions and reduce energy costs. The college will also inevitably have to comply with climate change

---

[72] Beth Daley, "Man-Made Factors Fuel Hurricanes, Study Finds," *The Boston Globe*, Sep 12, 2006, http://www.boston.com/news/nation/articles/2006/09/12/man_made_factors_fuel_hurricanes_study_finds/.

regulations when they are passed in Massachusetts, as they have been in several other states already.[73] Making these changes now will only save money in the long term. With such economic benefits, becoming more environmentally responsible should be even easier for the college.

Taking action against climate change is also important to Wellesley's public image and its standing among other institutes of higher education. The increase in hybrid cars on the road, carbon credit companies, and environmentalism in the news demonstrates that "going green" is definitely a trend at the moment in the United States and around the world. Colleges and universities that are taking an active role in controlling their carbon footprint are receiving large-scale publicity. Examples include Lewis & Clark, Tufts, and Cornell, which have all pledged to commit to the 7% greenhouse gas reduction mandated by the Kyoto Protocol for the U.S., and other colleges that are trying to reduce even further by adhering to the Presidents' Climate Commitment.[74] Such actions provide these institutions a competitive advantage in recruiting from an increasingly environmentally minded pool of potential students.

Finally, as an educational institution, Wellesley has a responsibility to inform its students about the key issues in today's world. Climate change is undoubtedly one of these issues and, while it is already a topic of discussion in classes from a wide variety of departments, education about climate change should extend beyond the Wellesley classroom. An institution that emphasizes service and international affairs must address an issue that most dramatically affects some of the poorest regions and unique cultures in the world like the islanders of Tuvalu, may have to move their entire civilization elsewhere because the ocean might overtake their islands. By not only recognizing the potential consequences of climate change but by also taking preventative action, the college can instill ethical concern through its example.

Not taking action against climate change at an institutional level not only accelerates the process of climate change, but it is a major disservice to Wellesley students and to the Wellesley community as a whole. Many of the changes that decrease greenhouse gas emissions will not only improve Wellesley's carbon footprint but also its cumulative environmental footprint. Because of the potential benefits and Wellesley's obligation as an educational institution, it is in the college's best interest to take action against climate change.

73 "Architects and Sustainable Design- Green Building Legislation in the States," *Advocacy*, The American Institute of Architects, http://www.aia.org/adv_sustainability_greenbldg50stateleg.
74 Shelley Smithson, "Big Plan on Campus," *Grist*, Jul 31, 2002, http://www.grist.org/news/maindish/2002/07/31/smithson-campus/.

Greenhouse Gas Audit of Wellesley College

7.

Audit Overview and Overall Results

Audit Overview

In order to analyze the raw data obtained for the audit, we used the Clean Air-Cool Planet (CA-CP) Campus Carbon Calculator.[75] Clean Air Cool Planet[76] is a non-profit agency located in New Hampshire that seeks to address global warming issues through developing policies and fostering civic engagement. The CA-CP calculator tool is used at over 200 schools around the nation to conduct these greenhouse gas emissions audits.

The CA-CP calculator is an Excel workbook where raw data can be entered and emissions are calculated in carbon dioxide equivalents (CO_2e). The different greenhouse gases released in the course of various human activities have different global warming potentials, and with the various gases it can be difficult to ascertain what effect combusting fossil fuels really has. Thus we attempt to synthesize the impacts of various greenhouse gases into one comprehensive unit so that we can better understand the effects we have on the environment.

Within the parameters of the Clean Air Cool Planet framework for calculating carbon dioxide equivalents, we look at the global warming potentials of several different gases in terms of the most common anthropogenic greenhouse gas, carbon dioxide. By putting emissions into carbon dioxide emissions equivalents, we provide of common denominator for all greenhouse gas emissions and gain a panoramic view of how different sources of combustion affect the environment (carbon dioxide is the most common anthropogenic greenhouse gas). In trying to ascertain the effects of various greenhouse

[75] Clean Air-Cool Planet, "Conduct an Emissions Inventory," http://www.cleanair-coolplanet.org/toolkit/content/view/43/124/

[76] Clean Air-Cool Planet, http://www.cleanair-coolplanet.org/

gases, we calculate how much global warming potential the equivalent amount of carbon dioxide would have, and put the burned fuel into those terms.

The CA-CP calculator allows greenhouse gas emissions to be calculated from 1990 through 2020, adjusting the outputs based on increasing efficiency of various processes. The Excel worksheet contains the formulas necessary to do the calculations, so the data simply has to be entered. This data must be in a certain format, however. For example, the calculator requires the inputs to be in amount of gasoline used for transportation. When gathering data, we were often given mileage of the vehicles, and had to estimate the amount of gasoline based upon a miles per gallon estimate. Our assumptions will reflect any errors we might have made in our calculations.

For this audit, we wanted to make sure that we were as comprehensive in our emissions calculations as possible, so we approached each emissions source from a life cycle analysis (LCA) perspective. LCA is a method of examining the effects of a product or service in which its consequences are examined over its entire lifespan. For an environmental analysis of an automobile, for instance, LCA would not only include the vehicle's emissions from its exhaust pipe during its lifespan, it would include the emissions created from mining all the iron ore needed for the steel in the car and those created during recycling and disposal of all the components. On Wellesley's campus, LCA caused us to include not only the gases emitted directly by waste decomposition in a landfill but also those emitted by the trucks that transport the waste to its final destination. This approach is especially important because it accounts for certain processes and activities that do emit greenhouse gas emissions, but might otherwise be ignored.

For our final calculations, we decided to use a constrained LCA and only examined emissions that were generated on campus or those that were arose at or en route to facilities that were one journey away from Wellesley. This restriction meant that we counted the emissions created by delivery trucks traveling to and from Sysco and Garelick Farms, but not by the trains supplying these food companies with produce from across the country or by fertilizer on the farms that grew the food. We made this decision because it narrowed our focus to a reasonable scope and because the college only has control over emissions that are one step away from it. It was also nearly impossible for some of our delivery sources to trace the product's path from its inception without communicating with each individual supplier directly, and this process would have been overwhelmingly time-consuming. Therefore, while we omitted a portion of college-related emissions, we included everything that we could directly affect in the mitigation section.

Overall Results

Since 1994, Wellesley's total greenhouse gas emissions have remained relatively constant over time, varying primarily due to the amount of oil and natural gas used by the cogeneration plant, the campus' largest greenhouse gas emitter. In 2007, including all factors that the report quantified, the college emitted a total of 48,350 tonnes of CO_2e. If the largest factor that is not included in the Presidents Climate Commitment, student travel to and from home, is removed from this total, the college emitted a total of 38,563 tonnes of CO_2e. The reporting of the lower emissions total would be required by the ACUPCC.

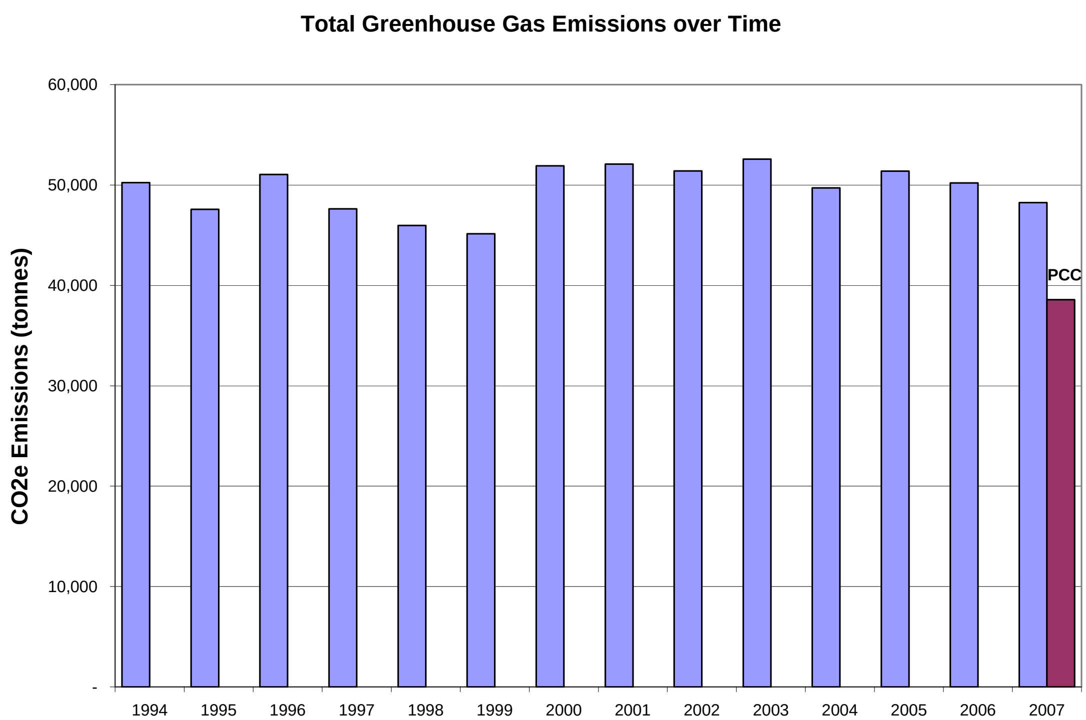


Figure 7.1: Total Greenhouse Gas Emissions over Time

These total greenhouse gas emissions figures are within the same range as the calculations of total greenhouse gas emissions that other colleges have conducted in the past four years. Smith College emits 33,025 tonnes,[77] Amherst College emits 26,481 tonnes,[78] and Bates College emits approximately 20,000 tonnes of CO_2e yearly.[79] While the emissions calculation methods vary greatly between institutions (for example, whether or not college-funded travel is included), a comparison with Smith College demonstrates that the calculations made in this audit are comparable to those made by other institutions in calculating total greenhouse gas emissions.

---

77 Thomas, Elizabeth. "Greenhouse Gas Emissions at Smith College." (May 2005) http://www.cleanair-coolplanet.org/partners/documents/Smith_GHGinventory.pdf

78 "Carbon Inventory," Green Amherst, Amherst College, https://cms.amherst.edu/campuslife/greenamherst/carbon_inventory

79 "Greenhouse Gas Emissions Inventory." Current Initiatives Climate Neutrality. (2006) http://www.bates.edu/x166375.xml

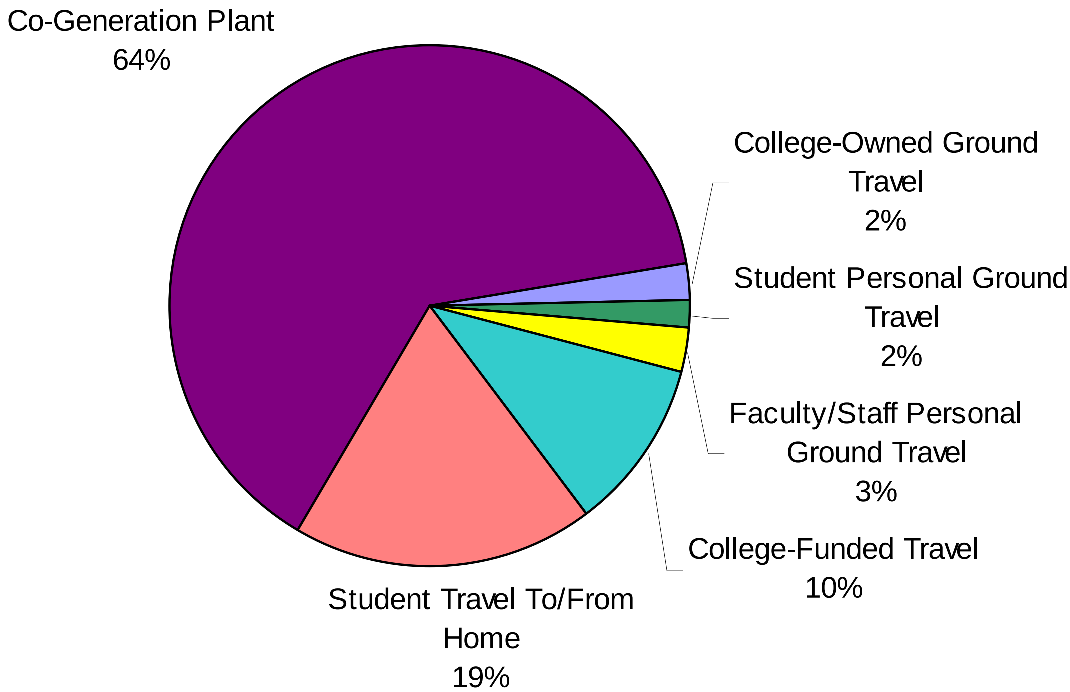


Figure 7.2 Total Emissions by Source, 2007

The largest source of greenhouse gas emissions is the cogeneration plant, which accounts for 64% of total emissions. Air travel also composes a large portion of total emissions, accounting for the majority of emissions within the categories of student travel to and from home (19%) and college funded travel (10%). The remaining categories from the travel sector - faculty/staff personal ground travel, student personal ground travel, and college-owned ground travel (Motor Pool)– account for 7% of total emissions. The most insignificant sources of CO_2e emissions/sequestration are fertilizer use, waste disposal and forest sequestration, each accounting for less than 1% of total emissions. They are therefore not included in Figure 7.2, above.

8.

Energy Sector

Energy consists of electricity, heating, and air conditioning and is most often generated using greenhouse gas-emitting fossil fuels. Understandably, then, our campus' largest source of greenhouse gas emissions is its energy sector. Currently, the energy sector accounts for 64% of Wellesley's greenhouse gas emissions.

Before 1994, Wellesley College purchased all of its energy from the Town of Wellesley. Since 1994, Wellesley has generated its own electricity with its cogeneration Physical Plant, using the town for back-up electricity. The Physical Plant's cogeneration activities provide the school with electricity, heating, and cooling.[80]

A cogeneration plant, also referred to as CHP (combined heat and power) system, is more efficient than other fossil fuel-powered energy generation plants because it utilizes wasted heat from the electricity generation process for heating and air conditioning.[81] Without this waste heat, Wellesley would have to use even more fossil fuels for temperature control.

The cogeneration Physical Plant has five engines for electricity generation. All of these are fueled by natural gas and one engine can also switch to run on #6 fuel oil. The combustion of these fossil fuels is used to power a spark-ignited, lean burn, turbocharged, four-stroke engine that drives a generator, which produces electricity. The byproducts of this process are hot exhaust gas, hot oil, and hot jacket cooling loop water. In addition, a turbocharger intercooler is also heated.[82]

---

[80] ES300-S03, *Audit of Wellesley College's Greenhouse Gas Emissions*, http://cs.wellesley.edu/~weed/papers/GHG-Assessment-spring-2003.pdf, 14.
[81] Michael Dawley, Assistant Director of Physical Plant, PowerPoint presentation to ES300-S08 Class, March 3, 2008.
[82] Michael Dawley, Assistant Director of Physical Plant, PowerPoint presentation to ES300-S08 Class, March 3, 2008.

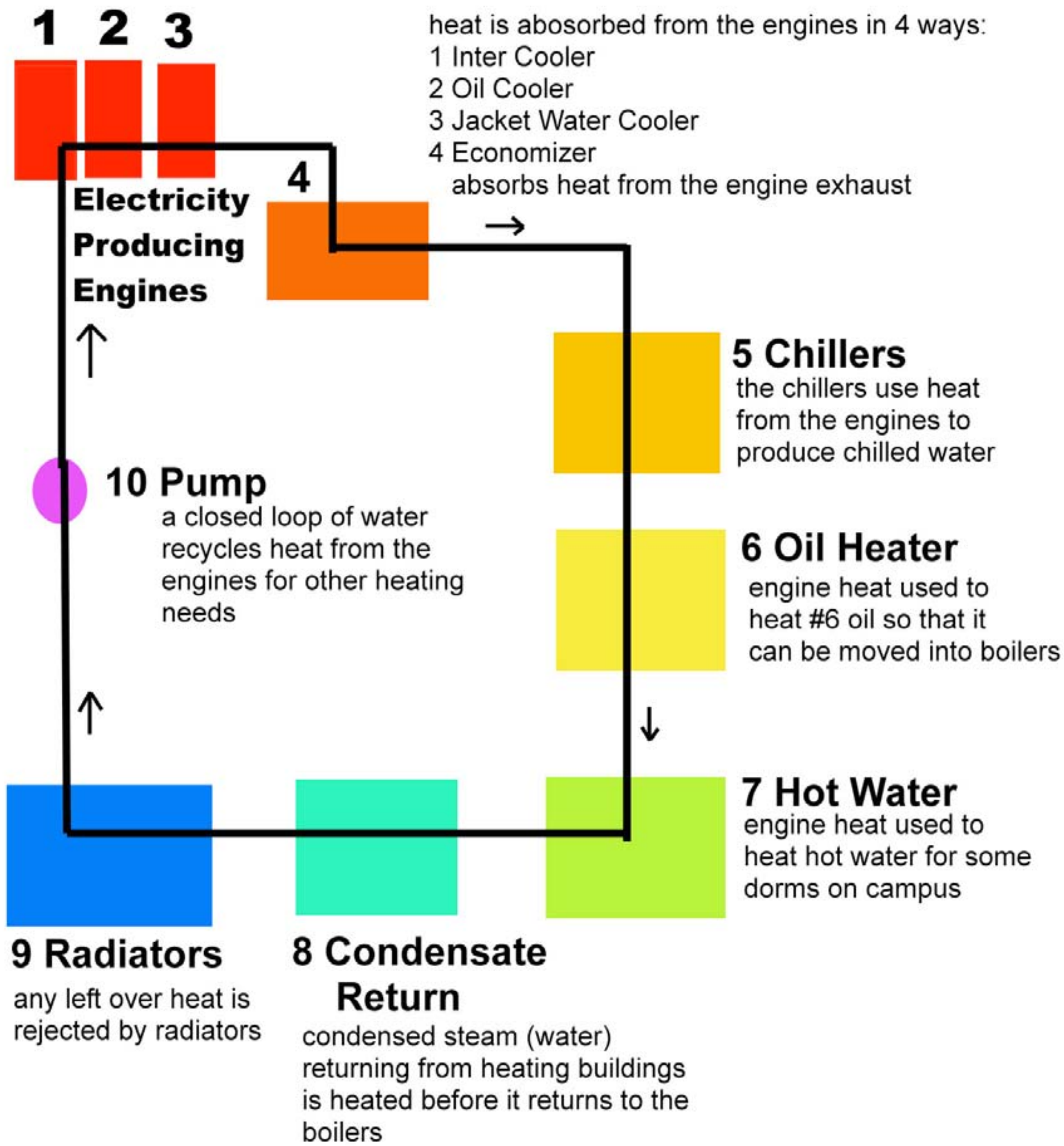


Figure 8.1: Diagram of Wellesley College Co-generation Processes[83]

Heat exchangers allow for the heat to be transferred from the hot oil, hot jacket water, and intercooler to a secondary water loop, which is then further heated by exhaust gas. Water in this loop then passes through several heat exchangers to transfer heat for several purposes including heating#6 oil, heating hot water for bathing and heating radiators in buildings, and running the absorption chillers to produce chilled water. The #6 oil used in the Plant's engines and boilers must be heated for use, and hot water is also put toward that end.[84] The hot water absorption chiller uses a salt solution and a low pressure chamber to

[83] ES300-S03, *Audit of Wellesley College's Greenhouse Gas Emissions*, http://cs.wellesley.edu/~weed/papers/GHG-Assessment-spring-2003.pdf

[84] Michael Dawley, Assistant Director of Physical Plant, PowerPoint presentation to ES300-S08 Class, March 3, 2008.

allow heat from the hot water loop to evaporate water off the chilled water loops and carry heat away from that water with it, thereby essentially making hot water to make cold water.

This hot water is also used to help heat water flowing into the boilers, which then gets heated further to produce steam for heating and humidifying Wellesley's buildings. While there are five boilers total, one for each engine, there are only three large main boilers that are typically used. These boilers use additional fossil fuels. Boiler 1 can run on either #6 oil or natural gas, while Boilers 2 and 3 run exclusively on #6 oil.[85]

While both are fossil fuels, #6 oil and natural gas differ in their contribution to climate change. Natural gas emits fewer greenhouse gas emissions: .0599 tonnes of CO_2/MMBtu, versus oil's .0767 tonnes of CO_2/MMBtu.[86] We still have #6 oil as an option in Boiler 1 because of Wellesley's gas contract. This contract allows us to buy natural gas at a cheaper price, provided that our provider can cut off our supply (and thus have Boiler 1 run on oil instead of gas) when demand for gas is particularly high.

[85] Michael Dawley Assistant Director of Physical Plant, PowerPoint presentation to ES300-S08 Class, March 3, 2008.

[86] ES300-S03, *Audit of Wellesley College's Greenhouse Gas Emissions*, http://cs.wellesley.edu/~weed/papers/GHG-Assessment-spring-2003.pdf, 15.

Greenhouse Gas Emissions from Wellesley's Energy Sector

Overall energy emissions rose sharply at the beginning of the new millennium, but have been decreasing on average since 2003 (see Figure 8.2, below). The sharp increase in emissions from 1999 to 2000 can be explained by the increase in the use of #6 oil (see Figure 8.3, below), which emits more greenhouse gases than natural gas.

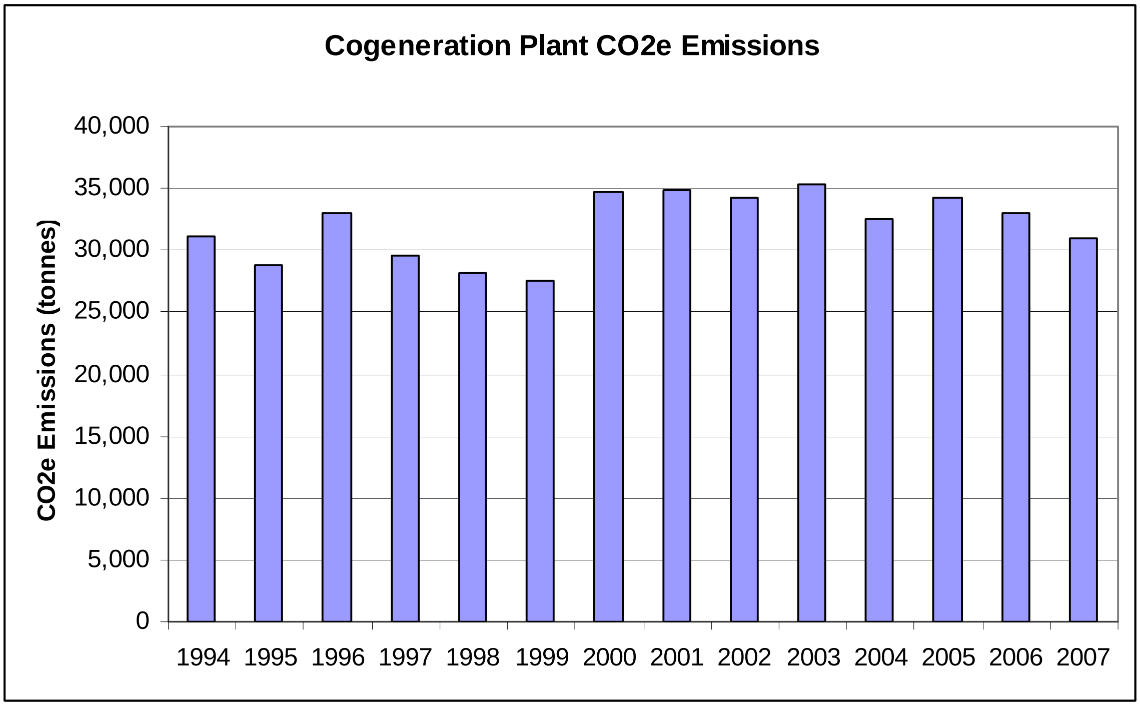


Figure 8.2: Cogeneration Plant CO_2 Equivalent Emissions

While electricity produced and used on campus increased throughout the 1990s, we have actually seen modest decreases since 2000 (see Figure 8.4, below). Overall energy consumption has remained relatively steady since 2000 (see Figure 8.3, below), despite an increase in energy demand due to changes such as the addition of the Wang Campus Center in 2005. This is due partially to the new chilled water plant, an increase in control of building heating systems, and energy-saving initiatives in buildings, such as more energy-efficient light fixtures.[87] Renovations have also installed more efficient heating systems, insulation, and windows. EnergyStar appliances have become more standard on campus as well.[88] Energy demand is still "high in comparison to peer institutions and gross square footages,"

[87] Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 21.
[88] Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 23..

however.[89] Future goals stated in the 2008 Sustainability Committee's report include further reductions in energy consumption by 13% by 2013.[90]

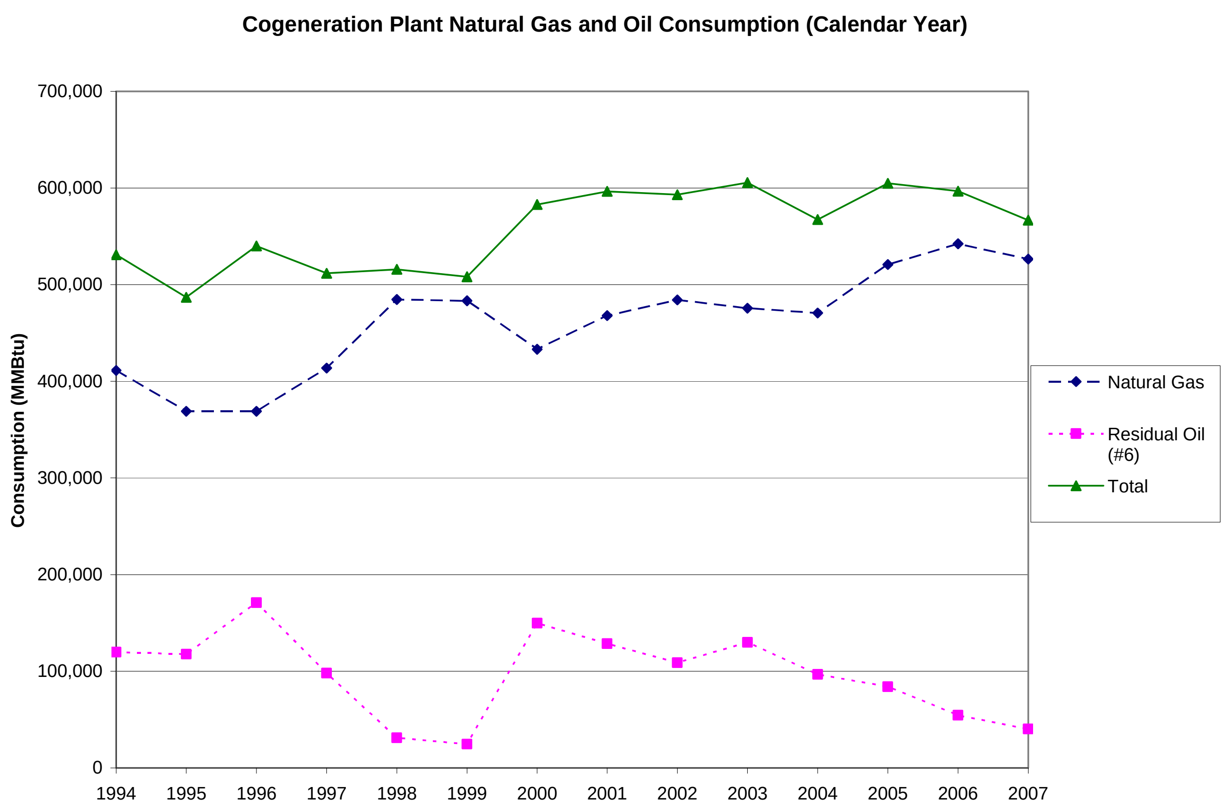


Figure 8.3: Cogeneration Plant Oil and Gas Consumption by Calendar Year in MMBtu

Cogeneration plant efficiencies reflect trends in improved power plant technology. Steam efficiency has increased 22% between 1999 and 2007 while electric efficiency has remained about 30%, which is typical of a fossil fuel-powered electric plant. The combined steam and electric efficiency gives our cogeneration plant an overall efficiency level between 78% and 91%.[91]

89 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 21.
90 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 3
91 George Hagg, Personal Communication.

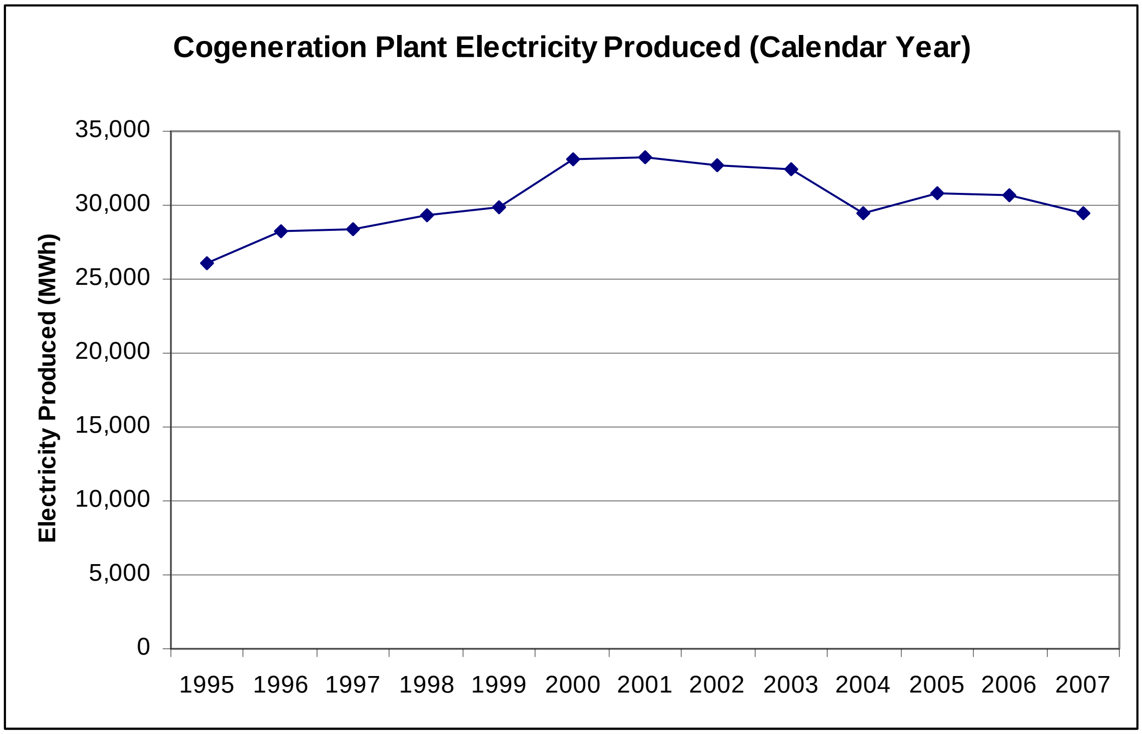


Figure 8.4: Cogeneration Plant Electricity Produced by calendar year

Wellesley's academic and auxiliary buildings consume 85% of the electricity used on campus, while residence halls consume 15%. The college is currently unable to measure the energy consumption of individual residence halls; we can only calculate the consumption by residence hall "blocks."

