Bowdoin College
Climate Neutrality Implementation Plan

Revised Thursday, November 2, 2009

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1.0- Introduction

Bowdoin College has made a commitment to become carbon-neutral by the year 2020.

This demonstration of the College's environmental stewardship is the embodiment of one of the College's fundamental principles—stated in the inaugural address by Joseph P. McKeen, Bowdoin's first president—"to count Nature a familiar acquaintance."

This ambitious effort to erase the College's carbon footprint reflects a heightened institutional response to the growing consensus on the catastrophic effects accelerating climate change will have on the natural world and human societies if current trends are not offset by innovative and creative solutions on a global scale.

Bowdoin is not alone in realizing the key role that higher education must play in educating a new generation of citizens who are environmentally literate and capable of innovating the new solutions and technologies required to meet these pressing environmental and social challenges.

In 2007, Bowdoin President Barry Mills signed the American College and University Presidents' Climate Commitment (ACUPCC)—a pledge by leaders of more than 640 colleges and universities to move their campuses toward carbon neutrality and build new academic pathways for addressing sustainability issues.

As part of the ACUPCC, colleges committed to set a date by which their institutions would achieve carbon neutrality and to develop a public institutional action-plan for doing so. After a year of intensive study, the College developed a detailed implementation plan for becoming carbon neutral by 2020.

Bowdoin's Climate Neutrality Implementation Plan was developed by a team of Bowdoin staff, faculty, students, and trustees who evaluated a wide range of strategies for increased energy efficiency, transportation adaptations, renewable-energy generation, and carbon offset options that will be necessary in order to erase our carbon footprint.

Download the Bowdoin Blueprint for Carbon Neutrality at:
http://www.bowdoin.edu/sustainability/pdf/climate-blueprint-2009.pdf

The Bowdoin Blueprint for Carbon Neutrality is an overview of the basic goals and strategies of that plan, with an explanation of the rationale, costs, and outcomes associated with these important steps.

It is a dynamic plan that will be revisited and updated every two years so that Bowdoin community members can measure the effectiveness of strategies, evaluate the financial feasibility of specific projects, and incorporate new technological advances.

This is not a simple initiative. It will demand participation from all corners of campus to achieve carbon neutrality in little more than a decade. Some of the strategies will immediately reduce our carbon footprint; other options will take longer to yield results and require greater financial investment. The educational components are more difficult to quantify, yet no less important. In many ways, they are the College's most potent response to the uncertainties that lie ahead, for they will shape the hearts and minds of those on whom the future rests.

The assumptions underlying this particular path to carbon neutrality are not fixed, nor should they be. The Carbon Neutrality Implementation Plan will be updated, reassessed, and modified to reflect changes at Bowdoin as well as in the world. This updating process could identify a new path to achieve carbon neutrality more quickly, through different strategies or different costs.

2.0- Greenhouse Gas Emissions: Inventory, Trends, Mitigation, and Targets

2.1- Greenhouse Gas Inventory

This inventory accounts for the six greenhouse gases specified by the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons, and sulfur hexafluoride.[1] Each greenhouse has a different effect on global warming per molecule of emission. This is taken into account by assigning each gas a global warming potential. The global warming potential relates the effect of a given mass of a greenhouse gas to the same mass of CO_2. This allows for the total greenhouse gas inventory to be reported in terms of a carbon dioxide equivalent (CO_2e). The table below illustrates the global warming potential for each greenhouse gas emitted by Bowdoin.

Gas	Molecular Formula	GWP[2]
Carbon Dioxide	CO_2	1
Methane	CH_4	23
Nitrous Oxide	N_2O	296
HFC-134a	CH_2FCF_3	1,300
HCFC-22/R-22		1,700
R404A		3,784
R416A		1,000

[1] Bowdoin did not use perfluorocarbons or sulfur hexafluoride in 2008.
[2] Because each greenhouse gas has a different atmospheric lifetime it is necessary to choose a specific time horizon to compare relative impacts. A time horizon of 100 years is used in this report to relate each greenhouse gas into equivalent units of CO2. See: www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/wg1/020.htm#tabTechSum3

2.1.1- Greenhouse Gas Sources

Bowdoin College creates greenhouse gas emissions both directly and indirectly. To explain the difference between direct and indirect emissions it is helpful to imagine a large impervious box placed over the top of Bowdoin's physical campus. Direct emissions are those that would be trapped inside this box. Indirect emissions are those that the College is responsible for or has influence over but that occur outside of the imaginary box.

All of the greenhouse gases that were accounted for at Bowdoin College were assigned to one of three scopes. Bowdoin's inventory uses the scopes defined by the Greenhouse Gas Protocol[3], and described by the ACUPCC in their Implementation Guide for colleges and universities:

Scope 1 Greenhouse gas emissions are from sources that are owned or controlled by the institution, including: on-campus stationary combustion of fossil fuels; mobile combustion of fossil fuels by institution owned/controlled vehicles; and "fugitive" emissions. Fugitive emissions result from intentional or unintentional releases of greenhouse gases, including the leakage of HFCs from refrigeration and air conditioning equipment as well as the release of CH_4 from institution-owned farm animals." (ACUPCC Implementation Guide [1] p. 11)

Scope 2 emissions are indirect emissions generated in the production of electricity consumed by the institution." (ACUPCC Implementation Guide [1] p. 11)

Scope 3 emissions are all the other indirect emissions that are a consequence of the activities of the institution, but occur from sources not owned or controlled by the institution such as commuting, air travel for college activities, waste disposal; embodied emissions from extraction, production, and transportation of purchased goods; outsourced activities; contractor-owned vehicles; and line loss from electricity transmission and distribution (ACUPCC Implementation Guide [1] p. 11-12).

The protocols for computing greenhouse gas emissions do not include the direct or indirect activities of students enrolled on campus, except to the extent these are reflected in the above sources of Scope 1, Scope 2 and Scope 3 emissions. Therefore, student commuting and off-campus use of electricity and heating fuels and other student-related greenhouse gas emissions are not included in this inventory.

2.1.2- Baseline Greenhouse Gas Emissions:

Bowdoin College chose Fiscal Year 2008 – the 12 month period starting July 2007 and ending June 2008 – as its baseline year (hereafter "2008"). This was the most recent year for which the College had a complete set of data to calculate emissions. Bowdoin emitted

[3] www.ghgprotocol.org

a total of 24,048 short tons of CO_2e in the year 2008.[4] Scope 1 emissions made up 42% of the total; the remaining 58% is from Scope 2 and Scope 3 emissions. See Figure 2.1 below.

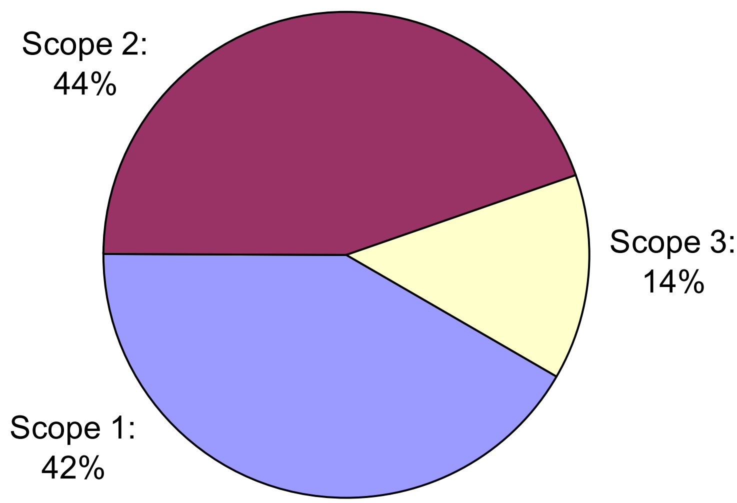

Figure 2.1: 2008 Emissions by Scope
Scope 1 is direct emissions. Scope 2 is indirect emissions from electricity consumption. Scope 3 is all other indirect emissions.

A brief discussion of each Emission Source and the baseline calculation methodologies is provided below.

Scope 1 emissions account for 9,989 short tons of CO_2e, approximately 42% of the total. Scope 1 emissions are shown by major category in the Figure 2.2 below. Scope 1 emissions are dominated by fuel combustion on campus of natural gas, #2 distillate oil and propane for heating purposes. Smaller contributions came from fuel consumed by College-owned vehicles and the inadvertent release of refrigerants, which contributed 4% and 1%, respectively.

[4] Short tons are used throughout this report to match the units of the Regional Green House Gas Initiative (RGGI) that is described elsewhere in this report. Hereafter "short tons" or simply "tons" are used interchangeably and are equivalent to 2,000 pounds.

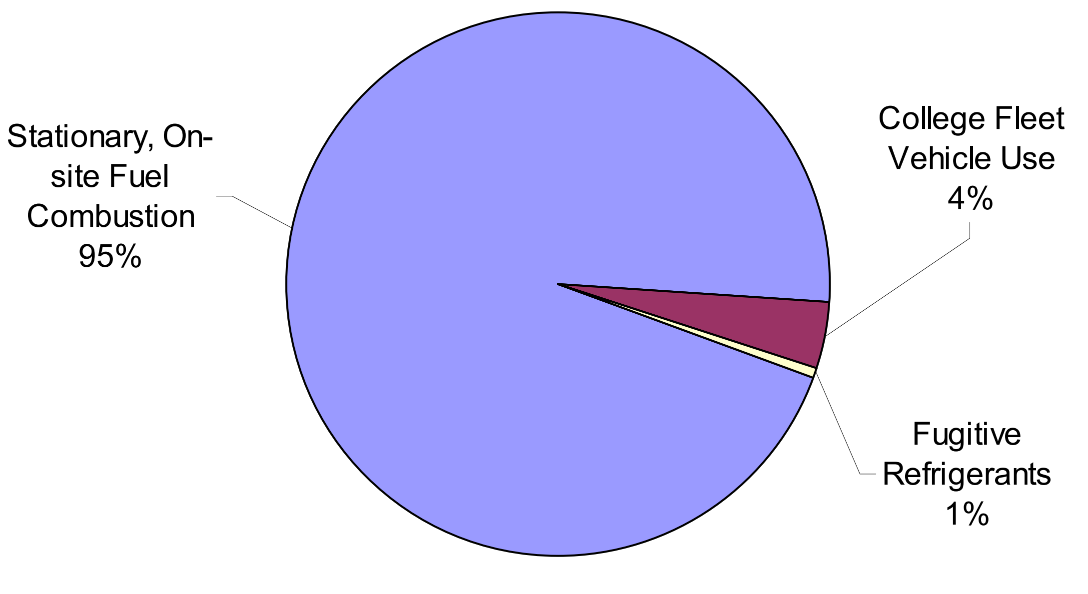

Figure 2.2: 2008 Scope 1 Emissions
Direct emissions from onsite and college owned sources. Scope 1 is dominated by space and water heating.

During 2008, 87% of Bowdoin's onsite thermal load was supplied by natural gas, 10% was provided by #2 distillate oil and 3% by propane. See Figure 2.3 below. This represents a dramatic and deliberate shift by Bowdoin in the last decade away from higher carbon fossil fuels including #6 residual oil and #2 distillate oil to cleaner burning natural gas. This topic is discussed in more detail in section 2.2.3.

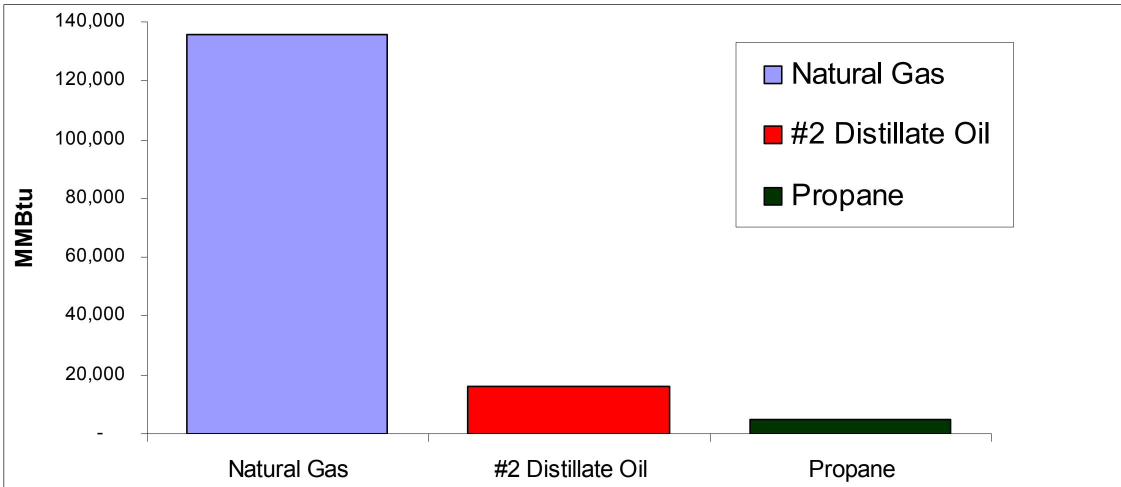

Figure 2.3 Onsite Thermal Combustion
Bowdoin has shifted away from oil to lower carbon natural gas as its predominant heating fuel.

Vehicle use made up 4% of the Scope 1 totals or 375 tons. Actual gasoline consumption data was used from two primary sources: purchases for College-owned central fuel tanks (23,449 gallons) and from the fleet vehicle fuel purchasing card program (14,663 gallons).[5]

Fugitive refrigerants make up 1% of Scope 1 emissions. Bowdoin had equipment on campus during 2008 that used the following refrigerants: R-22, R-134, R404A and R416A. Replacement totals provided by Bowdoin's refrigeration vendors for each refrigerant were used to calculate emissions for this baseline.

Scope 2 emissions were all associated with Bowdoin's purchase and consumption of 20,350 MWhs of electricity. The total greenhouse gas emissions from electricity consumption amounted to 10,766 tons of CO_2e, almost 44% of the total greenhouse emissions in 2008. Bowdoin's scope 2 calculations used average power generation emission factors for the state of Maine as published by the United States Environmental Protection Agency (EPA).[6]

Scope 3 emissions at Bowdoin are caused by employee travel and commuting, the loss of purchased electricity through the transmission and distribution process, and the disposal of solid waste. These activities were responsible for the release of 3,293 short tons of CO_2e, 14% of total greenhouse gas emissions in 2008. See Figure 2.4 below.

[5] Gasoline from the fleet vehicle fuel purchasing card program might have occurred outside of the imaginary box that we have placed over the Bowdoin Campus to define Scope 1 emissions, and it is likely to have been used in both owned and rented vehicles. It has been included in Scope 1 in its entirety as a simplifying assumption.

[6] www.epa.gov/cleanenergy/energy-resources/egrid/index.html

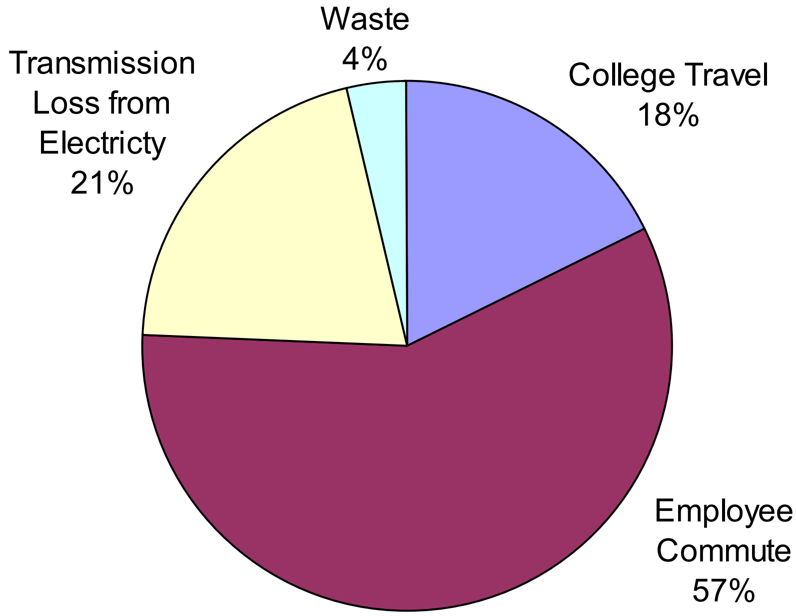

Figure 2.4: 2008 Scope 3 Emissions
From sources not owned or controlled by the college

Employee commuting makes up the majority of Scope 3 emissions at 57% or 1,898 tons. It is estimated that Bowdoin employees commuted 5.34 million miles in 2008. Employee commuting mileage was estimated by calculating the distance between the main campus and the zip code for each of the 1,133 employees to whom Bowdoin mails paychecks. Type of employment was used to estimate the number of trips made each year from each employee in each zip code.[7] National carpooling averages were assumed and appropriate filters were applied.[8] Total mileage was converted to emissions by using Energy Information Administration (EIA) records indicating the percentage of each vehicle type registered in the region. The fuel economy of the bestselling models of each vehicle type was multiplied by its percent of the region's vehicles, and these values were totaled to generate "regional fuel economy”. Total driving distance was then divided by regional fuel economy averages to generate the number of gallons of gasoline and diesel used.