The electricity for faculty apartments and houses is supplied primarily by the Town of Wellesley. The town's utility company provides electricity for 80% of faculty apartments and 72% of faculty houses; Wellesley's Physical Plant provides the remainder of the power for these buildings. The Physical Plant supplies heat to 28% of the apartments and the town's utility company supplies the remaining 72%. Thus, this audit only takes into account the energy of the small percentage of faculty housing that is provided by Wellesley's Physical Plant.

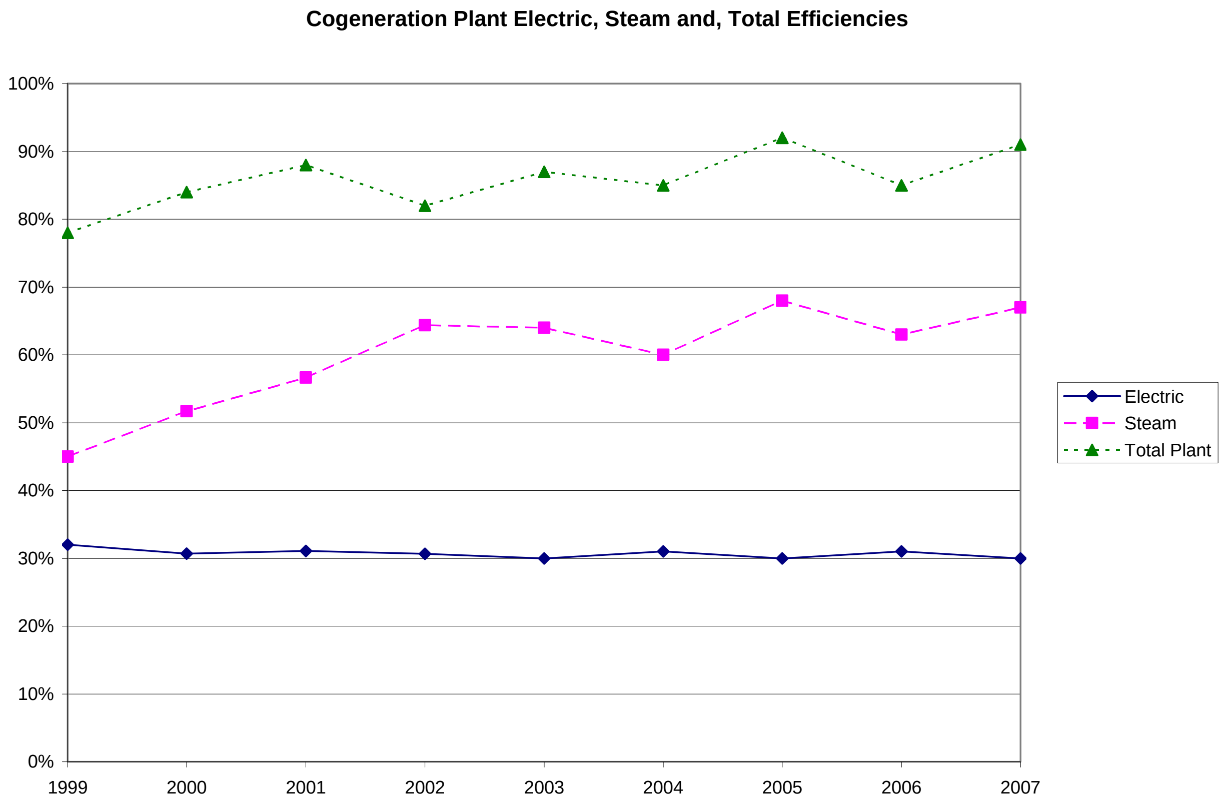


Figure 8.5 Cogeneration Plant Electric, Steam, and Total Efficiencies

9.

Transportation Sector

Transportation is essential to the daily life of Wellesley College. Transportation can be divided into four categories: transit, Motor Pool, waste removal, and deliveries. Transit consists of student travel, faculty-staff commuting, shuttles, and college-funded student and faculty travel. Motor Pool encompasses intra-campus travel by college vehicles. Waste removal is essential to the function of the institution, because various sources of waste all need to be transported out of Wellesley. There are also a number of regularly scheduled deliveries of products, ranging from food to office supplies to oil.

While we worked to be as comprehensive as possible, much of the data had to be extrapolated from smaller data sets. For example, faculty and staff conference travel data was collected for two months out of the year and then extrapolated to paint a complete picture for one year. This travel is a significant source of greenhouse gas emissions, so the margin of error could have a large effect on the overall results. We were, however, quite precise whenever data was readily available. Data from previous years has been included when possible and found available, but the focus of the data collection was on detailed information for a single year rather then vague trends over time.

Greenhouse gases emitted by transportation are significant. The cars, trucks, and buses operated by the college, its students, and its commuting employees used nearly 300,000 gallons of gasoline and over 50,000 gallons of diesel fuel in 2007. The college also directly funded more than 18 million miles of passenger air travel and 100,000 miles of train travel, which is enough to go to the moon and back almost forty times. This travel resulted in total emissions of 17,100 $MTCO_2e$ for the entire sector. Though it may not be possible to immediately reduce emissions in all of these areas, these numbers help to highlight the more significant sources of greenhouse gas emissions and areas that would result in the largest amount of reduction at minimum cost.

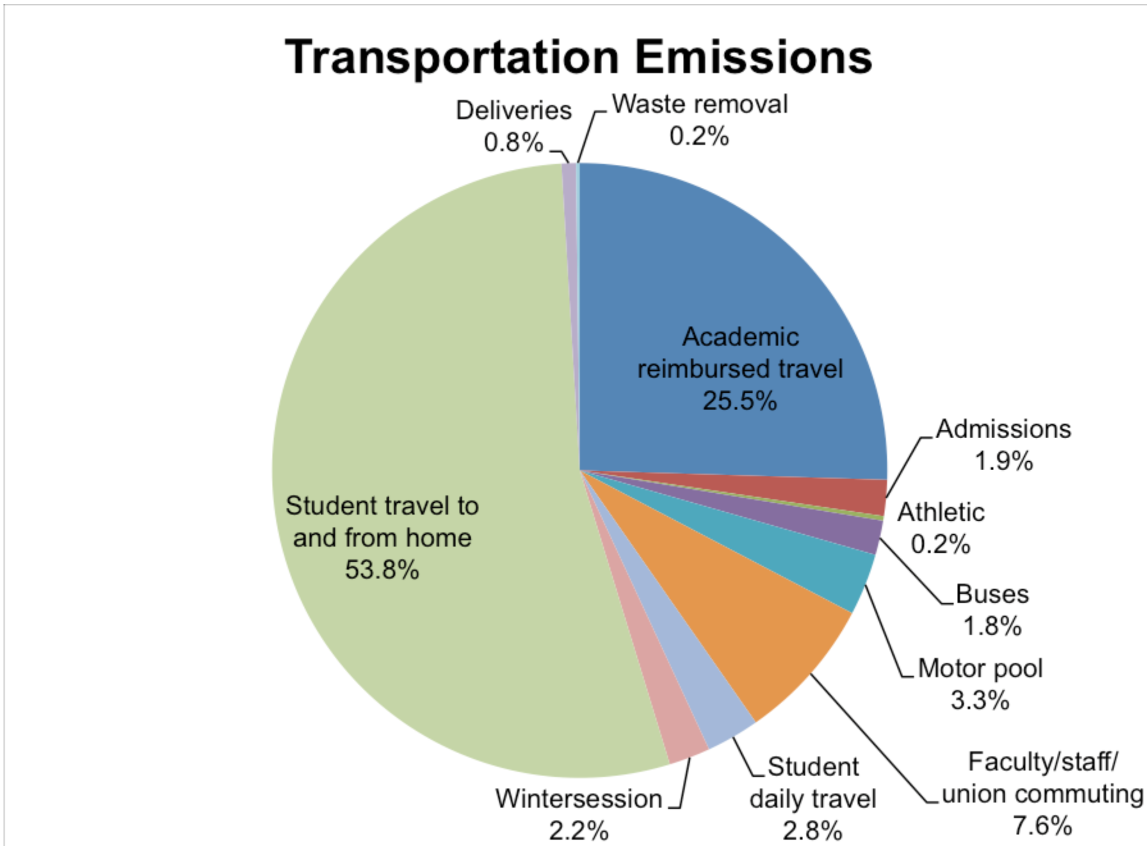


Figure 9.1: Breakdown of transportation emissions by activity.

The transportation sector is the second largest greenhouse gas emitter, after the energy sector. The various aspects of transportation emit 17,100 MT CO_2e all together. The majority of these emissions are from student travel to and from home. The next largest component is college-funded travel. Together, these account for 79.3% of total emissions thatresult from transportation. The ACUPCC does not require the calculation of greenhouse gas emissions from student travel to and from home, although it is a significant source of greenhouse gas emissions. However, we wanted to be as comprehensive as possible. Strategies to consider reducing the greenhouse gas emissions from transportation are considered further in the mitigation section.

<u>Transit</u>

Student Daily Travel

Cars are an important method of transportation for students on the Wellesley College campus. After their first year of college, students are allowed to have a vehicle on campus, if they pay a fee. There are 444 student cars on campus, according to Campus Police's parking registration for student lots.[92]

In order to establish how cars are used on campus and what types of cars are in use, we collected data in several different ways. First, we counted student cars and sorted them into several different categories of car based on gas usage. These categories we used were: compact cars, mid- and full-sized cars, SUVs/trucks, vans, and hybrids. We then counted vehicles in student lots throughout the campus to create an overall picture of the types of cars that students have on campus.

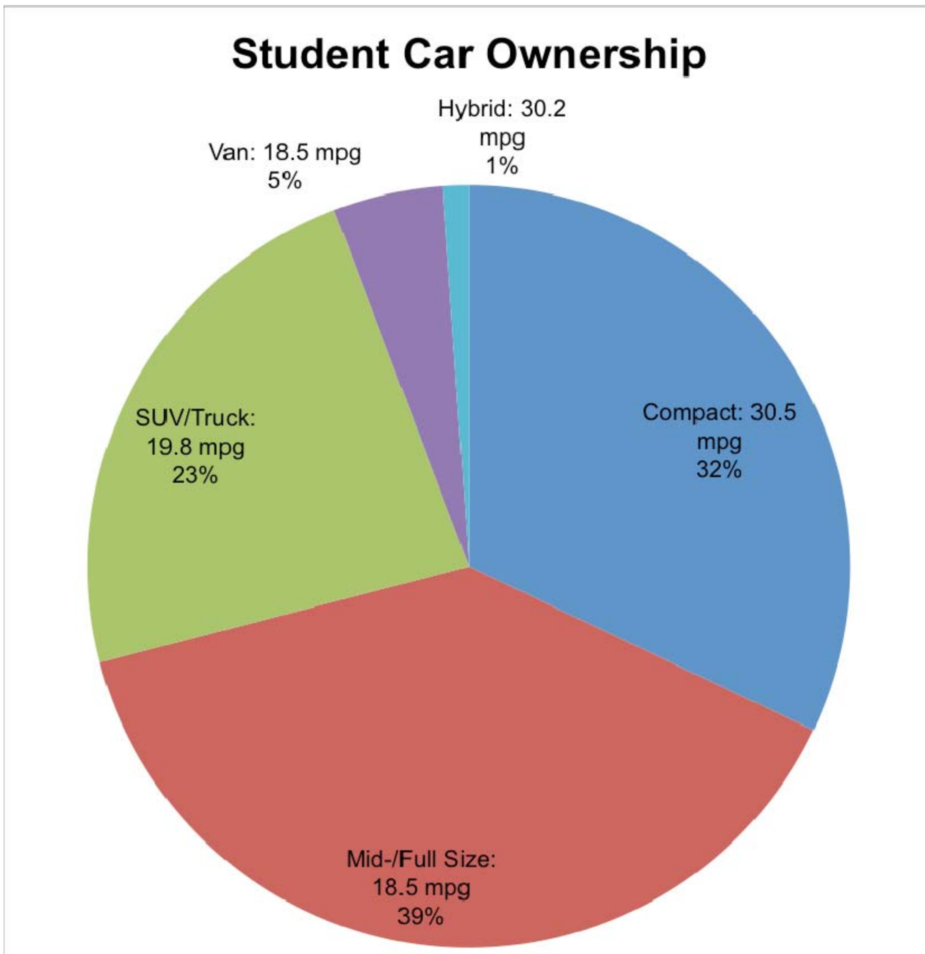


Figure 9.1: Student car ownership by car type, determined from counting cars in student parking lots. Students drive on average 82 miles per week. Gasoline usage was determined using average mileage figures for each car type and multiplying by average miles driven.

In order to ascertain student car use, we sent a survey to FirstClass conferences and to personal inboxes of students that were known to have cars on campus. The survey asked

92 Officer William Bowman of Wellesley College Campus Police, Personal Communication, March 9, 2008.

what category each student's car fell into, how many miles the student drove in the past week, and how many miles she drove in the past month. Ninety-two responses were recorded, although not each respondent had a vehicle. From the surveys, we extrapolated from students' monthly estimates to determine how far students drive in a week to account for longer road trips. The monthly estimate of miles traveled was then divided by 4.35, the average number of weeks in a month, to find a more uniform number to represent a week of student car use.

We found that, on average, our figures derived from monthly estimates were 17% higher than the estimates that students gave for distance traveled in a week. Using monthly estimates had allowed us to capture longer trips that occurred sporadically. Then, the calculated weekly travel number was multiplied by 32 weeks to get an average for the academic year.

The student car survey gave us percentages for each type of vehicle, but the high occurrence of compact cars and low occurrence of SUVs in the survey compared to our parking lot counts led us to believe that survey respondents were biased based on car type. Students who drove more fuel efficient cars were perhaps more likely to take a survey for a greenhouse gas audit.We therefore ignored the survey percentages and used only the lot counts to account for the type of vehicle. These percentages were then used to break down the total number of student cars on campus (444) into numbers of each type of vehicle on campus. Miles per gallon (MPG) for the different vehicle types were found at the Environmental Protection Agency's (EPA's) Fuel Economy website.[93] The number of students with cars, percent driving each type, miles driven per week, and weeks per academic year were multiplied together and divided by miles per gallon to get the total gallons per year used on student travel at the college, 53,601 gallons. This equates to 478.9 tons of CO_2e released into the atmosphere.

There are several potential sources of error. First, the student survey was voluntary, which could affect the type of students who responded to the survey. As we clearly stated that we are an Environmental Studies class, those who are more eco-conscious may have been more willing to respond, and these types of students may be more aware of their fuel use and have made a choice about the type of car that they have. Students who are not as concerned about environmental issues may have been less willing to respond to the survey. Similarly, some students might be embarrassed to admit their actual car usage given our

---

[93] From this resource, reports from 2003 were used to find the MPG for compact, midsized, SUV/trucks and vans. The estimates for hybrids were found in the 2008 report, which has the most accurate and up to date numbers for hybrids since earlier estimates were often skewed too high.

Fuel Economy Guide Model Year 2003. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, U.S. Environmental Protection Agency. 2003, http://www.fueleconomy.gov/feg/FEG2000.htm;

Fuel Economy Guide Model Year 2008. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, U.S. Environmental Protection Agency. 2008, http://www.fueleconomy.gov/feg/FEG2000.htm=.

purposes. These factors can lead to responses that do not accurately reflect the driving patterns or types of cars on campus, and are likely to undercount student-driving activity.

Students estimated mileage for the most part, so there is potential for students to have estimated incorrectly. Results were extrapolated from the available data to be indicative of the entire 444 student cars on campus. Any errors in the averages for student travel would then also be carried out in extrapolating the data. Nonetheless, the estimate gives a useful view of the likely impact of driving by Wellesley students on the environment.

Faculty, Staff, and Union Commuting

Faculty, staff, and union workers commute to Wellesley throughout the entire year, accounting for significant greenhouse gas emissions in the transportation sector. These commuters produce 1,304 tonnes of CO_2e, which accounts for 7.6% of the total transportation emissions. In order to determine commuting patterns, we created a survey asking respondents to tell us what method of transportation they use to get to work, what kind of car they drive, and how many days per week they commute to Wellesley during the school year, Summer session and Wintersession. Professor DeSombre posted this survey to the Faculty-Staff conference on FirstClass, and each of us emailed professors whom we know personally in order to increase response rates. The survey was also given to Acting Dean of Students Michelle Lepore and Jason LaPrade, head of Dining Services, who graciously forwarded the survey to their departments. Paper copies of the survey were given to Patrick Willoughby and to Sheilah Casiano in the Trade Shop, who in turn distributed them among employees. A paper survey was conducted in these offices because Physical Plant and Trade Shop workers tend not to use the online system as much as students and faculty, and we wanted to maximize inclusion.

This survey suffered the same biases as the student one, and we received a higher rate of response from more eco-conscious faculty (especially those associated with the Environmental Studies Program). The results made it appear as though 23% of faculty members drive hybrids and only 2.6% drive SUVs or trucks. We counted cars in the Davis Parking Facility, Gray Lots, and the Distribution Center Faculty/Staff lot to determine a realistic breakdown of car types among faculty, staff, and union workers. The car counts showed that 25% of faculty, staff, and union workers drove SUVs and only 2.5% drove hybrids. Due to the significant difference between the survey and parking lot counts, we decided to ignore the survey breakdowns and instead used the lot count breakdowns for all college employees.

To estimate the average miles driven per year, we doubled the driving distance for each survey respondent to get a round trip distance, multiplied this figure by the number of days per week commuted in each calendar period, and multiplied this by the number of days in each calendar period. For respondents that gave us special instructions about how frequently they come to work during different periods, we calculated those separately according to their variable commuting patterns. We are probably undercounting, since much of the faculty and staff data is from more environmentally conscious respondents.

We then averaged the miles per year for each group—faculty, staff, and union workers—and found that the average miles traveled per year ranges widely. We calculated an average of 3,891 miles for union workers and an average of 1,792 for faculty. Because there is such a difference, we multiplied each of these separate numbers by the number of personnel in each group and then by the percentage of each type of vehicle for all employees from the lot data. This gave us the number of miles driven for each type of car for different types of employees, which was then divided by miles per gallon for each car class to determine that employee driving uses 145,950 gallons of gasoline per year. From the survey responses, we determined the percentage of respondents from each employee sector (faculty/staff/union employee) who used public transportation and took that percentage out of the total, so this number only accounts for the employees that actually drive to work.

Shuttles

Shuttles are the primary mode of transportation for most students on campus who go to Boston, local shopping areas, or other campuses. There are several different shuttles that the campus runs including the Exchange and Senate Bus into Boston and Cambridge.

The Exchange and Senate buses use diesel fuel and run an estimated 3,200 miles during 122 trips into Boston each week.[94] The route has not changed significantly since 2003, and estimates were calculated based on routing and schedules.[95] There are approximately 32 weeks in the academic calendar that the Exchange/Senate buses run regularly. During Wintersession, they run half as much, only every other hour, totaling 1600 miles per week for four weeks. Buses run during spring break on the same limited schedule, every other hour, and travel a total of 1,600 miles during the week of Spring Break. The Exchange/Senate Bus does not operate during the summer. There is a summer weekend shuttle that operates infrequently and irregularly. Because of these inconsistencies its emissions are negligible compared to other shuttles. In total the Exchange/Senate buses

[94] ES300-S03, *Audit of Wellesley College's Greenhouse Gas Emissions*, http://cs.wellesley.edu/~weed/papers/GHG-Assessment-spring-2003.pdf, 28.

[95] Overall Transportation Sector Trends, Appendix B 7 and 8. First Class Conference ES300 – S08 E-Reserve, "Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003)

account for about 110,400 miles traveled and 28,210 gallons of diesel burned each year, which is equivalent to 284 tonnes of CO_2e per year.[96]

The Mall Shuttle, also a diesel-powered vehicle, operates on Saturdays and runs about 116 miles per week.[97] It does not run during Wintersession or during the summer, meaning that there are 32 weeks a year that the shuttle runs. This accounts for 3,712 miles traveled and 1,020 gallons of diesel burned, which is equivalent to 10.3 tonnes of CO_2e.[98]

The Olin/Wellesley/Babson Shuttle (OWB Shuttle) is a new addition to the Wellesley fleet. The OWB Shuttle is a gasoline-powered van and travels between the three schools in a 7.6 mile loop that is runs 21 times each week day, except for Tuesdays when it does an additional two loops.[99] It runs 32 weeks a year during the academic year, which amounts to a total of 3,424 times. It travels a total of 26,020 miles each year. In total, the OWB Shuttle uses 1,750 gallons of gasoline per year, which produces 15.6 tonnes of CO_2e per year.

Student Travel To and From Home

Wellesley is a diverse institution with students from all 50 States, 3 U.S. Territories, and 60 other countries. Many students travel long distances to get to and from Wellesley. Therefore, when students travel to the college and to their homes, a large number of GHGs are emitted.

The CO_2e emitted in student travel to and from home is the second largest component of transportation related emissions. Although the Presidents Climate Commitment does not require that this form of travel be measured or reduced, we examined this because our goal is to measure all GHGs emitted by the college. GHG emissions for this section are estimated because it is not feasible to gather travel data on the behavior of 2,400 students.

While it is impossible to predict all of the travel that students do during the course of the year, there are four times during this time period when students must leave or return to campus. We estimated that the majority of students probably return home during these times. They include: traveling to campus for the beginning of the year in September, traveling home in December when the campus closes, returning in January to resume classes,

---

96 MIT Exchange Bus and Senate Bus. Wellesley College Transportation. Accessed Mar 20 2008. Wellesley College. <http://www.wellesley.edu/Transportation/>.

97 ES300-S03, *Audit of Wellesley College's Greenhouse Gas Emissions*, http://cs.wellesley.edu/~weed/papers/GHG-Assessment-spring-2003.pdf, 28.

98 Overall Transportation Sector Trends, Appendix B 7 and 8. First Class Conference ES300 – S08 E-Reserve, "Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003)

99 Wellesley-Olin-Babson Shuttle. Wellesley College Transportation. Accessed Mar 20 2008. Wellesley College. <http://www.wellesley.edu/Transportation/>.

and leaving at the end of the school year. Traveling at these times would mean that each student makes at least two round trips during the school year.

The Wellesley College Directory was used to obtain the address of each student by state or country, in order to calculate the number of students traveling from various locations and the origin of their journey. We could not figure out the exact travel method of each student, so we estimated it by assuming that students within 350 miles of Wellesley drove to campus, and all others flew. Airports were used as the central point in all locations because they provide a uniform location. All air travel was designated to begin and end at Boston's Logan Airport.

The calculators for airport distances[100] were not comprehensive, however, and some domestic and international airports were omitted. In order to fill in the blanks, we used two methods to find distances for these locations. First, Google Earth[101] was used to measure the distance between the student's originating airport and Boston's Logan airport. We then used ArcView 9.2, a Geographic Information Systems (GIS) software with a data layer that contained airport information.

The distance was calculated by averaging the numbers from the two programs. Each country and state represented had a number of kilometers traveled for one leg of the four trips taken home each year. We then multiplied this number by four to get the total number of kilometers traveled each year per student. Each location's total was then multiplied by the number of students traveling there to determine total kilometers traveled. These numbers were then summed and converted to miles to calculate the total distance traveled by airplanes, which was 11,577,987 miles. This travel emits 8,994.46 tons of CO_2e.

We repeated these same steps for the states, given the category of driving states, within a 350-mile radius of Wellesley. We then added these numbers together to give total miles driven by parents who drive their children to Wellesley and return home. To determine this value, the total mileage traveled by students within driving range of Wellesley was divided by the number of students in this area to acquire the average driving distance. Next, the total number of driving students was subtracted from the population of Wellesley students with cars. This enabled us to account for error and find the low end of students whose parents would drive them to campus. Finally, this value was multiplied by the average driving distance per student, and multiplied again by two, for a round trip, because any parent driving a student to campus would then have to drive home. It results in 521,593.74 miles traveled, 28,194.25 gallons of gasoline burned, and 249.68 tons of CO_2e emitted. In total, student travel to and from home releases about 9,244.14 tons of CO_2e.

---

[100] These include Air Routing International and Calculator Cat:
Air Routing International: Time/Distance Calculator. http://www.airrouting.com/content/tdcalc.html;
CalculatorCat.com. *Airport Distance Calculator,* BlueMarmont, Inc, 2002,
http://www.calculatorcat.com/free_calculators/airport_distance.phtml

[101] Google.com., *GoogleEarth,* http://earth.google.com/

There are potential errors in our calculations. First, we assumed that students make these trips four times a year. It is possible that students may choose to stay in Boston over winter break or the summer months; especially international students who may find traveling home to be very costly, which would reduce their number of miles traveled. Many students go home for other vacations, such as Thanksgiving or Spring Break, but they also might stay in Boston or go to other destinations. Since we have no way of quantifying this actual travel, we had to ignore all other travel during the year except for these four times. Extra travel during other points in the year is a potentially significant source of greenhouse gas emissions cannot be quantified in this report.

Room for error also exists in looking at the traveling distances. Some students who live outside of the states designated as driving states may choose to drive despite the distance, and others in the driving states might choose to fly despite being closer. We also have no way of determining how students get to and from the airport, both in Massachusetts and in their home state. There are many travel options, ranging from public transportation to Wellesley shuttles to private cars. But, because of the difficulty required of determining emissions arising from travel to and from airports, we have omitted these emissions from our calculations. As a result, our estimates for GHG emissions from travel to and from home are lower than what they would have been had this aspect been included.

There is also room for error in the calculations for each location's distance. By choosing a central location in each state it is likely that some students travel further or less then has been estimated. They may fly to different airports and then travel by car instead of taking flights entirely to their home state (for instance flying to Chicago and then driving home to Iowa rather than flying into Iowa City).

Despite these possible areas of error, it was vital that this report calculated emissions for student travel to and from the college given the significant amount of travel that occurs. Our method gives an initial estimate that at least demonstrates the rough magnitude, and likely minimum estimate of 9,211.09 tons of CO_2e, for student travel.

College-Funded Student and Faculty Travel

Wellesley College funds an enormous amount of faculty-staff and student travel. College-funded travel includes athletic, research, admissions, and conference travel. Given the high level of travel throughout the year there is simply too much data for us to process. We analyzed the months of April and October in order to give us a snapshot of collegiate travel that we could extrapolate to the entire year.

In choosing which months to examine we took many different factors into consideration. June had a large number of reimbursement forms because travelers turned in forms just before the deadline at the end of the academic year. January, July, and August had few reimbursements because there were far fewer people on campus to submit forms, although major conferences and research trips occur throughout Wintersession and the summer. September and February would be problematic because professors tend to travel less at the very beginning of the semester and because many of the reimbursements in those months come from Wintersession or summer travel.[102] Travel during those periods is probably different (more extended research trips and multi-destination trips) than most conferences or presentations during the semester. March has Spring Break in the middle of it and November has Thanksgiving, so there would be significant gaps in travel in those months as well. May is mostly finals and end-of-year preparation, so people are busy and unlikely to travel much until after finals, when there are limited college events. Because students, faculty, admissions officers, and athletic teams all travel extremely frequently, we chose months in which the school was on a relatively normal schedule. October and April are ideal choices because they cover both the fall and spring semesters, are right in the middle of their respective semesters, have no major breaks, and have close to the monthly average number of records.

The Finance and Treasurer Office provides a centralized location for records of travel of all types and, we hypothesized, would have records of every trip funded by the college. There is no electronic database that contains destinations and distances for reimbursed travel, so we personally examined paper reimbursement files and receipts.

We began by obtaining a list of all reimbursement form IDs over the past two years that were submitted under the travel account. We then looked through every reimbursement form that corresponded to the ID numbers on the list and recorded the ID number, name, department, origin, destination, total mileage if available, and method of transportation for each form. If there were multiple trips on a single form such as a flight and then a taxi from the airport to a hotel, we recorded them as two separate trips so we could accurately reflect the difference in emissions per mile. For trips in which there were no recorded origins and destinations, for example, for a rental car to get around a city after a flight there, mileage was recorded when available or the trips were omitted if no mileage was available. For nearly all cases, this situation only arose for short trips in taxis and rental cars. Major destinations were always noted on the reimbursement forms, and therefore we captured the large majority of the travel on each form. These omissions mean that true emissions will actually be slightly higher than our figure, but this error is not likely to be significant.

A greater source of error that we uncovered when searching through the records was the fact that some trips were submitted under accounts other than travel. Because the list of ID numbers that we received from the financial office only contained IDs for travel account reimbursements, and because we began October's analysis by skipping reimbursements that

[102] Andrew Evans, Vice-President of Finance and Treasurer of Wellesley College. Personal Communication

were not on the list, we may have skipped a significant portion of records at the beginning of the month.

By far, the largest assumption we have made in our analysis is that April and October can be accurately extrapolated to represent travel over the entire school year. The list of ID numbers was only 1½ pages long for July but was 13 pages long for June, so there is a significant variation in the number of travel forms submitted in each month. Note that forms are organized by the month in which they were submitted, not the month in which the travel took place, and so forms from October and April included travel as far back as the summer or winter, respectively.