Transmission line losses were 21% of the Scope 3 total or 687 tons. Transmission line losses are an unavoidable consequence of purchasing electricity produced at remote generation facilities. As electricity is delivered over the network of lines that connects all power generators and end users, some percentage is lost due to voltage transformation

[7] Employment types included: Full Time Year Round; Full Time Academic Year; Part Time Year Round; Part Time Academic Year; Casual; Adjunct Faculty; and Full Time Academic Year Part Time Summer.

[8] Any employee in a job class with more than 100 trips per year but a round trip commute of more than 100 miles had their commute "corrected" to 25 miles roundtrip, the average for full-time personnel. In addition if an employee in the “casual” job class lived more than 500 miles away, the # of roundtrips per year was reduced to 1. The average result across all employees was 15.2 round trips and 393 miles per month.

and what is know as $(I^2)(R)$ losses.[9] These losses are assigned to all end users of electricity. The amount of loses assigned does not depend on geographic location or which power plant is generating the electricity but rather on the voltage at which an end user takes electric service. The majority of Bowdoin's electric load is served at primary voltage behind the Central Maine Power distribution utility. The line loss factor for primary service in CMP service territory is 4.08%. In addition there are "Pool Transmission Facility" loses of approximately 2% associated with the bulk transmission system that are not included in the CMP number. Therefore Bowdoin must purchase, and a power plant must generate about 6% more electricity than is actually used on campus. Transmission line losses are entirely outside of Bowdoin's direct control and associated carbon emissions can only be reduced by a reduction in electricity consumption.

College travel, which consists primarily of air travel by College employees, made up 18% of the Scope 3 totals or 589 tons. An estimate of miles flown had to be made based on the total monetary expenditure on air fare. After accounting for taxes and fees, an average cost per air mile of $0.15 was used to determine that 5.21 million air miles were traveled. Environmental Protection Agency fuel economy data for commercial airplanes from the Climate Leaders Greenhouse Gas Inventory Protocol was used to convert miles traveled to CO_2e emissions.

Bowdoin generated approximately 752 tons of solid waste in 2008. About 25% of this, or 188 tons, was recycled. The remaining 564 tons was sent to a landfill that does not currently use gas recovery systems. Waste and recycling emissions were calculated to be 119 tons of CO_2e, or 4% of the Scope 3 total, using factors from Environmental Protection Agency's Waste Reduction Model (WARM).[10]

[9] I is current in amperes and R the resistance in ohms. The calculated product is in watts.

[10] www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

2.1.3- Greenhouse Gas Trends:

Bowdoin has calculated long term trends for the two major categories of greenhouse gas emissions, onsite combustion of fuel and purchased electricity. Actual usage data was used for each year starting with 1990. The data is shown in Figure 2.5 below along with two trend lines: one from 1990 to 2020 and one from 2000 to 2020.[11] The projection from 1990 is bleak – showing that carbon emissions would grow to more than 27,000 tons per year by 2020. The projection from 2000, however, demonstrates that Bowdoin has already turned a corner on carbon emissions. Bowdoin has reduced its carbon emissions associated with electricity and fuel used at the heating plant significantly since the start of this decade despite the addition of about 200,000 square feet to the campus. Carrying forward the trend line from 2000 shows Bowdoin's emissions falling to almost 15,000 tons by 2050.

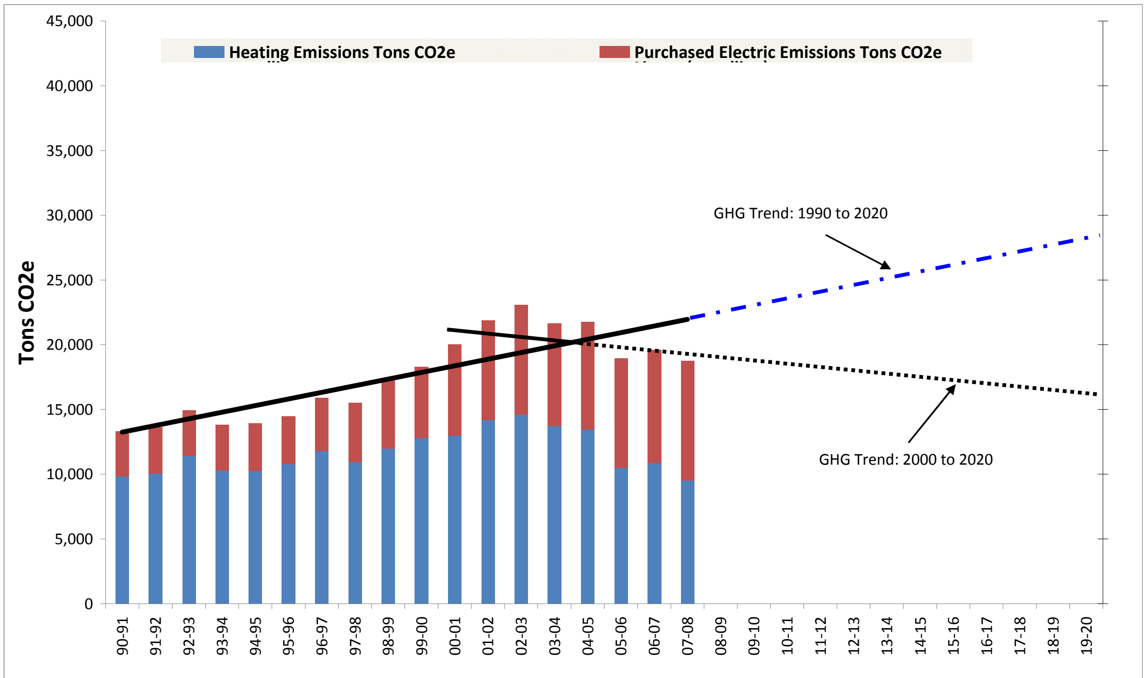

Figure 2.5: GHG Trends 1990-2020 & 2000-2020
Comparing the 2000-2008 trend (and projection to 2020) to the 1990-2008 trend (and projection to 2020) shows that Bowdoin has made significant progress since the start of the current decade in reducing GHG emissions.

The downward trend in total greenhouse gas emissions since 2000 is more impressive considering that it came during a period of significant growth in the size of the College, both in square footage and in the number of students, faculty and staff. The next chart shows greenhouse gas emissions on a per square footage basis.

[11] Chart is based on a Clean Air Cool Planet Calculator maintained by Bowdoin. It accounts for emissions from heating load (#2 oil, propane and natural gas used on campus) as well as purchased electricity.

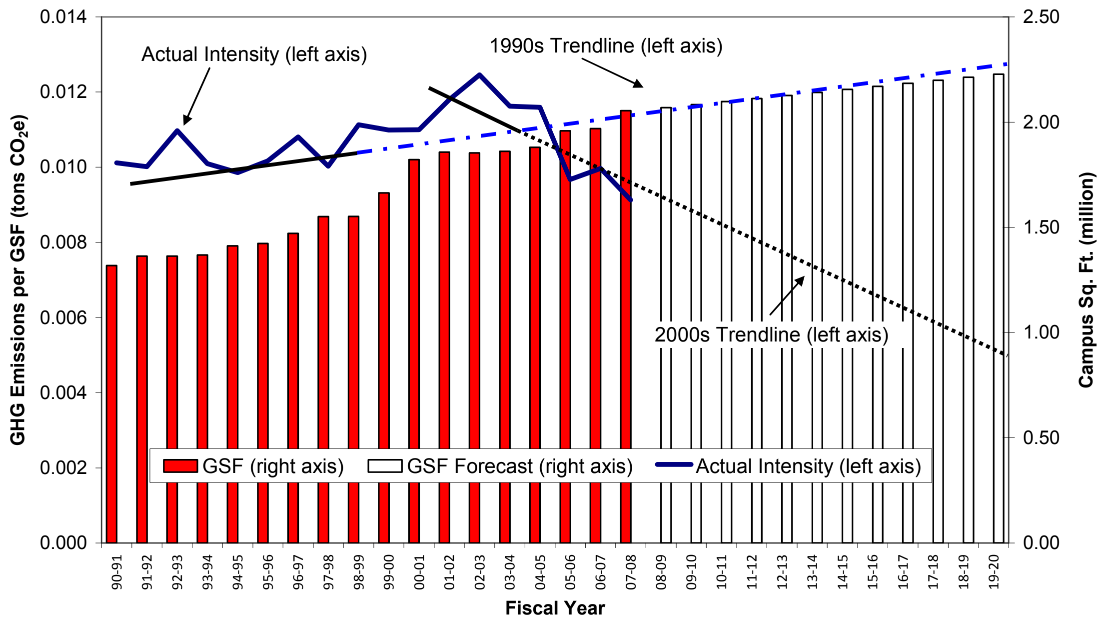

Figure 2.6: GHG Intensity Trends

GHG Intensity (emissions per square foot) increased during the 1990s but the trend has been decreasing since 2003.

The solid red bars are plotted against the right hand Y axis and show the historical growth of the campus in units of million square feet. The un-shaded bars show projected campus growth by year through 2020. The campus was about 730,000 square feet larger in 2008 than 1991. The solid blue line is plotted against the left hand Y axis and shows greenhouse gas intensity (tons of CO_2e per square foot). Actual greenhouse gas intensity was flat to increasing during the 1990s and the first two years of the current decade. The trend since 2003, however, is clearly lower. Greenhouse gas intensity set a new low in 2008 at 0.009 tons CO_2e per square foot - 27% lower than the peak reached in 2003. Two trend lines have been added to the chart; the blue dashed line projects greenhouse gas intensity based on 1990s data and slopes upward to more than 0.012 tons CO_2e per square foot by 2020. The black dotted trend line projects intensity based on the current decade and declines to about 0.005 tons CO_2e per square foot by 2020.

While trend data clearly demonstrates that Bowdoin is already moving in the right direction, it will be difficult to sustain the pace of recent improvements in greenhouse gas emissions and even more difficult to reduce total emissions to zero by 2020. The next section focuses on strategies to sustain this momentum and to attain the carbon neutrality target by 2020.

2.2 Greenhouse Gas Mitigation Strategies

Upon review of the energy and operational policies at Bowdoin College, it was determined that there is significant opportunity to reduce carbon emissions in five areas. These areas include:

- electricity conservation;
- physical plant operations;
- fuel switching;
- new construction and renovations; and
- behavioral changes of students, faculty and staff.

We discuss selected initiatives currently being undertaken by Bowdoin in each of these five areas below as well as measures that are anticipated to be necessary to achieve carbon neutrality. We have divided these initiatives into two categories: (1) projects that are underway currently, ongoing, or expected to be completed by 2020 and (2) projects that are planned or under consideration for implementation by 2050, but which are currently cost prohibitive or technologically unfeasible.

2.2.1- Electricity Conservation:

The conservation of electricity results in the reduction of Scope 2 greenhouse gas emissions, and to a lesser degree in Scope 3 emissions from transmission line losses. This can be accomplished by upgrading to newer, more energy efficient technology as well as behavioral changes on the part of students, faculty and staff. Behavioral changes will be discussed in Section 2.2.5.

By 2020 Projects

Bowdoin College owns over 600 personal computers that are used by staff, faculty, and students. Bowdoin's Information Technology department evaluated the operation and use of these computers and found that many were left on 24 hours a day whether or not they were being used. Computers do not require a large amount of power relative to the entire campus load, but the unnecessary operation of hundreds of computers at all times was nonetheless an important conservation initiative. Bowdoin's Information Technology department changed the setting on each PC so that it enters sleep mode after a short period of inactivity. It is estimated that this initiative will reduce electricity use by 7.3 MWh per year and reduce greenhouse gas emissions by 4.28 tons of CO_2e per year. Despite the relatively small impact, this initiative was important for a couple of reasons. First, it conveys a consistent message to almost every staff, faculty and student member on campus about Bowdoin's commitment to reduce energy consumption. Second, it is an example of a conservation project that saves the College money – many more of which will need to be uncovered and implemented. The College will save about $900 per year on electricity costs at 2008 rates by permanently changing the sleep settings on all public computers on campus. The College also hopes to reduce electricity use from student-owned computers by educating students about energy conservation practices. Educational outreach efforts designed to encourage conservation will be discussed later in the report.

Roughly 45% of all electrical usage on college campuses is related to lighting.[12] Bowdoin commissioned a detailed lighting audit of its facilities and is in the process of a significant retrofit.[13] Currently, the College is in the process of replacing every incandescent light bulb on campus with a compact fluorescent light bulb. It will be College policy to stock only compact fluorescent lights in the lighting inventory.[14] Through the conversion to 13 and 15 watt compact fluorescent lights, the College can reduce energy expenditures without sacrificing the quality of lighting in its facilities. These energy savings are estimated at 764 MWh per year. Although the fluorescent lights have a higher initial cost than incandescent bulbs, they consume much less power and have a longer average lifespan. Bulb specifications vary widely across manufacturers and are constantly evolving, but a 13 watt compact fluorescent bulb provides about as much light as a traditional 60 watt incandescent with 78% less electricity. Most compact fluorescent bulbs have a rated life that is 10 times longer than traditional incandescent bulbs (10,000 hours compared to 1,000 hours).[15] By switching the 3,874 incandescent bulbs identified in the lighting audit in 48 of the buildings on campus to compact fluorescents, Bowdoin can reduce its greenhouse gas emissions by 447 tons of CO_2e per year. Bowdoin will also save money by switching to compact fluorescent lighting. Not including any savings associated with reduced labor from the longer life span of the bulbs, Bowdoin will save over $100,000 per year in electricity costs. The cost per avoided ton of CO_2e is significantly negative at -$136/ton. Bowdoin will also continue with a four year old program to give compact fluorescent bulbs to all first year students when they arrive on campus. This program provides the compact fluorescent bulbs for free for use in student-owned lighting.

Further reductions will be realized through ongoing upgrade of all T12 fluorescent tube lights throughout the campus to T8 and "super T8" fluorescents. These projects will improve light quality and result in reduced energy consumption of 694 MWh and carbon savings of 407 tons of CO_2e per year. Bowdoin will save approximately $100,000 per year in electricity costs from this project. The cost per avoided ton of CO_2e is significantly negative at -$79/ton.

Bowdoin is following the development of diode lighting technology very closely and has already implemented a pilot project to evaluate the performance of diode light bulbs as a potential replacement for compact fluorescents. With current technology Bowdoin could save about 153 MWh and $20,000 per year in energy costs compared to the equivalent compact fluorescent lights. The current high cost of diode light bulbs – at close to $50 per bulb – as well as the lack of experience with this emerging technology prohibits campus

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[12] Based on Fall 2007 audit by Trident Controls. Estimated lighting consumption was scaled using the ratio of building space included in the audit to total campus building space. See Bowdoin Carbon Plan _102809.xls workpaper.

[13] See Trident Controls. Fall 2007 Bowdoin College Lighting Audit..

[14] At least until diode lighting or another technology with similar efficiency benefits becomes viable for widespread adoption.

[15] See, for example, http://www.doi.gov/greening/energy/bulbs.html

wide adoption at this time. The College expects diode lighting technology to improve rapidly in the next 5 years and has modeled the savings associated with a $25 per bulb installed cost – about ½ of current market price levels. The simple payback of a diode light bulb is over 4 years – even at the $25 price point – but due to their very long life expectancy of 50,000 hours on average they should still provide a 21% rate of internal return. The cost per avoided ton of CO_2e is also attractive at -$65/ton. Bowdoin, therefore, plans to install only a limited number of diode style bulbs in the coming year as a pilot project to gain familiarity with light quality and performance. Once costs have declined to the $25/bulb range the College will look to start phasing in this technology across the campus. Bowdoin anticipates that this could be as soon as 2011.

Similar to diode light bulbs, diode tube lighting is currently very expensive and relatively untested. Unlike fluorescent tubes, diode lighting technology does not require a ballast to operate and so retrofit of the existing fixture stock should be relatively easy. With current technology Bowdoin could save about 434 MWh and $60,000 per year in energy costs compared to the equivalent fluorescent tube. At close to $150 per installed lamp, and considering the lack of experience with this emerging technology, Bowdoin is not able to adopt diode tube lighting at this time. The College has modeled the savings associated with a $75 per tube cost, including installation, which is about ½ of current market price levels. The simple payback of a diode light tube is almost 5 years – even at the $75 price point – but due to their very long life expectancy of 50,000 hours on average they should still provide a 14% rate of internal return. The diode tube lighting would also save 254 tons of CO_2e per year at an attractive cost per avoided ton at -$130/ton. Bowdoin will therefore plan to install a limited number of diode tube lights in the coming year as a pilot project to gain familiarity with light quality and performance. Once costs have declined below the $75/tube range Bowdoin will look to start phasing in this technology across the campus. Bowdoin anticipates that this could be as soon as 2015.

In addition to increased computer and lighting efficiency projects on campus, the College is excited to be implementing a robust metering program that will provide Facilities Management with greater detail of its electricity consumption and power/peak loads over time. Used as an analytical and trouble-shooting tool, the program will provide quick and easy downloadable data sets that will be used for monitoring, verification and trouble shooting. The system archives detailed electrical data by building, which will allow the College to determine causes of spikes in electricity use and locate malfunctioning equipment.

Bowdoin's standard policy for replacing non-lighting electrical equipment including: HVAC, refrigeration, water pumping, and plug loads (computers, copy machines, vending machines and washing and drying appliances) is to use Environmental Protection Agency ENERGY STAR rated or better technology. Bowdoin also encourages all first-year students to purchase ENERGY STAR appliances for their dorm room in the student orientation material. ENERGY STAR is an energy efficiency certification system affiliated with the Environmental Protection Agency.[16] The agency updates its ENERGY

[16] www.energystar.gov

STAR ratings on a rolling basis as energy efficiency improves or minimum industry standards are increased. This ensures that ENERGY STAR rated equipment is always near the most efficient on the market.

Personal computers were first given ENERGY STAR ratings in 1992 and, although the measures used to determine energy efficiency have evolved, it is instructive to look at how the efficiency requirements for a computer in "sleep mode" have changed. The original requirements specified that a personal computer could draw no more than 30 watts when in sleep mode. The most recent requirements released in 2007 state that a computer can draw a maximum of 4 watts during sleep mode.[17] This is an improvement of nearly 87% in a fifteen year period. See figure 2.7.

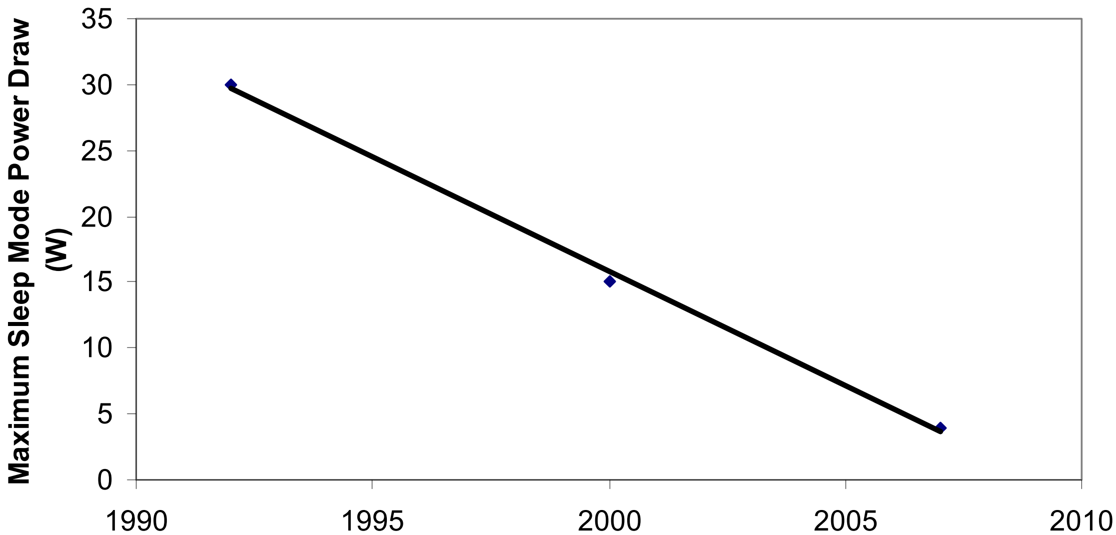

Figure 2.7 Energy Star Computer Requirements
The Energy Star program forces sustained incremental improvements in the efficiency of a wide variety of equipment and appliances.

It may not be possible to replicate the dramatic energy efficiency gains achieved with computers in all other appliance categories. Even if other appliances increase in efficiency at only a quarter of the rate of personal computers, Bowdoin could reduce its plug load electricity consumption 9% by 2020 and 30% by 2050,or about 900 MWh and 3,000 MWh respectively, by regularly purchasing or requiring through competitive contract provisions[18] the most recent ENERGY STAR appliances. This represents approximately 500 tons of CO2e by 2020 and 1,500 tons of CO2e by 2050. [19]

[17] Personal computers are about to undergo their fourth ENERGY STAR requirements update to ENERGY STAR 5.0. However, the vast majority of ENERGY STAR rated appliances are on their first or second version.

[18] In general, Bowdoin owns pumps and HVAC equipment but not copiers, vending machines and laundry; these are governed by contracts.

[19] Based on eGRID 2007 Version 1.1: Year 2005 GHG Annual Output Emission Rate of 0.58 tons per MWh for Maine.

Furthermore this can be done at close to zero cost if equipment is replaced at the end of its useful life as part of the normal major maintenance schedule.

2.2.1- Electricity Conservation Overview:

The installation of compact fluorescent and more efficient fluorescent tube lighting will reduce electricity usage by 1,460 MWhs per year and greenhouse gas emissions by 850 tons of CO_2e. The eventual conversion from fluorescent to diode lighting technology will reduce electricity usage by an additional 600 MWh per year and greenhouse gas emissions by 350 tons of CO2e. The continual upgrade to new ENERGY STAR rated equipment has the potential to reduce Bowdoin's electricity consumption by about 900 MWh annually and 500 tons of CO2e.

2.2.2- Physical Plant:

Reducing the energy used for heating purposes is a significant opportunity given Bowdoin's Maine location and large number of buildings relative to gross square footage.

By 2020 Projects

Bowdoin is committed to an ongoing campaign to improve building performance on campus. Some significant work has recently been completed and much more has been identified by energy audits.

Bowdoin recently completed a campaign to upgrade the building envelopes at the six first-year dormitory buildings: Appleton Hall, Hyde Hall, Coleman Hall, Moore Hall, Maine Hall and Winthrop Hall. The dormitories were renovated in three phases between 2006-2008. Reducing energy consumption was a focus; windows, mechanical systems and plumbing fixtures were upgraded and ENERGY STAR certified products were used for all laundry equipment. Natural daylight and high efficiency compact fluorescent and fluorescent lighting were used to reduce the electric load of the buildings. Water usage was reduced with low-flow plumbing fixtures and motion sensor flushometers and faucets. These water saving measures greatly reduced water use (and hot water heating load). A significant hurdle to improving energy efficiency is the lack of detailed metering data. A key part of Bowdoin's building renovations include the installation of electrical sub-meters. These meters will provide ongoing accountability of building energy consumption over time and provide a sound basis for future improvements as technology and building science continue to improve.

In 2009 Bowdoin received the results of two separate energy audits it commissioned for many of its satellite buildings. The first audit was commissioned based on the 7 biggest fuel users on a per square foot basis;[20] the second was done on the thirteen faculty rental

[20] Richard Grondin, Integrated Energy Systems, PLLC, Falmouth, Maine. Energy Audit: Bowdoin College. 26 March, 2009. Hard copy located in Bowdoin College Facilities Management.

houses on campus.[21] All of these buildings tend to be small with a high percentage of surface area relative to interior square footage. The audit identified significant opportunities to reduce electrical and thermal loads by improving the building envelopes, converting from oil to natural gas, and controlling the interior temperature of each building more precisely. Converting the buildings in this audit (as well as other satellite facilities on campus) to natural gas is discussed in Section 2.2.3. The other improvements identified by the audit will save 265 tons of CO_2e each year.[22]

Many of the main dormitories, academic and athletic facilities at Bowdoin are connected to the central heating plant via a network of underground steam pipes. Some sections of the steam system are over fifty years old and were found to be leaking. As a result, the overall efficiency of the heating system can be improved through upgrading these steam lines.[23] By eliminating leaks and reducing heat loss with better insulation, fuel usage – and associated greenhouse gas emissions – can be reduced at the central heating plant. Bowdoin is in the middle of a multi-phase plan to excavate and replace the leaking sections of steam line. With the support of the Facilities and Properties Committee of the Board, the College plans to use deferred maintenance funding to replace 600 linear feet of line in 2009, 600 feet in 2010 and 351 feet in 2011 for a total of 1,551 feet. The new lines will reduce fuel usage at the central plan by 3,250 MMBtu each year. Greenhouse gas emissions will be reduced by 189 tons of CO_2e per year once the final phase has been completed in 2011.

The central heating plant at Bowdoin currently has 3 large boilers that produce the steam used for heating and domestic hot water. Bowdoin has already done the feasibility level planning to replace two of the oldest boilers with a single more efficient boiler.[24] One of the boilers being replaced is over 45 years old and has reached the end of its reliable life cycle. The older boilers are less efficient than a newer model due to improvements in technology and the inevitable degradation of boiler performance over time. The replacement of this boiler is scheduled to take place concurrently with the installation of a cogeneration system and will reduce greenhouse gas emissions through greater energy efficiency in the fuel combustion process. The boiler is expected to reduce fuel usage by a minimum of 5% or 6,000 MMBtu per year once it is online in October 2011. This will reduce emissions by more than 340 tons of CO_2e each year.

The installation of a cogeneration system will be a significant step in the process of upgrading the energy efficiency of the Bowdoin campus. The College conducted an in depth study of cogeneration options in 2008 and identified a project that had a significant carbon savings and an acceptable financial payback. The central plant currently generates

[21] Justin Pizzolato , Maine Green Energy Audit, Harpswell, Maine. Hard copy of audits located in Bowdoin College Treasurer's Office.

[22] The GHG reductions identified in this audit of satellite facilities are assumed to be part of the renovation standards discussed in section 2.2.4 and have not been accounted for independently.

[23] RMF Engineering, Inc. Baltimore, Maryland. Cogeneration Feasibility Study: Bowdoin College. September 2008. Hard copy located in Bowdoin College Facilities Management.

[24] RMF Engineering, Inc. Baltimore, Maryland. Cogeneration Feasibility Study: Bowdoin College. September 2008. Hard copy located in Bowdoin College Facilities Management.

heat for campus buildings through the combustion of either natural gas or #2 heating oil. The fuel is combusted in 3 large boilers converting water into steam that is distributed to campus buildings via an extensive underground network of pipes.

Currently, a pressure relief valve is used to reduce the pressure of the steam produced by the boilers to the proper pressure for the system of steam distribution pipes. Bowdoin will replace its pressure relief valve with a 400 kW backpressure steam turbine. The backpressure turbine will serve the same function as the pressure relief valve with the added benefit of producing 1,600,000 kWh of "free" electricity. This system will produce about 8% of Bowdoin's annual electrical requirements and reduce Bowdoin's greenhouse gas emissions by 600 short tons of CO_2e per year once the turbine is installed and online in October of 2011.

The central heating plant is typically operated from October 1st to May 31st each year. It is shut down each summer to save fuel when campus thermal loads are not high enough to justify its operation. Domestic hot water needs during the summer are met by many smaller boilers distributed around campus. In addition, many satellite facilities are not connected to the campus steam system and have small boilers and/or hot water heaters that operate year round. As Bowdoin replaces these older less efficient boilers, it is using more efficient technology.

Another efficiency project recently completed is the boiler at the Schwartz Outdoor Leadership Center. The boiler was running at approximately 72% efficiency. Therefore, 72% of the energy generated from the combustion of fossil fuels was being converted into heat. Essentially, 28% of the fuel was being wasted. Bowdoin completed the replacement of this boiler with a new boiler that operates at 95% efficiency, resulting in less fuel being burned to generate the same amount of energy required to heat the building. The new boiler has reduced fuel usage by 100 MMBtu per year and has resulted in the reduction of 7 tons of CO_2e per year.

A noticeable source of heat loss is the windows, especially in older buildings that utilize single-paned glass or are not as well sealed as their modern counterparts. Consequently, there is a large energy savings to be realized through the installation of new windows or the addition of storm windows. Replacing the current windows in the Hawthorne-Longfellow Library with double pane low-E argon windows, for example, would reduce greenhouse gas emissions resulting from the heating of the building by 69 tons of CO_2e per year. A similar replacement of the Coles Tower windows would result in greenhouse gas reduction of 131 tons. Therefore, replacing the windows in these two buildings would reduce the College's emissions footprint by 200 tons of CO_2e per year. Bowdoin expects to undertake these two projects within the next 10 years.

Elevators, if heavily used, can account for 3-5% of a building's total energy use, second only to lighting and air conditioning.[25] Coles Tower, standing at sixteen stories, is the tallest building on Bowdoin's campus. The more than 200 students that call Coles Tower

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[25] www.aceee.org/buildings/coml_equp/elevators.pdf

home ensure that the elevators are in continuous use. Based on a suggestion during our spring 2009 Climate Matters contest, a contest designed to generate greenhouse gas reduction suggestions from the campus community, Bowdoin is exploring the possibility of replacing the current elevator with a Gen2 elevator. Typically a Gen2 elevator uses 50% less energy than a conventional elevator. If the Gen2 elevator is outfitted with a regenerative drive that captures and uses energy that is usually lost to heat in the breaking process, the elevator can use up to 75% less energy.[26] Considering the large amount of use the elevator in Coles Tower receives, Bowdoin could reduce its greenhouse gas emissions by over 5 tons of CO_2e per year. This figure increases to almost 8t tons annually, if a regenerative drive is included in the upgrade.[27]

Beyond 2020 Projects

Although Bowdoin does not have any plans to replace natural gas as a primary heating source, new technology may provide that opportunity in the future. Potentially paradigm-shifting technologies may be in early stages of development or remain entirely unknown today. One possible technology is a low carbon or carbon neutral alternative fuel, such as a cost effective, mass produced, and easily transportable biofuel. The use of current biomass technologies, including wood pellet and wood chips are prohibited by space and transportation constraints at Bowdoin's Central Utility Plant. A biofuel with a higher energy density might eliminate this constraint in the future.

Electric heat is another potential "fuel" for the future. To date electrically powered air-to-air heat pumps have only been widely used in climates more temperate than Maine. Recent improvements have allowed some companies to begin marketing "cold-climate" air-to-air heat pumps. If these heat pumps were distributed around campus, they could conceivably displace the need for a Central Heating Plant entirely.

Electric heat technology will become more interesting as emissions from the electricity grid are reduced over time by renewable portfolio standard mandates and regional or federal emissions caps. The potential to extract more than 5 GW of electric capacity from deep water offshore wind turbines in the Gulf of Maine – technically enough to supply all of Maine's heating and transportation energy – is receiving much attention this year. Wind turbines capable of operating economically in the deep waters of the Gulf have not yet been invented but the University of Maine at Orono has received millions in seed money from both State and Federal sources to establish the first in the United States test facility for prototype floating wind turbines. The timing of utility scale offshore wind in Maine is uncertain. Currently, there are no offshore wind facilities in the United States at any water depth and only one prototype deepwater offshore wind turbine in the world. Champions of deepwater offshore wind in Maine believe that it is feasible to achieve the

[26] www.otisgen2.com/gen2_adv/green.shtml

[27] See "Gen2 Elevator" Tab in the workpaper: "BowdoinCarbonPlan_102809.xls" for assumptions on avoided emissions.

5 GW goal by 2020.[28] Due to the time and costs associated with a potential transition from a central heating plant to hundreds of distributed electric heating systems, Bowdoin believes that wholesale adoption of electric heat pumps powered by offshore wind turbines by the College is not likely to be financially viable until after 2020.

Although the impact of distant technologies on heating cannot be predicted with precision, it is entirely possible that a more efficient, less polluting heating source will become technologically and financially feasible beyond 2020.

2.2.2- Physical Plant Overview:

Projects such as the improvement of satellite building envelopes, steam line replacement and the installation of a new boiler and cogeneration system in the central heating plant will reduce greenhouse gas emissions by over 1,400 tons of CO_2e. The installation of improved windows in Hawthorne-Longfellow and Coles Tower would result in a 200 ton emission reduction. Beyond 2020, Bowdoin will continue to follow developments that might allow it to transition away from heating with fossil fuels.

2.2.3- Fuel Switching:

In 2003, in an effort to cut greenhouse gas emissions, Bowdoin converted its central heating plant from #6 residual oil to cleaner #2 heating oil. The combustion of distillate fuel such as #2 heating oil releases 161 pounds of CO_2e per million Btus, while #6 oil releases 174 pounds of CO_2e to generate the same amount of energy[29]. In converting to #2 oil, the College was able to reduce its greenhouse gas emissions by over 1,000 tons of CO_2e per year.