We had to account for all the aforementioned anomalies when we extrapolated the data for the year. To do so, we multiplied the total travel emissions for both months by the ratio of the number of total entries in the ID list to the number of entries in the two months. That way, we essentially created an average emissions profile for a single reimbursement form and extrapolated it to all reimbursements. April and October did not have significantly different emissions profiles, so we did not need to weight the spring months differently than the autumn months. We found that the college reimbursed almost 5,500,000 million miles of air travel, nearly 110,000 miles of train travel, and over 180,000 miles of car and bus travel. By dividing the road travel figures by average mileages for cars and buses, we found that the college reimbursed the burning of 7,360 gallons of gasoline and almost 450 gallons of diesel.[103] Converted air miles equals 4,272 metric tonnes of CO_2e, while train travel equals 320,100 kilowatt hours or 2201 metric tonnes of CO_2e. Gasoline works out to be 66 metric tonnes of CO_2e and diesel is 5 metric tonnes.

Admissions travel

Admissions officers travel around the country for recruitment trips. We received a sheet of admissions counselor travel in 2007, with a list of destinations by city and by method of travel. For the cities, we assumed that the counselors traveled to the major airport closest to the city, with Boston Logan airport as the origin. Similar to the student travel section, we used online calculators to determine the airport distances. If the counselors are using their own cars, we assumed that Wellesley College is the originating location. While we are capturing the majority of admissions travel, our calculations are not entirely comprehensive because it is very difficult to know the amount that counselors are traveling

[103] Bus mileage figure was an average based on 3 articles: Jane Hadley, "Hybrid buses' fuel economy promises don't materialize," *Seattle Post-Intelligencer*, 13 Dec 2004, http://seattlepi.nwsource.com/transportation/203509_metro13.html. Tim Ellis, "Fuel costs hit all: Be glad you aren't driving a bus," *Arizona Daily Star*, 25 Apr 2005, http://www.azstarnet.com/sn/related/72010.php. "FAQs," *Milwaukee County Transit System*, http://www.ridemcts.com/about_mcts/index.asp.

within the cities they visit. The reimbursement figures should account for these intra-city trips, but it is impossible to know if they cover all of them.

Wellesley also funds some prospective students to visit the institution. The Admissions Office provided us with a list of originating destinations of students and their method of travel. Our calculations do not include student travel to and from their originating airport or from Wellesley to and from Boston Logan.

Overall, the Admissions Office records show that in 2007, the office was responsible 403,400 miles of air travel, or 313 metric tonnes of CO_2e. In addition, Admissions was responsible for almost 7100 miles of train travel, which is equivalent to 20,661 kilowatt hours and 14 metric tonnes of CO_2e. There were 24,000 miles of car and bus travel were due to admissions travel. When converted into gallons car and bus travel equals 1,050 gallons of gasoline, or 9 metric tonnes of CO_2e, and 20 gallons of diesel, which works out to be 0.2 metric tonnes.

Athletic Transportation

Wellesley's student athletes compete against students from other Northeastern schools. Travel from thirteen athletic teams contributes almost 41 tonnes of CO_2e each year, or 2.4% of transportation emissions.

We obtained a record of all off-campus games and practices of Wellesley athletic teams in the 2007-2008 school year.[104] We then calculated the mileage between Wellesley College and the opponent. Our calculations include the following athletic teams: basketball, cross country, fencing, field hockey, golf, lacrosse, soccer, softball, squash, swimming and diving, tennis and volleyball. The only team not accounted for is crew, as the team travels into Boston daily for practices. Excluding crew, Wellesley athletic teams participated in 147 off-campus events, traveling 13,880 miles during the school year.

The Wellesley crew team travels 845 miles per week, going by bus five days a week to practice. The team also travels to regattas by bus, along with shells in tow by truck. These vehicles each account for another 411 miles during the season. During the season, the crew team is responsible for 1,268 miles of travel.

This report does not account for athletic teams traveling during spring break. Teams go on spring training trips to Florida, California and Georgia. Unfortunately, we cannot account for this travel because we could not access information about these trips. We therefore are dramatically underestimating the travel emissions from athletics.

---

[104] Bridget Belgovine, Director of Athletics, Personal Communication

In total, more than 8,200 miles are driven on an annual basis in athletic travel, which means that 250 gallons of gasoline and 3,840 gallons of diesel were used, equivalent to about 41 tonnes of CO_2e.

Wintersession

Wellesley directly sponsors a number of international and domestic trips over Wintersession that generate significant emissions due to air travel. There is also travel within the countries during these trips, but there is no way for us to quantify these journeys. Furthermore, these trips are part of the curriculum, so they are impossible to target for mitigation purposes.

To ascertain the greenhouse gas emissions from Wintersession travel, we looked at data over the last four years. We determined course enrollments and the number of professors that were on each trip.[105] We are assuming that the only faculty/staff on the trip are the ones listed, although the emissions figure could be an underestimate because there might be others who attend but are not listed as official instructors. We looked at trips taken in 2006, 2007, and 2008[106] and determined average travel distances by calculating the distance from each airport in the specific city of the trip,or the most central airport in the country, to Boston Logan. Our estimations are generally lower than the actual figure because we ignored connecting flights.

The number of trips appears to have increased over the past four years, although it is unclear based on the 2005–8 data whether we can apply a trend to the total number of miles traveled. There were 5 trips in 2005 and the total mileage was 392,562. There were seven trips each year in 2006 and 2007, although the total miles traveled in those years was slightly smaller at 354,693 and 391,087, respectively. In 2008, the total miles traveled on the eight trips offered increased dramatically to 477,906. Looking at the past four years is probably a good indicator of Wintersession travel, since typically each trip is offered every other year, but the short timescale makes it impossible to develop trend data.

Motor Pool

The Wellesley Motor Pool accounts for all cars owned by the college including all maintenance vehicles (trucks, snow plows, lawn mowers), campus police cars, escort vans, waste transportation, athletic vehicles, science department vehicles, and boats. In total, this

---

105 *Wellesley College Banner System*, https://bannerss.wellesley.edu:4453/dbprod/twbkwbis.P_GenMenu?name=homepage.
106 Jennifer G Lewis, "Curriculum Links, "*CCI Individual Major*, Wellesley College Dean's Office, http://www.wellesley.edu/DeanCollege/CCI/curriclum.htm.

aspect of Wellesley emitted 559 tons of CO_2e into the atmosphere in 2007, 3.2% of Wellesley's total transportation related emissions.

There may be some discrepancies in our estimation methods. We removed emissions due to waste transport from the Motor Pool figure because those emissions were calculated separately. We excluded many emissions due to athletic travel because a large amount of this travel is contracted out and much of that travel is to destinations far enough away that the vehicles refuel off-campus. These longer trips are included in Athletic Travel, while shorter trips are included in Motor Pool.

As the Motor Pool includes a variety of vehicles, each subgroup pays for fuel through a general account, so it is impossible to determine specific fuel usage and mileage amounts for each Motor Pool subcategory.[107]

Diesel usage in 2007 totaled 4,789 gallons, and gasoline usage for the year totaled 55,651 gallons.[108] Emissions from Motor Pool diesel fuel totaled 61 tonnes of CO_2e, while emissions from gasoline usage emitted 497 tonnes of CO_2e. The only omission from this amount would be fuel bought on longer car trips, such as athletic events, when the vehicle refueled off campus, and some of this can be captured through the data collected on athletic travel. In total, 558 tonnes of CO_2e are emitted from Wellesley vehicles.

There are small boats located on the lake that require fuel to operate. The Wellesley Boat House purchases its fuel separately from the rest of Motor Pool because these boats are fueled by premium gasoline. In order to find fuel usage for the Boat House, we divided the total amount spent on premium gasoline by the Boat House for the 2005–2006 academic year ($100) and the 2006–2007 academic year ($186) by the estimated prices for premium in those years, respectively, $1.85 and $2.30.[109] The results were that in the 2005–2006 academic year, 54 gallons were used, and in the 2006-2007 school year, 81 gallons were used. Together, these make an average of 67 gallons of premium gasoline used by the Wellesley College Boat House per year. This gasoline usage results in 0.6 tonnes of CO_2e emissions.

Waste Removal

As detailed in the waste section, Wellesley generates a significant amount of refuse that needs to be removed from campus. We have attempted to quantify the greenhouse gas emissions that arise from the transportation of this waste. We have accounted for the removal of garbage, recycling, and other miscellaneous wastes. In total, waste removal accounts for about 33 tonnes of CO_2e, or 2% of the total transportation emissions.

---

107 George Reebe, Head of Motor Pool, Personal Communication, Feb 28, 2008.
108 Patrick Willoughby, Associate Director Physical Plant, Personal Communication, Feb 21 2008.
109 Jack Daigle, Head of the Boat House, Personal Communication, April 3, 2008.

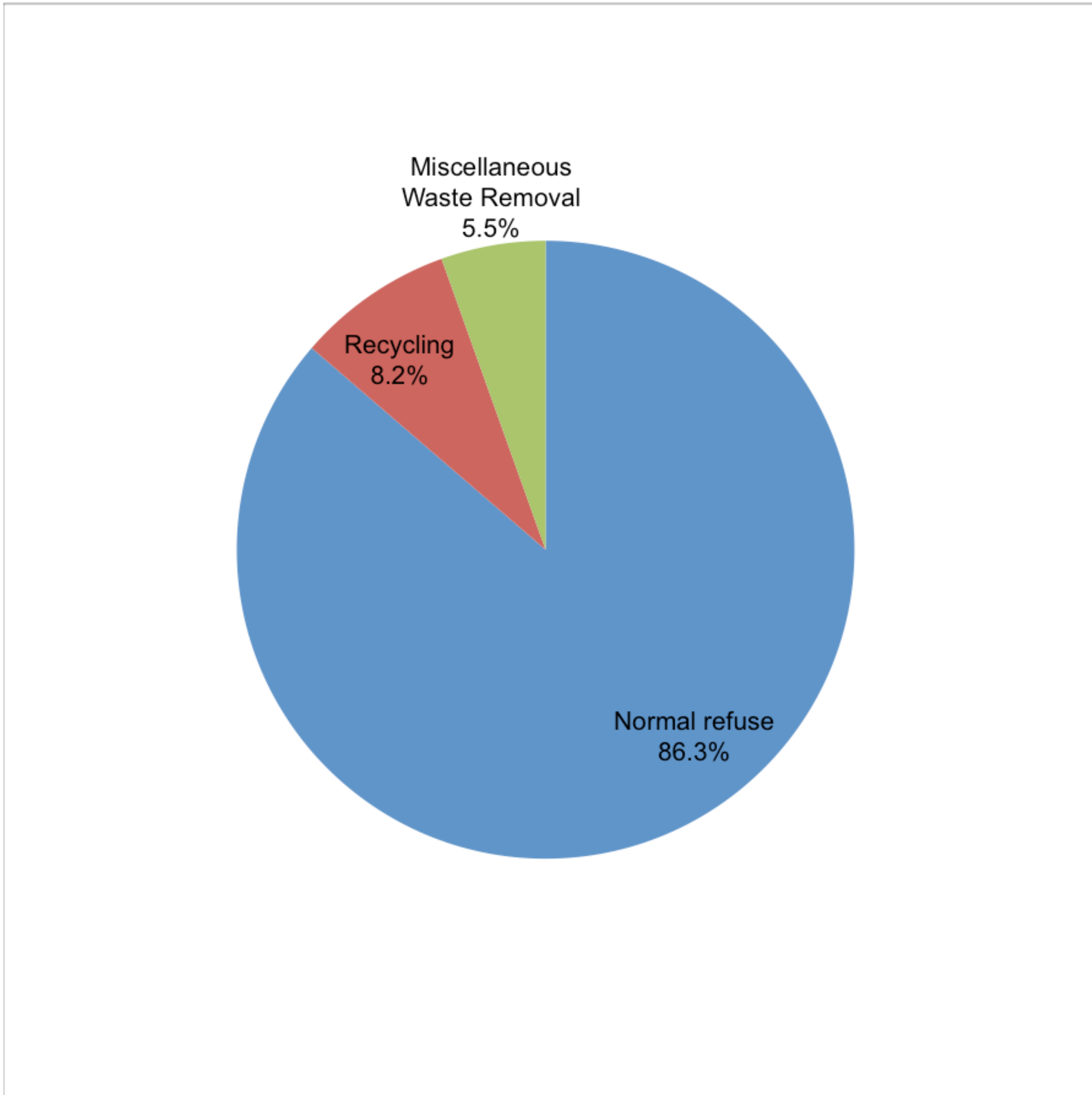


Figure 9.3: Breakdown of waste removal emissions from transportation.

Waste at Wellesley is incinerated at a waste to energy plant. For purposes of this sector, we are only quantifying emissions from the transportation. The journey to the incineration facility goes from Wellesley College to a transfer station in Holliston and on to the waste to energy plant in Braintree. This journey takes 35.8 miles.[110]

Open dumpsters are found outside of each building with a dining hall. There are six such containers in total from the residence halls: Stone-Davis, Bates, Beebe, Pomeroy, Cazenove, and Tower.[111] Each waste container is emptied roughly four times a week during the school year (36 weeks), or enough so that a compactor truck makes 7 total trips per week

110 Patrick Willoughby, Associate Director of the Physical Plant, Personal Communication
111 Patrick Willoughby, Associate Director of the Physical Plant, Personal Communication

on average to the waste to energy plant.[112] This accounts for 252 trips for open container wastes to the dumpster, which totals 18,040 miles to transport this form of garbage.

There are four waste compactors on campus, each emptied once a week during the academic year. This waste is sent to the waste to energy facility 144 times a year,[113] which accounts for 10,310 miles traveled.

In total, 28,350 miles are traveled each year transporting garbage, which uses 2,840 gallons of diesel fuel, equating to 29 tonnes of CO_2e. This is the primary source of greenhouse gas emissions from transportation in waste removal, accounting for 86% of the emissions from the section. These estimates are potentially low because they do not account for wastes generated during the summertime, when a few dining facilities are open and waste pickup continues. This waste removal would increase the miles and GHG emissions to the total amount used to transport garbage.

Almost all recycling at Wellesley goes to Conigliaro Industries in Framingham, which is 6.4 miles away.[114] Over the entire calendar year, a 12-yard swap truck makes an average of 4 trips per week to transport all recycling from around campus. This truck travels an additional 2,660 miles, and uses 270 gallons of diesel fuel per year. This transport generates 2.7 tonnes of CO_2e a year.

There are miscellaneous wastes that are not considered part of the regular garbage removal or recycling. There is waste that comes from individual departments that require special processing, like hazardous Science Center materials, or do not leave campus on a regular weekly basis. In total, miscellaneous waste transport accounts for 1690 miles of truck travel and 180 gallons of diesel fuel burned. This is the equivalent of 1.8 tonnes of CO_2e and 5.5% of total emissions from waste removal.

Science Center wastes, Co-Generation Plant wastes, Motor Pool and Trade Shop wastes are all removed by Northland Environmental located in Providence, Rhode Island. Prior to 2000, the company removed wastes 8–10 times a year. Since 2000, campus wastes have increased from the restoration of Paint Shop Pond, construction wastes, and wastes from the recently created wetland. In 2006, this company made 17 pickups from Wellesley and continues to make roughly 15–20 pickups a year. Northland Environmental is located 45.8 miles away from the Wellesley campus. Prior to 2000, trucks traveled roughly 820 miles per year to remove wastes. After 2000, this number increased to 1,560 miles.[115] Motor Pool also has waste removed by an additional company, Cyn, in which a 1,000 gallon truck makes an 85.4 mile round trip to campus twice a year from Stoughton, Massachusetts. The Trade Shop and Motor Pool also have waste removed by Safety Kleen, which is 32.7 miles away.

---

112 Patrick Willoughby, Associate Director of the Physical Plant, Personal Communication
113 Patrick Willoughby, Associate Director of the Physical Plant, Personal Communication
114 Patrick Willoughby, Associate Director of the Physical Plant, Personal Communication
115 Suzanne Howard, Director of the Office of Environmental Health and Safety, Personal Communication

This company removes no more than fifty gallons of waste twice a year. Therefore, 130 miles are traveled on an annual basis for this form of waste removal.[116]

Deliveries

To calculate greenhouse gas emissions from deliveries, we determined the number of miles that the distributors were traveling and the fuel efficiency of the vehicles used. Even if Wellesley is part of a loop including other institutions, we have calculated the distance from the distributor to Wellesley directly. In many cases, we also made assumptions about the type of vehicle being used: either a van, mid-sized or large truck. We were given some of this information, but in many cases we had to guess, based upon the distributor and the frequency of deliveries to campus. Our guesses might skew the results, as some distributors could have larger or smaller vehicles, affecting the miles per gallon and the resulting emissions. We were not able to find information about the location of three of the distributors online for both all of these categories, so we had to omit them, which slightly decreases our numbers. In addition, we do not account for the loops that the delivery vehicles take around campus so our numbers are actually lower. Many of these vehicles also idle outside buildings, further increasing gasoline usage.

Under the jurisdiction of the Purchasing department, the college buys office supplies, furniture, and other necessities to keep the institution running. OfficeMax, FedEx, UPS, and DHL all visit campus five days a week. Smaller distributors such as Office Environments, Millhenge, Circle Supply and IKON come to campus once a week. There are many other smaller suppliers and repair companies (such as Thyssen Krupp and MacGray) who only come to Wellesley on an as-needed basis, which averages to about two times a month.[117] We are assuming that these deliveries occur for 50 weeks out of the year. In total, this transport amounts to 43,345 miles of travel per year in big trucks, medium trucks, and vans, and a total of about 45 tonnes of CO_2e emitted.

---

[116] Suzanne Howard, Director of the Office of Environmental Health and Safety, Personal Communication
[117] Tom Kane, Purchasing Department, Personal Communication
Google, *GoogleMaps, http://maps.google.com.*

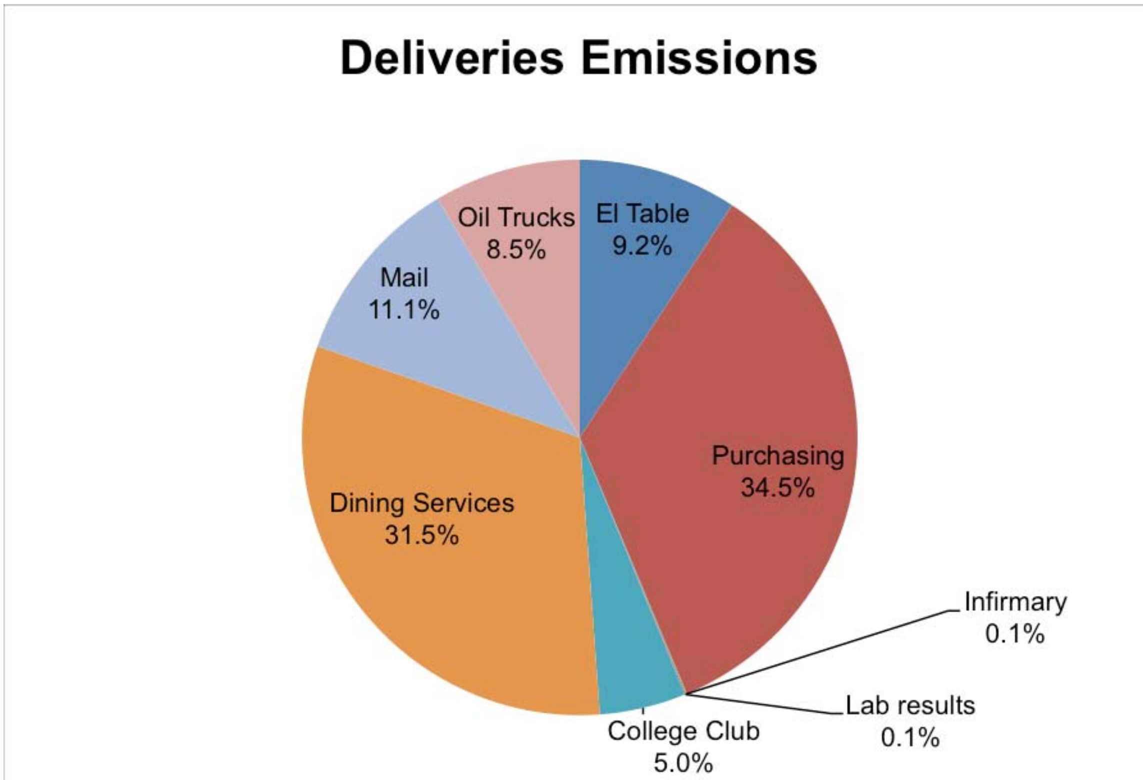


Figure 2. Deliveries emissions broken down by purpose. Data was gathered through communications with various staff sources.

One major source of deliveries is Dining Services, which receives deliveries from multiple vendors multiple times a week. Some of the larger vendors include Sysco, Costa Produce and Tropicana, who make three deliveries to Wellesley per week.[118] For dining services, deliveries are fairly constant throughout the year—during Winter and Summer Sessions when dining services operates on limited hours, the number of deliveries per week does not decrease, just the volume in each delivery. Based upon this assumption, we calculated dining services deliveries for 50 weeks in the year, which resulted in a total of 28,500 miles, or 4,000 gallons of diesel fuel burned, per year, or 40 metric tonnes of CO_2e. Planes also flew 116,000 miles, (worth 90 metric tonnes of CO_2e) used to transport specialty foods to the college.[119]

The College Club and El Table are smaller entities on campus that have deliveries not accounted for through Purchasing or Dining Services. The College Club has one additional trip from Sysco not on the college loop and operates throughout the entire year.[120] El Table, a student-run co-op, has two additional food deliveries per week, and each week the also students take a trip with a ZipCar to obtain food. Deliveries are calculated for 36

[118] Google, *GoogleMaps, http://maps.google.com.*
Jason LaPrade, Head of Dining Services, Personal Communication
[119] Jason LaPrade, Head of Dining Services, Personal Communication
[120] Kevin Reardon, Manager of the College Club, Personal Communication

weeks out of the year, since El Table is only open during the fall and spring semesters and Wintersession.[121] In total, trucks traveling to these locations drive 11,070 miles per year and use 1,820 gallons of diesel, which equals 18 metric tonnes of CO_2e, and 24 gallons of gasoline equaling .21 tonnes of CO_2e.[122]

The Bookstore receives daily deliveries from both FedEx and UPS, but these are accounted for through Purchasing, which includes these deliveries as a part of their daily deliveries on campus. At the beginning of the semester, textbooks are shipped from Lincoln, Nebraska. This shipping occurs twice a week for what we estimate are the first three weeks of the semester.[123] This accounts for six trips per semester, or twelve per year, which results in 15,960 miles of flying per year, creating 12 metric tonnes of CO_2e. The distance from Boston Logan to Wellesley College is also accounted for, assuming that a truck takes the books from the airport to the college.

During the normal business week, Wellesley College receives mail for various departments, offices, and 2300 students. We can estimate the mileage of the mail truck. Twice a day, the mail truck travels from Wellesley College to the nearby Post Office, returns to Mail Services, and then makes 30 stops throughout campus to deliver mail. Fran Adams, the Mail Services director, recorded the mileage of the Wellesley College mail truck to be 276 miles a week. The mail truck totals 14,350 miles a year, which uses 1,440 gallons of diesel, creating 15 metric tonnes of CO_2e. This fuel use, however, is included within the Motor Pool fuel usage and so has not been calculated separately in the total amount of CO_2e. It is helpful to break out the data in this section to get a sense of where Motor Pool fuel is being used when possible.

We conducted our estimates based on a standard week with no extraneous deliveries. There are ways, however, in which this assumption could cause errors. In not having a broad range of weeks to average as a means of determining the miles traveled, the distance estimated may be incorrect. The only times that these values would significantly differ, however, are during the summertime, when there is less mail on campus and during the holiday season. From November until January, the volume of holiday mail increases significantly. As a result, the mail truck takes more trips to the Post Office to accommodate these mailings. During the summer, significantly less mail arrives to Wellesley College because there are fewer students on campus; and most students have given alternative addresses to those who might send them mail. The mail vehicle might take fewer trips with lighter loads, but the truck must still make thirty stops along the campus route to drop mail off at offices and in the Campus Center for those remaining on campus.

121 Lisa Wiley, El Table Manager, Personal Communication.
122 Google, *GoogleMaps, http://maps.google.com.*
123 Joe Leva, Bookstore Manager, Personal Communication

The Wellesley Infirmary has three forms of transportation that emit GHGs. They include Quest Diagnostics testing, deliveries from Andrews Pharmacy, and irregular ambulance transport.[124]

Quest Diagnostics picks-up and returns lab tests performed on students. This occurs between one and three times a day during the business week. The vehicle travels 3.75 miles solely between the Newton/Wellesley Hospital and the Wellesley campus for a total mileage of 15 miles a day. From this, the Quest van travels 2,400 miles during the school year to transport lab results. This equals 160 gallons of gasoline per year, which produces 1.43 tonnes of CO_2e.

Andrews Pharmacy delivers student prescriptions to the infirmary one to three times a day, six days a week. The pharmacy is located in the vicinity of Wellesley College, 0.96 miles away, and pharmacy employees drive in a car.[125] This transport accounts for 3.84 miles a day and 614 miles during the academic year, creating 0.25 metric tonnes of CO_2e.

Lastly, the infirmary transports students to either the Newton/Wellesley Hospital (3.75 miles) or Metro West Hospital (6.76 miles) in the event that care that students need cannot be provided by the professionals at Wellesley.[126] Ambulance transports are irregular and occur roughly once every two to three months. There are approximately four ambulance trips during the academic year. If there were two trips a year to the Newton/Wellesley hospital, two ambulance trips would be 15 miles round trip, from the ambulance bay. If there were two trips a year to the Metro West Hospital, two ambulance trips would be 27 miles. These trips translate to a total of 42 miles traveled by ambulance per year, barely a couple of gallons of fuel, which works out to be an insignificant number of metric tonnes of CO_2e.

In total, 3,060 miles are infirmary related travel. This data only includes months during the school year. With fewer students on campus during the summer months, there are fewer patients at the infirmary. The number of deliveries and transports that are made could be over estimated given that summer data is unknown.

In the recent past Wellesley relied heavily on oil as a resource for heat during the winter months. While faculty homes still receive regular oil deliveries, the installation of the natural gas line in 1992 has eliminated regular delivery trips to the main campus. This reduces GHGs by eliminating the need for regular oil deliveries. Oil deliveries to campus are sporadic at best through they year and do not generate significant carbon emissions given their low frequency.

There are 39 faculty homes on the extension of the Wellesley Campus. These homes receive oil from a local company, James Devaney Oil Company, located 6.5 miles away in

[124] Jodi Colman, the Office Administrator at the Infirmary, Personal Communication
[125] Google, *GoogleMaps, http://maps.google.com.*
[126] Google, *GoogleMaps, http://maps.google.com.*

Newton, Massachusetts. Each house receives a monthly delivery of oil for roughly eight months of the year (September until April). As a result, there are 312 oil deliveries on an annual basis. This accounts for 6,590 miles of tanker truck travel, which burns 1,100 gallons of diesel per year, or 11 metric tonnes of CO_2e.[127]

In total, Wellesley's transportation sector is responsible for 17,100 $MTCO_2e$, or 36% of the college's total emissions. The majority of these emissions come from student travel to and from home, and college-funded travel. Greenhouse gas emissions from these two types of travel are especially difficult to reduce, so gains must be made in other ways, and we should examine ways to offset this necessary travel.

[127] Suzanne Howard, Director of Environmental Health and Safety, Personal Communication.

10.

Waste Sector

Waste disposal contributes a very small portion of the college's GHG emissions. In 2006, Wellesley produced approximately 1,839 short tons of waste, 10% of which was recycled.[128] The remaining 90% of the college's waste is incinerated in a waste-to-energy (WtE) facility. No matter which disposal method used, waste would constitute less than 4% of the college's total greenhouse gas emissions, but the WtE process emits fewer greenhouse gas emissions than landfilling.[129] In addition, the WtE process emits fewer greenhouse gas emissions than would have otherwise been emitted in the production of an equivalent amount of energy by fossil fuels, often resulting in a net greenhouse gas emissions savings. Although this energy is not used by Wellesley directly, the WtE process still contributed to a net emissions savings of 61 tonnes of CO_2e, approximately 0.1 % of total emissions, in 2006. As a result, most of the greenhouse gas emissions associated with waste come from the transportation of waste to the WtE and recycling facilities.

Waste Generation

It is difficult to quantify the exact amount of waste produced at the college because the number of weekly open container (dumpster) pickups is highly variable, from 1 to 6 per week, and the waste content of open containers and the campus' four compactors is highly variable. Nonetheless, the college estimates that in the year 2006 it produced 1,270 short tons of waste in open containers and 569 short tons of waste in compactors, totaling 1,839 short tons of waste.[130]

Waste-to-Energy

---

[128] Patrick Willoughby, personal communication, 4/3/08. Based on 70 lbs/cubic yard open container per week (1,270.36 tons/year over 698 cubic yards) and actual weights of compactors between 7/2005 and 6/2006 (average of 568.78 tons).

[129] "Campus Carbon Calculator v5.0." Clean Air, Cool Planet, 2006; "The ABCs of Integrated Waste Management." Waste-to-Energy Research and Technology Council. http://www.seas.columbia.edu/earth/wtert/faq.html.

[130] Patrick Willoughby, personal communication, 4/3/08. Based on 70 lbs/cubic yard open container per week (1,270.36 tons/year over 698 cubic yards) and actual weights of compactors between 7/2005 and 6/2006 (average of 568.78 tons).

All non-recycled solid waste is sent to waste-to-energy plants for incineration. Waste to energy (WtE) is a process that converts solid waste to usable energy by incinerating it at temperatures of more than 1800 degrees Fahrenheit.[131] Large items, such as televisions, are removed prior to incineration, and ferrous materials are removed by magnet after incineration for recycling.[132] The small amount of remaining ash (5-15% of the original waste volume) is either landfilled or used to create asphalt and filling compounds for construction projects.[133]

A typical WtE process gives 500-600 kWh of energy per short ton of waste, the energy equivalent of one barrel of oil or 0.25 short tons of coal.[134] Between 1990 and 2005, Wellesley produced 1,821 short tons of waste per year. Recently, the amount of on campus wastes has decreased as recycling efforts have increased. In 2006 and 2007, Wellesley decreased the waste produced to 1,659 short tons of waste per year, due to increased recycling. In 2006 or 2007, Wellesley generated more than 829,320 kWh per year by incinerating its waste in a WtE plant. While this amount of energy generation is not used directly by the college and is very small in comparison to the amount of energy the college uses daily, WtE is the most greenhouse gas efficient method of waste disposal.