This trend in fuel switching has continued through recent years. Starting in 2005, Bowdoin began to convert the boilers in the central heating plant so that they could burn either #2 oil or natural gas. Natural gas emits only 116 pounds of CO_2e per million Btu, thus making it the "cleanest" fossil fuel. In addition, because natural gas is delivered via pipeline instead of by tanker truck, it reduces the greenhouse gas emissions associated with local delivery by 12 tons of CO_2e per year compared with #2 oil.[30] Although the boilers at the central plant will remain dual fuel – with the capability to burn either #2 oil or natural gas – Bowdoin has used very little #2 oil over the last several years. This has provided a significant economic benefit to the College as the price of natural gas has been much lower than the price of #2 oil over this period. Even if this situation were to

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[28] Dr. H. J. Dagher, PE presentation to Maine Ocean Energy Task Force on Dec 10, 2008: www.maine.gov/spo/specialprojects/OETF/Documents/Dec10'08_TFmtg/Dagher_MainesPlaceNewEnergyWorld.pdf

[29] www.eia.doe.gov/oiaf/1605/coefficients.html

[30] A simplifying assumption is made that the emissions associated with the exploration, production and processing of natural gas and oil are roughly equivalent upstream of the local delivery company. See the "Oil Delivery Tab" in the workpaper: "BowdoinCarbonPlan_102809.xls" for assumptions on local delivery emissions.

reverse, however, Bowdoin is now in the position to put its own internal price on CO_2e when it makes decisions about which fuel to burn.

Bowdoin has further reduced the use of #2 oil by collecting up to 1,000 gals of fry oil each year from campus dining services. This fry oil has been used in the central heating plant as a direct substitute for #2 oil. While heating oil produces over 22 pounds of CO_2e per gallon combusted, the biofuel made from the fryer oil produces less than a pound of CO_2e per gallon. By displacing 1,000 gallons of #2 heating oil Bowdoin reduces about 11 tons of CO_2e each year.[31]

The following chart provides a graphical representation of the ongoing transition at Bowdoin from higher carbon to lower carbon fuels.

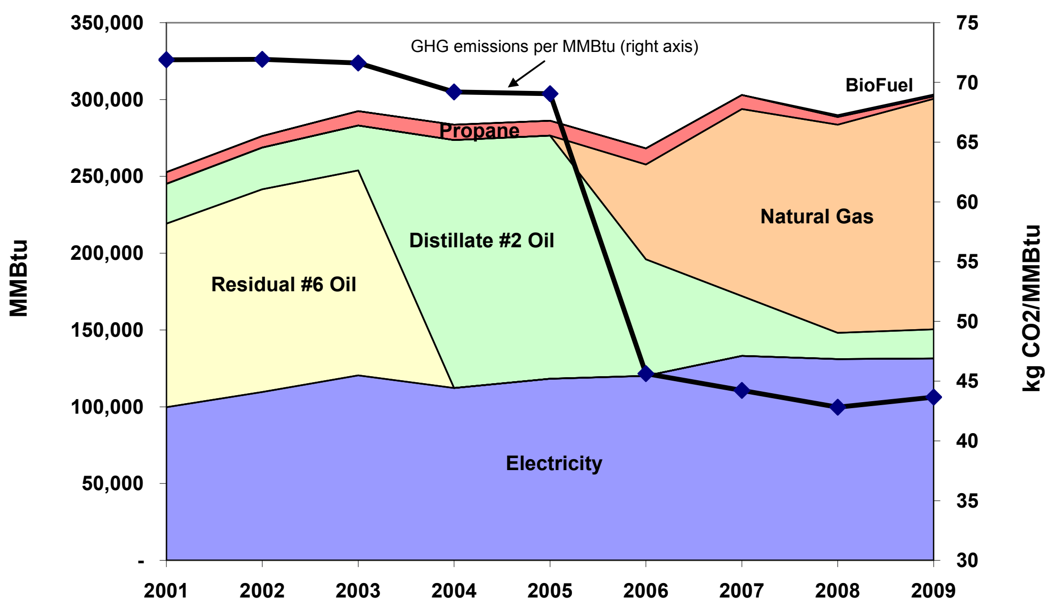

Figure 2.8 Changing Energy Composition

Lower carbon natural gas has displaced oil as the primary fuel for space and water heating. The result has been a significant drop in GHG emissions per heating unit (MMBtu)

Notes: 1) MMBtu = million British thermal units; 2) All fuels have been converted to MMBtu; 3) GHG emissions include methane, carbon dioxide and nitrous oxide. These are presented in units of equivalent kilograms of CO2 and plotted on the bold black line.

By 2020 Projects

Many of Bowdoin's satellite facilities are designed to use #2 heating oil for space heating and domestic hot water. Bowdoin is working with the local distribution utility, Maine Natural Gas, to convert these facilities from #2 oil to natural gas as the distribution network is expanded and the heating equipment reaches the end of its useful life. There are several advantages to using natural gas instead of #2 oil. In the current energy market natural gas is much less expensive on an MMBtu basis than oil. Natural gas is also the

[31] See "BowdoinCarbonPlan_102809.xls" workpaper for assumptions.

cleanest burning fossil fuel and, because it is delivered via pipeline instead of by truck, it reduces the greenhouse gas emissions associated with local delivery to these satellite locations by about 5 tons of CO_2e per year compared with #2 oil.[32] Over 70% of the oil boilers in the satellite buildings will reach the end of their useful life and need to be replaced by 2020. Converting these boilers to natural gas will account for an annual emissions reduction of 400 tons of CO_2e. By replacing the boilers at the end of their expected life, the greenhouse gas savings associated with the conversion will have zero net cost for the College.

In an effort to reduce emissions prior to their eventual conversion to natural gas, Bowdoin has been experimenting with the use of biofuel at three satellite facilities since 2005. Together, these three facilities use about 10,000 gals of oil each year. Bowdoin is currently using B20 (80% oil and 20% biofuel) which reduces emissions by 51 tons each year compared to 100% #2 fuel oil. Unfortunately, the number of competitive suppliers that are able to deliver B20 to the Bowdoin campus is very limited. Bowdoin is considering a switch to B5 (95% oil and 5% biofuel) which is sold by a larger number of competitive suppliers. If the switch to B5 were accompanied by an expansion of the biofuel program to all satellite facilities currently using #2 oil, Bowdoin would achieve an incremental reduction in emissions of 21 tons. Compared to 100% #2 oil, the use of B5 at all satellites would reduce emissions by a total of 72 tons each year.

The switching of heating fuel sources at Bowdoin College is not just limited to conversion between combustible fuels. Four of the most recently constructed or renovated buildings at the College: Osher and West Halls, the Museum of Art, and Studzinski Recital Hall, all utilize ground source geothermal heating and cooling systems. The system extracts heat from the ground to heat buildings in the winter and deposits heat into the ground to cool buildings in the summer using a heat pump. This savings associated with geothermal systems is achievable due to the fact that deep underground the earth maintains a seasonally moderate temperature (approximately 50° F) throughout the year. By utilizing the earth as a heat source or sink, the system is able to operate more efficiently than traditional heating and cooling systems, thus reducing greenhouse gas emissions. The College estimates that it is currently reducing greenhouse gas emissions by 11 tons each year with its current geothermal systems. The benefits of the geothermal systems at Bowdoin include less steam plant load, increased efficiency, financial payback, reduced emissions, and less visual and noise impact compared with standard air conditioning equipment. The challenges have been initial cost, electricity infrastructure impacts, reliance on unknown geology and hydrology of the well field, highly technical systems, and water quality.

While generally satisfied with the 3 of the 4 installations, some lessons learned were: (a) to take into account initial costs, operational savings, and ability to achieve state utility incentives; (b) to acknowledge that thorough engineering and commissioning are required; and (c) to involve all stakeholders up front including staff, administration, and students. Design lessons learned include performing up front testing of well capacity and water quality and carefully selecting projects appropriate for geothermal. With respect to

[32] See footnote 22.

the installation at the Museum of Art, the college's engineers are composing a white paper about the particular challenges and shortfalls of this installation. The Museum of Art geothermal installation system will be retrofitted to be a hybrid system- using both cooling and geothermal technologies, still providing energy savings to the College. The College plans to take advantage of this technology in future construction and renovation projects when feasible and cost effective. If geothermal systems are used in 25% of all new facilities added to the campus, reductions could increase to 230 tons by 2020 and 915 tons by 2050.[33]

Another area in which the consumption of fossil fuels at Bowdoin College can be reduced is in the operation of its vehicle fleet. The College has a plan to replace all College-owned vehicles with gasoline-electric hybrids when a suitable hybrid vehicle is available and economically viable. The College vehicle fleet is always evolving, and the switch is being done within the scheduled vehicle replacement cycle. Currently the College operates about 61 cars, vans, and trucks, 5 of which are hybrids. Once this conversion process is completed around 2020, the College will reduce its greenhouse gas emissions by 156 tons of CO_2e per year.

Beyond 2020 Projects

The conversion of satellite facilities from #2 oil to natural gas heating will be completed when the final 30% of boilers reach the end of their useful life between 2020 and 2050. The incremental greenhouse gas reduction associated with this final phase is 170 tons of CO_2e. In total, installing the necessary infrastructure to completely convert 100% of the satellite facilities existing during the 2008 base year will reduce greenhouse gas emissions about 600 tons of CO_2e per year. Natural gas is currently priced at a significant discount to #2 oil and the near term conversions will therefore also reduce the costs of purchasing fuel. Although the relative cost of #2 oil and natural gas will fluctuate over time, it is possible that the conversion schedule will be accelerated if the cost of boiler replacements prior to the end of their useful lives can be financially justified by expected fuel cost savings. Completing the conversions on the schedule presented by this plan is therefore a "worst" case scenario.

A second vehicle fleet conversion involves the transition from gas-electric hybrids to solely electric-powered vehicles. Of the 61 vehicles maintained by the College currently, 1 is an all electric vehicle. This conversion is tentatively schedule to be complete by 2025. However, this is heavily dependent on advances in current technology to develop more practical and cost-effective electric vehicles. Once this change takes place, Bowdoin's emissions will be reduced by an additional 288 tons of CO_2e per year compared to the hybrid fleet.

2.2.3- Fuel Switching Overview:

[33] Reductions in 2050 assumes that the electric grid becomes more efficient as described in section 2.4.3.

Installation of natural gas burning boilers at satellite facilities has the potential to reduce greenhouse gas emissions by over 400 tons of CO_2e by 2020. The geothermal heating and cooling of new and renovated buildings could result in the avoidance of 230 tons of CO_2e by 2020 and over 915 tons by 2050. Satellite facilities should be entirely on natural gas by 2050, reducing an incremental 170 tons of CO2e. Converting the College's vehicle fleet to hybrids would avoid 156 tons of greenhouse gas emissions while an all electric vehicle conversion would result in an additional 288 ton annual reduction.

2.2.4- New Construction and Renovation:

As Bowdoin College grows and changes as an institution, the physical campus will have to evolve accordingly. Unfortunately, there is a fundamental tension between the need for physical growth of facilities on campus and the commitment to reduce greenhouse gas emissions produced by the College. As new buildings are constructed, new sources of greenhouse gas emissions are created. With the goal of achieving carbon neutrality by 2020, necessary steps must be taken to ensure that new facilities are designed and constructed to operate in the most energy efficient manner possible.

The College adheres to a comprehensive set of sustainable design standards[34] for all major renovations and seeks the United States Green Building Council's (USGBC) LEED certification for all new construction. Bowdoin's design standards for renovations rely heavily on Stanford University's "Guidelines for Sustainable Development, which are based on USGBC's LEED[35] rating system. The majority of construction activity on the Bowdoin campus since 2005 has focused on building renovation, vastly improving the efficiency performance of nine historic campus buildings. Four new buildings have been constructed on campus since 2005, all registered with the USGBC. Bowdoin received LEED silver certification for two dormitories in 2005 and completed the first LEED certified collegiate hockey arena in the country in 2009. The College's new fitness center anticipates receiving LEED silver certification upon completion in the fall of 2009.

As shown in section 2.1.3 Greenhouse Gas Trends, Bowdoin has been able to significantly reduce its greenhouse gas emissions since 2002 despite the expansion of campus facilities. The College aims to continue this trend with future development. In the event that the Waxman-Markey bill[36] that is currently being debated in the U.S. Congress is passed, there will be a precedent set for the construction of more energy efficient buildings. The bill mandates that every new building constructed reduces its energy consumption by 30% from the 2006 IECC code for residential buildings and the 2004 ASHRAE code for commercial buildings. This goal is increased to a 50% reduction by 2015 and increases in 5% increments every three years up through 2030 when a 70% reduction from the baseline is mandated. These goals will lead to standardized energy

[34] www.bowdoin.edu/sustainability/sustainable-planning/designstandards.shtml

[35] Leadership in Energy and Design. See www.usgbc.org.

[36] H.R. 2454: American Clean Energy and Security Act of 2009

efficiency guidelines that LEED does not currently have and will push the development of more energy efficient buildings.

The October 2003 Bowdoin Master Plan anticipated growth from the then-current 1.9 million square feet to 2.7 million square feet by 2050. Total square footage is projected to be near 2.2 million by Bowdoin's target date of 2020. [37]

By 2020 Projects

Bowdoin will strive to make near term construction and renovation projects at least 20% more efficient than the average of the 2008 building stock. Bowdoin will work to increase the efficiency standards applicable to new and renovated buildings incrementally. Although the existing building stock at Bowdoin is more efficient than the ASHRAE commercial code used as a benchmark by the proposed Waxman-Markey bill, Bowdoin believes that it can match the pace of efficiency called for by the bill in new additions to campus – even after starting with a 20% goal in 2009. This would require almost a 2.4% annual increase in efficiency until 2020 when new additions to campus would be over 45% more efficient than the 2008 building stock. The associated reduction in greenhouse gas emissions is 945 tons annually by 2020.

Bowdoin is improving its ability to measure progress towards these goals by continuing its current practice of installing sub-meters on newly constructed and renovated buildings. Meters on electricity, water and steam consumption would provide the historical information at the individual building level that would allow Bowdoin to evaluate the performance of specific upgrades. As mentioned in section 2.2.1, Bowdoin is implementing a software system to compile and analyze electricity data.

Beyond 2020 Projects

Extrapolating the annual average efficiency gain, Bowdoin expects that, by 2030, additions to the building stock will be 70% more efficient than 2008 and emissions reduced by 2,150 tons of CO_2e annually. After 2030 Bowdoin assumes lower annual efficiency gains of 0.5% each year until 2050 when new additions would be 80% more energy efficient than 2008 and annual emission reductions would be 5,160 tons of CO_2e annually.

2.2.4- New Construction and Renovation Overview:

If Bowdoin is able to achieve incremental efficiency improvements in new and renovated building stock on a schedule similar to the proposed Waxman-Markey bill, new College buildings will be over 45% more energy efficient than the 2008 building stock by 2020 and 80% more efficient by 2050. The associated reduction in greenhouse gas emissions is 945 tons annually by 2020 and 5,160 tons annually by 2050. LEED guidelines will be

[37] See Bowdoin College Master Plan. October 2003. Skidmore, Owings and Merrill, LLP. Chicago, Illinoise.

followed for new construction and sustainability guidelines will be followed for renovations.

2.2.5- Behavioral Changes:

Although technological upgrades and conservation practices are critical to reducing greenhouse gas emissions at Bowdoin College, they are not the only solution for reduction. To reach carbon neutrality, it is crucial that the campus population be actively involved in efforts to reduce the College's carbon impact as well. This can only be accomplished through continual education and awareness training.

Though they may seem like a small piece of Bowdoin's greenhouse gas picture, emissions reductions from behavioral changes will play a key role in the College's mitigation efforts. Adopting energy-saving habits and reducing personal energy use remains one of the most cost-effective ways to lower emissions in a collegiate setting. Behavioral change is a challenging reductions strategy for college campuses, however, because it requires substantial effort and buy-in from the entire school community to make a significant impact.

Recent studies have shown that certain communication strategies are more effective at inspiring behavioral changes than others and that the phraseology used to encourage changes is vitally important. The most effective tools for creating behavioral changes include written commitments, prompts and reminders, norms, and incentives. Bowdoin already employs many of these strategies through its outreach initiatives such as the Student and Office Eco-Reps and the Commute Another Way program. Future initiatives, such as a campus-wide energy conservation outreach program will use these tools to motivate change within the college community. Examples of possible future programs could include the following:

- A written commitment for all incoming first-year students pledging to join Bowdoin in reducing energy use and environmental impact. This would also provide an opportunity to inform students about the ACUPCC.
- An educational outreach program using positive norms to highlight environmental consciousness at Bowdoin (i.e. "Half of the Class of 2010 goes "trayless" at least once a week! Join your class mates in helping to save energy and save water.").
- Prompts and reminders to encourage energy and water conservation and waste reduction in offices, dorms, and other College facilities
- Expanded non-monetary incentives for sustainable behaviors, such as alternative commuting or reducing energy use.

Overlooked by many seeking to change behavioral patterns, social norms can be an extremely effective tool for influencing actions, habits, and decision-making. Establishing positive social norms that portray eco-friendly actions as the "thing to do" has proven to be much more effective than simply using educational messages or negative messages that tell people what *not* to do.[38] The challenge for Bowdoin will be establishing energy conserving actions (i.e., turning off lights, shutting down computers, taking shorter showers) as campus norms in a positive and effective way.

To help establish these norms, Bowdoin will utilize the new energy metering system being installed during the 2009-2010 academic year. A component of this system includes a graphical user interface that will make Bowdoin's energy use visible, engaging and easily understood by students, faculty and staff. The platform will allow building occupants to compare current usage with historical usage as well as provide real-time feedback during the energy conservation dorm competitions. Similar systems installed at other colleges have produced significant energy savings. In addition to the savings Facilities Management expects due to better locating of malfunctioning equipment, Bowdoin hopes the monitoring system will achieve an electricity reduction of 5% by 2020 (1,175MWh) and 10% by 2050 (2,350 MWh). Associated reductions in CO_2e emissions would equal 590 tons by 2020 and 1180 tons by 2050.[39]

The Psychology Department could play an important role in helping establish these norms and facilitating behavioral changes at Bowdoin to help reduce emissions. Behavioral change is contingent on the psychological processes of the individual, and using a psychological approach can help in understanding what motivates change. A behavioral study or survey of the Bowdoin community could indicate the best ways to approach behavioral change initiatives at the College and help establish energy conservation as the norm.

By 2020 Projects

Bowdoin will be installing the energy monitoring system early in the FY2009-2010 academic year. Assuming an energy use reduction of 5%, the College can eventually save 1,175 MWh of electricity and mitigate almost 600 tons of CO_2e. Bowdoin will also be initiating its campus-wide energy conservation outreach program in the fall of 2009.

With the guidance of the Psychology department, the College will investigate the development of a behavioral study or survey to help understand the most effective ways to inspire behavioral change.

Beyond 2020 Projects

Bowdoin plans to continue to promote energy savings and reduced emissions through behavioral changes in the long term by using positive social norms that foster a "culture of conservation and efficiency" on campus.

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[38] Psychology Matters. "*Shaping Pro-Environment Behaviors: Certain Messages Work, Don't Work*. http://www.psychologymatters.org/environment.html

[39] Assumes a 5% savings in electrical consumption by 2020 and a 10% savings by 2050. Savings figure is based on 2008 usage of 20,350 MWh and 0.58 tons per MWh. For wedge analysis, savings are linearly interpolated between the following points: 2008 (0% savings) and 2020 (5% savings).

2.2.5 - Behavioral Changes Overview:

By installing the new energy metering system and encouraging students, staff and faculty to reduce their individual energy use, the College will strive to reduce its electricity consumption 5% by 2020 and 10% by 2050. The College will investigate the development of behavioral studies with the help of the Psychology Department in order to better understand how to promote behavioral changes. Bowdoin will also strive to create positive social norms on campus that encourage energy conservation and reduced greenhouse gas emissions. Associated reductions in CO_2e emissions would equal 590 tons by 2020 and 1180 tons by 2050.[40]

2.3 - Role of Renewables, Green Power, and Offsets:

So far this plan has focused on the ways that Bowdoin plans to reduce greenhouse gas emissions by lowering consumption of electricity and fossil fuels. In order to achieve carbon neutrality Bowdoin will also need to look at the way in which its energy is produced and shift over time to sources that emit fewer greenhouse gases. As referenced in Section 2.1.2, 47% of the College's greenhouse gas emissions are a result of the consumption and transmission of grid-purchased electricity. Bowdoin is looking seriously at onsite renewable energy generation opportunities and anticipates that this activity will increase dramatically in the next decade as implementation costs continue to fall. Bowdoin also recognizes that renewable energy credits and carbon offsets are a necessary component of our plan to achieve complete carbon neutrality.

2.3.1- On-Site Renewable Power Opportunities:

While Bowdoin College has implemented several renewable energy projects on campus, to date the focus has been on efficiency and fuel conversion projects that have provided the best return on investment and the lowest cost per ton of avoided CO_2e. Bowdoin anticipates that it will be able to make increasing use of onsite renewable generation as it moves towards neutrality.

The College currently uses geothermal heating and cooling in Osher and West Halls, as well as the Museum of Art and the Studzinski Recital Hall. Although it is a renewable resource, geothermal was already discussed in Section 2.2.3.

By 2020 Projects

An additional technology that the College will continue to explore is the implementation of solar thermal water heating on campus. Solar thermal is a more mature technology

[40] Assumes a 5% savings in electrical consumption by 2020 and a 10% savings by 2050. Savings figure is based on 2008 usage of 20,350 MWh and 0.58 tons per MWh. For wedge analysis savings are linearly interpolated between the following points: 2008 (0% savings) and 2020 (5% savings).

than solar electric, and Bowdoin may expand its use more rapidly on campus. The College has recently installed a solar thermal system on the Schwartz Outdoor Leadership Center to supplement the existing domestic water heating system. The operation of this project will have a relatively small impact, reducing greenhouse gas emissions by about one ton of CO_2e per year. However, the installation will provide good working experience with solar thermal systems and will explore the viability of installing solar thermal systems on future facilities as the technology improves.

Bowdoin is in the process of exploring two additional solar thermal installations on campus: Greason Pool and Thorne Hall. These are the two largest users of hot water on campus and therefore represent the largest potential for savings. The hot water for these two facilities is currently heated with steam from the central utility plant from October through May and with onsite natural gas boilers for the June through September summer season. Bowdoin estimates that solar thermal systems at Greason Pool and Thorne Hall could avoid about 90 tons and 80 tons of CO_2e per year respectively.[41]

Another large opportunity for renewable energy generation on campus is through the harnessing of solar power. The efficiency of solar photovoltaic technology has increased tremendously in the past decade as has the cost-effectiveness of generating solar power. The trend towards higher efficiency and lower cost is expected to continue; figure 2.9 below shows recent projections for declining production costs for various types of solar cells. The chart also shows four potential scenarios for increasing grid-based electricity rates. The forecast is for a convergence between solar photovoltaic production costs and grid-based electricity rates in the 2014 to 2016 time period.

[41] See the "Farley Solar Heating" and "Thorne Solar Heating" tabs in the workpaper: "BowdoinCarbonPlan_102809.xls" for calculations.

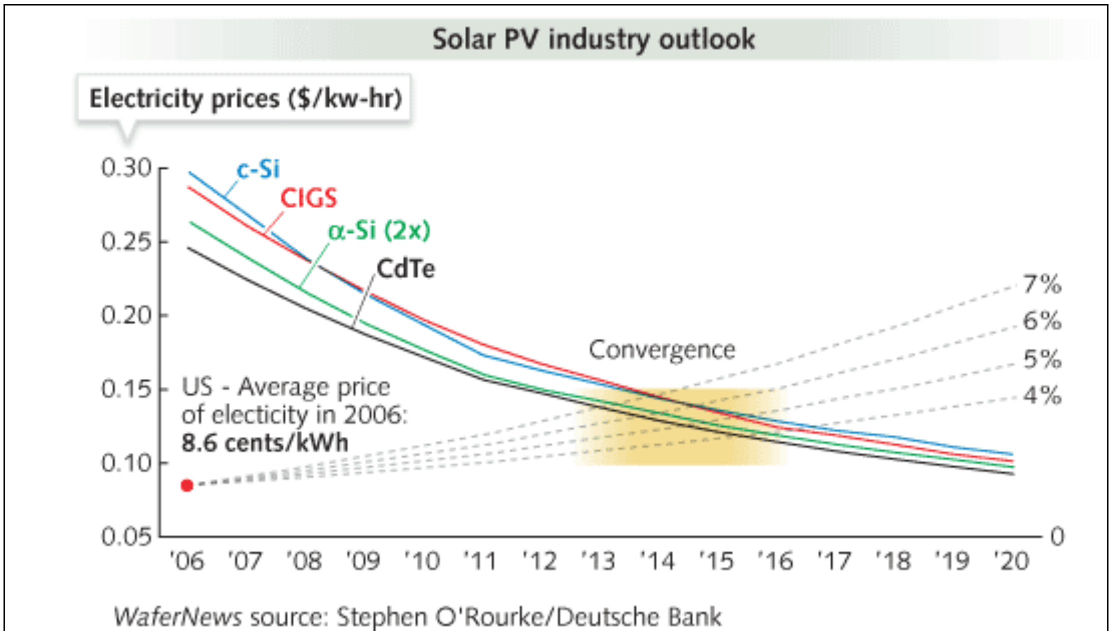

Figure 2.9: Solar PV Production Cost
Solar PV costs have been declining rapidly and the trend is expected to continue. If electricity prices increase, solar PV could reach parity with "grid" pricing in the next 5 years.

Bowdoin plans to phase in solar photovoltaic installations as the cost nears parity with the cost of grid power. Bowdoin has already evaluated plans to install a 100 kW photovoltaic array on Farley Field House. The proposed project would produce an estimated 128,000 kWh of electricity and reduce greenhouse gas emissions by 76 tons of CO_2e per year.[42] Due to its high cost per avoided ton of CO_2e, Bowdoin has not yet implemented this project.

As PV technology becomes more efficient and economically competitive with grid-purchased electricity, Bowdoin hopes to increase its use on campus until it provides about 15% of electrical use. At current solar cell conversion efficiencies this would require 2 MWs of installed solar capacity. In addition to solar cell efficiency and cost, the quantity of solar radiation in a particular geographic location is an important variable in a financial analysis. According to the National Renewable Energy Laboratory (NREL) solar photovoltaic could be cost competitive with grid power on or about 2015 in Maine. The dark red in the below graphic indicates states where NREL expects solar photovoltaic to be at or near parity with grid power by 2015.

[42] 2007 "Proposal for 100 kilowatt Solar Electric System" from EnergyWorks LLC (now Revision Energy LLC)

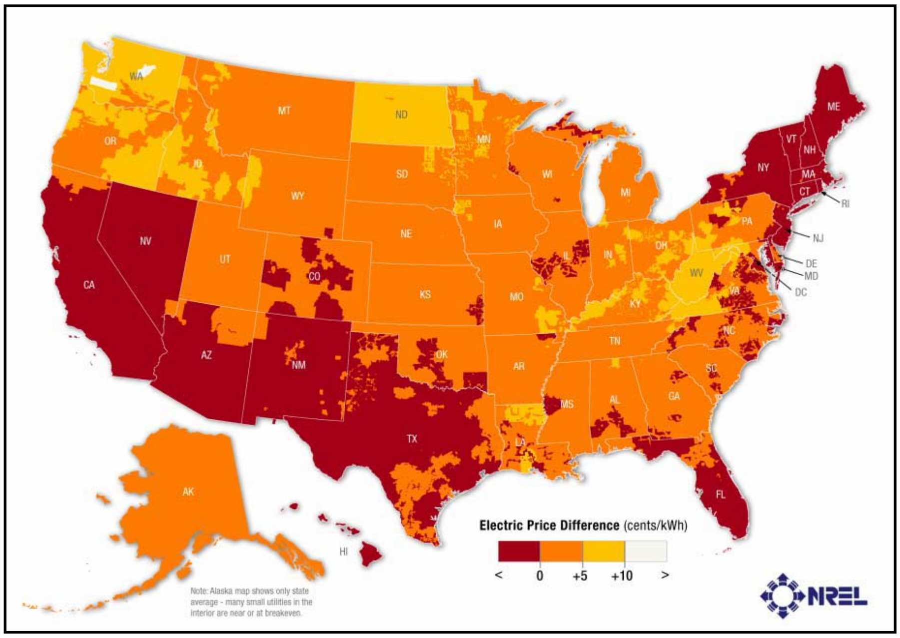

Figure 2.10: Solar PV Electricity Price Differentials
The Northeast has high electricity rates compared to much of the U.S. and NREL expects PV to be a competitive alternative bv 2015.

In addition to roof mounted systems such as the one being considered at Farley Field House, Bowdoin may soon have the space for a significant ground mounted system at the Brunswick Naval Air Station. The Brunswick Naval Air Station is being closed in 2011, and Bowdoin may acquire approximately 175 acres of land adjacent to the existing campus. Ground mounted systems allow tracking of the sun from east to west across the sky each day as well as north and south as the height of the sun above the horizon changes with the seasons. A dual axis tracking systems can increase solar photovoltaic output by 30%. As an example, Bowdoin may consider setting aside 10 acres for a 2 MW ground mounted solar photovoltaic system. Assuming a 20% capacity factor, this system would produce 3,500 MWh per year and displace 2,000 tons of CO_2e per year. At current industry prices of about $6 per watt installed, this system would cost about $12 million and would produce electricity at a levelized cost of about 30 cents per kWh – nearly double the current delivered cost of electricity at Bowdoin. The levelized cost could drop to grid parity within the next 10 years making it a zero cost alternative for Bowdoin. To break even on a net present value basis with current grid prices the installed cost of solar photovoltaic would need to fall to about $3 per watt. Of course, if grid prices increase the breakeven price will be higher. Since the property at BNAS has not been acquired and construction plans are not in place, solar photovoltaic will be explored in the future under a cost-benefit analysis.

2.3.1- On-Site Renewable Power Opportunities Overview:

Bowdoin is exploring the use of solar thermal systems and solar photovoltaic systems on campus. Solar thermal systems at the two largest users of hot water on campus could reduce emissions by 170 tons of CO^2e annually. A 100 kW solar photovoltaic system at Farley Field House could reduce emissions by 76 tons of CO^2e and a 2,000 kW solar photovoltaic system at the Navy Air Station could avoid 2,000 tons of CO^2e per year.

2.3.2- Regional Green Power Mandates:

In 1999, the state of Maine adopted a renewable portfolio standard that mandated that 30% of Maine's power be generated by renewable energy sources by the year 2000.[43] The renewable portfolio standard includes the following qualifying technologies: fuel cells, tidal power, solar, wind, geothermal, hydroelectric, biomass, and generators fueled by municipal solid waste in conjunction with recycling so long as the capacity of these facilities does not exceed 100 megawatts (excluding wind power).

In order to stimulate the growth of new renewable energy sources, Maine's renewable portfolio standard mandate was modified to require an additional one percent annual growth in the amount of electricity produced from renewables from 2008 through 2017 for a total growth of ten percent over the ten year period.[44] Additionally, the one percent annual increase must come from "new" facilities defined as facilities placed in service after 1997. Assuming the mandate is met, the amount of greenhouse gas emissions from electricity generation should shrink proportionally throughout the mandate's lifespan.

The expected impact of the renewable portfolio standard on Bowdoin's carbon emissions is discussed in Section 2.4.3.

2.3.3- Renewable Energy Credits and Carbon Offsets:

The purchase of renewable energy credits or carbon offsets (Offsets) will be required to achieve Bowdoin's goal of carbon neutrality. Renewable energy credits and Offsets are useful and economically efficient tools to support the transition to a less carbon intensive economy but they should only be used to the extent that there are no efficiency or onsite power generation options that cost less per ton of avoided CO_2e.

Renewable energy credits and Offsets are economically efficient because they allow a buyer to support renewable power generation and emissions reductions wherever they are most cost effective. Bowdoin, for example, does not have a good wind resource and it would therefore be very expensive and inefficient to produce wind power at the campus. It makes more sense for Bowdoin to support wind power through the purchase of

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[43] See Maine Statutes Title 35-A Section 3210 or the following link: www.mainelegislature.org/legis/statutes/35-A/title35-Asec3210.html

[44] See footnote 43.

renewable energy credits from a wind farm located in an area with higher wind speeds. Similarly, efficiency projects might be available elsewhere in the United States or the world that yield a much larger reduction in CO_2e emissions per dollar invested than can be found at Bowdoin. Renewable energy credits and Offsets will become increasingly important as Bowdoin approaches its goal of carbon neutrality and the cost of additional reductions on campus becomes progressively more difficult and expensive.

Renewable Energy Credits

Renewable energy credits have been in use for more than 10 years and are very well understood. A renewable energy credit represents the "green" attributes of 1 MW of power generated from a renewable source. Because the electricity put onto the transmission grid from a renewable source such as wind or solar is physically indistinguishable from the electricity produced from fossil fuels, it is possible for the green benefits of renewable power generation to be unbundled from the commodity electricity and traded separately as demonstrated in Figure 2.11

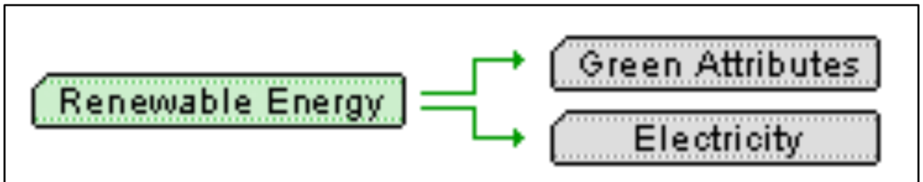

Figure 2.11
Renewable Energy Credits (RECs) are the "green attributes" of a unit of electricity. RECs are commonly traded separately from the underlying electricity.