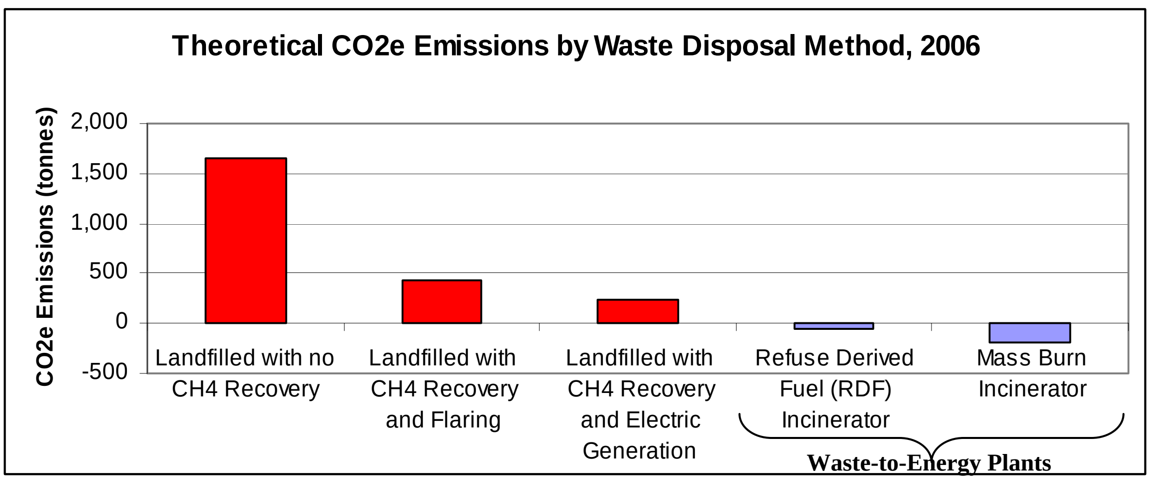


Figure 10.1: Theoretical CO_2e Emissions by Waste Disposal Method, 2006 [135]

In addition to producing fewer net greenhouse gas emissions than landfilling, WtE plants do not emit aqueous pollution that can contaminate nearby water supplies and reduce the space requirements of landfilling the college's waste by 90%.[136]

---

131 "Audit of Wellesley Greenhouse Gas Emissions." Environmental Studies 300, Wellesley College, May 2003, 39.
132 "Audit of Wellesley Greenhouse Gas Emissions." Environmental Studies 300, Wellesley College, May 2003, 39.
133 "Audit of Wellesley Greenhouse Gas Emissions." Environmental Studies 300, Wellesley College, May 2003, 39.
134 "The ABCs of Integrated Waste Management." Waste-to-Energy Research and Technology Council. http://www.seas.columbia.edu/earth/wtert/faq.html.
135 "Campus Carbon Calculator v5.0." Clean Air, Cool Planet, 2006.

Yard Waste

Wellesley composts all of its yard waste and re-uses it for landscaping projects. With few exceptions, yard waste produces all loam that the campus requires.[137] All wood debris, stumps, etc. are put through a tub grinder twice, and used to produce 90% of the mulch used on campus.[138] By producing the vast majority of the compost and mulch used on campus, the college significantly reduces the greenhouse gas emissions of both transporting yard waste to an off-campus disposal location and of transporting purchased compost and mulch to campus. In addition, waste concrete and asphalt are staged and pulverized and street sweepings are sometimes used for sanding the roads, thereby diverting such waste from the solid waste disposal stream.

Recycling

In many cases, recycling is an effective way to reduce greenhouse gas emissions because it reduces the amount of net waste that has to be landfilled. Landfills emit methane, and land use changes required for landfilling also influence the climate system. This is not the case for Wellesley, since all waste is sent to a WtE plant instead of being landfilled. Recycling nonetheless decreases the use of new resources and is often less energy-intensive than producing a product from new resources, thus eliminating greenhouse gas emissions at several points in the life cycle of any product. For example, in the case of paper, recycling paper decreases the carbon dioxide emissions of raw material extraction and processing, in addition to decreasing the removal of trees, a carbon sink.

Since 2002, on-campus student organizations such as Wellesley Energy and Environmental Defense (WEED) have promoted recycling at Wellesley. These initiatives helped create an institutionalized recycling system. In addition to most commonly recycled materials, Wellesley also recycles fluorescent light bulbs, batteries, electronics, appliances, Freon, and mattresses.

---

136 "The ABCs of Integrated Waste Management." Waste-to-Energy Research and Technology Council. http://www.seas.columbia.edu/earth/wtert/faq.html.

137 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008).

138 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008).

Figure 10.2: Wellesley College's Recycled Goods by Type, 2006[139]

Prior to 2005, Wellesley recycled approximately 18 short tons of waste per year, 1% of total waste produced.[140] In 2006 and 2007, Wellesley recycled approximately 180.5 short tons per year or 10% of total waste produced.[141]

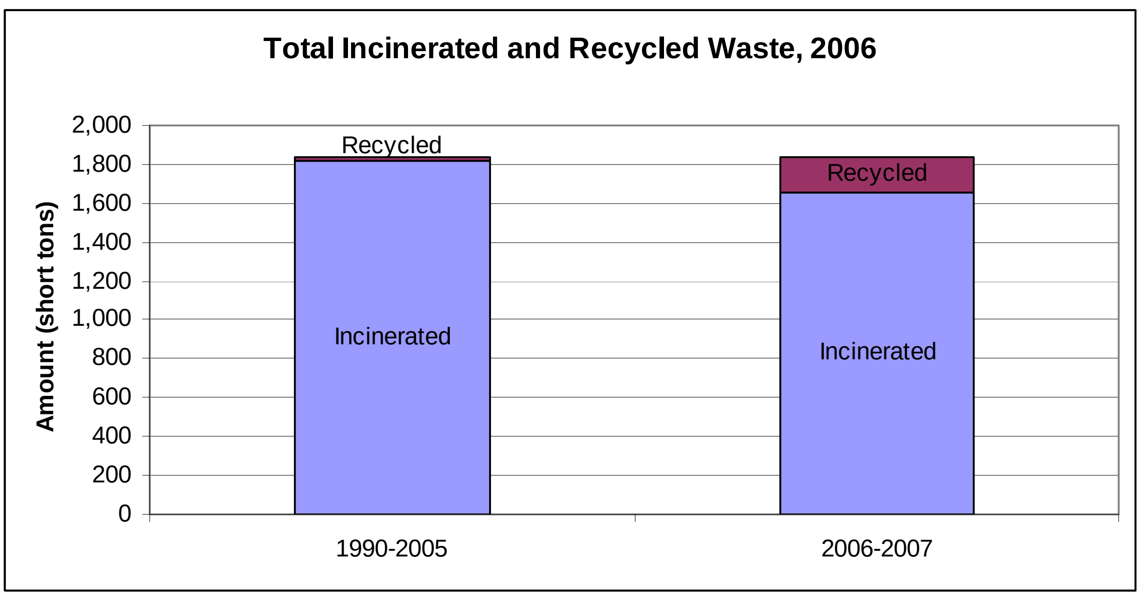


Figure 10.3. Total Incinerated and Recycled Waste, 2006[142]

---

[139] Duff, Madison, Liu, Kristy, & Yen, Tina. "Wellesley College Recycling." Economics 228, Wellesley College, May 14, 2007. http://www.wellesley.edu/Economics/Sneeringer/econ_228/paper-Recycling.pdf

[140] Patrick Willoughby, personal communication, 4/3/08.

[141] Patrick Willoughby, personal communication, 4/3/08.

[142] Patrick Willoughby, personal communication, 4/3/08. Based on 70 lbs/cubic yard open container per week (1,270.36 tons/year over 698 cubic yards) and actual weights of compactors between 7/2005 and 6/2006 (average of 568.78 tons).

Wellesley contracts with Conigliaro Industries in Framingham, MA for recycling. Wellesley pays a per tonnage rate that varies depending on the material recycled. Conigliaro credits Wellesley for recycling more valuable recyclables, like steel. Conigliaro credited the college $9,814 in 2006 and almost $12,000 in 2007 which was spent toward recycling improvements.

Although the percentage of waste recycled has increased, Wellesley still has much progress to make. The Earth Engineering Center of Columbia University estimates that up to 40% of waste can be recycled or composted.[143] A waste audit of the campus conducted by Wellesley Energy and Environmental Defense estimated that 42% of the campus wide waste stream consists of recyclable materials.[144]

Transportation

The primary source of greenhouse gas emissions connected with waste, therefore, results from the transportation of waste. Over time, the college's transportation methods for recyclable waste have become increasingly streamlined. In 2003, the college's waste was transported to four different waste incinerating facilities on a rotating schedule; SEMASS in Carver (51.5 miles away), Covanta Company in Haverhill (28 miles away), and RESCO in both Millbury (33 miles away) and Saugus (25.5 miles away).[145] Currently, waste to be incinerated is trucked first to a transfer station in Holliston (8.3 miles away),[146] and then to the SEMASS trash-to-energy plant in Braintree (27.5 miles away from Holliston).[147] Wellesley contracts with Wellesley Trucking, Incorporated to transport recycled materials to the Conigliaro Facility in Framingham (6.4 miles away).[148] For more information on the greenhouse gas emissions of the transportation of waste, please refer to the Transportation section.

---

143 "The ABCs of Integrated Waste Management." Waste-to-Energy Research and Technology Council. http://www.seas.columbia.edu/earth/wtert/faq.html.

144 Waste Audit 2002, Wellesley Energy and Environmental Defense, 4/26/2002. Referenced in: "Audit of Wellesley Greenhouse Gas Emissions." Environmental Studies 300, Wellesley College, May 2003, 49.

145 "Audit of Wellesley Greenhouse Gas Emissions." Environmental Studies 300, Wellesley College, May 2003, 35.

146 "Get Directions," Wellesley, MA to Holliston, MA, Google Maps, maps.google.com

147 "Get Directions," Holliston, MA to Braintree, MA, Google Maps, maps.google.com

148 Duff, Madison, Liu, Kristy, & Yen, Tina. "Wellesley College Recycling." Economics 228, Wellesley College, May 14, 2007. http://www.wellesley.edu/Economics/Sneeringer/econ_228/paper-Recycling.pdf; "Get Directions," Wellesley, MA to Framingham, MA, Google Maps, maps.google.com.

11.

Land Use Sector

Along with our more obviously anthropogenic elements included in aforementioned sectors, all of the "natural" elements of the Wellesley campus (bodies of water, plant and animal life, etc.) affect the college's greenhouse gas emissions. These land characteristics have the capacities to be both emitters and sinks of greenhouse gases. In addition, emissions from inputs onto the land, such as fertilizer, and changes in land use through construction and renovation projects, also affect Wellesley's greenhouse gas emissions. Overall, land use accounts for a very small portion of the college's total greenhouse gas emissions or sequestration.

Carbon Sequestration

Carbon sequestration is the process of storing carbon and it can occur in a variety of ways, from geoengineering projects trapping carbon underground to the absorption of carbon dioxide by plants. In the photosynthesis process, plants absorb carbon dioxide and store it in biomass, such as leaves, branches, and roots. The trees and foliage on Wellesley's campus act as "carbon sinks," sequestering carbon and slightly decreasing the college's net greenhouse gas emissions.

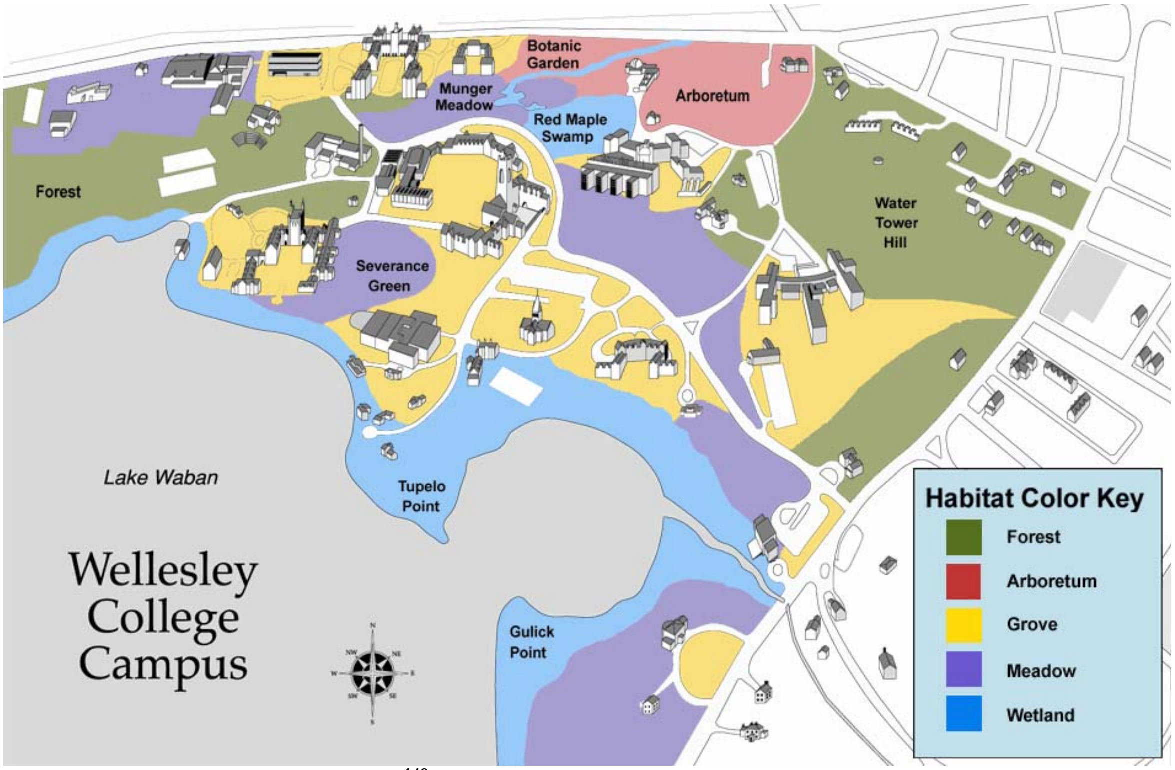


Figure 11.1. Campus Habitats[149]

In 2004, Wellesley's carbon sequestration budget was estimated by multiplying the area of each type of habitat on campus by its established sequestration rate. With the lake, wetland, meadow, turfgrass, grove, and woodland habitats, Wellesley was calculated to have a sequestration budget of 149,595 kg or 150 tonnes of carbon sequestered per year.[150]

There have not been enough major changes to the Wellesley landscape to change the college's carbon sequestration budget significantly over time. Over the last 10 years, approximately 5.7 acres of asphalt and gravel parking and roadways have been returned to landscape, including 3.6 acres from the Alumnae Valley restoration.[151] In the restoration of Lake Waban, 7.5 acres of wetlands were recreated, representing a 30% increase in wetland area.[152] Since 1997, the college has added approximately 4,000 trees, 14,000 shrubs and tens of thousands of herbaceous perennials.[153] These changes have slightly changed the campus' ability to sequester carbon, as seen in the table below.

---

149 Nick Rodenhouse et al, "Everything but the Carbon Sink," Wellesley College Environmental Studies 300, 2004, http://www.wellesley.edu/EnvironmentalStudies/Research/pdf/managing_land_2004.pdf.

150 Nick Rodenhouse et al, "Everything but the Carbon Sink," Wellesley College Environmental Studies 300, 2004, http://www.wellesley.edu/EnvironmentalStudies/Research/pdf/managing_land_2004.pdf.

151 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 5, 11.

152 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 8.

153 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 8.

Further land use recommendations made in the 2008 Sustainability Report that would optimize the carbon sequestration capacity of the campus include planting long-lived tree species, expanding forest areas, mowing minimally, allowing organic matter to build up, and not draining wet areas.[154]

	CO_2 Sequestration	Area at Wellesley	Annual Sequestration
	kg/ha/yr	ha	kg/yr
lakes	270	42.61	11,505
wetlands	480	10.42	5,002
meadow	400 - 800	4.48	1,792 - 3,584
turfgrass	817	32.94	26,895
grove	850 - 972	22.87	19,439 - 22,229
woodland	1,013 - 1,158	83.88	84,962 - 97,099
total sequestration/yr (kg)			**149595 - 166,314 kg/yr**
total sequestration/yr (tonnes)			**149.595 - 166.314 tonnes/yr**
average sequestration/yr (tonnes)			**158 tonnes/yr**

Table 11.1. Annual Sequestration by Habitat Type[155]

[154] Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 9.

[155] Nick Rodenhouse et al, "Everything but the Carbon Sink," Wellesley College Environmental Studies 300, 2004, http://www.wellesley.edu/EnvironmentalStudies/Research/pdf/managing_land_2004.pdf.

Year	Change	Sequestration Area Removed (Acres)	Sequestration Area Removed (Hectacres)	Sequestration Decrease (kg)	Sequestration Decrease (tonnes)	Average Sequestration Decrease (tonnes)
2001-2002	Paintshop Pond Restoration	40 wood	16	16,208 - 18,528	16.2 - 18.5	17.3
2003-2005	Campus Center Construction	1.14 wood	0.4645	470 - 537.9	0.47 - 0.54	0.5
2003-2005	Davis Parking Garage Construction	1.14 grove	0.4645	394.8 - 451.5	0.394 - 0.451	0.43

Table 11.2. Changes in Campus Sequestration Since 1994[156]

Fertilizer

Nitrogen-based fertilizers will eventually become to nitrogen oxide through processes in the nitrogen cycle. Thus nitrogen-based fertilizers contribute to Wellesley's greenhouse gas emissions. More importantly, the processes required to manufacture synthetic nitrogen-based fertilizers are heavily dependent on petroleum.

Fertilizer is applied twice a year on campus: once in late summer and once in Spring. For fertilizer application, the campus is treated as three separate operations; the main campus, athletic fields, and Nehoiden golf course. Wellesley works with the Tom Irwin Company (a turf products distributor) to develop turf management plans for each area of the campus. Regular soil testing is done to determine the amount of fertilizer required based on soil PH and fertility. Current horticultural practices, including aerification and seeding, limit the need for herbicides, pesticides, and fungicides.[157]

The college uses a mixture of synthetic and organic fertilizers. Long chain synthetic fertilizers are currently used to minimize leaching into unwanted areas and to reduce frequency of application.[158] The synthetic fertilizer used on campus also has a nitrogen

156 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 9.
157 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 9.
158 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), 9.

content between 15% and 19%,[159] which contains less nitrogen than fertilizer used by the average homeowner.[160] In contrast, organic fertilizer has a nitrogen content of 4%.[161]

Wellesley kept no records of fertilizer use until 2003, and we assume that 100% synthetic fertilizer was used across all areas of campus until 2003.[162] Currently, the campus receives 50,535 total pounds of fertilizer: 90% synthetic and 10% organic. The athletic fields receive 2,514 total pounds of fertilizer: 30% synthetic and 70% organic. On the playing field itself, only organic fertilizer is applied, and synthetic fertilizer is applied only to the "surrounds" (edging) of the playing field area. The Nehoiden golf course receives 6,545 total pounds of fertilizer; 70% synthetic and 30% organic. One of the goals stated in the 2008 Wellesley College Sustainability Report is to increase the proportion of organic fertilizers used to 30% of total by weight in 2008.[163]

This year, the Nehoiden golf course is participating in the Audubon International Cooperative Sanctuary Program.[164] The goal of this program is the enhancement of natural areas and wildlife habitat, increased efficiency of water and chemical use, and the minimization of potentially harmful impacts of golf course operations.

Large-Scale Construction

In addition to affecting the college's carbon sequestration capacity by changing the landscape of the campus, construction projects produce greenhouse gases. Construction machinery, most of which runs on diesel fuel, emits greenhouse gases. Due to the lack of data and difficulty of giving an estimate of Wellesley's emissions from construction, the following calculations were made but the results are not included in the total emissions figures.

Construction companies responsible for the recent campus renovations did not supply the college with any figures with which to calculate construction-related greenhouse gas emissions,[165] so this figure was estimated by looking at greenhouse gas emissions from construction throughout the U.S. and then scaling down to Wellesley for the years during which major construction or renovation was occurring since 1994. For the purposes of this study, these years were deemed to be the Paintshop Pond restoration from 2001 to 2002 and the Wang Campus Center/Davis Parking Garage construction from 2003 to 2005.

---

159 Patrick Willoughby, personal communication, 3/13/2008
160 Patrick Willoughby, personal communication, 3/13/2008
161 "Campus Carbon Calculator v5.0." Clean Air, Cool Planet, 2006.
162 Mr. John Olmsted, personal communication, 3/20/08 and 3/26/08.
163 Patrick Willoughby and Kate Salop, "Wellesley College Sustainability," (Sustainability Report, Wellesley College Sustainability Advisory Committee, 2008), p. 9.
164 Audubon Cooperative Sanctuary Program for Golf Courses (ACSP). Audubon International. http://www.auduboninternational.org/programs/acss/golf.htm.
165 Patrick Willoughby, personal communication.

From the latest draft version of the U.S. Greenhouse Gas Inventory,[166] we were able to obtain information on greenhouse gas emissions (separated by CH_4, N_2O, and CO_2 emissions) from U.S. construction/mining vehicles in 2006. We then set up a proportion (U.S. Construction Emissions/U.S. Population = Wellesley Construction Emissions/Wellesley Population) in order to calculate Wellesley's approximate greenhouse gas emissions from construction. Below is shown an example of the calculations, using data from 2006. We repeated the calculations for 1990, 1995, 2000, 2001, 2002, 2003, 2004, and 2005, which were the years for which our source gave data.

	U.S. CH_4 **emissions***	**U.S.** N_2O **emissions****	**U.S.** CO_2 **emissions*****	**U.S. total GHG emissions**	**U.S. total GHG emissions**	**Wellesley GHG emissions**
	(Tg CO_2 *equivalent)*	*(Tg* CO_2 *equivalent)*	*(Tg* CO_2 *equivalent)*	*(Tg* CO_2 *equivalent)*	*(tonnes* CO_2 *equivalent)*	*(tonnes* CO_2 *equivalent)*
2006	0.1	0.5	63.7	64.3	64,300,000	**472**
2005	0.1	0.5	62.4	63.0	63,000,000	**462**
2004	0.1	0.5	61.4	62.0	62,000,000	**455**
2003	0.1	0.5	59.6	60.2	60,200,000	**441**
2002	0.1	0.5	57.9	58.5	58,500,000	**429**
2001	0.1	0.4	56.2	56.7	56,700,000	**416**
2000	0.1	0.4	51.7	52.2	52,200,000	**383**
1995	0.1	0.4	45.6	46.1	46,100,000	**338**
1990	0.1	0.3	39.1	39.5	39,500,000	**290**

	*from Table 3-21	**from Table 3-22	***from Table A-96	
	CH_4 Emissions from Mobile Combustion	N_2O Emissions from Mobile Combustion	CO_2 Emissions from Non-Transportation Mobile Sources	

Table 11.3: Wellesley Greenhouse Gas Emissions from Construction

[166] EPA, *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006.* (Washington, DC: EPA, 2008), http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

Sample Calculation, using data for 2006:

Emissions from non-highway vehicles, specifically construction/mining vehicles[167]

CH_4: 0.1 Tg CO_2e

N_2O: 0.5 Tg CO_2e

CO_2 emissions from Non-Transportation Mobil Sources[168]

CO_2: 63.7 Tg CO_2e

Thus, total CO_2e emissions

= CO_2 contribution + N20 contribution + CH_4 contribution

= 63.7 + 0.5 + 0.1

= 64.3 Tg CO_2e

Conversion Factors:

1 Tg = 1.0E+12 g = 1,000,000,000 kg

1 tonne = 1000 kg

Conversion:

64.3 Tg * 1,000,000,000 kg/1 Tg * 1 tonne/1000 kg

= 64,300,000 tonnes of CO_2e

Proportion Setup Using:

Population of U.S.: 303,631,185[169]

Population of Wellesley: 2200

U.S. construction emissions: 64.3 million tonnes of CO_2e

Wellesley construction emissions:

= U.S. construction emissions / U.S. population * Wellesley population

= 64,300,000 million tonnes CO_2e/ 300,000,000 * 2200

= 472 tonnes CO_2e

In 2006, Wellesley would have emitted roughly 472 tonnes of CO_2e. However, because the numbers calculated for our construction emissions are only rough estimates and are small compared to our overall emissions, we have not included these in our final emissions totals. It is, however, important to keep in mind the potential emissions when deciding whether to or how to take on a new construction project at Wellesley College.

[167] EPA, "Energy," *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006.* (Washington, DC: EPA, 2008), http://www.epa.gov/climatechange/emissions/downloads/08_Energy.pdf

[168] EPA, "Annex 3.2," *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-200.* (Washington, DC: EPA, 2008), http://www.epa.gov/climatechange/emissions/downloads/08_Annex_3.pdf

[169] U.S. Census Bureau, *Census Bureau Home Page*, http://www.census.gov/ (accessed March 17, 2008 at 12:07 PM)

Recommendations

12.

Mitigation

With the many sources of greenhouse gas emissions, the next step is to look at the ways in which the college can reduce its impacts. This section provides a wide variety of ideas for mitigating our greenhouse gas emissions, which have varying cost, levels of difficulty in implementation and carbon reductions. When possible, specific numbers are provided for cost and carbon savings. In our discussion of each option, we rank the difficulty of implementing each strategy on a scale of 1 (easy) to 3 (very difficult).

While the calculations in this section make use of the most accurate numbers possible, they should be taken as estimates. There are significant sources of error, as is necessitated by the nature of our job, but we have worked to be as accurate and realistic in our assumptions as possible. We have explained where assumptions are made, and when concrete numbers are used.

It is also important to keep in mind that this is not an exhaustive list of all the climate change mitigation options Wellesley could possibly choose to implement. The mitigation strategies offer a wide spectrum of actions on many different levels, from the administrative to the individual. Please note that we do not recommend all of the options listed in Table 12.1 on the next page. Recommendations for which of these options would be best to implement can be found in the Conclusions Section (Chapter 14, page 141) of the report. This list simply covers the options we considered in depth as possible mitigation strategies.

Letter	Method	CO_2 Saved	Difficulty	Cost
A	Hire a Sustainability Coordinator	###	***	$$$
B	Forced hot water	###	**	$$$
C	Decrease heating across campus	###	*	-
D	Insulate buildings better	###	**	$$$
E	Renewable energy	###	***	$$$
F	Eliminate oil use on campus	###	***	$$$
G	Turn off/Sleep mode for computers	##	*	-
H	Energy Star for students appliances	##	*	$
I	Put Energy Star buying policy in place	##	*	$
J	Make faculty housing efficient	##	**	$$
K	Unplugging electronics	#	**	$
L	Centralized distribution of CFLs	#	*	$
M	Install low-flow showerheads	#	**	$$
N	Charge students for electricity use	#	***	$$$
O	Install energy efficient windows	#	***	$$$
P	Hybrid exchange bus	##	***	$$$
Q	Use a smaller Exchange bus	##	**	$$
R	Disincentives for parking on campus	##	**	-
S	Create incentives for public transport	##	**	$
T	No more idling	#	*	$
U	WVO Biodiesel	#	*	-
V	Motor pool fuel efficiency	#	*	$$$
W	Don't run the Escort Van unless requested	#	*	-
X	Community bike share program	#	**	$$$
Y	Reduce paper usage by 50%	##	**	-
Z	Purchase green materials when possible	##	*	$
AA	Recycle all recyclables	#	*	$
BB	Eco-friendly food carriers	#	*	$$
CC	Trayless dining	#	*	-

Table 12.1: Mitigation Strategies and Relative Carbon Savings, Difficulty, and Financial Costs

Table 12.1 shows all of the possible mitigations strategies considered by the report and organized by carbon savings from greatest to least. The more # signs there are the higher the carbon savings, while increasing numbers of * and $ indicate increasing difficulty and cost respectively. A dash (-) in the cost column indicates no cost associated with the option, and often, possible savings for the college as well.

Option: **Hire a Sustainability Coordinator for the campus.**

Implementation: Hiring someone to oversee the many different plans for making Wellesley College a truly environmentally friendly and possibly carbon neutral campus is essential to seeing real results. While many people are working to better Wellesley College's environmental footprint, there needs to be one person dedicated to this work who is able to follow up and continue projects. While faculty and many members of staff are working hard on environmentally related issues, it is not their primary job, so they are often busy working on other tasks related to their job titles.

In order to make sure that this campus is making real changes and implementing the mitigation strategies suggested by this report, and the other ideas generated by other environmentally aware people and groups on campus, the college should create and hire someone to fill the post of Sustainability Coordinator. This person could oversee the Sustainability Advisory Committee, work with WEED and the administration to implement carbon reducing strategies on campus, increase recycling, decrease waste and energy use on campus, and make Wellesley College a leader in protecting the environment. Colleges similar to Wellesley, such as Smith, Pomona and Middlebury, have all hired Sustainability Coordinators in the past few years.

Carbon Effect: While quantifying the impact of a Sustainability Coordinator is impractical, it is possible to say that whatever mitigation strategies are implemented because there is a person guiding them, those carbon savings could be attributed to the Sustainability Coordinator. This position has the potential to be the most important carbon reducing strategy this project could recommend if implemented properly.

Cost: While such a position would be costly, in that it would require a salary and benefits for the individual hired, doing so would show a true commitment to sustainability and protecting the environment, more so than attempting several mitigation strategies. Within a couple of years, this position might be able to fund itself with the savings generated from the environmental initiatives that the Sustainability Coordinator helps implement.

Difficulty: Creating a new position in an already large administration, and college, is a difficult task; we ranked this option a 3 (very difficult). Along with the search and hiring process, integrating this person into the administration and encouraging collaboration could be a long and difficult process.

Other Factors: A Sustainability Coordinator would show a larger long-term commitment by the school to continuing to go green, and make progress far into the future. If Wellesley College is truly committed to reducing its carbon footprint, then this position is of vital importance.

Option: **Move away from steam heaters towards forced hot water systems.**

Buildings on campus are currently heated either by a steam heating system or a more recently installed forced hot water system. Forced hot water systems are more energy efficient than steam heating systems because they operate at lower temperatures.[170] This mitigation option consists of converting all remaining steam heating systems to forced hot water systems.