In Maine there are both compliance markets and voluntary markets for renewable energy credits, and Bowdoin is already active in both. Energy suppliers use renewable energy credits to satisfy the Maine renewable portfolio standard discussed in Section 2.3.2. Compliance renewable energy credits are tracked and verified by an independent third party system in New England called the NEPOOL Generator Information System.[45]

Today, renewable energy credits are increasingly used by consumers to go above and beyond the renewable portfolio standard requirements set by regional administrators. Renewable energy credits can be purchased from a number of third party vendors in voluntary bilateral transactions. The quality of voluntary renewable energy credits are commonly certified through an independent third party. Green-E has become the most recognized renewable energy credits certification standard within the voluntary carbon trading framework in the United States although other third party verification organizations exist.[46]

[45] www.nepoolgis.com
[46] www.green-e.org

Carbon Offsets

Carbon offsets are emission reduction credits that allow a purchaser to support greenhouse gas reduction projects by "buying" a ton of emissions reductions. Each carbon offset is equivalent to one ton of avoided CO_2e. Carbon offsets are different from renewable energy credits in that they are typically associated with the biological and technological sequestration of previously generated carbon emissions or the construction of energy efficiency projects. Carbon offsets are still relatively new and are less well understood than renewable energy credits.

Similar to renewable energy credits, Offsets are traded in both compliance and voluntary markets. Independent third party verification is necessary to insure that the carbon savings are: real, permanent, additional, verifiable and enforceable. In purchasing a renewable energy credits or Offset, the purchaser claims the sole benefits of the carbon reduction and "retires" the credit.

Maine is one of ten states in the northeast and mid-Atlantic region that has imposed a cap on CO_2 emitted by power plants as a part of the Regional Greenhouse Gas Initiative (RGGI).[47] Emissions from Maine power plants that produce 25 MW or more are capped at 6 million short tons through 2014 and then reduced by 2.5% a year for 4 years to achieve a 10% overall reduction. Future federal legislation imposing a national carbon cap and trade program for electricity producers appears likely. Depending on the effectiveness and structure of the legislation, the College could see additional decreases in the amount of CO_2e emissions released due to electricity consumption because of an increase in the development of green power needed to meet emissions caps.[48]

2.3.4- Purchase versus Investment:

Bowdoin recognizes that it cannot conceivably eliminate all of its greenhouse gas emissions through conservation measures and onsite renewables without a significant technological breakthrough in the future. Therefore, renewable energy credits and Offsets will play a role in Bowdoin's journey towards carbon neutrality.

Bowdoin has mitigated the carbon associated with 100% of its electricity usage since 2006. Bowdoin achieves this by purchasing renewable energy credits in the voluntary market for all electricity that is not already mandated to be green by the Maine renewable portfolio standard.[49] See Figure 2.12.

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[47] www.rggi.org
[48] H.R. 2454 American Clean Energy and Security Act of 2009
[49] See Maine Statutes Title 35-A Section 3210 or the following link: www.mainelegislature.org/legis/statutes/35-A/title35-Asec3210.html

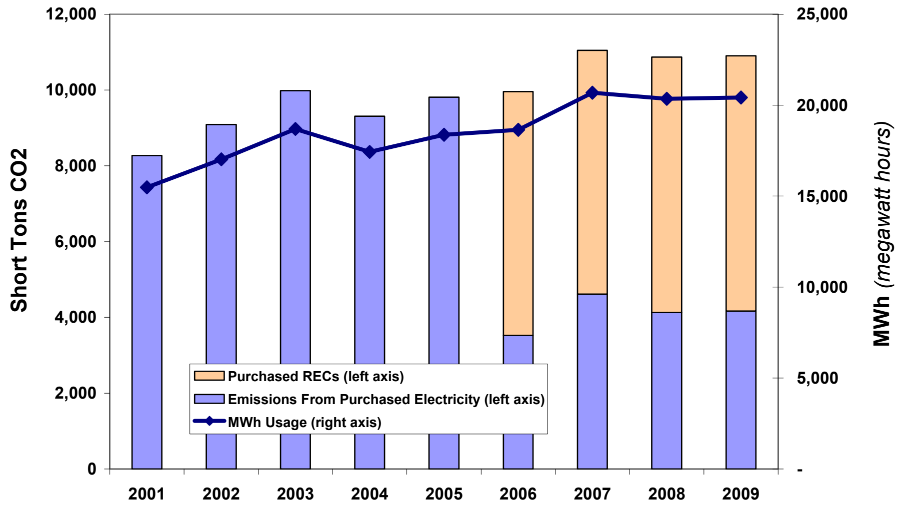

Figure 2.12 Electricity Offsets
Bowdoin has been making voluntary purchases of RECs since 2006
Note: Green house gases associated with electricity usage are converted to units of equivalent short tons of CO2 (1 short ton = 2,000 lb)

In Maine, the generation of 1 MWh of electricity emits 0.58 tons or 1167 pounds of CO_2e.[50] Therefore, by purchasing one REC, Bowdoin offsets approximately 0.583 tons of CO_2e. Consequently, the purchase of approximately 1.71 renewable energy credits offsets the production of one ton of CO_2e.

Bowdoin's philosophy regarding renewable energy credit purchases has been to prioritize support for renewable energy projects within Maine to the extent possible. The College has purchased renewable energy credits from the Worumbo hydroelectric project in Lisbon Falls, Maine as well as the Mars Hill wind project in Mars Hill, Maine.

The Worumbo hydroelectric project has been certified by the Low Impact Hydro Institute as a low impact hydroelectric dam. Therefore, the renewable energy credits purchased from the Worumbo project represent clean power that produces no net CO^2e emissions and has a low impact on the environment compared to traditional hydroelectric facilities. Since 2006 Bowdoin has purchased 12,000 renewable energy credits each year from the Worumbo hydroelectric project. This purchase offsets about 7,000 tons of CO^2e. Worumbo was also attractive to Bowdoin because its location 11 miles from the campus provides educational synergies with students.

Bowdoin also purchases renewable energy credits from First Wind, the company responsible for the development of the Mars Hill wind project. Bowdoin purchases approximately 570 Green-E certified renewable energy credits each year. This purchase offsets over 334 short tons of CO^2e.

[50] eGRID 2007 Version 1.1: Year 2005 GHG Annual Output Emission Rates: www.epa.gov/cleanenergy/energy-resources/egrid/index.html

The future pricing of renewable energy credits is uncertain due to a number of factors. Because Maine's new renewable portfolio standards require a one percent annual growth in renewable energy production, compliance renewable energy credits within Maine could become more expensive as companies exhaust inexpensive renewable energy generation supplies. The price of compliance renewable energy credits in Maine is also dependent on the renewable portfolio standards passed in other New England states. Most laws pertaining to renewable portfolio standards allow compliance by using renewable energy credits from qualifying renewable resources anywhere in the New England power pool. Also, the possibility of a national renewable portfolio standard or carbon cap and trade system could further increase the prices of renewable energy credits both locally and nationally. The price of renewable energy credits traded in the voluntary markets is highly dependent on the demand from individuals, businesses and institutions such as Bowdoin and the number and size of renewable energy projects that are brought online in the future.

Renewable energy credits and Offsets will always be a necessary part of a carbon neutral Bowdoin. The future cost of these tools is uncertain but – due to their economic efficiency – they are always likely to be relatively "inexpensive." However, renewable energy credits and Offsets retire greenhouse gas emissions for only one year while investment in energy efficiency and onsite renewables at the College result in real emissions reductions that will continue year after year.

The net present value (NPV) of all RECs purchased between the 2008 base year and 2020 is currently projected to be -$360,000. This figure assumes that Bowdoin is able to continue its current commitment to Maine based low impact certified hydroelectric RECs at current rates (12,000 MWh per year and NPV of -$270,000) as well as Maine based Green-E certified wind RECs (570 MWh per year and NPV of -$40,000). It also includes a one time purchase of RECs or Carbon Offsets in 2020 to achieve neutrality (11,000 MWh and NPV of -$50,000). The undiscounted cost of all RECs from the 2008 base year through 2020 is approximately -$560,000. To arrive at the -$360,000 net present value, purchases made in the future have been discounted to account for the time value of money at an annual rate of 6%.

Bowdoin plans to prioritize investment in on campus carbon reduction projects. This will be done in a cost effective manner that pursues both high impact and low cost measures first, maximizing the effect of internal investments while gradually reducing and minimizing the purchase of renewable energy credits and Offsets.

2.3.4- Purchase versus Investment Overview:

Bowdoin is already purchasing renewable energy credits in the voluntary market equivalent to 7,334 tons of CO_2e per year. These renewable energy credits are sourced from generators based in Maine. Although Bowdoin will seek to maximize onsite efficiency and use of renewables, this plan recognizes that renewable energy credits and Offsets will be a necessary and ongoing part of carbon neutrality.

2.4 - Greenhouse Gas Targets and Objectives

Bowdoin has established a goal to be carbon neutral by 2020. The College is taking a number of steps today to reduce carbon emissions. The main projects that are already being implemented or that are in the advanced stages of planning have been identified and quantified in this report. These near term projects make a significant start on the journey to neutrality but more steps will be needed. Making predictions about the evolution of technology, changes in public policy and the future size of the College is fraught with uncertainty. Making such predictions is a necessary part of mapping out a path to achieve neutrality, however. Bowdoin is setting the following goals:

Discrete projects that are currently being implemented will reduce greenhouse gas emissions from business as usual by approximately 2,500 tons of CO_2e per year by 2015. This is more than a 10% reduction from the 2008 base year.

Discrete projects being considered at Bowdoin for implementation between 2015 and 2020 will reduce an additional 2,900 tons of CO_2e each year for a total of 5,400 tons each year by 2020. This is a 23% reduction from the 2008 base year.

Ongoing initiatives that have no discrete online date could reduce emissions by almost 2,300 tons by 2020 and 9,000 tons by 2050. These are approximately 10% and 38% reductions from the 2008 base year respectively.

In total these ongoing and discrete projects represent a 32% reduction from the 2008 base year by 2020 (7,700 tons CO_2e annually) and 62% reduction from the 2008 base year by 2050 (14,900 tons CO_2e annually). These figures do not include any emissions reductions achieved through the voluntary purchase of renewable energy credits. If the existing level of voluntary renewable energy credit purchases is taken into account, an additional 7,300 tons of CO_2e is offset per year bringing the total to 15,000 tons (63% of the 2008 baseline) by 2020 and 22,000 tons (93% of the 2008 baseline) by 2050.

2.4.1- Growth Assumptions:

If Bowdoin were to continue operating under a "business as usual scenario", greenhouse gas emissions would grow from almost 24,000 tons in 2008 to 26,900 tons of CO_2e in 2020, and 33,000 tons in 2050. This increase is mainly due to the expected expansion of the College from 1,888,000 gross square feet in 2008 to 2,200,000 gross square feet in 2020 and 2,700,000 gross square feet by 2050. The expected annual growth rate through 2025 is 1.3% slowing to 0.7% by 2050. The business as usual scenario assumes that greenhouse gas emissions would increase linearly with size.

2.4.2- Own Source—Emission Reductions:

The emissions reductions from business as usual at Bowdoin College are mainly achieved through a combination of projects identified as being viable by 2020. The projects are summarized in the below table along with projected impact on carbon emissions and relative cost.

Scope	Item Name	Description	Annual Offset (tons CO2e)	Cost/ton CO2e	Online Date	% of 2008 Base Case	% of 2020 Business As Usual Case
	Energy Conservation						
2	Computers	Setting 600 public & shared PCs to sleep mode	4	-239	2009	0.02%	0.02%
2	Lighting - CFL Bulbs	Change 3,874 incandescent 60w bulbs to 15w CFL - replace CFLs every 2 years	447	-136	2009	1.86%	1.66%
2	Lighting - Super T8	Change 4,953 T12 lamps at 82w per lamp to 50w Super T8 - replace every 6 years	407	-79	2010	1.69%	1.51%
2	Lighting - LED Bulbs	Change 3,874 15w CFL to 6w LED - replace every 11 years	89	-69	2013	0.37%	0.33%
2	Lighting - LED Tubes	Change 4,953 Super T8 lamps at 50w per lamp to LED - replace every 11 years	254	-130	2015	1.06%	0.95%
1 & 2	Energy Star	Use Only Energy Star rated equipment and appliances	508	0	Ongoing	2.11%	1.89%
	Energy Conservation Subtotal		1,710			7.11%	6.36%
	Physical Plant						
1	OLC Boiler	Replace boiler at the Schwartz Outdoor Leadership Center	7	-69	2009	0.03%	0.03%
1	Steam Line	Phased replacement of old steam line	189	279	2011	0.79%	0.70%
1	Central Plant Boiler	Replace oldest boiler at central heating plant	343	5,491	2011	1.43%	1.28%
1	Heating Plant Cogen	Install 400 kw + backpressure steam turbine in central heating plant	600	-59	2013	2.50%	2.23%
1	H&L Windows	Replace all single pane windows with thermal pane low-e argon or better	68	183	2016	0.28%	0.25%
1	Coles Tower Windows	Replace all single pane windows with thermal pane low-e argon or better	131	286	2016	0.54%	0.49%
2	Coles Tower Elevator	Replace elevator at end of its useful life with Otis Gen2 with regeneration or better	8	TBD	2019	0.03%	0.03%
	Physical Plant Subtotal		1,346			5.60%	5.00%
	Fuel Switching						
1	Fuel Oil Conversion 1	Conversion of satellite facilities from #2 oil to natural gas	410	-58	2014	1.70%	1.52%
1	Vehicle Fleet	Transition Vehicle Fleet First to 100% Hybrids	156	-87	2020	0.65%	0.58%
	Fuel Switching Subtotal		565			2.35%	2.10%
	New Construction & Renovation						
1 & 2	New Building Improvements	New building improvements: 20% by 2009 and 46% by 2020 compared to 2008	945	-107	Ongoing	3.93%	3.51%
	Behavioral Changes						
1 & 2	Behavioral Changes	Sustained and increasing behavioral changes by staff, faculty and students	590	N/A	Ongoing	2.45%	2.19%
	Onsite Renewables						
1	OLC Solar Thermal	Solar thermal Installation on the Schwartz Outdoor Leadership Center	1	330	2009	0.00%	0.00%
1	Solar Thermal II	Farley complex and Thorne Hall solar thermal system	102	TBD	2012	0.42%	0.38%
2	Farley PV	100 kW solar PV system at Farley Field House	76	247	2017	0.32%	0.28%
2	Navy Base PV	2,000 kW PV system on dual axis tracker on 10 acres at former Naval Air Station	2,053	0	2020	8.54%	7.63%
1 & 2	Geothermal	Expand use of geothermal for heating and cooling	230	TBD	Ongoing	0.96%	0.86%
	Onsite Renewables Subtotal		2,463			10.24%	9.15%
Total			7,620			31.69%	28.32%

Figure 2.13: Carbon Reduction Projects

Summary of projects that have been identified to reduce Scope 1 and Scope 2 GHG emissions.

Bowdoin has also identified certain projects beyond 2020 that will achieve additional green house gas emission reductions and therefore reduce the number of renewable energy credits and carbon offsets required to maintain neutrality. These projects are shown below.

Scope	Item Name	Description	Annual Offset (tons CO2e)	Cost/ton CO2e	Online Date	% of 2008 Base Case	% of 2020 Business As Usual Case
	Energy Conservation						
1 & 2	Energy Star II	Continue to use only Energy Star rated equipment and appliances (through 2050)	1,270	0	Ongoing	5.28%	4.72%
	Fuel Switching						
1	Fuel Oil Conversion 2	Complete conversion of satellite facilities from #2 oil to natural gas	171	-58	2040	0.71%	0.63%
1	Vehicle Fleet 2	Transition Vehicle Fleet From Hybrid to Electric	288	-1,941	2025	1.20%	1.07%
	New Construction & Renovation						
1 & 2	New Building Improvements II	Continued improvements in all new building space beyond 2020 (through 2050)	4,213	-107	Ongoing	17.52%	15.66%
	Behavioral Changes						
1 & 2	Behavioral Changes II	Sustained behavioral changes by staff, faculty and students (through 2050)	590	N/A	Ongoing	2.45%	2.19%
	Onsite Renewables						
1 & 2	Geothermal II	Expand use of geothermal for heating and cooling (through 2050)	685	TBD	Ongoing	2.85%	2.55%
Total of Post 2020 Projects			7,216			30.01%	26.82%
Cumulative Total Including Pre 2020 Projects			14,836			61.69%	55.14%

Figure 2.14: Post 2020 Carbon Reduction Projects

Summary of projects that have been identified to reduce Scope 1 and Scope 2 GHG emissions.

Many of these projects will save the College money over their lifespan and, ultimately, allow Bowdoin to fund further energy upgrades with this positive cash flow. These projects have a negative cost per ton of CO_2e.

2.4.3- Other Sources—Emissions Reduction Assumptions:

Regulatory

Because of the renewable portfolio standard in effect since 2000, at least 30% the electricity provided to end users in Maine must be generated by qualifying renewable sources. Therefore, the College knows that at least 30% of the power it consumes (6,105 MWh in 2008) produces little or no net CO_2e emissions. As mentioned in Section 2.3.2, state legislation requires the Maine renewable portfolio standard to increase one percent annually from 2008 through 2017, increasing the minimum standard to 40%. If this is achieved and fossil fuels are replaced by electricity sources with little or no carbon emissions, Bowdoin's emissions from electricity consumption will be reduced proportionally.

In addition to the Maine renewable portfolio standard, there is the possibility of a national renewable portfolio standard or carbon cap and trade program that would target electricity generation. Depending on how stringent the federal regulations are, implementation of either of these programs could have an accelerating effect on the amount of renewable power generated in Maine, which would lead to additional greenhouse gas emission reductions related to Maine electricity generation.

Another scenario that could have a large effect on the amount of green house gases that are emitted from generation of power in Maine is the proliferation of offshore wind energy. Recently, there has been much speculation on Maine's potential to handle massive offshore wind farms that could supply the majority of the state's electricity as well as heating and transportation needs. Whether this becomes technologically or economically viable will have a large effect on the power mix within the state and, subsequently, Bowdoin's greenhouse gas emissions.

Commuting

In May of 2009, the Obama administration announced its plans to increase federal corporate average fuel economy standards from the current standards, enacted in 2005.[51] The manufacturer's fleet average must be 35.5 mpg in 2016, a 58% change from 2008.[52] This figure is based on the goal of producing passenger vehicles such as cars and vans with an average fuel efficiency of 39 mpg. The fuel efficiency of larger vehicles such as light trucks and SUVs is mandated to reach 30 mpg by 2016.

Assuming that the vehicles used by Bowdoin staff to commute keep pace with these new fuel economy standards, greenhouse gas emissions from their commute can be greatly reduced through 2016. From 2008 through 2016 the fuel efficiency improvements made in the automobile manufacturing industry will greatly outpace the anticipated growth of

[51] online.wsj.com/article/SB124266939482331283.html

[52] www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/2006FinalRule.pdf

Bowdoin College, assuming the number of commuting miles traveled by the Bowdoin staff grows proportionally to the number of students. Using this model, the average fuel economy of commuters will increase from an estimated 22.5 mpg in 2008 to 35.5 mpg in 2016 and greenhouse gas emissions will be reduced by 786 tons of CO_2e per year from 2008 levels. However, barring new legislation or the mass adoption of more greenhouse gas friendly technologies such as electric or fuel cell vehicles, the expected increase in commuting miles by Bowdoin staff will outpace fuel efficiency gains from 2016 to 2020.[53] Assuming a fuel efficiency increase of 0.2 mpg per year[54] after 2016 in the Bowdoin staff vehicle average, the 2020 greenhouse gas emissions from commuting will be reduced by 234 tons of CO_2e from 2008 emissions levels.

There is a newfound interest by the automobile industry in the development of more fuel efficient vehicles. Consumer pressures on automobile manufacturers, in combination with the new federal corporate average fuel economy standards, are responsible for this interest. It is possible that automobile fuel efficiency will increase at a faster rate than the historical average due to the increased interest in developing new, more fuel efficient technologies. To account for this possibility, an "aggressive" fuel efficiency scenario is explored and demonstrated in Figure 2.14 below. The aggressive scenario assumes an annual fuel efficiency increase of 0.4 mpg after 2016. The "aggressive" model does not have much impact on 2020 projections but by 2050 Bowdoin employee commuting emissions would be reduced by an additional 240 tons of CO_2e per year compared to the baseline assumption.

[53] Total Bowdoin staff commuting miles is expected to increase by over 1,840,000 miles per year from 2008 to 2050

[54] This is approximately equivalent to the average annual fuel efficiency increase from 1970 to 2006: www.project.org/info.php?recordID=384

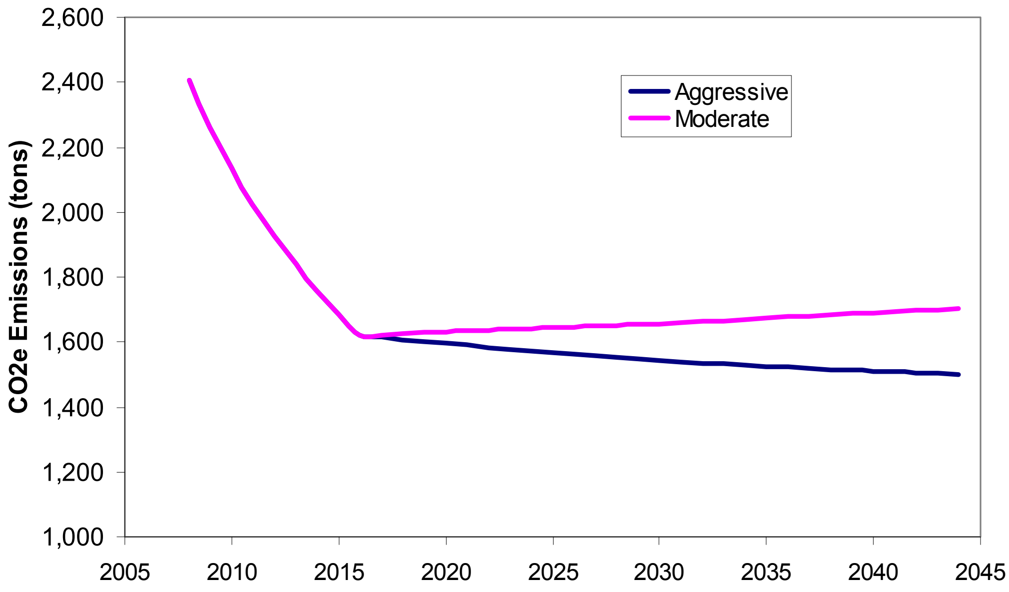

Figure 2.14: Potential Impact of CAFE Improvements on GHG Emissions from Employee Commuting

New England Grid Reductions:

The electricity that Bowdoin consumes flows from a large and interconnected grid of power plants and transmission and distribution lines. There are many zero emission power plants feeding into this grid such as hydroelectric dams and wind turbines. However, the vast majority of electrical power is still generated through the combustion of fossil fuels such as coal, oil and natural gas. Consequently, in the year 2005, the production of one MWh of electricity in the State of Maine resulted in the emission of approximately 0.58 tons of CO_2e on average.[55]

The amount of greenhouse gases emitted as a result of electricity production will likely decrease in the future due to the addition of new, net zero emission power sources to the grid as well as continued efficiency increases in fossil fuel combustion. Power generation and transmission infrastructure requires a significant initial investment and is designed to operate for an extended time period. Therefore, the replacement of existing infrastructure will progress gradually as old units are retired, creating a gap in supply that can be filled effectively by cleaner power generation technology. In modeling how greenhouse gas emissions will change in the future, three rates must be taken into account: the rate of growth of energy demand within the grid, the rate of improvement of fossil fuel fired power generation technology, and the rate that net zero emission technology is added to the grid.

[55] eGRID 2007 Version 1.1: Year 2005 GHG Annual Output Emission Rates: www.epa.gov/cleanenergy/energy-resources/egrid/index.html

A model of the future power grid in Maine was constructed to estimate the likely impact of changes to Maine's generation mix. The model assumes one percent annual load growth within the grid. The model also assumes a one percent annual emissions reduction for natural gas generated power and technology starting in 2005 and coal generated power technology starting in 2020. Oil fired power plants were assumed to stay at current emissions levels.

The Maine renewable portfolio standards dictate a one percent annual growth in zero emission electricity generation through 2017. This is equal to the one percent annual load growth assumed by the model. The renewable portfolio standard essentially matches the state electricity consumption growth. Therefore, the model simply projects that the zero emission generation keeps pace with grid growth through 2050, resulting in a greenhouse gas emissions reduction of almost 0.3 tons of CO_2e per MWh of electricity generated. Using this model, emissions at Bowdoin would be reduced by 1,800 tons of CO_2e per year from the 2008 level by 2020 and by 6,280 tons of CO_2e by 2050 assuming Bowdoin's electricity consumption remains relatively constant at approximately 20,000 MWh per year.

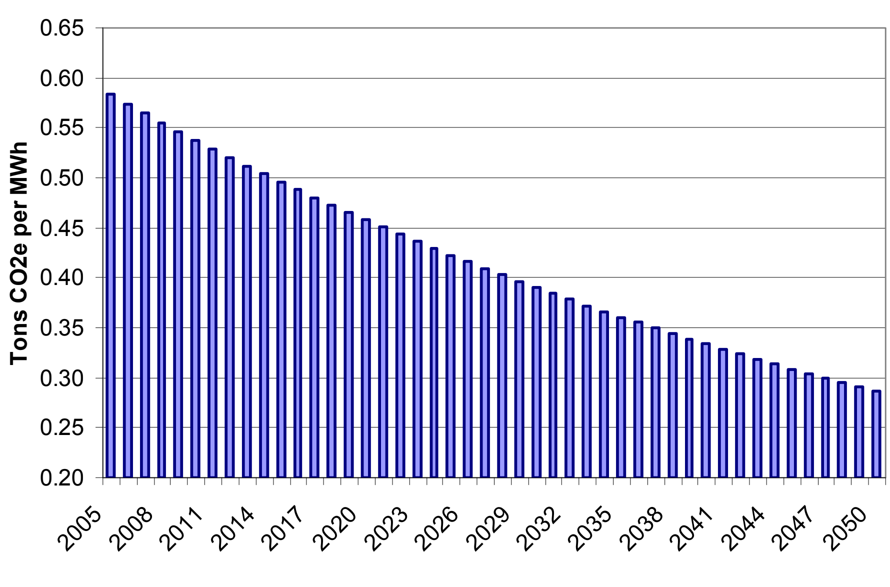

Figure 2.15: Maine GHG Emission per MWh
Estimated decrease in emissions per MWh for Maine Power Grid

2.4.3- Other Sources—Emissions Reduction Overview:

By 2020, Bowdoin anticipates that greenhouse gas emissions from faculty and staff commuting will be reduced by over 230 tons of CO_2e due to improvements in automobile fuel efficiency. Incremental improvements to the power generation mix in Maine should result in a reduction of about 1,800 tons of CO_2e per year by 2020.

2.4.4- Wedge Analysis:

The following chart shows how the discrete projects that have been indentified in this report, combined with the expected other source improvements discussed in the prior section will bring Bowdoin within striking distance of net zero greenhouse gas emissions by 2020.

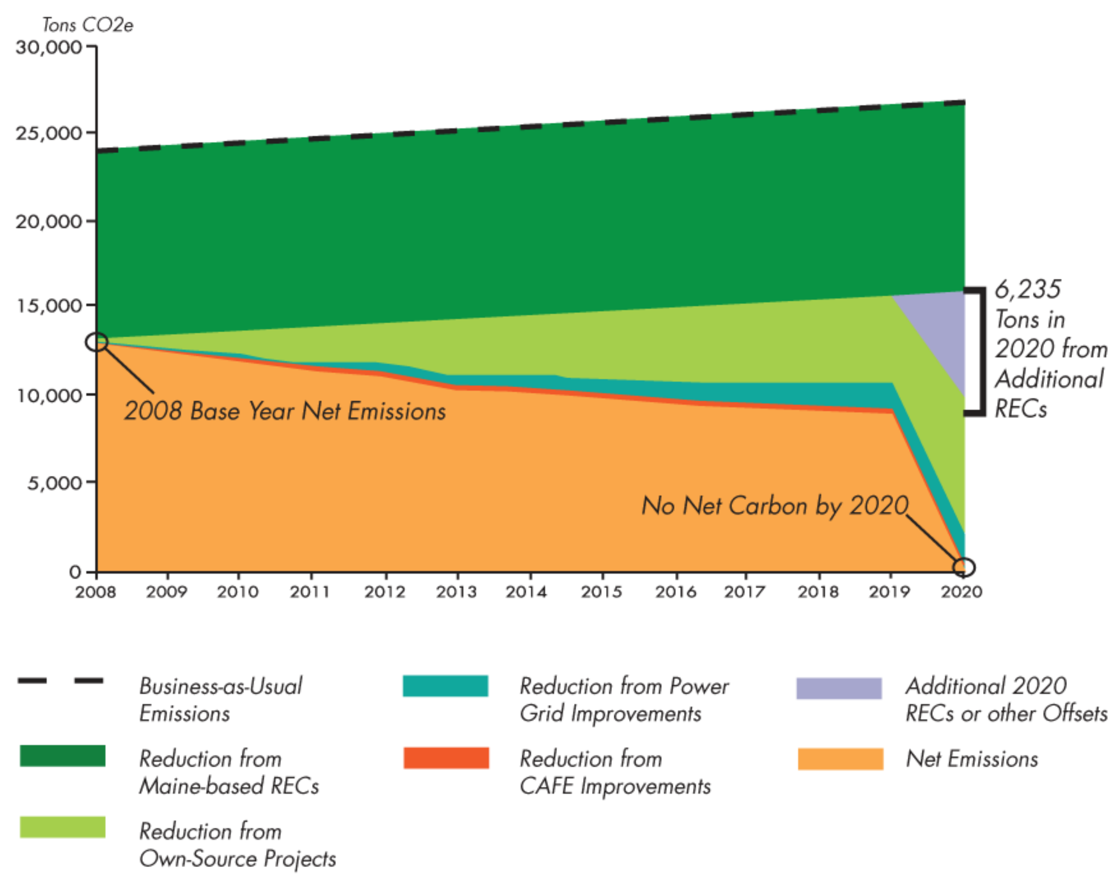

Figure 2.16: Wedge Analysis

These projections rely on numerous assumptions including future growth of the campus; the willingness of students, faculty, and staff to make meaningful behavioral changes; the pace at which new "green" technologies improve; and the future cost of energy.

Figure 2.16 shows business-as-usual growth in gross CO^2e emissions from 2008 through 2020 as the dashed black line across the top. Knowing that some combination of renewable energy credits and carbon offsets will be required we have started with the assumption that Bowdoin will carry forward its 2008 commitments and this is shown by the dark green area. Notice that while gross emissions in 2008 were about 24,000 tons; net emissions in 2008 – after renewable energy credit purchases – were only 13,000 tons.

The light green area then shows the reduction associated with the own-source projects that Bowdoin has identified and discussed at length in this report. The blue area shows the expected reduction from improvements to the power grid and the red area shows the expected reduction from employee commuting improvements. An additional purchase of renewable energy credits or offsets is projected to be required to achieve neutrality and is shown in the year 2020 by the purple shaded area. The orange area shows expected emissions during the entire period.

By following this plan Bowdoin should have net greenhouse gas emissions of 6,235 tons in 2020. This will be a dramatic 77% reduction from the business as usual scenario. If additional opportunities other than those discussed in this plan are not identified in the years ahead, Bowdoin will need to purchase additional renewable energy credits or carbon offsets in 2020. The projected level of additional renewable energy credits or carbon offsets needed by 2020 is manageable, however, as it is less than Bowdoin's current level of voluntary purchases.

2.4.5- Tracking Greenhouse Gas Emissions:

The College's energy consultant, Competitive Energy Services, LLC in Portland, Maine, has developed a carbon tracker modeling program for Bowdoin that estimates the College's greenhouse gas emissions based on operational and consumptive practices. With ongoing advice and counsel from Competitive Energy Services, Bowdoin will assimilate and organize the data that is necessary for the program to accurately track the emissions from year to year. This responsibility will fall mainly upon the Department of Facilities Management as well as the Treasurers' Office to track electricity and fuel consumption as well as waste recycling and disposal. Accurate record keeping will allow the College to track greenhouse gas emissions and, consequently, identify areas in which emission reductions are on track and areas that are falling behind and need to be improved. The information captured by the ongoing tracking activities will be disseminated in regular reports to the Climate Commitment Advisory Committee and the broader college community in order to facilitate the creation and maintenance of an informed and engaged population.

2.5- Summary and Recommendations

The Climate Commitment Advisory Committee concludes that it is possible for Bowdoin to achieve carbon neutrality by 2020. Furthermore, the committee concludes that it is economically feasible to achieve carbon neutrality by 2020 without undue reliance on the purchase of carbon offsets or renewable energy credits. The plan laid out in this report attempts to avoid an overreliance on the easy assumption that technical innovation will make achieving the neutrality goal easy at some point in the near future. It is unlikely that there will ever by a silver bullet; instead Bowdoin will need to rely on a large number of initiatives from the very small to the very large. Together these initiatives can provide ongoing and measurable progress towards neutrality.