Some Wellesley buildings already use forced hot water systems instead of steam heating systems, including McAfee, Bates, Freeman, Stone-Davis, Severance, the Science Center, the Lulu Chow Wang Campus Center, Jewett, Pendleton East, the Distribution Center, the Physical Plant, the Trade Shops, and the Grounds/Motor Pool facilities.[171] These relatively recent renovations from steam to forced hot water heating systems have resulted in significant efficiency gains in the heating requirements of these buildings.[172] In addition to the increased efficiency of forced hot water over steam heating, forced hot water systems also increase the control that the Physical Plant has over heat usage in buildings across campus.[173]

Implementation: Building and pipe renovations would be necessary to replace our steam heating systems with forced hot water systems. The pipes and radiators in most buildings would need to be replaced, along with the piping that would deliver the hot water, instead of steam, to each building.

Carbon Effect: If full conversion from steam heating systems to forced hot water systems resulted in a 10% decrease in fossil fuel usage at the cogeneration plant, this would result in a 3,104 decrease in CO_2e emissions.

2007 Cogeneration Emissions = 31,035 tonnes CO_2e
Potential carbon savings = 31,035 * 0.10
= 3,104 tonnes CO_2e

Cost: A campus-wide conversion of the remaining steam heating systems to forced hot water systems would cost approximately $300,000.[174] Since a higher-efficiency heating and cooling

---

170 "EERE Consumer's Guide: Furnaces and Boilers," Energy Efficiency and Renewable Energy, U.S. Department of Energy, http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12530.
171 Patrick Willoughby, Personal Communication, April 16, 2008.
172 Patrick Willoughby, Personal Communication, April 16, 2008.
173 Willoughby, Patrick and Kate Salop, "Wellesley College Sustainability," Wellesley College Sustainability Advisory Committee, May 2008, 23.
174 Patrick Willoughby, Personal Communication, April 23, 2008.

system can decrease the financial costs of heat generation by 30-40%, this initial cost would pay for itself over several years.[175]

Overall cost: $300,000
Cost per carbon savings: $300,000/8,456 = $35 / tonne CO_2e

It could be argued that these heating system conversion costs are not "additional." The Facilities Master Plan includes the conversion from steam heating to forced hot water as a priority for significant renovations.[176] The college heating systems are routinely being serviced, and renovations and replacements must be made to existing pipes and building heating systems. With continuing renovations planned, the conversion from steam heating to forced hot water could likely be absorbed by the price of these specific projects.

Difficulty: This option has a likely difficulty rating of 2 (medium). Due to the constant renovations occurring on campus, and the significant energy savings to be realized, it is reasonable to advocate for conversion from steam heating to forced hot water in all buildings on campus. If each building's renovations include conversion from steam to forced hot water, the campus would have only forced hot water heating systems without much extra labor or financial capital over the course of just a few decades.

175 Patrick Willoughby, Personal Communication, April 23, 2008.
176 Patrick Willoughby, Personal Communication, April 23, 2008.

Option: **Since Wellesley is centrally heated, turn down the quantity of heat available to the College by a small amount, especially during the winter when heat is in high demand.**

Implementation: Heating across campus is controlled from the cogeneration plant, where the boilers that create steam are heated by hot water, a byproduct of electricity generation, and burning fossil fuels. This heat is then released in controlled amounts depending on the need for it, which is determined by weather and number of people on campus. Heat is only released as it is needed, so a building can only pull from the heat available to it, and cannot individually determine its heating needs. It would be possible to reduce the amount of heat used on campus by lowering the amount available by a small amount. If the amount of heat were reduced slightly across campus, it would create an overall reduction in heat use.

Carbon Effects: Exact reductions in emissions are difficult to quantify since the levels by which heat could be lowered would vary depending on the weather each year. But any overall drop in heating would mean that less natural gas or oil would be burned, which in turn would result in a drop in emissions. Each set of buildings on campus uses different heating systems, making it hard to quantify emissions savings. For instance, some of the residence halls in the quad use steam, while others such as Stone-Davis use forced water heaters.

Cost: There is no cost associated with this mitigation strategy, as all the college is required to do is burn less fuel and create less heat. In fact, this could add up to major savings for the college, as it would mean that less natural gas or oil would have to be purchased.

Difficulty: This option would be easy to implement, we have designated it a 1 (easy). It would require no change in policy or cost to the college. Implementing the option simply requires the power plant to regulate a little more tightly the amount of heat it creates. Students and other building occupants would not be required to change their habits either, although they might be forced to put on a sweater more often than in the past.

Other Factors: It will take careful balancing to make sure that enough heat is provided to the buildings so that everyone is warm, but not enough to create extra heat in the buildings. Also, students and others in buildings might be somewhat annoyed with the prospect of having to put on an extra layer of clothing, but as long as their rooms or offices are decently insulated and warm this should not be a large problem. Also, the college would not need to inform the campus community, just simply lower the temperature, in which case students would be less likely to notice or complain.

Option: **Insulate buildings better.**

Implementation: Sealing cracks, insulating attics, and making sure that walls are properly insulated can help to save money and emissions in heating for all buildings. These emissions savings are especially relevant for the college, which has many older buildings that may not have been properly insulated when they were built, or which are more prone to deterioration because of age.

Carbon Effect: Because of the wide variety of buildings on campus, and the various levels of insulation, exact numbers on energy or emissions saved are complex because of the different variables involved for each building, but estimates put savings per home at 2,000 pounds per year.[177] Wellesley has some 2.4 million square feet of area[178], while the average two-person home in the US has 1,928 square feet in it, meaning Wellesley equals about 1,288.31 homes. That means Wellesley could save about 2,489,626.6 pounds or 1,129.28 tonnes through better insulation. Even if this number is slightly smaller since Wellesley buildings are not really equivalent to houses in their design style, it is still a significant carbon savings.

Cost: Cost for insulation vary widely depending on the type and amount needed, which also varies according to the building. It would most likely be an initially expensive change, but only in the short run because of the reduction in the use of fuel needed for heating. Since the fuel savings are significant the cost would most likely be eliminated completely over time.

Difficulty: This option is ranked a 2 (medium) in terms of difficulty, it requires some amount of installation, as well as funds upfront, but the cost and work are not immense. Insulating could be done initially wherever it was easiest to do in easy to access places. Any amount would help with heating, so it could be done over time or as funds became available.

---

177 "Insulate Your Home." Stop Global Warming, *Take Action!*. http://www.stopglobalwarming.org/sgw_actionitems.asp.
178 Reed, William and René Stewart Poku, "Standard XIII: Physical Resources," NEASC's Commission on Institutions of Higher Education's Standards for Accreditation, http://www.wellesley.edu/Reaccreditation/eight.html

Option: **Investigate the feasibility of renewable energy generation on campus (i.e. photovoltaic cells)**

Implementation: The college could explore a broad range of energy generating technologies. Installing solar panels on the Sports Center is one of the approaches that is possible for renewable energy generation on Wellesley's campus. Solar panels might be installed on the large amount of roof space on campus, although they would require some sort of converting device to harness the energy and make it useful to the campus. This option can be expensive and labor intensive, but has the ability to be renewable and long lasting once installed and operational.

Carbon Effect: The carbon reductions achieved are huge, and relatively limitless if put in place in large enough quantities. With each solar panel the amount of energy dependence on fossil fuels would be reduced. Oil and natural gas account for the majority of the college's carbon footprint, so alternative energy sources are an important way to begin reducing energy related carbon emissions.

Cost: The cost of installing and maintaining solar panels, as well as geothermal power would be substantial at first. One school district in San Diego paid $2 million to install solar panels in fifty schools in its district.[179] While that scale might be slightly larger than Wellesley, it gives a good comparison for cost, which would probably be similar. The cost is substantial, and that does not include maintenance of the panels, which would eventually be needed.

Difficulty: This option would rank as 3 (very difficult). It would require intensive installation at first, as well as methods to convert the energy for the college. These systems would then require upkeep as well over time.

Other Factors: It is difficult to say if Wellesley would be a good place for solar panels, since it is not a particularly sunny climate and this might hinder the amount of energy solar panels could generate. An additional benefit would be the educational opportunity renewable energy would provide.

[179] "Schools Hope Rate will Solve Snag." Chris Moran, *Sign On San Diego*. April 16, 1008. http://www.signonsandiego.com/news/education/20080416-9999-1n16solar.html.

Option: **Eliminating oil use on campus.**

Implementation: Eliminating oil use on campus would require switching over all of the boilers in the power plant to natural gas boilers. Right now only one of the boilers is convertible, so it is possible that this could remain and just run off of natural gas, but the rest would need to be replaced.

Carbon Savings: In 2007 Wellesley College used 40,329 MMBTu of residual oil, resulting in 3,226.32 MT CO_2e according to the CA-CP.[180] Removing residual oil would mean a significant drop in emissions form the power plant, since natural gas is a cleaner burning fuel that emits less CO_2e. Additionally, heat is necessary to keep the residual oil warm enough that it can be piped into the boilers. The additional heating of the oil requires fuel as well, which would not be needed if oil were removed, and this would have additional carbon savings.

It is difficult to show an exact ratio of carbon savings when oil is compared to natural gas because they are used in different forms (oil in gallons and natural gas in cubic feet.) A good basis of comparison is the college's past use of natural gas and oil. In 2004 and 2007, the amount of electricity produced was very similar (less than 0.5% difference). However, in 2004, the cogeneration plant used more than two times the amount of oil and approximately 10 percent less natural gas.

Oil and Natural Gas Usage (MMBtu)				
	Oil (MMBtu)	Natural Gas (MMBtu)	Electric Output (KWh)	CO_2e (tonnes)
2003	129,968	475,518	32,426,304	35,371
2004	96,662	470,694	29,518,464	32,503
2005	84,037	520,884	30,854,112	34,170
2006	54,523	542,276	30,700,992	32,987
2007	40,329	526,429	29,417,856	31,035
Difference between 2004 and 2007	56,333	55,735	100,608	1,468

Table 12.2: Oil vs. Gas Usage and Resulting Emissions[181]

180 CA-CP, EF_Stationary Sheet.

181 George Hagg, Personal Communication. "Campus Carbon Calculator v5.0." Clean Air, Cool Planet, 2006.

Therefore, a "lower limit" of the greenhouse gas emissions reductions by removing oil as a source of fuel on campus is 1,458 tonnes CO_2e.

Cost: One method of ball parking the potential cost moving away from oil is to calculate the cost of a year in which the natural gas line was interrupted for a long period of time and the cost of a year in which the natural gas line was uninterrupted.[182] In 2001, Wellesley's natural gas line was cut off for almost five months of the year (so Boiler 1 ran almost entirely on oil) and, in 2002, the natural gas line was never interrupted (so Boiler 1 ran on natural gas the entire year).

In 2001, the total cost of fuel was $1,221,456 (1,112,216 gallons of oil at $0.73/gallon and 68,830 MMBtu of natural gas at $5.95/MMBtu). Had an uninterruptible line in use, fuel costs would have been $1,498,862 (679,400 gallons of oil at $0.73/gallon and 133,720 MMBtu of natural gas at $7.50/MMBtu).[1] This is a difference of $277,405. In 2002, natural gas cost the college $793,373 ($5.95/MMBtu). If this had been from a firm natural gas line (@$7.50/MMBtu), it would have cost the college $1,000,050, a difference of $206,677.[1] Therefore, a firm natural gas line would have cost Wellesley College an additional $277,405 in 2001 and $206,667 in 2002."[1]

The current market price of residual fuel oil is currently 155% greater than the price that Wellesley paid in 2001/2002 ($1.86/gallon)[183] and the current market price of natural gas is currently 33% greater than what Wellesley paid in 2001/2002 ($10/MMBtu).[184] While the monetary terms of Wellesley's fuel contracts are not known, it is reasonable to state that the rising cost of oil has made the possibility of converting to a firm natural gas line more economically feasible.

Additionally, the cost of switching all the boilers (with the possible of the exception of the one convertible boiler) over to natural gas boilers is extremely expensive. There are six boilers that would have to be replaced most likely at great cost considering the machinery and installation that would be necessary.

Difficulty: This would be a difficult project for the college to undertake, so it earns a rating of a 3 (very difficult) because of the amount of work that would have to go into replacing the boilers on campus. This would also interrupt the heating of the campus, although perhaps

---

182 "Wellesley College Greenhouse Gas Emissions." Environmental Studies 300 Report, May 2003, p. 66, 77-78.
183 "Refiner Petroleum Product Prices by Sales Type." Energy Information Agency (January 2008). http://tonto.eia.doe.gov/dnav/pet/pet_pri_refoth_dcu_nus_m.htm
184 "Natural Gas Weekly Update." Energy Information Agency (April 10, 2008). http://tonto.eia.doe.gov/oog/info/ngw/ngupdate.asp

the boilers could be changed over one at a time so that heating was never fully interrupted. This initiative would still require major changes at the facilities plant, as well as major installations. The college's fuel contract would have to be re-negotiated, although this should not be hard to do.

Other Factors: There would be reduced emissions from transport of fuel because natural gas arrives to the College by pipeline, whereas oil is transported via truck. Moving away from oil also gives the college more control over its GHG emissions, which will be important if the college chooses to sign the Presidents Climate Commitment or follow a GHG reduction scheme.

Option: **Turn off computers at night or put them in sleep mode**

Implementation: Computers are some of the most used appliances by students and employees at colleges. Many people leave their computers on all day long, even when they are in class or out for the day. It is a common misconception that screen savers reduce energy use. The better way to save energy is to set the computer's preferences to automatic switch to sleep mode or by manually turning laptops and computers off when sleeping or out during the day. The public computers on campus are automatically set to sleep mode by default.

On the student level and employee level, there can be a "turn off your computer" initiative. Many students at Wellesley College, as is the case at other schools, have gotten into the bad habit of keeping their computer on at all times. The reasons for this behavior come from a variety of sources. There is an attitude at Wellesley that people need to be ready to do work at any time and cannot wait for a computer to turn on. Another potential cause of this behavior is that members of the Wellesley community do not face direct costs for the amount of electricity they use. Though electricity appears to be free, these costs are factored into the budget and can result in budget reductions in other sectors or increases in tuition or fees.

Programming about being energy efficient that is visible to the students and employees may be helpful in changing the attitude surrounding computer use. Even though the only way to completely stop electricity from being drawn is to unplug the appliance, there could also be a reminder for students and employees to set their computers and laptops to automatically shut off after a certain amount of time. Although there is no guaranteed way to get community members to turn off their computers every time they are not in use, there are more pressing measures that would heavily encourage a behavior change, for example, charging students for energy usage in their individual residence hall rooms.

Carbon Effects: We are assuming that each student has a laptop. This is not accurate, as there are students with desktops and some without computers at all. Laptops use about 30 Watts in normal operation.[185] Assuming 2,300 laptops are powered at .03kW for 224 days of the academic year, and calculating 4 additional hours of sleeptime, 61,824 kWh/year are saved, and multiplied by .658 kg of carbon dioxide equivalents, 40.68 tonnes of CO_2e are saved from laptops alone.

On campus, there are 1,600 Faculty and Staff Desktop computers. They each use about 80 watts, and assuming that faculty and staff use their computers 45 weeks per year, 5 days a

185 "Computers and Energy Efficiency." Tufts Climate Initiative. <http://www.tufts.edu/tie/tci/Computers.html>

week, sleep time can be increased 2 hours per day. We assume that most faculty and staff turn off or put their computers in sleep mode when leaving the office for the day, but it is feasible to increase sleep time by two hours over the course of the day, during lunchtime, meetings, or office hours. Over the year, this would account for 57,600 kWh saved, an equivalent of 37.9 tonnes of CO2e.

Costs: Having an initiative to have students shut off their computers at night to save energy is a cost-effective measure, in fact, it actually saves money. The only thing the school may have to spend money on is to make flyers to remind students and educate faculty.

119, 424 kWh/year x Average cost of electricity $0.16/kWh = $19,107.84 savings

Difficulty: On a scale of 1(easy) to 3 (hard) the difficulty of actually accomplishing the goal of having students at Wellesley set their computers to sleep mode is 1, because that is a one time action. Getting students to turn off their computers at night is probably a 2 (medium). It is not easy to change the behavior of those students who are used to keeping their laptops on all the time. Getting faculty and staff to change their behavior might be harder though, since some of them might not know how to switch the modes of their computer.

Other Factors: The advantage of leaving a computer on is that access to email, the Internet, and work is easily accessible whenever a student comes back to her room or an employee gets back to the office. This is time efficient, but not energy or cost efficient. The issue of time constraints would serve as incentives for students to leave their computers on because there is no difference for them whether they leave it on or not.

People may not know the difference between using a screen saver and putting a computer in sleep mode. The sleep mode uses 70% less electricity than during normal operations, including screen savers.[186] If students and employees know the impact of switching to sleep mode, they might be more likely to have an incentive to change their behavior.

---

[186] "When to Turn off Personal Computers." U.S. Department of Energy: Energy Efficiency and Renewable Energy. <http://www.eere.energy.gov/consumer/your_home/appliances/index.cfm/mytopic=10070>

Option: **Require Students to Use EnergyStar Refrigerators**

Implementation: The idea behind this mitigation option is fairly straightforward; the school should institute a college-wide policy requiring that all students who purchase a personal refrigerator must purchase an EnergyStar certified one. To make sure that every student complies with the policy, Residential Life Staff can conduct yearly checks to ensure that refrigerators comply, and any new purchases will have to be reported to the appropriate person. As of now, Wellesley has no policy regarding student energy-saving appliances other than to encourage students to use them, and thus this option could be quite effective.

The implementation would be relatively easy—all students who purchase a refrigerator would be required to prove via receipt and/or personal inspection to a member of ResStaff, either their Resident Director (RD) or Resident Assistant (RA), that their appliance is EnergyStar certified. ResStaff would verify at the start of each year that all refrigerators are EnergyStar certified; any appliances purchased during the course of the year would also be reported to an RD so that they too could be verified. If the appliance does not comply the student would be fined a certain amount (either an upfront fine, or a certain amount for every month/week that they continue to use the appliance), or simply prohibited from using it.

Carbon Effect: We are assuming that 800 students (roughly one-third) of Wellesley's students own a refrigerator. These would be on for 224 days, 24 hours a day, assuming they are continuously running during the 32 week academic year. An average 1.7 cubic foot refrigerator has a wattage of 126[187], amounting to 677 kWh per year. Using a coefficient of 1.342 lbs./kWh, this results in 726,827 lbs or 220 tonnes of CO_2e for the student body. EnergyStar fridges are 40% more efficient than standard ones, so if every student switched over, the savings would be 132 tonnes of CO_2e.

Cost: The cost of the initiative depends on how the school decides to implement the policy, although it can potentially be low. If the school simply writes the policy into the Residential Life Handbook and trains ResStaff to identify the technology, there is practically no cost. If the school volunteers to pay the differential cost of purchasing an EnergyStar refrigerator, as opposed to a regular one, the cost might go up slightly. In any case, the energy savings would more then make-up for any cost.

[187] "Energy Usage Calculator". Public Services of New Hampshire. Accessed April 14, 2008. http://www.psnh.com/Residential/ReduceBill/Applianceusage.asp

Difficulty: This has the ranking on a 1 (easy) in terms of difficulty. The implementation is straightforward in that all that is required is a simple policy change and the residence hall checks needed to enforce the policy. The more intensive part of the is the enforcement of the policy, but even this is not difficult—as students do not pay for their utilities, once a refrigerator has been purchased, a student has no motive to switch appliances. The checks at the start of each year and with each new purchased appliance require a very small time investment for the amount of carbon saved.

Other Factors: One thing to consider with this policy is the grandfather clause that will likely come into effect when this policy is implemented; i.e., the school has to consider whether it will enforce the policy on students who already own non-EnergyStar refrigerators. The school may decide to impose this rule only on the next class of incoming first-years and all subsequent classes, or it may decide to impose the rule now on all student refrigerators on campus. While the second option would result in immediate carbon emissions reductions, the first might be simpler to implement across the college.

Option: **Implement an EnergyStar buying policy.**

Implementation: While for the most part the Purchasing department is currently buying Energy Star appliances, it should become the policy to purchase EnergyStar appliances whenever they are available.

Carbon Effect: EnergyStar appliances reduce greenhouse gas emissions through their reduced energy usage. Examples of EnergyStar appliances that could by purchase include refrigerators, washers and dryers as well as many other appliances used on campus. There would, however, be a lag time between when the policy was implemented and the actual purchases were made as necessary, resulting in a lag time forcarbon savings.

Cost: Energy Star appliances will help save the college money in terms of electricity and fuel saved on every appliance that is purchased. If there is an increased cost for such appliances, it is quickly offset by the cost savings of decrease energy use.

Difficulty: Considering that the Purchasing Office is already doing this for the most part it will take very little change, making it a 1 (easy). It will only require that the Purchasing Office ensure that everything it buys is Energy Star if possible.

Option: **Make faculty housing as efficient as possible.**

Implementation: Many of the suggestions made in this report can be applied to faculty housing, which the college owns and maintains. Improving insulation, installing energy saving windows, and low-flow shower heads, ensuring that CFLs are available, and other initiatives can help to improve the overall efficiency of these buildings and result in less water, heat and energy used in these homes.

Carbon Effect: While the overall reduction will also depend on faculty willingness to be more environmentally conscious, these strategies can help to reduce emissions without any major changes in habit, and will help to save faculty money on utilities at the same time. Carbon savings to the college, however, would only result for those faculty houses that are on its college grid.

Difficulty: This option earns a difficulty rating of 2 (medium). This strategy could be done over time with maintenance of the buildings, which would make it relatively easy to implement, although some of the renovations, such as insulation and upgrades on windows, might be difficult, and might dislocate faculty temporarily while these repairs are being made.

Option: **Unplugging electronics and encourage power strip use**

Implementation: Many electronics continue to draw small amounts of power even when they are turned off. These are called "phantom loads". On average, 75% of the electricity used to power home electronics comes from these phantom loads.[188] Although Wellesley does not have the same types of electricity use as homes do, it still has phantom loads for the electronics that are used on campus. In efforts to avoid this problem, unplugging appliances or using a power strip and turning the switch on the power strip to off when not in use can not only save electricity and money, but also saves on the amount of carbon dioxide emissions resulting from electricity production.

In order to save energy on campus by unplugging electronics and power strips, efforts from both the students and administration need to be taken. Students can either purchase their own power strips or the school could distribute power strips at a small cost. This initiative could be something taken on by the Eco-Reps, the Sustainability Advisory Committee, or become part of a first-year orientation program.

Unplugging the power strip is an even better way of saving electricity than having an energy-saving power strip. By unplugging electronics, the electricity that continues to be drawn into appliances that are turned off would be eliminated. This initiative, although beneficial, is challenging to implement and get students to participate. Encouraging power strips to be turned off requires more motivation, as it involves a daily action by students. The benefit of potentially providing a power strip to students is that several electronic devices can be plugged into it. This way it is only necessary to remember to unplug one thing instead of multiple electronics.

Carbon Effects: A cell phone charger has a phantom load of 1.2 watts, a stereo 2.5 watts, and a television 3.5 watts[189]. If each dorm room has one of these items (and even if it doesn't there are probably other electronics it will have such as printers, camera chargers, iPod chargers, etc.) then each dorm room use about 7.2 watts or .1728 kilowatt hours each day. During the academic year of 32 weeks this works out to about 38.7 kilowatt hours per student. This creates a campus total of 89,026.56 kilowatt hours for the 2,300 students on campus, for a total of 61.37 $MTCO_2e$ of savings if each of these items is unplugged when not in use.

---

[188] U.S. Department of Energy, *Home Office and Home Electronics.* http://www1.eere.energy.gov/consumer/tips/home_office.html

[189] Maura Yates, *Energy Vampires Surround Us Cut Them off and Save!,* Your Guide to Green. http://www.yourguidetogreen.com/learn/articles/index.php?article=Energy-Vampires-Surround-Us

Costs: Unplugging electronics or power strips is a relatively cost-effective way of saving energy. If the school were to provide each student with a power strip, instead of relying on them to purchase one themselves, this would cost about $28,809. This calculation takes into account that there are about 2,300 students at Wellesley and a power strip costs an average of $10.00[190]

Energy saving costs of students unplugging electronics and power strips when not in use would make a significant impact for the college:

89,026 kWh saved x Average cost of electricity $0.16/kWh[191]
= $14,244.25 in savings for the college

Difficulty: The difficulty of actually accomplishing the goal of having students at Wellesley unplug their electronics and power strips when they are not in their rooms is a 2 (medium). The action itself of unplugging is very simple, but the problem lies in the habit. Students are already encouraged to turn off their lights when they leave their room and yet dorm lights are still often left on. Creating an educational campaign and getting students to make unplugging their electronics a daily habit will be difficult.

---

190 "Power Strip." Staples. <http://www.staples.com>

191 "Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State" Energy Information Administration. http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html

Option: **Installing Compact Fluorescent Lightbulbs (CFLs).**

Implementation: The College should install CFLs in all campus buildings that do not already have them. The college must also create a more centralized system than what we currently have to ensure that the light bulbs are being replaced in a timely fashion, and that the CFLs are being disposed of properly.

The first phase of implementation would be that bulbs would have to be bought and installed. The school could choose one of two options: the first being to install them all at once, and the second to install them as the old bulbs burn out. The second implementation option consists of maintaining and organizing a process through which the bulbs can be reliably replaced. The best option might be to designate someone affiliated with maintenance and utilities to oversee the project; this person might be one of the employees at the power plant, a person affiliated with the Sustainability Advisory Committee, or designated on a building-by-building basis.

Carbon Effect: Lighting comprises a vital part of the college's energy consumption, especially since lights in some buildings are left on nearly 24 hours a day. The sheer number of bulbs across campus and the long periods of use mean that any energy savings produced by switching to efficient bulbs would be well worth the investment. In 2003, 10,943 incandescent lightbulbs were purchased.[192] Assuming that changing a standard lightbulb to a CFL saves 100 lbs. of CO_2e per year[193], then that would equal 3,284,900 lbs or about 1400 tonnes per year.

Cost: According to our calculations, there are 32,829 lightbulbs on campus. At a cost of 50 cents per CFL,[194] the total startup cost of this initiative is $16,424, without installation costs. There are, however, some CFLs already on campus, but we cannot quantify that amount, so the actual cost would be lower. CFLs tend to last 8 to 15 times as long as an incandescent bulb,[195] so there will eventually be cost savings associated with them.

Difficulty: This strategy would be fairly easy to accomplish, earning a ranking of a 1 (easy) in terms of difficulty. The most difficult aspect would be installation and determining what buildings already have CFLs. This is simply time consuming. Another aspect would be

192 ES300 "Spring 2003, Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003)
193 "Stop Global Warming". Accessed April 14, 2008. http://www.stopglobalwarming.org/
194 Patrick Willoughby, Personal Communication, May 14, 2008
195 Long Island Power Authority News. "LIPA Encourages All Long Islanders to Join in the Change a Light, Change the World Campaign." Oct. 26, 2006. Accessed April 21, 2008. http://www.lipower.org/newscenter/pr/2006/102506_cal.html

disposal of the CFLs – as they contain mercury, they cannot be disposed of in the regular waste stream.

Other Factors: The most difficult issue would be creating a consistent disposal system for CFLs, especially increasing education. This might require some extra work on the part of the maintenance staff, as ordinary people cannot dispose of the bulbs if they break. Also, there is the question of whether or not to replace the existing, non-CFL bulbs right away, or wait for them to burn off. If the incandescent bulbs were to be thrown away, this would be a loss of money but the energy savings from implementing CFLs right away might negate this cost. Since some buildings on campus leave lights on for 24 hours per day, the CFL lifespan might not be as long as advertised.

Option: **Install low-flow showerheads to reduce water use and energy for water heating on campus.**

Implementation: Installing low-flow showerheads across campus is an easy way of reducing water use and the heat necessary for showers. While Shafer and Stone-Davis have recently had these showerheads installed, they should be put in place across campus and in faculty housing, to help reduce GHG emissions through heating water, as well as for conserving water itself. The low-flow showerheads are effective because they help to control water use without requiring a change in habits from users. There have been efforts made to get the student body to take shorter showers, such as the five-minute shower timers that were installed earlier this year, along with various education campaigns. Low-flow showerheads would be a good supplement to this education as well.

Carbon Effect: There are 319 showers on campus.[196] Only a few of these are currently low-flow (and those were installed within this academic year and therefore their effects will not show up in our emissions calculations), but a switch over at a savings of 350 pounds of carbon for each showerhead[197] would mean a total of 111,650 pounds or 50.6 tonnes of CO_2e saved.

Cost: Ultimately this option would pay for itself. The 319 showerheads would have to be replaced. In order to outfit all of the showers with low-flow showerheads, it would cost $7975. The low-flow showerheads themselves cost $7.00, including shipping. Accounting for labor and installation costs, the actual cost is closer to about $25.[198]

The college could choose to replace all the showerheads in the near future, which would mean purchasing hundreds of showerheads for the campus. There have been about thirty low-flow showerheads already installed, so that would bring down the cost to about $7,225. Another option would be to replace showerheads as they come up for replacement naturally and old showerheads wear out. This would be a much cheaper option, because the showerhead needs to be replaced anyway, and the cost is simply the differential between the two types. However, this would take probably take quite a long time to happen and is probably not worth the wait.

---

[196] Patrick Willoughby, Personal Communication, May 14, 2008.
[197] "Install a Low-Flow Showerhead," Stop Global Warming, *Take Action!*. http://www.stopglobalwarming.org/sgw_actionitems.asp.
[198] Patrick Willoughby, Personal Communication, May 12, 2008

There would be some offset in natural gas/oil cost that would decrease with less fuel needed to heat the water that could be put towards purchasing the showerheads.

Difficulty: This would rank as a 1 (easy), the work required to install showerheads would need to be done over time and is minimal.

Other Factors: In addition to energy savings this initiative would is also would help conserve water.

Option: **Remove the room and board fee for individual power usage and charge students separately for electricity in their rooms.**

Implementation: The college currently does not break down electricity usage within residence halls, or by room, meaning that students are not charged individually for their energy use on campus. If students were held accountable monetarily for their energy use in their residence halls, it might be possible to reduce energy use since the college would create a monetary disincentive to leave lights on, keep electronics plugged in or otherwise waste electricity. In order to put such a system in place an individual meter system for each room would have to be installed across campus. Students would then receive monthly bills for their electricity use.

Carbon Effects: It is impossible to say exactly how this option might change students' electricity consumption, and while they might reduce their use, it is difficult to say by how much.
Given the many current reminders in and around residence hall rooms to turn off lights, the reduction from the change may not be significant. Or, with a sudden cost attached to electricity, students might take active measures to cut their energy use. Predicting the habits of the student body is uncertain.

Cost: The cost of this mitigation strategy could end up being large. Since there is currently no system in place to measure electricity usage by room, one would need to be installed, which could be very expensive. Once such a system was in place it would then be necessary to send bills to students each month, as well as collect payment. Doing so would also add to the workload of the Housing Office, or to whichever office would take responsibility for it.

Difficulty: This would be a difficult system to put in place given that every residence hall room on campus would need to be linked into a new system for measuring electricity usage. It would also require a constant oversight in terms of sending out bills and collecting them. For that reason it receives a 3 (very difficult).

Other Factors: Roommates who are sharing a room might need to share one electricity bill, but may be using different amounts of electricity. For instance if one student uses a desktop they would have a higher energy use then their roommate with a laptop. While roommates do this all the time in the real world it is still something to be taken into consideration as a possible complication, leading perhaps to roommate conflicts.

Option: **Install energy efficient windows across campus.**

Implementation: While energy efficient windows have been slowly integrated into the campus there are still many buildings that have older windows. While these historic windows are an important part of the campus, they are expensive to maintain, and many of these windows are lined with lead.[199] Double-glazing the windows would help to increase their energy efficiency as much as 90%, but this process is difficult and might not be possible in some cases. These windows are often repaired on campus since they are no longer in production, which may lead to health risk for those who do the work.[200]

Carbon Effects: Despite the cost, the emissions savings are significant. Each house in the U.S. that makes the switch to energy-efficient windows is estimated to save 10,000 pounds of CO_2e.[201] Wellesley is estimated to comprise the equivalent of 1,288.31 homes.[202] Energy efficient windows would save 128,831 pounds or 58.44 tonnes of CO_2e, although potentially a little less since there are already some energy efficient windows installed on campus. Also, these numbers might be somewhat larger because the design of Wellesley College buildings may not be directly equivalent to houses in terms of how its space is distributed. Regardless, this is still a good way to save on carbon, and increase the efficiency of college buildings.

Cost: The cost of new windows in the residence halls is significant, approximately half a million dollars for each hall.[203] Replacing these windows would be expensive, but in doing so Wellesley could offset the cost in energy savings once new windows were installed. Another solution was demonstrated in Stone-Davis when sliding glass storm panels were installed on the inside of the original windows. While they are not as efficient as double glazing or other energy efficient windows, they did increase energy efficiency by as much as 30%.[204] They cost significantly less as well, as little as $3 per window sheet as compared to double-glazed window that can run about $30[205]. The cost of this project would also be offset to some degree in energy savings for heat, which would mean less natural gas/oil needed for the college.

---

199 ES300 "Spring 2003, Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003). 62.

200 ES300 "Spring 2003, Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003) 62.

201 "Switch to Double Pane Windows." Stop Global Warming, *Take Action!*. http://www.stopglobalwarming.org/sgw_actionitems.asp.

202 Calculated based on information from Reed, William and René Stewart Poku, "Standard XIII: Physical Resources," NEASC's Commission on Institutions of Higher Education's Standards for Accreditation, http://www.wellesley.edu/Reaccreditation/eight.html

203 ES300 "Spring 2003, Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003). 62.

204 ES300 "Spring 2003, Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003). 62.

205 ES300 "Spring 2003, Audit of Wellesley College's Greenhouse Gas Emissions" (May 2003). 62.

Difficulty: This would be a very project difficult project to implement, making it a 3 (very difficult). The project would require major renovations across campus at a great cost to the school

Other Factors: There are also possible safety concerns with the continued use and repair of lead lined windows, and switching over would mean removing a possible safety hazard on campus.

Option: **Use hybrid buses for the Exchange Bus during the week and the Mall/Movie Shuttle on weekends.**

Implementation: Although this is a relatively straightforward change, Wellesley must overcome the fact that it contracts all of its shuttle buses and that none of the companies that it contracts with use any kind of energy efficient buses at the moment. Either the college will have to either find companies that use hybrid buses, or it will have to purchase its own bus fleet. Peter Pan's website mentions nothing about any of these technologies and JFK Transportation, the company that provides the Olin/Wellesley/Babson (OWB) shuttle, operates vans and mini-buses in a size range that lacks alternative fuel solutions.[206] In fact, the only bus carriers that employ appreciable numbers of environmentally friendly buses are municipal transit authorities because hybrid buses are far more expensive than their standard diesel counterparts and because there is no infrastructure for electric and natural gas yet.[207] Therefore, Wellesley would have to create its own bus fleet.

A full Wellesley fleet would include two large coach-style or city-style buses for the Exchange and Senate buses, another smaller bus for the Movie/Mall Shuttle, and a 15-passenger van for the OWB shuttle. In addition, the college should also purchase another large bus and another smaller bus or 15-passenger van to use in case of emergencies with any of the other buses and to allow some of the buses time for maintenance. Wellesley would then need parking space for all of these options and a garage large enough for maintenance since very few bus repair shops have experience with hybrid buses. It would also need to pay drivers and mechanics to staff its new fleet and facilities. Finally, it would have to insure its new vehicles and everyone riding them, which the current bus companies do for less than Wellesley ever could because they can spread its costs among all of its thousands of passengers. These startup and overhead costs are enormous, so a conversion on this scale is impossible.

It is feasible to purchase a pair of Azure Dynamics gasoline hybrid Citibuses for use for the Exchange Bus during the week and for the Mall Shuttle on the weekend, since they are already a proven consumer technology, only require insurance for two small buses, are small enough that they should not require a new garage, would only require minimal expansion of parking areas, and contain a warranty that includes in-house repairs by company technicians. Wellesley would need to modify its contract with Peter Pan so it would only receive their

206 "The 'Green & Environmentally Friendly Bus Company," Peter Pan Bus Lines, http://www.peterpan.bus.com/whoweare/goGreen.php
207 "Corporate Transportation," Local Motion of Boston, http://www.localmotionofboston.com/shuttlebus/business_travel.html

services for the Senate Bus, but this should not be very difficult. Perhaps in the future, when alternative buses become more common and cheaper, overhead costs will lessen and allow expansion of the fleet, but it would be impossible at this point to justify all the purchases needed for such a step now.

Carbon Effect: If the smaller hybrid gasoline bus runs in place of the Exchange Bus during the week and the Mall/Movie Shuttle on the weekend, it should produce just[208]

$$\text{75\% emissions of regular gas bus} \times \frac{0.00893 \text{ MTCO}_2\text{e/gal. gas}}{0.01008 \text{ MTCO}_2\text{e/gal. diesel}}$$
$$= \text{66\% of Exchange and Mall Shuttle emissions.}$$

That results in a total savings of[209]

$$\text{16,980 gal. diesel/yr. for Exchange and Mall Shuttles} \times 0.01008 \text{ MTCO}_2\text{e/gal.} \times \text{34\% savings}$$
$$= 58 \text{ MTCO}_2\text{e/yr.}$$

Cost: Most bus companies do not post prices for their vehicles on their websites, especially those that develop alternative powertrain vehicles, so it is difficult to accurately estimate the cost of purchasing new vehicles. Diesel Forum states that New York City Transit purchased diesel-electric hybrid buses between 1997 and 2002 for $385,000, or 33% more than conventional diesel buses.[210] Coupling this price premium with two estimates for typical cutaway buses that average to $72,500 per bus,[211] and that the hybrid technology has gotten less expensive in recent years, we can estimate that a hybrid gasoline bus costs less than $96,000. Azure Dynamics also guarantees its buses and will perform repairs in-house if there are any problems; this makes maintenance costs nearly free for the first few years. Insurance costs are impossible to find without talking to an insurance agent to get a price quote, so the added insurance cost is unknown but probably upwards of $5,000 per year for a bus. Drivers for the two buses would likely cost around $50,000 per year each. Therefore, in total, Wellesley would have to pay about $192,000 up front and at least $110,000 per year for its buses. This would be offset by the fact that the college would no longer pay Peter Pan for buses for its present weekly trips, so that should reduce the yearly costs by about $62,000, thus bringing the yearly cost difference to a more reasonable $47,500. That means

208 Clean Air Cool Planet, "CA-CP Calculator," 2006, EF_Transportation Sheet. "Equipment Guide," U-Haul, http://www.uhaul.com/guide/index.aspx?equipment=truck-24.
209 Clean Air Cool Planet, EF_Transportation Sheet.
210 Diesel Forum, "Diesel-Electric Hybrid Vehicles," http://www.dieselforum.org/fileadmin/templates/whitepapers/diesel-electric.pdf.
211 eBay Motors, "2001 Chevrolet Express Cutaway Bus," http://www.ecarlist.com/cgi-bin/pdf.pdf?mode=window&id=80757&d_id=1000. Ulster County Area Transit, "Resolution No. 244: Authorizing The Chairman Of The Ulster County Legislature To Execute An Agreement With The New York State Department Of…," (Kingston, NY: 2006), 1.

that there is an overall cost of $3,310 per tonne up front and $820 per tonne yearly for the college.

Difficulty: Purchasing hybrid buses and negotiating part-time busing contracts with the bus companies that Wellesley already uses will likely give the hybrid solution 2.5/3 (medium to very difficult). Although Azure will fully guarantee its buses, its main office is in Ontario and it is impractical to have someone make the trip to Boston for all regular maintenance and minor emergencies. Thus, a mechanic on campus will have to become familiar with the hybrid bus technology. Furthermore, the bureaucracy surrounding insurance and hiring drivers could become rather cumbersome. None of these problems are unsolvable, but since much of the transportation system will be in-house, someone will have to concentrate on its daily management to make sure the buses make their stops on time, emergencies are fixed promptly, and maintenance schedules are followed.

Other Factors: Both of these options are very visible to the public and to the campus at large. Hybrid buses can display advertising demonstrating how much of an environmentally friendly college Wellesley has become to the hundreds of drivers per day along the bus route. This option is therefore very valuable for the college from a public relations standpoint.

Additionally, the Azure hybrid buses are small mini-coach buses, so their emissions reductions should be added to the reductions gained from using smaller, lighter buses during the week, outlined in the next option.

Option: **Use smaller, lighter buses for the Exchange Bus during the week when larger buses are unnecessary.**

Implementation: Wellesley can make existing diesel buses more efficient by essentially focusing on lessening wasted energy in every possible aspect. Both the OWB shuttle and the Exchange Bus run with the majority of their seats empty for much of their operating times. During the week, the Exchange Bus frequently has less than twenty passengers,[212] and at times other than right before and after classes, the OWB shuttle can run with as little as two passengers. To prevent this, Wellesley can do a simple one- or two-week survey in which it gives each of its bus drivers counters so that it can record the number of passengers on each bus trip. With this information, the college can more accurately choose buses that are suited to each trip. JFK uses buses ranging in size from a minivan to a large 20-passenger handicap-accessible bus for the OWB shuttle, so it should not be a problem for that carrier to switch to the smaller vehicles in its fleet when possible, and it would even benefit from the gas savings between a minivan and a delivery-van-sized bus. Peter Pan, unfortunately, has only coach buses and specialty buses like trolleys and 1950s-style buses for celebratory occasions, so another bus company would have to take over for it during the week.

The Senate Bus can also be more efficient because coach buses are unnecessarily large for short trips into Boston. The entire luggage compartment on the bus is unused and constitutes a large portion of unnecessary weight. So-called "activity coach" buses, which are usually school bus models with nicer interiors, have no cargo area and can therefore transport the same number of passengers while transporting less overall weight. Again, Peter Pan does not supply these types of buses, so Wellesley would have to switch to a company like Local Motion of Boston that does. Local Motion rents activity coaches that seat 52—3 less than a full-size coach—and have a center aisle where people can stand and grasp a bar above the seats, so they essentially have the same capacity as the deluxe coaches.[213] This company will also provide the college with the various types of smaller buses that it needs at different times, including a 12-passenger conversion van, a 23- and 33-passenger mini-coach, and the activity coach mentioned above.[214] The college would therefore have to terminate its contract with Peter Pan and sign a new one with Local Motion, which may lead to penalty costs and bureaucracy surrounding that decision, but it should be worth this effort.

---

212 Margaret Weirich, Personal Communication, April 15, 2008.

213 "Corporate Transportation," Local Motion of Boston, http://www.localmotionofboston.com/shuttlebus/business_travel.html.

214 "Corporate Transportation," Local Motion of Boston, http://www.localmotionofboston.com/shuttlebus/business_travel.html.

Carbon Effect: Calculating the carbon effect is a simple difference in mileage calculation between large buses and smaller buses. By using smaller buses during the week, the college will save

$$\frac{4 \text{ mpg bus}}{10 \text{ mpg medium truck}} = 40\% \text{ of Exchange and Mall Shuttle emissions.}$$

Although there are no mileage figures on Local Motion of Boston's website, we can estimate that mileage for their buses are on the higher end of typical bus mileage estimates and that heavy coach buses are on the lower end. Thus, activity coaches will release

$$\frac{3.8 \text{ mpg activity coach}}{4.2 \text{ mpg full - sized coach}} = 90\% \text{ of Senate Bus emissions.}$$

For the OWB shuttle, we can estimate that a minivan can be used in place of a large van for 50% of the total trips, since the minivan can accommodate up to 6 passengers, which is more than enough space for a majority of the trips. The new shuttle will result in a savings of

$$\frac{15 \text{ mpg large van}}{18.5 \text{ mpg minivan}} \times 50\% \text{ of trips} \times 1{,}750 \text{ gal. gas} \times 0.00893 \text{ MTCO}_2\text{e/gal. gas.}$$
$$= 6.3 \text{ MTCO}_2\text{e.}$$

In total, this will result in

$$60\% \text{ Exch./Mall savings} \times 170 \text{ MTCO}_2\text{e} + 10\% \text{ Senate savings} \times 124 \text{ MTCO}_2\text{e} + 6.3 \text{ MTCO}_2\text{e}$$
$$= 121 \text{ MTCO}_2\text{e savings.}$$

Cost: As there is no pricing on Local Motion of Boston's website, it is impossible to predict a cost for switching bus carriers. Using these more efficient buses will result in a savings of 11,420 gallons of diesel and 710 gallons of gasoline, which at a typical gasoline price in Wellesley of $3.40 per gallon and a diesel price of $4.25 per gallon will result in $290,000 per year in fuel savings.[215] It is unknown whether this savings will be greater than the cost of switching bus companies.

Difficulties: Wellesley will have to overcome contract obligation problems with Peter Pan if it switches to a different bus company and will have to find a company that suits its needs, but neither of these problems are very difficult so this option gets a 2 (medium) for difficulty. Apart from negotiating the contract, the college also has to make sure that it records

[215] Estimate based on several prices from *Massachusetts Gas Prices*, .http://www.massachusettsgasprices.com. April 15, 2008

accurate ridership information, so it may have to give its drivers incentive to make accurate passenger counts. The college will also have to search for a bus company that gives a good price and has all the necessary bus sizes and options. Finally, it will probably have to appease complaints about activity coaches not being as comfortable as regular coaches, although these complaints will likely diminish over time as students accept the activity buses and forget the previous coach buses. Overall, this is not a very difficult switch to make, as long as there is no major contractual obligation to continue with the current bus agreement.

Other Factors: The only other major factor is that Local Motion of Boston may not be able to provide the size service that Wellesley requires. The information on the company's website made it seem like it could provide shuttles every day using multiple types of buses, but its services appeared to target companies that may be smaller and require less frequent shuttles than Wellesley. If Local Motion is inadequate, the college may need to look for multiple bus services, which could add expense and difficulty.

Option: **Put in place monetary disincentives for parking on campus or incentives to discourage employees from bringing cars to campus**

Implementation: Many of the College's employees commute to the college by car. As the transportation sector demonstrated, faculty/staff commuting accounts for significant portion of carbon emissions. In order to combat these emissions, two different types of strategies could discourage commuting by automobile. First, disincentives for bringing cars to campus are needed, but more importantly, incentives for using other methods of transportation must support this policy.

Disincentives would need to focus on parking, which is the one major part of transportation that the college has control over since it cannot control fuel prices. Right now employees pay no fee for parking on campus, so the only cost to them for driving to campus is gasoline. In order to decrease the number of cars being brought to campus a parking fee, similar to the one students pay for the use of the parking facilities, could be implemented. This fee would have to be yearly, since a one-time parking fee is not a disincentive if an employee stays for many years. This parking fee could then be used to fund incentives for employees who choose not to bring their cars to campus, or to subsidize the use of public transport. Another option would be to have a pay-as-you-go system, so that there is a daily incentive not to bring a car. It might also be feasible to reduce the parking fee or eliminate it entirely for those who have energy-efficient vehicles. This policy, however, would unfairly discriminate against those who cannot afford to purchase newer energy-efficient cars.

Incentives to avoid bringing cars to campus could include monetary bonuses for those who live near the college and choose not to register a car on campus, and therefore must walk to work each day. These incentives would more difficult for those who live further away from the college to participate in, but there can also be incentives for carpooling or other innovative ways of getting to work.

Carbon Effects: It is difficult to say how effective such a measure would be. It would depend on the number of people who chose not to bring their cars and the other ways they choose to commute. The next mitigation strategy will discuss the possible benefits of increased number of employees utilizing public transportation.

Cost: This strategy would have no cost for the college, and it might end up being a source of income for the college if a large number of employees continue to bring their cars.

Difficulty: This mitigation strategy earns a 2 (medium). Implementation is relatively simple--it just requires a fee to be collected at the beginning of each year from employees. This is something done easily through one of the departments of the college, most likely Campus Police, which already does so for student If a daily fee system were put in place, collecting the fee would be somewhat more difficult, but an automated system would still be relatively easy to institute. This strategy, however, would not be popular amongst employees. There are certain employees who will not want to (or in some cases, cannot) change their driving habits. Given that the infrastructure and public transportation systems in the Boston area are not very convenient, it might be very difficult or impossible for some employees to reach Wellesley without a car.

Other Factors: Employees may be angered over this change, especially given the distance that many of them live from the college, which does not give them a choice about how they commute. It would also disproportionately affect staff and union members, who are not provided with housing close to campus, and who live on average further away from the campus. Despite the cost, most people would probably pay the fee to have the flexibility to bring their car when they needed it. In the case of a yearlong permit, a fee might actually serve to increase driving for those looking to get the most out of the service they are paying for. A daily pay as you go system would avoid this problem. There is already a swipe system set up in Founders Lot, but this could cause complications in the Davis Parking Facility where students, guests and employees park. In addition, systems would have to be implemented in Gray Lot, the Distribution Center Lot and other places where employees might park. Having a parking fee on campus might simply increase the amount of people who are illegally parking in the "Ville" or slightly off-campus in order to eschew the fee.

Options: **Create incentives for using public transport, such as subsidizing passes and providing reimbursement.**

Implementation: Increasing use of public transport is a key way of decreasing the emissions that result from the employees who commute to work each day. While there are a number of good options for transporting employees to the campus, such as shuttles from far suburban areas, and coordinating car pools, probably the best way is to provide incentives for public transport. Behavioral change would probably require a monetary incentive. The College should subsidize public transportation such as the Commuter Rail and the T.

Carbon Effect: Just how effective this option would be is unknown, especially since those who already do take public transport would not be changing their habits, they would just be reimbursed. Also, it is impossible to know how many people really would change their behavior in this case. Potential savings could be high, since on average faculty drive 1,792 miles a year (16.01 tonnes CO_2e) and union employees drive 3,891 miles a year (34.76 tonnes of CO_2e). If ten people from faculty and ten union employees were to change their transportation habits 50.77 tonnes of CO_2e could be saved.

Cost: If subsidized public transportation and parking fees for employees are done in conjunction, the money from parking registration on campus can be used to fund public transportation. Otherwise it would be a cost for the campus, although to what extent is hard to predict since the cost would be based on the number of employees who decide to participate and what sort of public transport they take. Commuter rail passes from Boston to Wellesley (located in Zone 3) would cost \$163 per month of unlimited travel. A Monthly LinkPass would cost \$59 for unlimited travel on Subway and Local Busses.[216]

Difficulty: This option is ranked a 1 (easy) since it would be easy to implement.

Other Factors: Incentives for using public transport would be helpful for employees and would have the additional environmental benefits of decreased driving (such as decreased air pollution of other types). In order to encourage use of the T, the college can run a shuttle to the Woodland Station on the Green Line during prime commuting hours. This idea would increase the cost of this initiative.

---

216 "Information on Fares and Passes." Massachusetts Bay Transportation Authority. http://www.mbta.com/fares_and_passes/?eid=10512&sidebar=false)

Option: **Do not allow vehicles to idle unnecessarily**[217]

Implementation: It is illegal to idle a vehicle for more than five minutes in Massachusetts.[218] To make Wellesley an anti-idling campus, the behavior of students, faculty, and staff must be changed. This is especially true with the Exchange/Shuttle Buses that idle in front of the Chapel and Campus Police vehicles that idle in front of the police station. Behavior can be changed through education. If this is ineffective, fines are also a way to ensure that behavior changes because they range from $100 to $25,000 in the state of Massachusetts. It would be desirable to reduce idling by delivery vehicles that often do not know where they are going, or leave their trucks on when making deliveries or getting directions. Having all deliveries made to the Distribution Center and then delivered by Motor Pool vehicles would reduce idling on campus.

Carbon Effect: Reducing idling by five minutes a day, could save 0.1 tonnes of CO_2e per year per person.[219] While the majority of the Wellesley population may not idle for five minutes daily, there are certain vehicles on campus, like buses and delivery trucks, that idle more than others. An estimated 50 trucks and buses idle around 20 minutes per day each. This releases roughly 20 tonnes of CO_2e a year. These savings might be higher if more vehicles idle on campus, and also possibly lower if Motor Pool were to make deliveries.

Cost: There is no cost to turn off the engine of an idling vehicle. The costs for educating the Wellesley community would be minimal. Preventing idling vehicles would save money and not cost people anything. Idling wastes fuel, and not idling a single vehicle for five minutes a day during one year would save 10.91 gallons of diesel, which is roughly $49.[220] This equates to a campus-wide savings of $9,800 in fuel costs.

Difficulty: There is little difficulty in attempting to accomplish this goal, this option has a rank of 1 (easy). A campaign could be done for engines with signs saying: "Turn off the juice when not in use," similar to other environmental initiatives on campus. There is already a law mandating that idling be limited. There are three exceptions to this law, only

---

217 Unnecessarily as deemed by Massachusetts General Law (MGL), Chapter 90, Section 16A, 310 Code of Massachusetts Regulation (CMR), Section 7.11 and MGL, Chapter 111, Sections 142A – 142M

Vehicles allowed to legally idle for more than five minutes include: vehicles being serviced, delivery vehicles, and vehicles that provide energy.

218 "The Massachusetts Anti-Idling Law." http://www.ci.somerville.ma.us/CoS_Content/documents/Anti-Idling%20Law%20With%20Penalties.pdf (accessed Apr 14, 2008).

219 Idle-Free Facts PDF

Michaud, Wayne. "Idle-Free VT idling Facts." http://idlefreevt.org/idlingfacts.index.html (accessed Apr 14 2008).

220 Idle-Free Facts PDF

Michaud, Wayne. "Idle-Free VT idling Facts." http://idlefreevt.org/idlingfacts.index.html (accessed Apr 14 2008). "Gasoline and Diesel Fuel Update," Energy Information Administration, http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp.

one of which would apply to Wellesley, and that is idling associated with deliveries, such as ones made to the campus. Idling for deliveries could be eliminated relatively easy by having Motor Pool make deliveries, such as with the mail truck, and educating Motor Pool employees about the effects of idling. It might be difficult, however, to persuade many individuals to change their behavior. Because Wellesley hires Peter Pan for the Exchange/Senate bus, the College is likely to exert the greatest effect on this service, and the finite stops on campus would make monitoring behavior relatively easy.

Other factors: An additional reason to undertake this measure is for health. Idling vehicles emit toxins including particulate matter, carbon monoxide, and sulfur dioxide that cause headaches, lung disease, impaired learning, and the aggravation of asthma and allergies.[221]

221 Idle-Free Facts PDF
Michaud, Wayne. "Idle-Free VT idling Facts." http://idlefreevt.org/idlingfacts.index.html (accessed Apr 14 2008).

Option: **Use waste vegetable oil from the dining halls to create biodiesel that can power some of the diesel buses.**

Implementation: Wellesley can also use waste vegetable oil (WVO) from the dining halls to create biodiesel to power as many buses as possible. Right now, the dining halls must pay an oil removal company to properly dispose of the waste oil that comes from all fried food. This waste oil, however, can be processed and turned into standard biodiesel that can power any diesel engine with nothing more than a few large vats, lye, and glycerin. One study found that biodiesel produced from waste vegetable oil can reduce greenhouse gas emissions up to 87%.[222] WVO use also emits less GHGs than biodiesel made from crops grown specifically for fuel because it requires no extra fertilizer or land clearing beyond that which has already been devoted to food use. Though the quantities that Wellesley produces come nowhere near the amount needed for all the diesel buses on campus based on estimates done for a similar project at MIT,[223] the project will still help the college's carbon footprint. It also eliminates the land clearing problems that occur as a result of growing plants for ethanol and biodiesel. Furthermore, it reduces emissions created by trucks transporting oil to a disposal plant when delivering diesel to the campus fueling station.

For WVO conversion to happen on Wellesley's campus, a tank needs to be devoted to converting the oil to biodiesel, someone needs to organize the processing, and students need to work to do the actual filtering process. Based on estimates from MIT,[224] a 55-gallon drum should be fine as long as filtering occurs constantly and the drum gets emptied every week. Organization would most likely be tasked to a group like WEED or the ES department, and the organizer will have to research the WVO conversion and the oil removal process at Wellesley to choose the right solution for the college. Manual labor will be required every week to ensure that the oil actually gets processed. Once the framework has been set up, the project should be relatively easy to maintain.

---

222 "Biodiesel Could Reduce Greenhouse Gas Emissions," *ScienceDaily*, (Nov 30, 2007): par. 6, http://www.sciencedaily.com/releases/2007/11/071127101930.htm.

223 ES 300 Spring 2008 Class, "2008 Wellesley Greenhouse Gas Audit Transportation CA-CP," (ES Capstone, Wellesley College, 2008), Commercial Sheet.

224 Matt Zedler, "Biodiesel@MIT: Making Grease Good," *MIT Undergraduate Research Journal* 15, (Spring 2007): 9.

Carbon Effect: By using an estimate from a similar project at MIT that found that the dining halls there generate 5,000 gallons of WVO per year,[225] scaling that figure to apply to Wellesley's smaller community, and substituting biodiesel for a percentage of the total diesel used for the Senate Bus,[226] we can calculate that the college will save[227]

$$5000 \text{ gal. WVO at MIT} \times \frac{2300 \text{ Wellesley students}}{4172 \text{ MIT undergrads}} \times 87\% \text{ savings}$$
$$= 2400 \text{ gal. diesel.}$$

In $MTCO_2e$, this results in an absolute savings of

$$2400 \text{ gal. diesel} \times 0.01008\ MTCO_2e/\text{gal. diesel} = 24.2\ MTCO_2e/\text{yr.}$$

Cost: WVO processing only requires lye and glycerin and can reduce biodiesel costs to as little as \$1.15/gallon including labor and materials.[228] At this cost, the college can payback the equipment used to make the fuel after only 2,500 gallons, or two and a half years of use. Labor costs are kept inexpensive by using student labor at \$9-10 per hour for around five hours per week. Furthermore, Wellesley will no longer have to pay for waste oil removal, so its trash costs will also decrease, though we were unable to separate oil removal costs from the cost of standard waste removal. WVO costs over 70% less than petrodiesel, so the college should save almost \$7,500 per year through this program. Though WVO-biodiesel will not make a large impact on the college's greenhouse gas emissions, it is economically favorable and easy to implement, so there is no reason why the project should not go forward.

Difficulty: Setting up a waste vegetable oil collection system should be rather simple and the WVO plan receives a 1.5 (somewhat easy) in terms of difficulty. Dozens of plans for WVO-biodiesel converters already exist on the Internet and individuals in their houses have already created many conversion setups.[229] The only problem with creating biodiesel is convincing the bus company to put it in its buses, but if there is a problem, the fuel can be mixed with diesel to make B20 (20% biodiesel), a standard mixture, or it can go into motor pool vehicles instead. Either way, there will be a use for the oil and it will not go to waste. Also, it might be possible to use this fuel for buses owned by another company, meaning Wellesley would

---

225 Matt Zedler, "Biodiesel@MIT: Making Grease Good," *MIT Undergraduate Research Journal* 15, (Spring 2007): 9.
226 Clean Air Cool Planet, "CA-CP Calculator," 2008, Input_Commuter Sheet.
227 MIT Enrollments 2007-2008," Massachusetts Institute of Technology, http://web.mit.edu/facts/enrollment.html
228 Utah Biodiesel Supply, "Biodiesel Cost/Benefit Analysis Worksheet," http://www.utahbiodieselsupply.com/biodieselproductioncosts/BiodieselProductionCosts-20080207.gif.
229 Utah Biodiesel Supply, "Getting Started Making Biodiesel," http://www.utahbiodieselsupply.com/gettingstarted.php.

only have to develop the fuel and not also invest in buses. This, however, would have to be negotiated with the company at the time the contract was being drawn up.

Training students or employees should be quite easy if there are simple directions on the Internet. There may be liability issues involved in handling lye, but these problems can be covered with waivers similar to the ones that chemistry classes must sign for their labs, as well as proper protective materials. Either a person or an organization will certainly have to take responsibility for the entire system, so there will need to be some sort of initialization procedure.

Other Factors: Involving students in the effort to reduce emissions will make the environmentally friendly image more visible on campus and can empower us to know that we can make a tangible difference in the fight against climate change. The project relies on WEED and the Sustainability Advisory Committee, along with other environmentally aware people and groups on campus, to generate student enthusiasm so that there are enough employees for the project, but the monetary incentive combined with the knowledge that this work will help both the school and the environment should keep workers on board the project. If we advertise that our buses are fueled by biodiesel, we can also demonstrate our environmental credentials to the outside world as well and hopefully get someone to realize that it truly is easy to reduce emissions by recycling vegetable oil. This project produces very positive publicity both inside and out of the college.

Option: **Require that Motor Pool buy fuel-efficient vehicles.**

Implementation: Motor Pool currently drives vehicles that are not fuel-efficient, a majority of which include Ford Rangers.[230] Mandating that the college buy fuel-efficient vehicles would require a College-wide policy. Once accepted, Motor Pool has several vehicle options with improved fuel economy, air pollution, and greenhouse gas emissions.

If Motor Pool continues to buy small pick-up trucks, similar fuel-efficient options include the 2008 Toyota Tacoma[231] and the 2008 Ford Ranger.[232] If Motor Pool were to buy a hybrid SUV, the one most similar to the Ranger would be the 2008 Ford Escape Hybrid.[233]

The Environmental Protection Agency (EPA) has rated vehicles on a zero to ten scale to determine the most environmentally friendly, with 1 being the least environmental and 10 being the most.[234] The current vehicle predominately driven by Motor Pool, the 2000 Ford Ranger, receives an air pollution score of 1 and a greenhouse gas score of 2. Comparable fuel-efficient vehicles have considerably higher scores: the Toyota Tacoma and Ford Ranger have air pollution scores of 6 and 7 and greenhouse gas scores of 5 and 4, respectively. The hybrid SUV, the Ford Escape, has an air pollution score of 9.5 and a greenhouse gas score of 8.

Carbon Effect: The 2000 Ford Ranger emits 13.07 tonnes CO_2e a year, which is considerably more than its fuel-efficient counterparts. The Toyota Tacoma emits 10.18 tonnes CO_2e per year, the 2008 Ford Ranger 11.44 tonnes CO_2e per year, and the Ford Escape Hybrid 6.57 tonnes CO_2e per year. Purchasing one of these three vehicles would save between 1.63 and 6.5 tonnes CO_2e per truck per year.

Cost: There is an upfront cost to purchase new fuel-efficient vehicles, but overall this policy would result in a cost savings for the college. The Toyota Tacoma starts at $14,280, the 2008 Ford Ranger starts at $14,220, and the Ford Escape Hybrid starts at $26,505.[235] These vehicles must be updated at some point, so some cost is inevitable, but there may be a small

---

230 For the sake of measuring, the Ford Rangers will be assumed to be models from the year 2000. Additionally, it is assumed that they have 4 Wheel Drive (4WD) so that on campus services can be implemented in the event of inclement weather.

2000 Ford Ranger specs: Engine: 4 Liter, 6 cylinder, Transmission: Automatic, 5 speed; Fuel Type: Gasoline; Drive: 4WD

231 2008 Toyota Tacoma, Engine: 4 Liter, 6 cylinder, Transmission: Automatic, 5 speed; Fuel Type: Gasoline; Drive: 4WD

232 2008 Ford Ranger, Engine: 3 Liter, 6 cylinder; Transmission: Automatic, 5 speed; Fuel Type: Gasoline; Drive: 4WD

233 2008 Ford Escape Hybrid, Engine: 2.3 Liter, 4 cylinder; Transmissions: Auto Variable; Fuel Type: Gasoline; Drive: 4WD

234 "Green Vehicle Guide: United States Environmental Protection Agency." http://www.epa.gov/greenvehicles/Index.do;jsessionid=8230ee2c3e7078635980 (accessed April 14, 2008).

235 2008 Ford Escape Hybrid, Engine: 2.3 Liter, 4 cylinder; Transmissions: Auto Variable; Fuel Type: Gasoline; Drive: 4WD

additional cost for fuel-efficient vehicles. Additionally, not all vehicles to be replaced right now, so replacement can be a gradual process.

Some of the money spent on the vehicles would also be recovered in fuel costs. Because these vehicles have better gas mileage, they use less fuel. The 2000 Ford Ranger has an estimated annual fuel cost of roughly $2,839. The 2008 Tacoma costs $2,208 per year for fuel, the Ranger $2,484, and the Escape Hybrid $1,420. The average of these fuel saving vehicles, averaged and subtracted from the cost of the 2000 Ford Ranger shows that purchasing one of these three vehicles would save between $355 and $1,419 on fuel. Therefore, the cost per tonne CO_2e per truck, assuming the trucks will run for 10 years, is between $189 for the Escape Hybrid and $655 for the 2008 Ranger.

Difficulty: Implementing a policy mandating that all vehicles purchased would be more environmentally friendly would be relatively easy, as would finding fuel efficient vehicles to purchase. The automobile market is continually improving vehicle technology and fuel-efficiency; therefore vehicles will be manufactured in better ways. This project receives a rating of 1 (easy) for difficulty.

Option: **Do not run the Escort Van unless someone calls to request it.**

Implementation: Right now, the college runs the Escort Van on a regular loop from 6 PM until 2 AM, whether or not there is a need for it. The amount of fuel used by this service could be reduced by simply eliminating the regular schedule and using the Escort Van only when a student calls for it. This would decrease the amount of fuel used without hurting the ability of the Escort Van to operate as intended.

Carbon Effect: The Escort Van only runs around campus, but it has a weekly route of about 70 miles, which equates to 2,240 miles for the entire academic year. If the van were eliminated completely, the fuel saved would equal 20.01 tonnes of CO_2e per year, but since it will be running on a case-by-case basis the emissions savings will actually be lower. Since the van will be running directly from location to location instead of on a loop, the amount of fuel being saved should be significant.

Cost: There would be no cost associated with this change, and there might be some savings given that less fuel would be used since the Escort Van would not be running as it usually has.

Difficulty: This ranks as a 1 (easy) in terms of difficulty. It is easy to implement and possibly saves money. Student workers would simply need to sit in the police station instead of in the van when working their shifts for the Escort Van.

Other Factors: There is however, the issue of whether or not students would make use of the Escort Van if it required an individual call rather then running on a regular schedule. Many students may use the service because it is available and predictable; students may be more hesitant to call if a van trip required an action on their part and may choose to walk more often late at night. This creates a possible safety hazard that the Escort Van was designed to combat. Education and encouragement to utilize the Escort Van could be used to ensure students continue to use the service. There is also always the possibility that students might use it more frequently if the van was more reliable as a service requested on a case by case basis.

Option: **Establish a community bike share program on campus**

Implementation: Wellesley's campus already lends itself to walking, as it is too small to drive and most students do not have cars. If students do have cars, these vehicles are often parked in locations too far away to use, other than for trips off campus. There are, however, a number of places near the campus that students could bike to, instead of drive or walk to, if community bikes were readily available. The "Ville," (where many student shop and run errands,) Olin College, Babson College, babysitting jobs and other local venues are often a far walk, but a short bike ride.

If bicycles were made freely available to the Wellesley College , students might choose to bike more often than drive to places close to campus. Given the cost of fuel, and the expense of having cars on a campus, even students with cars or ZipCar accounts might choose to bike.

There has been some work done toward a community bike program on campus, by students as well as in Residential Life. Some bikes have been purchased, but their existence or the process for borrowing them is not generally known on campus. It is also unclear how much demand there is for bikes. This pre-existent infrastructure would decrease startup cost, although it also might be an indicator of how much the bikes might be utilized and the sort of carbon savings they might have.

Carbon Effects: It is possible that such a program, while beneficial to campus overall, would not actually create a major reduction in emissions, for several reasons. First of all, many students who do drive go to places that are far enough away that biking is not a possibility; therefore, the availability of bikes would not change these students' habits. Secondly, while the bikes may be heavily used by some students, it is likely for across-campus use, which would mean that walking, not driving, would be replaced by biking. This use would not actually change driving habits, but simply increase biking on campus. While a community bike share program may be something that college community would enjoy and utilize, it would not in this case be an effective carbon cutting measure.

Cost: The program would be somewhat costly to start, as it would involve buying a number of bicycles and helmets. There would also be ongoing cost for repairing bikes, and replacing bikes or helments that beyond repair or go missing.

Difficulty: This earns a rank of 2 (medium). The implementation and administration of the program will require effort by whichever entity on campus takes it on. In addition, a bike share program would likely face liability issues if students injure themselves while riding school-owned bikes.

Option: **Reduce campus paper use by 50%**.
Students, faculty and staff at Wellesley College use 75 short tons of paper per year. Since there are no restrictions on paper usage, there is no incentive to conserve paper. There are a number of ways to reduce paper usage on campus, and through targeting students, faculty, and staff it is possible to reduce campus paper usage by 50%.

Implementation: There are several ways in which this goal can be achieved. One initiative that would have a huge effect would be to limit student printing. Students can be given a certain number of printing credits each semester commensurate with the number of courses they are taking. After students use up their credits, they would have the option of purchasing more. Not only would this initiative reduce paper usage, but it could also trigger a behavior change. Students would think twice before printing something, as there would be a cost attached to each page. Currently, there are no signs in the computer terminals/library areas with computers about reducing printing. There is a sign in the mini-focus, but it is by the printer where students collect their printouts. Signs can be put up next to the computers or on the desktop backgrounds of the computers themselves.

There are changes that can be made in faculty and staff paper usage as well. Many departments do not have their printers set to double-siding as a default, but this option can easily be changed. Copier usage can also be tracked and statistics can be put up next to the copier so that faculty and staff members realize how much paper is being used. These also have default settings that can be changed as well to ensure double-sided copying. Departments can be rewarded for ordering less paper as well, in addition to the cost savings. Faculty members can require double-sided assignments and try to reduce handouts in their class. They can also encourage reading e-reserves online and sharing readings with a friend.

Carbon Effect: Currently, Wellesley College uses 75 short tons of paper annually. This paper usage is the equivalent of 194 tonnes of CO_2e if it is all virgin paper (2.5 tonnes CO_2e/tonne paper).[236] It should be noted that the college is not responsible for the emissions from this paper under the Presidents Climate Commitment. About 50% of the campus uses recycled paper of some sort, as do 52% of administrative departments and 47% of academic departments. Adjusting for recycled paper use (2.5 tonnes CO_2e/tonne paper), the CO_2e emitted would be 183 tonnes per year.[237]

If Wellesley reduces all paper usage by half, then we would save 91 tonnes of CO_2e. Paper reduced is paper that would never be created, so these emissions savings are relevant on a

[236] Z Group. "Final project paper." (POL 312s: Environmental Policy, Wellesley College, Fall 2007)
[237] Z Group. "Final project paper." (POL 312s: Environmental Policy, Wellesley College, Fall 2007)

global scale. The way in which we are conceptualizing mitigation, however, none of this carbon dioxide reduction would count in terms of our commitment for the President Climate Change Commitment.

Cost: This initiative would not cost any money; rather it would save the institution money. Re-programming the computer and copier settings would require Information Services to devote a few hours going around to each department. Alternatively, instructions can be given to the departments so they can do it themselves. If faculty digitized more of their reading assignments, then student workers would need to be employed to scan the readings into e-reserves. Overall, the college would probably end up purchasing less paper if these measures were employed, and since students would be paying for their printing, the college would recoup some of the costs of the purchased paper.

Wellesley buys about 3000 cartons of paper per year. Recycled cartons cost $44.99 from OfficeMax, and non-recycled cartons cost $33.99.[238] Assuming that Wellesley buys half recycled and half non-recycled paper (so 1500 cartons of each type of paper), this amounts to $118,500 spent on paper in a year. This estimate might not be accurate since certain departments purchase more paper than others, but given that 52% of administrative departments purchased recycled paper and 47% of academic departments do, this assumption should not be quite close. In total, reducing paper usage by 50% would save the college $59,250, not accounting for any extra hours Information Services (IS) would have to put in to change the settings of all the computers. On a per carbon unit, each pound of carbon reduced would save $3.40.

Difficulty: This initiative would rank as a 2 (medium). It is not physically difficult to change the settings on the computers and printers to make the default double-sided printing. Putting statistics by the copiers about paper usage is easy to do as well. There probably would not be much objection to doing it. Getting faculty to require double-sided assignments might be a little more difficult, since some of them do not like the concept, as it makes it difficult for them to write comments or grade. The most difficult aspect of this would be an initiative to limit student printing. This would be very politically unpalatable, as students feel as if they have the right to print out as much as they want. Logistically it is easy to track printer usage based on login name, but students would not be happy with this measure. There are also some smaller logistical issues, in terms of accounting for printer usage and allowances for student organizations.

[238] Office Max, *5000 sheets at Office Max*. http://www.officemax.com

Option: **Purchase green materials when possible (recycled paper etc.)**

Implementation: The Purchasing department should, whenever possible, purchase items for the college that are either made from recycled materials, or those made by environmentally conscious companies when recycled materials are not available. Other office supplies and items the school orders should also be purchased with recyclables in mind. Many companies now offer a variety of green options for the office including, notebooks, pens, pencils, binders, furniture, printer ink, filing cabinets, cleaning supplies, batteries and computer supplies.

Carbon Effect: One of the biggest places this can have an impact is in recycled paper purchasing. Each ream of recycled paper saves 5 pounds of carbon.[239] Considering the amount of paper the college goes through each year, it could add up to be a substantial amount. If Wellesley were to buy recycled paper for the 75 short tons it uses, equivalent to 30,000 reams of paper each year, the college would reduce its emissions by some 150,000 pounds or 68 tonnes of CO_2e.[240] The number, however, would actually be slightly lower since there are many departments that have already made the switch to at least partially recycled paper.

Cost: The downside to this option is that green options can often cost slightly more then regular office supplies, the benefit however, is that simply by purchasing, as with the recycled paper, other GHGs can be offset. The cost should for the most part, not be significant since all the items purchased would need to be bought whether or not they were green, so the only cost would be the additional amount of money necessary to buy a green version of each product.

Difficulty: This would not be difficult to implement, making it a 1 (easy). The main actionnecessary would be some initial research into green options Wellesley's purchases. There might be some reluctance among both faculty and staff who could no longer purchase their preferred brands of pens or paper, but they would likely adapt.

Other Factors: Changing offices over to using recycled materials can also help to create a mindset of going green on campus, and can contribute to an overall awareness of the environment. Education about these green products can help spread a broader awareness of the changes the college is making and its dedication towards the environment.

---

239 "Use Recycled Paper." Stop Global Warming, *Take Action!*. http://www.stopglobalwarming.org/sgw_actionitems.asp.
240 Z Group. "Final project paper." (POL 312s: Environmental Policy, Wellesley College, Fall 2007).

Option: **Recycle all our recyclables.**
Wellesley must recycle all waste products that can feasibly be recycled. This aspect of mitigation focuses on increasing recycling, not on waste reduction itself. While the institution has a recycling program, gains can be made in the area of environmental education and awareness of what, how and where to recycle.

Implementation: Recycling has been institutionalized in the campus center, academic buildings and residence halls. Custodians now pick up the recycling in the residence halls, shifting the responsibility away from students. This is a large step, ensuring that recycling is done consistently throughout the year.

In order to ensure that all of the potentially recyclable materials are recycled, awareness of what exactly can be recycled and how to do so must be increased on campus. One method of increasing awareness about recycling is to increase recycling on campus. This can be done in the residence halls by having the Eco-Reps give a short demonstration at each all-house meeting at the beginning of the year. Faculty and staff can be educated through department meetings or a sustainability training.

Another issue with recycling on campus is lack of awareness about where to recycle. Many recycling bins, particularly in the campus center, are poorly labeled or not easily visible. By clearly labeling bins and increasing the visibility of the bins, people will be able to recycle more easily. One initiative to increase awareness about the locations of recycling bins is to create a map of each building with the locations of recycling bins and place it both on the college website and at the entrance of each building, so that people are aware where they can recycle.

In order to rally the campus community around recycling, the Sustainability Committee should increase the visibility of RecycleMania, perhaps by creating a competition between residence halls. The annual Energy Competition every Fall between residence halls is successful in raising awareness among the students, since the results are published every week and each residence hall complex's reductions or gains are public knowledge. If similar programming were instituted for RecycleMania, people will be more motivated and hopefully recycle more.

Carbon Effect: On the global level, recycling decreases greenhouse gas emissions by reducing the use of raw resources. In the case of trees, this means eliminating fewer carbon sinks. In addition, the creation of new products from recycled materials is often less energy intensive than creating the same products from raw materials. The recycling process has different greenhouse gas emissions reductions depending on the type of material being recycled. For example, aluminum recycling saves 95% of the energy that would be required to make aluminum products from raw materials.[241]

Currently, Wellesley recycles about 10% of its solid waste each year (163.7 short tons), which is lower than the national average of 32%.[242] Based upon this figure, Wellesley can make large gains in the total amount of waste recycled. The Earth Engineering Center of Columbia University estimates that up to 40% of waste can be recycled or composted.[243] Similarly, a waste audit of the campus conducted by WEED estimated that 42% of the campus wide waste stream consists of recyclable materials.[244] If 40% of the college's total waste in 2006 were recycled, Wellesley would recycle 735.7 short tons of waste, 572 short tons more than is currently recycled.[245]

At Wellesley, due to the net greenhouse gas savings of waste-to-energy incineration, the greenhouse gas savings of recycling are primarily due to decreases in greenhouse gas emissions from the transportation of recyclables.[246] Waste vehicles at Wellesley travel 28,350 miles per year, whereas the recycling vehicles only travel 2,260 miles per year.[247] Currently, the recycling vehicles make fewer trips, but the facility is much closer to Wellesley (6.4 miles as opposed to 35.8 miles).[248] Assuming that one trip to the waste facility could be reduced per week, and instead go to the recycling facility, this would save 29.4 miles of travel per week, amounting to 1055.6 miles saved in the 32-week academic year. As these vehicles use diesel fuel, it amounts 105.75 gallons, which emit 2,347.56 pounds of CO_2e, or 0.10639 tonnes.

Cost: Increasing awareness about recycling is not very costly. Members of WEED and the Eco-Reps are student volunteers and could easily give a five-minute recycling demonstration at each of the residence hall meetings and to the faculty members. There is already a floor plan of recycling bins in the residence halls, which would need to be updated. Creating a map of the academic buildings and campus center could potentially be time consuming, but not very costly, as would labeling the recycling bins and making them more visible. The most

241 *Commonly Asked Questions—Benefits of Recycling,* PSSI, Stanford University, http://recycling.stanford.edu/recycling/caq_benefits.html.
242 *Measuring Greenhouse Gas Emissions from Waste*, Environmental Protection Agency, http://www.epa.gov/climatechange/wycd/waste/measureghg.html.
243 "The ABCs of Integrated Waste Management," Waste-to-Energy Research and Technology Council, http://www.seas.columbia.edu/earth/wtert/faq.html.
244 Waste Audit 2002, Wellesley Energy and Environmental Defense, 4/26/2002. Referenced in: "Audit of Wellesley Greenhouse Gas Emissions," Environmental Studies 300, Wellesley College, May 2003, 49.
245 See Chapter 10: Waste Sector.
246 See Chapter 10: Waste Sector.
247 See Chapter 9: Transportation Sector.
248 See Chapter 10: Waste Sector.

costly part of this initiative would be to buy more recycling bins and put them in the buildings. More recycling bins would have to be purchased in order to promote recycling. If fifty 23-gallon bins and lids were purchased at $77.78/set[249], this would be come out to $3,889. If approximately 0.10639 tonnes of CO_2e were saved, these recycling awareness and ease initiatives would cost $1.66 per tonne of CO_2e saved.

This expense could be fully funded by the payment that Wellesley receives from Conigliaro Industries for recycling every year. Conigliaro credited the college $9,814 in 2006 and almost $12,000 in 2007, which was put toward improvements in the recycling program and could be used specifically to purchase new recycling bins.[250]

Difficulty: This initiative would rank as a 1 (easy). The largest task in ensuring that all recyclables are actually recycled has already been done. Shifting the recycling in the residence halls from a student responsibility to a custodial responsibility is an important step, as recycling will be done consistently now. The next steps in increasing recycling awareness and ease are smaller and require increasing environmental education and awareness. Logistically, it should not take that much effort for a few people to go around to the academic buildings and create a map of where the bins are located, so that faculty and staff know where to recycle.

[249] *Recycle Bins*, Staples, http://www.staples.com/webapp/wcs/stores/servlet/yourorder?orderId=59063814&catentryId_1=88038&catentryId_2=88039&ddkey=StaplesAddToCart, Accessed 21 April 2008.

[250] Willoughby, Patrick and Kate Salop, "Wellesley College Sustainability," Wellesley College Sustainability Advisory Committee, May 2008, 23. See Waste Section for more details.

Option: **Eco-friendly food carriers and utensils for the Campus Center, Pomeroy, Stone-Davis, and Collins; eco-friendly napkins in residence halls and at conferences**

Implementation: Across campus there are a variety of places that use take away containers, and all of the eating facilities use paper napkins. The campus center uses plastic boxes for all to-go food, including sushi and when ordered, sandwiches, hamburgers, the create-your-own-sautée, and the dinner entrée. Cardboard boxes are used for pizza and paper cups are available for those wishing to take a drink to-go as well. There are plastic utensils (forks, spoons and knives) available for the taking, along with napkins on all the tables. Collins Café also uses only disposable plates and utensils. In Stone-Davis paper plates and plastic utensils are available for the late-night dining hours from 8-10pm. And last year, according to Wellesley College Dining Services, 77,000 paper cups were used in the Pomeroy dining hall.[251]

It is estimated that each cup takes 0.55 Mega joules to make,[252] which is 42,350 Mj just for the Pomeroy dining hall in cups last year. Paper is energy-intensive to manufacture, and is associated with further greenhouse gas emissions in its transport to its consumers and to the landfill.

Plastics, which comprise many of the containers and utensils used, are produced using fossil fuels, and are often disposed of in landfill. In the case of Wellesley College, disposal in landfills is not the primary concern, because most of the waste is incinerated in waste to energy facilities, although there are other effects of burning plastics. Instead, what needs to be focused on is the production of plastic take away containers.

If the college were to focus on buying from one of the many green companies now selling biodegradable products, we are likely to see benefits on both sides of the equation. Many of these companies, such as Eco-Products.com and International Paper have gone completely green when it comes to these products. Eco-Products, for example, runs its factory using solar power to create energy for their manufacturing, buying offsets for the areas they can't cut down on, and recycling waste so that the plants are very close to, if not, zero emission.[253]

---

[251] Display in the Pomeroy Dining hall April 10th 2008. Pomeroy Dining hall is a kosher and vegetation dining hall meaning that no food or dishes may be taken in or out of the dining hall because the dishes must be specially prepared for the dining hall.

[252] Institute for Lifecycle Energy Analysis, "Reusable vs. Disposable Cups." www.dartcontainer.com/web/environ.nsf/files/ILEA.pdf/$FILE/ILEA.pdf.

[253] Eco-Products, "Environmental Practices." http://www.ecoproducts.com/company%20pages/environmental%20practices.htm.

Carbon Effects: A plastic bottle similar in size and material to plastic takeaway containers takes 1.1 pounds of CO_2 to make.[254] If each student at Wellesley has 400 flex points to use during each year, that amounts to about 80 meals a year one can eat at the campus center. If a fourth of those are take away meals, each student uses about 20 containers a year. Given that there are approximately 2,300 students on campus, 46,000 meals a year are eaten in takeaway containers. That number times the carbon emissions for each container equals 50,600 pounds (number of meals times 1.1 pounds of CO_2e for each container), or 22.95 tonnes of CO_2e that could be saved by purchasing eco-friendly containers. This is a rough calculation for one kind of container on campus, and does not even begin to include napkins, paper/Styrofoam plates or utensils, for which numbers are more difficult to find. Because of the steps taken by many of the companies producing these goods, the lifecycle of the product are as close to zero emissions as possible. Since Wellesley does not routinely compost, there is little need to consider the composting side of the cycle. It is true, however, that most of these carbon effects are not counted in our audit. The carbon reduction for this measurement will be environmentally beneficial, but will not reduce the carbon for which we would be responsible for under the Presidents Climate Commitment.

Cost: At one university where take away containers are available students were charged an extra $0.20-0.25 for the containers to offset the cost.[255] This strategy is one possible way to help offset the cost for the college while still implementing the strategy efficiently. Another would be to absorb the cost, which at $0.25 per container would equal $11,000 for the academic year.

Difficulty: This plan is relatively easy to put into place, as it does not call for any change in habits, only in purchasing. This option is ranked a 1 (easy).

[254] Time For a Change, "What is a Carbon Footprint – Definition." http://timeforchange.org/what-is-a-carbon-footprint-definition.

[255] The Mountain Echo, "SGA Passes Biodegradable To-go Container Proposal." http://media.www.themountainecho.com/media/storage/paper565/news/2007/02/21/News/Sga-Passes.Biodegradable.ToGo.Container.Proposal-2740801.shtml.

Option: **Reduce waste in the dining hall (and hot water too) by not using trays**

Implementation: Dining halls are a major source of waste. After each meal food, as well as paper products (mostly napkins) are thrown away. All of the waste from the dining halls is thrown into dumpsters behind each dining hall, which is then taken away by a waste removal service to a waste to energy plant in Braintree. Dining Services has been looking for ways to reduce waste from the dining halls. One idea was to remove the trays from the dining halls and see if this change the amount of waste generated during a meal. Presumably, if people have less capacity to carry things, they will take less, consume less, and throw away less as a result.

Earlier this year the General Manager of Dining Services, Jason LaPrade, ran an experiment in one of the dining halls during lunch. The dining hall staff measured the waste from lunch one day and found waste to be equal to 65 pounds. The next day the staff removed all the trays and at the end of the meal weighed the waste again; they found the tray-less waste to equal only 26 pounds. Removing trays led a reduction of waste by 60% in one meal.[256] An expanded version of this program was put into effect in all dining halls during Earth Week in April.

Carbon Effect: This experiment represented the waste at one meal for an estimated 280 students that means each student's waste dropped from 0.23 pounds to 0.09 pounds. We assume that each student eats two meals a day (since many students do not eat breakfast, or may eat at the campus center, or may miss occasional meals on campus in the dining halls). If 2,300 students eat two meals a day, seven days a week for 32 weeks during the academic year, that works out to 1,030,400 meals eaten per academic year. At the current rate of waste that puts total food waste for the dining halls at 236,992 pounds of waste each year. Under a tray-less system that would drop to 21,329 pounds per year, a savings of 215,663 pounds of food waste a year, not including the campus center.

The dumpsters on campus have an area of eight cubic yards. The Massachusetts Department of Environmental Protection (DEP) guidelines for recycling materials state that one cubic yard of unfinished compost (which should be similar to our food waste) weighs 1,500 pounds.[257] When 137,984 pounds(the amount of waste being saved) is divided by that amount, the quotient is 92 cubic yards of waste (amount of waste saved divided by amount of pounds in a cubic yard), or 11.5 dumpster loads of trash saved (cubic yards divided by the

256 Communications with Jason LaPrade, General Manager of Dining Services.
257 The Massachusetts Department of Environmental Protection, "Volume-to-Weight Conversions for Recyclable Materials." www.mass.gov/dep/recycle/approvals/dsconv.pdf.

8 cubic yards in each dumpster) each academic year. Given that the dumpsters are emptied 252 times a year this would be a 2.3% reduction in waste removal generated GHGs. Right now 18,040 miles are traveled each year for waste, at 35.8 miles a trip (as calculated in waste transportation of this report) this would be a reduction of 205.85 miles traveled. It was estimated that 2,840 gallons of diesel were used overall out of the 28,350 miles traveled for waste including compacted trash. When 205.85 miles is found as a percentage of total miles and then multiplied by the total amount of fuels used the amount of diesel saved is found to equal 20.62 gallons of diesel fuel saved. The Environmental Protection Agency estimates that each gallon of diesel emits 22.2 pounds of CO_2e per gallon.[258] Tray-less dining would save a total of 457.76 pounds or 0.2 tonnes of CO_2e.

The carbon savings are small, but there are other benefits that are more difficult to quantify. Hot water is used in washing trays, and is responsible for greenhouse gas emissions from energy genderation. However, the amount of emissions saved by this is probably not significant either.

Cost: This would be an overall cost saving measure for the campus, which would no longer have to invest in trays, as well as lowered cost for transport of waste since there would be less waste to transport. There would be fewer dishes and no trays to wash for each person who ate in the dining halls, leading to an overall reduction hot water used. Money would also be saved, in terms of food produced and purchased; fuel needed to transport the food would also decrease, although its difficult to say how much this could add up over the long run. While it does not reduce our footprint by much, it does have other benefits, such as reducing waste.

Difficulty: This plan requires very little of the college, simply that trays no longer be put out at meals, meaning that this measure would actually mean less work for dining hall workers before and after meals. Considering these factors tray-less dining ranks a 1 (easy) on the scale of difficulty, as an extremely easy mitigation strategy to implement.

Other Factors: While the plan has other benefits, such as reduced work load in the kitchens, hot water saved, and less trash overall for the college, the benefits in terms of emissions are small. Also important to some degree is the student response as well. Trays are handy in a dining hall and there may be a student backlash to the removal of trays that students are used to using at each meal. The Earth Week pilot program suggests that any initial student opposition would be quickly dissipated. If students learn that trays are gone for good, what

[258] "Calculating C02 Emissions." Environmental Protection Agency, *Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel.* http://www.epa.gov/OMS/climate/420f05001.htm#calculating.

may have been a one-day adjustment might fade away as students simply learn to take more or go back for seconds.

Conclusion

This section has examined many different strategies for reducing the college's carbon footprint. These strategies include institutional changes and more personal changes that can be made. They differ in their potential carbon savings, difficulty of implementation, and cost, and some are more viable options than others. For further discussion of the mitigation options we have deemed best, see conclusions in Chapter 14.

13.

Committing Wellesley to the ACUPCC

If Wellesley were to sign the ACUPCC, the college would be required to meet the agreement's five basic requirements while working toward the ultimate goal of climate neutrality: (1) establishing an institutional structure to oversee implementation of the agreement, (2) measuring greenhouse gas emissions, (3) choosing at least two short-term actions to reduce emissions, (4) formulating a long-term climate action plan, and (5) reporting progress to Association for the Advancement of Sustainability in Higher Education (AASHE).

The first ACUPCC requirement, establishing an institutional structure of faculty, staff and students to oversee implementation of the agreement, is the initial step after signing the agreement. Within one year of the ACUPCC implementation start date, Wellesley would be required to annually inventory and publicly report the college's greenhouse gas emissions. Such an inventory could be done with the CA-CP Campus Carbon Calculator used in this audit, as it is consistent with the standards of the Greenhouse Gas Protocol of the World Business Council for Sustainable Development and the World Resources Institute.

Within two months of the ACUPCC implementation start date, Wellesley would be required to take at least two short-term (i.e. less than two year) actions to reduce greenhouse gas emissions while a long-term climate action plan is developed. These actions can be chosen from a list of seven options provided by the ACUPCC. These actions are as follows;

1. Commit to achieving U.S. Green Building Council's LEED Silver standard or equivalent for all new buildings and major renovations.
2. Adopt a policy that requires the purchase of Energy Star certified appliances in all areas for which such ratings exist.
3. Encourage the use of and provide access to public transportation for all faculty, staff, students and visitors to Wellesley.
4. Purchase or produce at least 15% of the college's electricity consumption from renewable sources within one year of signing the ACUPCC.
5. Establish a policy or committee that supports climate and sustainability shareholder proposals at companies where Wellesley's endowment is invested.
6. Participate in the Waste Minimization component of the national RecycleMania competition and adopt three or more associated measures to reduce waste.
7. Offset all greenhouse gas emissions generated by air travel paid for by Wellesley.

Within two years of the implementation start date, Wellesley would be required under the ACUPCC to develop a climate action plan with a start date and interim milestones for achieving climate neutrality. This plan would include a combination of conservation, renewable energy, and carbon offset measures such as those recommended in the mitigation section of this audit. Finally, the ACUPCC requires that Wellesley make the institutional structure, greenhouse gas inventory, climate action plan, and progress reports publically available through Association for the Advancement of Sustainability in Higher Education website.

Carbon Offsets

Carbon offsets are based on the simple idea that it is often less costly to pay to reduce greenhouse gas emissions at a location other than where the greenhouse gases are being produced. The idea of offsetting emissions works because greenhouse gases have the same global warming effect across the globe no matter where they are released.[259] Offsets are a way to counteract emissions in areas where greenhouse gas-emitting processes cannot be changed or where these processes are too expensive to change in the near future. When an individual or institution finds that it is unable to further reduce emissions, offsets provide a

[259] Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. vii.

way to reduce greenhouse gas emissions without compromising electricity production or other essential services. Carbon offsets are highly flexible in that they can be used to offset a small amount of carbon or to achieve complete carbon neutrality, the idea of reducing the greenhouse gas emissions of an individual or institution to zero.[260] Carbon offsets are the only way for Wellesley College to reach complete carbon neutrality and, if enough offsets were purchased, offsets would allow the college to reach carbon neutrality as early as next year while other emissions reductions strategies are still being implemented.

Some argue that offsets allow people to buy their way out of changing their greenhouse gas-emitting actions. While offsets do not change individual behavior, they allow for reductions in overall carbon emissions in a cheap and efficient manner having the same overall effect on the global environment at a lower cost. Offsets are a quickly growing business, and competition for sales is beginning to emerge in the market, helping to lower prices and provide a variety of offset companies from which to choose. The average offset costs $9.10 per tonne, significantly less than it would cost to reduce most types of greenhouse gas emissions at their original source.[261]

Since first gaining public attention several years ago, offsets have grown from a "feel good" idea into a rapidly growing industry. In most cases, carbon offset companies invest in a project involving low greenhouse-gas emitting technology, such as replacing a coal plant with a clean energy source, and sell offsets to individuals and institutions on a per-tonne basis. While the idea of offsets seems simple at first, the quality of offsets varies. When buying offsets, it is important to know the time frame and lifecycle of the offset. One example of a commonly perceived reduction is planting trees, but carbon sequestration by trees occurs over several decades, meaning there is a huge time lag before net CO_2e emission reductions occur. When the tree dies and decomposes, the carbon sequestered within it will be released, which means that there may not be an actual net carbon reduction.[262] Another important consideration when purchasing offsets is whether or not the reductions would have occurred without the funding from the offsets.[263]

---

260 Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. vii.

261 Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. 2.

262 Kevin Smith, *The Carbon Neutral Myth*, Chapter 3, "The Problems With Trees and Lightbulbs," (Amsterdam: The Transnational Institute), pp. 19-25.

263 Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. 8.

As carbon offsets become more popular, it is important to keep in mind the potential pitfalls of offsets and how to buy wisely. The first thing to look at in choosing a company to work with is transparency. It is critical that consumers are able to evaluate the type of offsets they are buying. Examine the type of offset program and assessing the viability of the offset method that the company is using is an important part of being a smart consumer. Being able to follow funds for offsets and ensure that they are being fully invested in the advertised projects is an important part of any good offset program. Otherwise, it is possible for companies to take funds and then only invest a percentage of them in the programs specified.[264]

The best way to avoid these problems regarding offset purchasing is for buyers to be informed about the history and track record of any offset company before investing. Understanding how the provider chooses offsets, previous reports, sales histories and any other background on the company can be helpful in evaluating their commitment to quality offsets. Attention to technical detail and understanding the science behind their offsets are also important components of the strength of a company.[265]

Given the price for offsets the college needs to consider the cost of offsetting emissions on campus. In some cases an on campus reduction may cost more than the price per tonne to offset that carbon elsewhere. It would then be cost effective for the college to invest elsewhere rather then spending more money on campus to reduce the emissions.

Wellesley will also need to buy offsets for areas it cannot make reductions in, such as faculty/student travel for conferences, student travel to and from home, and employee commuting. Offsetting all of the college's emissions would cost a total of $530,750, which breaks down to about $230.76 per student.

Signing the Commitment

This audit recommends that Wellesley sign the ACUPCC. The most compelling reason to do so is simply that greenhouse gas emissions reductions will eventually have to be made and the ACUPCC provides a tangible framework for immediate action. Without such a framework, reductions to greenhouse gas emissions will continue to be made in a slow, disconnected manner without any clearly defined reduction goals or deadlines. The

[264] Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. 8.
[265] Clean Air, Cool Planet, "A Consumer's Guide to Carbon Offset Providers," Clean Air, Cool Planet, December 2006. 9.

ACUPCC not only requires the establishment of an institutional structure to guide emissions reductions, the creation of a long-term plan to reach carbon neutrality, and annual inventories of greenhouse gas emissions, but the agreement also places Wellesley in a community of higher education institutions in which the college's progress will be publicly monitored.

Equally important as the tangible framework that the commitment provides, the requirements of the ACUPCC are reachable. A subsection or spin-off of the already-established President's Ad-Hoc Sustainability Committee would most likely qualify as the institutional structure to guide emissions reductions required by the ACUPCC. An annual audit of greenhouse gas emissions, as this audit has demonstrated, is completely feasible. This audit may be built upon and used as an example for future audits. In addition, the two required short-term actions to reduce greenhouse gas emissions are not unlike actions the college has already undertaken or has considered taking. Finally, the ultimate goal of carbon neutrality is not unreasonable. Under the Presidents Climate Commitment, which has a more narrow definition of the emissions for which the college is responsible than the definition used in this audit, Wellesley is only responsible for 32,114 tonnes of CO_2e.

Thus, the ACUPCC is valuable to the college for the tangible framework for reducing greenhouse gas emissions that it provides. The requirements of the commitment are reasonable and very similar to the changes to decrease greenhouse gas emissions that Wellesley is already considering and will ultimately be required by future regulation to make. Therefore, this audit recommends that Wellesley sign the ACUPCC as the first major step toward large reductions in greenhouse gas emissions.

14.

Conclusions

Since 1994, Wellesley's total greenhouse gas emissions have remained relatively constant over time. Including all the factors considered in this report, the college emitted a total of 48,350 tonnes of CO_2e and, according to the boundaries set by the ACUPCC, 38,563 tonnes of CO_2e in 2007. The largest source of these greenhouse gas emissions, accounting for 64% of total emissions, is the cogeneration plant. Therefore, the trajectory of campus greenhouse gas emissions has and will continue to be tied closely tied to energy production and consumption. Wellesley's next largest source of emissions, accounting for almost all of our remaining emissions, is our transportation sector. Most of these transportation emissions come from student travel to and from home at the beginning and end of each semester. The next biggest component of transportation emissions comes from College-funded travel, such as conference and research travel conducted by Wellesley professors and students. Any emissions from Wellesley waste generation and disposal or land use account for less than 1% of our total emissions. (Please note that some waste-related emissions are counted within the transportation sector.)

This report has outlined a variety of options to reduce the college's carbon footprint at the institutional level. There is, however, a select group of recommended mitigation strategies that have been deemed most reasonable for campus implementation and worth the initial investments of time and money. For full background information, cost, and emissions savings calculations for these recommended mitigation options, please refer to the Mitigation Section of the report.

The first and most important strategy at the administrative level is the hiring of a Sustainability Coordinator. Hiring a Sustainability Coordinator not only demonstrates an institutional commitment to an environmentally-friendly campus, but this action can also be vital to reducing the college's greenhouse gas emissions. The person in this full-time position will have the time and multi-year commitment required to make major change, including reductions in greenhouse gas emissions.

Other recommended mitigation strategies at the administrative level stem directly from findings in the Energy, Transportation and Waste Sectors of the report. Within the Energy Sector, instituting an EnergyStar purchasing policy and mandating EnergyStar student refrigerators are viable methods to reduce greenhouse gas emissions. In terms of the Transportation Sector, mitigation recommendations include disincentives for bringing cars to campus; incentives for public transport, hybrid buses for student transport; a mandate for purchasing fuel efficient vehicles for Motor Pool, and a no-idling policy. Finally, within the Waste Sector, a green materials purchasing policy, reducing paper use on campus by 50% through a variety of institutional changes, and mandating that dining services use eco-friendly take-away containers are additional ways of reducing greenhouse gas emissions on campus.

In addition, the Facilities Department can work with the administration to implement forced hot water heating and decrease the demand for heat across campus. Building maintenance can decrease energy consumption (and thus greenhouse gas emissions) by improving insulation, installing low-flow showerheads, centralizing CFLs distribution, improving the efficiency of faculty housing, and installing energy efficient windows. Lastly, in terms of individual actions, students, faculty and staff should all be encouraged to recycle all recyclables; unplug their electronics whenever not in use; and turn off their computers and use sleep mode whenever possible, as a means of reducing greenhouse gas emissions.

While these recommended mitigation strategies all are good ways of reducing greenhouse gas emissions, offsets will be still necessary for the college to reach the ACUPCC goal of carbon neutrality. This final recommended mitigation strategy will require administrative action as well as support from the college as a whole. We have determined that committing Wellesley to the ACUPCC is a good step toward decreasing our greenhouse gas emissions. A demonstrated commitment to solving the climate change challenge will bring Wellesley many benefits, including energy cost savings, a smaller chance of catastrophic environmental change, and a higher green status with which to compete with other schools for both new students and alumnae contributions. It must be remembered, however, that there is no reason to limit ourselves to only meeting the requirements of the ACUPCC; we can and should go above and beyond them.

Appendices

Appendix A: Full Text of the ACUPCC[266]

American College & University Presidents Climate Commitment

We, the undersigned presidents and chancellors of colleges and universities, are deeply concerned about the unprecedented scale and speed of global warming and its potential for large-scale, adverse health, social, economic and ecological effects. We recognize the scientific consensus that global warming is real and is largely being caused by humans. We further recognize the need to reduce the global emission of greenhouse gases by 80% by mid-century at the latest, in order to avert the worst impacts of global warming and to reestablish the more stable climatic conditions that have made human progress over the last 10,000 years possible.

While we understand that there might be short-term challenges associated with this effort, we believe that there will be great short-, medium-, and long-term economic, health, social and environmental benefits, including achieving energy independence for the U.S. as quickly as possible.

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. Campuses that address the climate challenge by reducing global warming emissions and by integrating sustainability into their curriculum will better serve their students and meet their social mandate to help create a thriving, ethical and civil society. These colleges and universities will be providing students with the knowledge and skills needed to address the critical, systemic challenges faced by the world in this new century and enable them to benefit from the economic opportunities that will arise as a result of solutions they develop.

We further believe that colleges and universities that exert leadership in addressing climate change will stabilize and reduce their long-term energy costs, attract excellent students and faculty, attract new sources of funding, and increase the support of alumni and local communities. **Accordingly, we commit our institutions to taking the following steps in pursuit of climate neutrality:**

1. Initiate the development of a comprehensive plan to achieve climate neutrality as soon as possible.

---

266 Presidents Climate Commitment, *Presidents Climate Commitment,* http://www.presidentsclimatecommitment.org/html/commitment.php

a. Within two months of signing this document, create institutional structures to guide the development and implementation of the plan.

b. Within one year of signing this document, complete a comprehensive inventory of all greenhouse gas emissions (including emissions from electricity, heating, commuting, and air travel) and update the inventory every other year thereafter.

c. Within two years of signing this document, develop an institutional action plan for becoming climate neutral, which will include:

i. A target date for achieving climate neutrality as soon as possible.

ii. Interim targets for goals and actions that will lead to climate neutrality.

iii. Actions to make climate neutrality and sustainability a part of the curriculum and other educational experience for all students.

iv. Actions to expand research or other efforts necessary to achieve climate neutrality.

v. Mechanisms for tracking progress on goals and actions.

2. Initiate two or more of the following tangible actions to reduce greenhouse gases while the more comprehensive plan is being developed.

a. Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.

b. Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.

c. Establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution.

d. Encourage use of and provide access to public transportation for all faculty, staff, students and visitors at our institution

e. Within one year of signing this document, begin purchasing or producing at least 15% of our institution's electricity consumption from renewable sources.

f. Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institution's endowment is invested.

g. Participate in the Waste Minimization component of the national RecycleMania competition, and adopt 3 or more associated measures to reduce waste.

3. Make the action plan, inventory, and periodic progress reports publicly available by providing them to the Association for the Advancement of Sustainability in Higher Education (AASHE) for posting and dissemination.

In recognition of the need to build support for this effort among college and university administrations across America, we will encourage other presidents to join this effort and become signatories to this commitment.

Signed,

The Signatories of the American College & University Presidents Climate Commitment

Appendix C: Additional Energy Sector Information

Calculations of Physical Plant Efficiencies:
Through correspondence with Mr. Hagg, we obtained data for the Physical Plant's electrical, steam, and overall plant efficiencies. The plant only had records extending back to 1999. To calculate steam, electrical, and plant efficiency we took four months evenly spaced across the year—February, April, August, and November— and averaged the efficiency totals for the four months to get a relative efficiency total. We calculated these numbers for each of the years between 1999-2007 to gain a better understanding of the Physical Plant's efficiency trends.

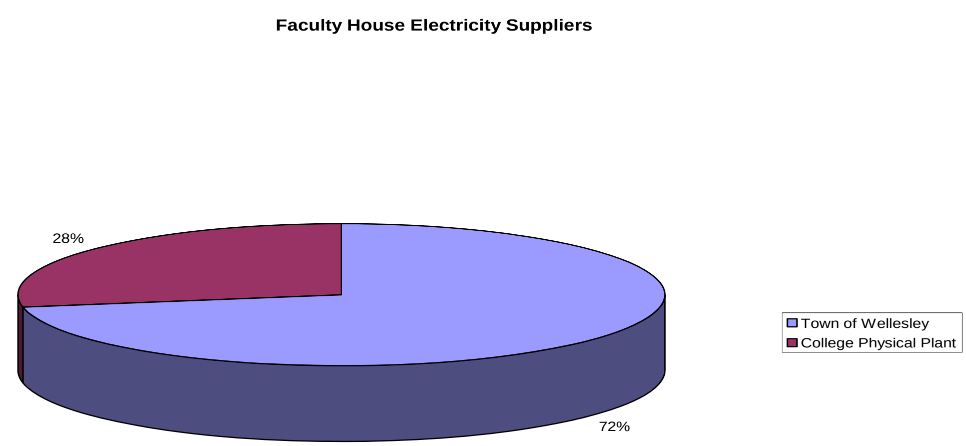


Figure B1. Faculty House Electricity Suppliers (town vs. college)

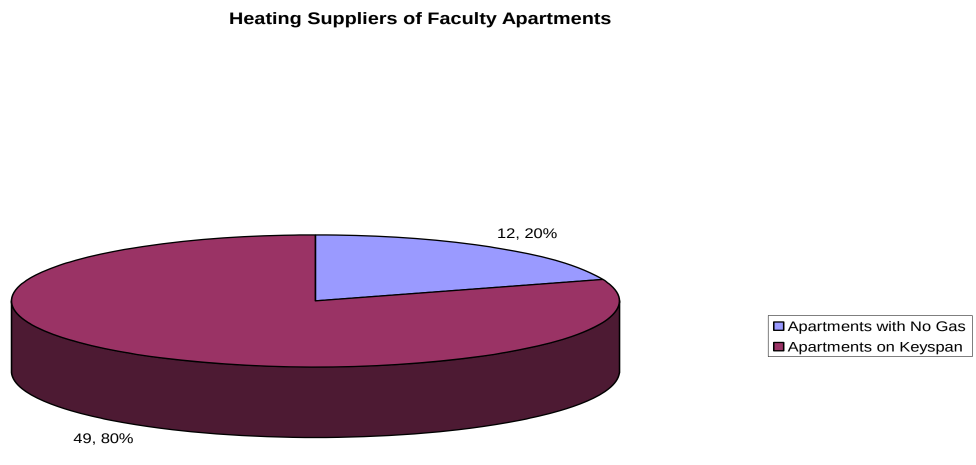


Figure B2. Faculty Apartment Heating Suppliers (gas vs. keyspan)

Appendix C. CA-CP Inputs and Summary Sheets

Table C1: CA-CP Framework, "Input" Worksheet Part 1

Fiscal Year	**Population**			**Physical Size**	**On-Campus Cogeneration Plant**						**Air Travel**	
	Full Time Students	Faculty	Staff	Total Building Space	Residual Oil (#5 - #6)	Natural Gas	Electric Output	Steam Output	Electric efficiency	Steam Efficiency	Faculty / Staff Business	Student Programs
	#	#	#	Square feet	Gallons	MMBtu	kWh	MMBtu	%	%	Miles	Miles
1994	2,340	225	821	2,400,000	798,808	411,221	14,905,617	177,546,950	32%	45%	5,717,825	12,369,596
1995	2,349	225	821	2,400,000	785,397	369,031	26,042,933	201,155,900	32%	45%	5,717,825	12,369,596
1996	2,288	225	821	2,400,000	1,140,387	369,031	28,268,544	193,474,300	32%	45%	5,717,825	12,369,596
1997	2,298	225	821	2,400,000	653,662	413,761	28,379,697	197,260,746	32%	45%	5,717,825	12,369,596
1998	2,319	225	821	2,400,000	207,746	484,589	29,287,860	202,791,858	32%	45%	5,717,825	12,369,596
1999	2,327	225	821	2,400,000	164,734	483,351	29,806,184	192,533,516	32%	45%	5,717,825	12,369,596
2000	2,316	225	821	2,400,000	999,071	433,055	33,055,467	243,873,143	31%	52%	5,717,825	12,369,596
2001	2,333	225	821	2,400,000	857,643	467,890	33,234,336	223,680,841	31%	57%	5,717,825	12,369,596
2002	2,287	225	821	2,400,000	726,702	484,155	32,708,928	178,172,265	31%	64%	5,717,825	12,369,596
2003	2,300	225	821	2,400,000	866,499	475,518	32,426,304	254,736,763	30%	64%	5,717,825	12,369,596
2004	2,289	225	821	2,400,000	644,446	470,694	29,518,464	190,368,664	31%	60%	5,717,825	12,369,596
2005	2,231	225	821	2,400,000	560,278	520,884	30,854,112	249,386,842	30%	68%	5,717,825	12,369,596
2006	2,318	225	821	2,400,000	363,506	542,276	30,700,992	253,729,405	31%	63%	5,717,825	12,369,596
2007	2,237	225	821	2,400,000	268,876	526,429	29,417,856	230,843,338	30%	67%	5,717,825	12,369,596

Table C2: CA-CP Framework, "Input" Worksheet Part 2

Automobile Usage								Fertilizer Application				Waste Disposal	Forest Preservation
Gasoline Fleet	Diesel Fleet	Faculty / Staff Gasoline	Students Gasoline	Faculty / Staff Diesel	Students Diesel	Faculty / Staff Electric	Students Electric	Synthetic	% Nitrogen	Organic	% Nitrogen	Refuse Derived Fuel (RDF) Incinerator	
Gallons	Gallons	Gallons	Gallons	Gallons	Gallons	kWh	kWh	Pounds	%	Pounds	%	Short Tons	Metric Tonnes CO_2
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	175.3
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	158
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	72,595	19%	0	0%	1,821	158
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	58,964	19%	632	4%	1,821	158
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	58,965	19%	632	4%	1,821	158
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	58,966	19%	632	4%	1,821	157
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	58,967	19%	632	4%	1,659	157
58,825	50,474	153,830	78,617	1,740	3,894	16,194	3,894	58,968	19%	632	4%	1,659	157

Table C3: CA-CP Framework, "Summary" Worksheet

Fiscal Year	Cogeneration Plant	Transportation					Agriculture	Solid Waste	Forest Preservation	SCOPE 1 Emissions	SCOPE 3 Emissions	Net Emissions (MT eCO_2)
	Total	Total	Fleet	Student Commuters	Faculty/Staff Commuters	Air Travel						
1994	31,170	19,067	1,039	748	1,415	15,865	55	(67)	(175)	32,265	17,961	50,226
1995	28,779	18,821	1,036	744	1,406	15,635	55	(67)	(175)	29,870	17,718	47,588
1996	32,956	18,101	1,035	743	1,405	14,918	55	(67)	(175)	34,046	16,999	51,045
1997	29,597	18,038	1,035	742	1,403	14,857	55	(67)	(175)	30,687	16,936	47,623
1998	28,100	17,879	1,034	741	1,402	14,702	55	(67)	(175)	29,190	16,779	45,968
1999	27,529	17,618	1,034	741	1,401	14,442	55	(67)	(175)	28,618	16,518	45,136
2000	34,683	17,236	1,034	741	1,402	14,059	55	(67)	(175)	35,772	16,135	51,907
2001	34,863	17,229	1,034	741	1,402	14,051	55	(67)	(158)	35,952	16,128	52,080
2002	34,183	17,229	1,034	742	1,402	14,051	55	(67)	(158)	35,273	16,128	51,401
2003	35,371	17,226	1,033	741	1,400	14,051	45	(67)	(158)	36,449	16,125	52,575
2004	32,503	17,230	1,034	742	1,402	14,051	45	(67)	(158)	33,582	16,129	49,711
2005	34,170	17,231	1,034	742	1,403	14,051	45	(67)	(157)	35,249	16,130	51,379
2006	32,987	17,231	1,034	742	1,403	14,051	45	(61)	(157)	34,067	16,136	50,202
2007	31,035	17,231	1,034	742	1,403	14,051	45	(61)	(157)	32,114	16,136	48,250

Appendix D. Travel Calculations

Table D1: Commonly Used Travel Numbers

Students with cars	444
Compact MPG	30.5
Mid- / Full Size MPG	18.5
SUV / Truck MPG	19.83
Van MPG	18.5
Hybrid MPG	30.18
Student miles / week	81.65
Weeks / academic year	32
Weeks / summer	14
Weeks / Wintersession	4
Weeks / month	4.35
Faculty members	448
Staff members	551
Union workers	292
Faculty driver %	77.5%
Staff driver %	92.1%
Union driver %	100.0%
Fac / staff compact %	31.3%
Fac / staff mid-/full size %	33.5%
Fac / staff SUV/truck %	24.8%
Fac / staff van %	7.8%
Fac / staff hybrid %	2.5%
Fac drivers mi / year	1,792
Staff drivers mi / year	2,798
Union drivers mi / year	3,891
Large truck MPG	6
Medium truck MPG	10
Large Van MPG	15
Car MPG	22.1
Bus MPG	3.8
Bus Passenger MPG	39.67
Train Passenger MPG	132.28
Food weeks / year	50
Purchasing wks / year	50
College club wks / year	52
El Table wks / year	36
Shuttle wks / year	32
Airplane T eCO_2 / person / mile	0.7769
Total reimbursement trips / year	1,986
1 mile in km	0.6214

Table D2: Travel Calculations, Individual Automobile Usage

	Students						Faculty					
	Students with cars	% driving each type of car	MPG for car type	Miles / Week	Weeks / Year	Gallons / Year	Faculty members	% Driving	% driving each type of car	MPG for car type	Miles / Year	Gallons / Year
Compact	444	32%	30.5	82	32	12,209	448	77.5%	31%	30.5	1,792	6,385
Mid- / Full Size	444	39%	18.5	82	32	24,393	448	77.5%	34%	18.5	1,792	11,267
SUV/Truck	444	23%	19.8	82	32	13,629	448	77.5%	25%	19.8	1,792	7,780
Van	444	5%	18.5	82	32	2,947	448	77.5%	8%	18.5	1,792	2,623
Hybrid	444	1%	30.2	82	32	423	448	77.5%	3%	30.2	1,792	515
	Total Yearly Student Gasoline Use, Gal.:					53,601	Total Yearly Faculty Gasoline Use, Gal.:					28,570

	Staff						Union Workers					
	Staff members	% Driving	% driving each type of car	MPG for car type	Miles / Year	Gallons / Year	Union members	% Driving	% driving each type of car	MPG for car type	Miles / Year	Gallons / Year
Compact	551	92.1%	31%	30.5	2,798	14,572	292	100%	31%	30.5	3,891	11,660
Mid- / Full Size	551	92.1%	34%	18.5	2,798	25,713	292	100%	34%	18.5	3,891	20,574
SUV/Truck	551	92.1%	25%	19.8	2,798	17,756	292	100%	25%	19.8	3,891	14,207
Van	551	92.1%	8%	18.5	2,798	5,987	292	100%	8%	18.5	3,891	4,790
Hybrid	551	92.1%	3%	30.2	2,798	1,176	292	100%	3%	30.2	3,891	941
	Total Yearly Staff Gasoline Use, Gal.:					65,205	Total Yearly Staff Gasoline Use, Gal.:					52,172

Total Regular Travel Gallons Used: 199,549

Table D3: Travel Calculations, Student Travel to and From Home

Air Travel	
	Miles / year
International	5,429,861
Domestic	6,148,126
Total air miles	11,577,987

Ground Travel			
	Miles / year	MPG	Gallons / year
Domestic	535,844	22.1	24,246

Table D4: Travel Calculations, Reimbursed Travel

	Miles / Trip	Trips / Year	MPG	Gallons / Year
Car/Vans	81.9	1986	22.1	7360
Bus	8.9	1986	39.7	447
Total Gasoline Gallons / Year				7,360
Total Diesel Gallons / Year				447

	Miles / Trip	Trips / Year	Miles / Year
Air	2767.6	1986	**5,495,204**

	Miles / Trip	Trips / Year	Miles / Year
Train	55.1	1986	109,348

Table D5: Travel Calculations, Commercial

	Food Deliveries				Purchasing				College Club			
	Miles / Week	Weeks / Year	MPG	Gallons / Year	Miles / Week	Weeks / Year	MPG	Gallons / Year	Miles / Week	Weeks / Year	MPG	Gallons / Year
Large Truck	362.4	50	6	3,020	421.4	50	6	3,512	74.6	52	6	647
Medium Truck	207.7	50	10	1,039	0	50	10	0	0	52	10	0
Van	0	50	15	0	314.8	50	15	1,049	0	52	15	0
Car	0	50	22.1	0	0	50	22.1	0	0	52	22.1	0
Bus	0	50	3.8	0	0	50	3.8	0	0	52	3.8	0
Total diesel gal. / year:				4,059				3,512				647
Total gasoline gal. / year:				0				1,049				0

El Table				Shuttles				Waste			Miscellaneous			
Miles / Week	Weeks / Year	MPG	Gallons / Year	Miles / Week	Weeks / Year	MPG	Gallons / Year	Miles / Year	MPG	Gallons / Year	Miles / Week	Weeks / Year	MPG	Gallons / Year
184.8	36	6	1,109	0	32	6	0	85.4	6	14	126.75	52	6	1,099
17	36	10	61	0	32	10	0	32,706	10	3,271	276	52	10	1,435
0	36	15	0	820.8	32	15	1,751	0	15	0	131.88	32	15	281
14.9	36	22.1	24	0	32	22.1	0	0	22.1	0	0	32	22.1	0
0	36	3.8	0	3316	33.5	3.8	29,233	0	3.8	0	0	32	3.8	0
			1,170				29,233			3,285				2,534
			24				1,751			0				281

	Food Deliveries			Bookstore		
	Miles / week	Weeks / Year	Miles / Year	Miles / week	Weeks / Year	Miles / Year
Plane	2,319	50	115,950	2,660	6	15,960
Total commercial air travel miles / year: 131,910						

Table D6: Travel Calculations, Athletic Travel

	Fall			Winter			Spring		
	Miles / Season	MPG	Gallons / Season	Miles / Season	MPG	Gallons / Season	Miles / Season	MPG	Gallons / Season
Van	1,445.1	15.0	96	811.2	15	54	324.6	15.0	96
Bus	4,751.5	3.8	1,250	4,927.5	3.8	1,297	2,874.1	3.8	1,250
Truck	0.0	10.0	0	0.0	10.0	0	411.4	10.0	41
Total diesel gal.			1,250			1,297			1,292
Total gasoline gal.			96			54			96

Total Gasoline Gallons / Year: 247
Total Diesel Gallons / Year: 3,839

Table D7: Travel Calculations, Admissions Travel

	Counselor Travel			Student Travel		
	Miles / Year	MPG	Gallons / Year	Miles / Year	MPG	Gallons / Year
Car	11,549.4	22.1	523	11,549.4	22.1	523
Bus	0.0	39.7	0	852.0	39.7	21

Total Gasoline Gallons/Year: 1,045
Total Diesel Gallons/Year: 21

	Counselors	Students
	Miles / Year	Miles / Year
Air	90710.7	312,646
Total Admissions Air Travel Miles		
403,357		

	Counselor Travel	Student Travel
	Miles / Year	Miles / Year
Train	2,580	4,515
Total Admissions Train Travel Miles		
7,095		