Bowdoin's plan builds on many conservation and onsite generation initiatives already underway on campus. The plan attempts to make reasonable projections about what projects will be feasible by 2020 and beyond. It is difficult to predict the future under the best of circumstances. This report is the first effort at quantifying the steps that will be needed to achieve carbon neutrality. The path to neutrality is likely to deviate over time from the one set forth here and Bowdoin needs to maintain flexibility as it pursues its goal. Below is a list of the main mitigation related recommendations discussed in this section.

By 2020 & Ongoing

- By 2020 achieve a 100% reduction from the business as usual scenario from all sources. (From 27,000 tons to 0 tons of CO_2e)

- Improve metering, tracking and auditing capabilities of greenhouse gas emissions and energy usage on campus.

- Complete the repair and upgrade of the underground steam distribution system.

- Complete the cogeneration and boiler replacement project for the campus central utility plant.

- Continue the conversion of College facilities from higher carbon distillate oil to natural gas. Continue to collect and use fry oil produced by dining services.

- Evaluate solar thermal for the two largest users of hot water on campus: Greason Pool and Thorne Hall.

- Implement all conservation measures that have attractive economic returns immediately. These include setting inactive public computers to sleep mode, weatherizing buildings and various lighting upgrades.

- Evaluate the performance of diode bulb lighting at the current and future pilot projects. Monitor improvements in the technology and the experience of other institutions with diode lights. Plan for widespread adoption of diode lighting as a replacement to compact fluorescent lighting.

- Update the greenhouse gas emissions inventory each year and this action plan every second year.

- Establish new efficiency standards/targets for renovations and construction.

- Replace single pane windows in Coles Tower and Hawthorne-Longfellow Library.

- Make efficiency a key criterion when the Coles Tower elevator needs to be replaced at the end of its useful life.

- Monitor improvements in diode tube lighting technology and plan for widespread adoption of diode lights as a replacement to super T8 fluorescent tube lighting once costs have been cut in half from today's levels.

- Consider geothermal HVAC systems or new heat pump technologies at all new building projects. Implement mechanisms to better evaluate payback and performance metrics compared to an equivalent facility without geothermal systems.

- Use only Energy Star rated or better equipment when replacing any non-lighting equipment on campus.

- Prioritize the purchase of hybrid vehicles within the College-owned fleet when current vehicles are up for replacement with the goal to be 100% hybrid by 2020.

- Consider planning for a potential 2,000 kW solar PV installation on land that will be acquired at the Brunswick Naval Air Station.

Beyond 2020 Projects

- By 2050 achieve a 36% reduction in purchased renewable energy credits or carbon offsets required to maintain neutrality. (From 17,200 tons in 2020 to 11,000 tons of CO_2e in 2050)

- Continue to use only Energy Star rated or better equipment when replacing any non-lighting equipment on campus.

- Expand the existing educational efforts of campus faculty, staff and students in order to affect behavioral changes that lead to sustained reductions in energy usage and associated carbon emissions.

- Finish the conversion of College satellite facilities from higher carbon distillate oil to natural gas.

- Pursue building envelope and HVAC system improvements for each renovation and new building project. Attempt to achieve a 70% improvement by 2030 and an 80% improvement by 2050 compared to current building stock.

- Monitor the improvement of full electric vehicles and begin to phase in their use as soon as the technology becomes commercially viable.

- Continue to support high quality renewable energy projects and carbon reduction projects with a sustained commitment to renewable energy credits and/or offsets. Prioritize local projects that have an impact on the local economy and air-shed.

3.0- Education, Research, and Community Outreach

Faculty and students across campus actively engage in courses, off-campus study, summer fellowships, civic engagement, and primary research examining climate change and the environment.

3.1- Education

Bowdoin College supports the study of the environment through several academic and Facilities Management programs.

3.1.1- Education Programs—Inventory and Assessment:

Three interdisciplinary programs play a major role. Environmental Studies includes 22 affiliated faculty members from 11 departments spanning the humanities, social sciences, and natural sciences. Students can choose to major in Environmental Studies in conjunction with an additional coordinate major. The Coastal Studies program does not consist of a major but seeks to support, encourage, and inspire research and creative projects broadly related to coastal studies undertaken by Bowdoin students and faculty. A concentration in Arctic studies, offered through the Department of Sociology and Anthropology, the Department of Geology, and The Peary-MacMillan Arctic Museum and Arctic Studies Center, provides students with opportunities to explore cultural, social, and environmental issues involving Arctic lands and peoples. Students interested in the Arctic often pursue field work at Bowdoin and in the North.

Bowdoin supports three off-campus research stations and programs central to the study of climate change. The Bowdoin Scientific Station, located on Kent Island, New Brunswick, Canada, was established in 1935 as a research facility and sanctuary for nesting seabirds. The station has been a member of the Organization of Biological Field Stations since 1988. Long-term student and faculty research is documenting changes in bird population sizes and migration patterns resulting from modern climate warming. The Merrymeeting Bay/Kennebec Estuary Research Program organizes faculty and students from Biology, Geology, Chemistry, History, and Anthropology around water quality and ecological issues in the local estuary ecosystems. This work has been key for identifying stressors to ecological communities, including changes in river discharge associated with climate change, which will be useful for helping to restore Maine's coastal estuaries. The Coastal Studies Center seeks to support Bowdoin academic courses, research, or creative projects that study the natural world at the Thalheimer property, an off-campus research facility located on Orrs Island. Courses and research at the Coastal Studies Center has been important for documenting controls species distributions, including those associated with invasive species and climate change. Bowdoin is in the process of developing an expanded mission for the Coastal Studies Center to include potentially a summer institute where scholars and students form around the country can participate in courses and research related to coastal issues and the environment, including climate change.

A grant from the Mellon Foundation has enabled the College to support three Mellon Global Scholars as a means of bringing more of an international perspective to the Environmental Studies dialog. These scholars include:

- Spring 2008 - Dr. Lance Van Sittert, (environmental historian), Associate Professor of Historical Studies at the University of Cape Town, Environmental Historian, South Africa who taught the course "African Environmental History", cross-listed with the History Department
- Fall 2008 - Ashish Kotahri, (sociologist), Coordinator of the Conservation and Livelihoods Programme, Kalpavriksh, India taught a course on "Development and Conservation in India" which was cross-listed with the Asian Studies Program
- Fall 2009 - Dr. Evans Mwangi, (biologist), Lecturer, University of Nairobi, Kenya who will teach a course titled "Biodiversity Conservation in Africa", which is cross-listed with the Africana Studies Program

In association with these scholars, the Environmental Studies program has held two, with plans for a third, Mellon Global Symposia. See Section 3.2.3 for a description of these Symposia.

In addition to supporting the Mellon Global Scholars and Mellon Global Symposia, the program has funded students who have broadened their experience by conducting international research. Most recently Emily Guerin was awarded a Mellon Student Fellowship in 2008 which enabled her to travel and conduct research in Chile. Her senior year Honors Project "*The Forest as a Mine: A History of the Development of the Forest Industry in Chile*" was based upon this research. In December, 2008, she was selected as one of fourteen students from around the country to attend "Conservation Capital in the Americas" in Valdivia, Chile from January 17-19, 2009. The focus of the forum was to bring together a range of national and international experts in the area of conservation finance innovation. At the forum, she presented and received feedback on her winning essay "*Accidental Conservation: How Decree Law 701 Inadvertently Encouraged Regeneration of Native Forests in Panguipulli, Chile*" which was a summary of her research conducted during the summer of 2008.[56]

3.1.2- New Education Initiatives:

In recent years, Bowdoin has developed several education initiatives linked to climate change and sustainability. New courses include Global Change Ecology, Food and Agriculture, Building Healthy Communities, Gulf of Maine and Bay of Fundy, Marine Conservation Ecology, Earth Climate History, Paleooceanography, Environmental Education, Sustainable Architecture, Coral Reef Biology, Sustaining Main's Northern Forest, and Telling Environmental Stories.

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[56] More information on the Mellon Global project can be found at: http://www.bowdoin.edu/environmental-studies/index.shtml.

The Environmental Studies Program is also developing new outreach opportunities to other academic programs on campus to broaden the discussion of climate change. These include:

- *Earth System Science* – This group consists of faculty affiliated with ES from Biology, Chemistry, Geology, Physics, and Math. The new ESS cluster will allow Bowdoin to enhance and strengthen our teaching and research related to climate and environmental change.
- *Africana Studies* – Race and the environment have always had an uncomfortable history. Several faculty members among ES, Africana Studies, History, and Sociology/Anthropology are initiating a conversation to see how we might be able to strengthen ties between ES and AS.
- *Psychology* – In recent years, Bowdoin has experienced a significant increase in ES-Psychology coordinate majors. This reflects the fact that these fields are merging in interesting ways as a result of research examining the social psychology of environmental changes and decisions. The ES program and Psychology Department have begun to strengthen the links between these programs (see section 2.2.5).
- *Religion*—Es is working with the department of Religion to develop stronger linkages between the programs in terms of new course offerings and shared speakers.

Increasing environmental awareness on campus is another major goal. Our global environment is changing in ways that will affect faculty, staff, and students for generations to come. Higher education needs to develop a curricular strategy to help our community gain the intellectual and practical skills to navigate this change and become important leaders in business, government, science, and civil society. Curricula should stay ahead of the curve. We should not merely be demand-led institutions, responding to what the students or public demand, but, instead, supply a unique environmental curriculum across the campus that asks students to reflect more deeply on environmental issues, and thus accelerate the training of leaders for tomorrow. In the words of the College's environmental mission statement, "The Bowdoin College community—being mindful of our use of the earth's natural resources, our impact on the environment of coastal Maine, and our responsibilities as members of a leading liberal arts college dedicated to serving the common good—recommit ourselves to environmental awareness and responsibility, and to actions that promote sustainability on campus and in the lives of our graduates… As an educational institution that has long derived great benefit and much of its identity from the natural beauty of Maine, Bowdoin has a special obligation to challenge its students and faculty to examine, discuss, and debate issues of ecological preservation, social justice, economic viability, and global responsibility."

Environmental Studies (ES) programs are often the focal point for environmental education and scholarship. It seems natural, then, for ES programs to deliver environmental literacy (EL) to the academic community. But giving ES responsibility for EL absolves the rest of campus from addressing it. Our disciplinary silos remain intact. ES programs are certainly key to this conversation, but all disciplines need to be part of this transformation. Environmental issues are increasingly covered in political science, economics, history, and philosophy courses. We could do more to show students how environmental changes are relevant to civil society, social traditions, and other expressions of the human condition.

Understanding environmental change and its impact on natural and social systems is a critical frame of analysis that needs to be added to the repertoire of student perspectives (such as race, class, and gender) and competencies (such as writing, quantitative skills, and languages). It is core to the general education mission of the liberal arts curriculum of the 21st century.

Adding an environmental frame to courses does not connote advocating a particular agenda or ideology. Rather, it is one of several analytical frameworks that allows faculty and students to evaluate critically the interconnected dimensions of our contemporary world, or as the Bowdoin Environmental Mission Statement articulates, to "ensure that Bowdoin graduates have the ability, knowledge, and intellectual flexibility to confront these complex issues through effective analysis and the application of creative thought, sound judgment, and ethical action." The goal would be to add an important point of analysis, somewhat akin to critical theory analyses of race, class, power, gender, (post)colonialism, (post)structuralism, (post)modernism, and psychoanalysis in the humanities and social sciences. This frame is critical for a more-sophisticated understanding what environmental studies means. That is, it is not just about habitat, charismatic animals, or government/corporate policy, but about all of the ways that the social and the cultural intersect with questions surrounding environment — What is nature, how it is implicated in our lives, who benefits and who loses from environmental harm, what issues of power and identity are invested in environmental discourses, how do we make policy or economic decisions given these questions?

The implementation of environmental analysis should be left to the discretion of instructors. Faculty in ES could take a leadership role in providing information, helping faculty understand concepts, and identifying useful case studies. Issues can be framed through the use of readings, papers, field trips, issues, media, case studies, and other approaches, where students would have the opportunity to explore how an environmental perspective adds meaning and important new perspectives to their understanding of disciplinary issues and experiences.

Increasing EL on campus would not be a universal mandate to faculty; it's an opportunity to build a community of courses and instructors who are willing to try something innovative to help prepare students for the challenges of the future. The point is not for ES faculty to tell instructors what the connections are between environmental frames and their disciplines; rather, other faculty members have an active role to play in figuring out which of those connections they'd like to emphasize in their courses. There are many courses right now that are already teaching potential ES or ES-related material without being fully self-conscious about it. With a little rethinking, several courses could help our institutions accomplish these goals with minimal changes, such as a different set of questions being posed about existing reading and subjects.

Environmental literacy has two natural partners on campus—campus sustainability initiatives and Community based learning (3.3.3). Community based learning often speaks to the purported mission of institutions to advance the common good. It puts academics into the service of particular communities, and there are many projects that could have a more explicit environmental connection (e.g., alternative spring break trips to New Orleans and New Mexico.) Service learning and community service work on many levels in reinforcing environmental literacy.

The challenges of EL are also a problem of message and constituency. When we speak of educating students about the natural world, whose nature and what audience are we talking about? To the extent that the environment is a social construction, shaped by individual experiences and values attributed to nature (or lack thereof), there are many ways our students conceive of their place in the world. It is likely that EL arising from first or second-wave environmental thought, which focused on wilderness preservation and pollution prevention largely benefiting white, middle and upper classes, will be irrelevant, at best, and culturally insensitive, at worst, to many of our students of color and students from working-class backgrounds. Simply turning up the volume with more ES&S courses or general education requirements runs the risk of being ineffective if it fails to acknowledge the socioeconomic backgrounds of our students. As Majora Carter argues, we need to bring the environment to our students' lives rather than just bringing students to our classes (see section 3.2.3).

We should work towards the goal of creating a curriculum where the majority of students are learning environmental perspectives outside the ES program. Major environmental challenges like climate change are too important. All parts of campus need to be part of this conversation.

3.2- Research

3.2.1 Existing Research—Inventory and Assessment:

Climate research at Bowdoin College spans the natural and social sciences, occurring primarily as external grant-funded faculty initiatives and sometimes as faculty collaborations. The primary areas of climate research include:

- Elevated CO_2 on forest ecosystems (Biology and ES);
- Impacts of climate warming on high-latitude ecosystems systems (Biology and ES);
- Analysis of global changes in atmospheric CO_2 and O_2 (Physics and ES);
- Changes in marine plankton communities and productivity in the Gulf of Maine (Geology and ES);
- Climate Policy (Government and Legal Studies and ES); and
- Understanding relationships between climate and Inuit cultures of Labrador and Greenland (Sociology/Anthropology, Archaeology, Arctic Studies, and ES).

These programs involve dozens of undergraduate research students each year in independent studies, course-related lab work, and honors theses.

3.2.2- Climate Change in the Curriculum:

The Environmental Studies Program offers 29 courses related to climate change or sustainability (Supplement 3.1). Many more courses throughout the curriculum are "sustainability cognate courses" (Supplement 3.2), courses that are instrumental to understanding ES issues or whose lines of inquiry are useful for cultivating sustainability "habits of mind."

Bowdoin supports a number of student research opportunities on climate change. Community-Based Learning (CBL) in courses and summer fellowships as a keystone activity throughout the Environmental Studies curriculum, in coordination with the McKeen Center for the Common Good. More information on these courses is included in Section 3.3.3.

Students have completed a number of independent study and honors thesis opportunities in Environmental Studies on issues surrounding climate change and sustainability. Recent examples include:

- "Transportation, Urban Sprawl, and Climate Change: A Review of the Literature";
- "From Hills to Coastal: Our Androscoggin";
- "Reconstruction of fire dynamics and carbon accumulation in Central Canadian Arctic peatlands"; and
- "Accounting for Rainforest, Carbon, & Livelihoods: The Challenges to reducing Emissions from Deforestation in Developing Countries".

3.2.3- Climate Change—Co-curricular Events:

The ES program sponsored or co-sponsored several climate and environment-related activities in the 2008-2009 academic year.

Mellon Global Symposia

The Mellon Global Grant has supported three symposia held in conjunction with the College's Mellon Global Scholars which have included "*Indigenous Environments: African and North American Environmental Knowledge and Practices Compared" –* (Spring 2008), and "*Conservation as If People Mattered: Indigenous and Community Conserved Areas Around the Globe and Here at Home*"- (Fall 2008). The third Mellon Global Symposium will focus on the responses of communities and societies to climate change through adaptation mechanisms by comparing international case studies with local experiences in the Northeastern United States. Titled "*Climate Change Responses and Adaptation: Cultural and Social Perspectives*", it will be held in fall of 2009.

Polar Extremes

To commemorate the centennial of Peary's attainment of the North Pole, ES coordinated with Arctic Studies and Coastal Studies on a speaker series called "Polar Extremes: Changes in a Warming World" (http://www.bowdoin.edu/news/archives/1academicnews/005812.shtml). This series included over 13 speakers and exhibits showcasing Peary's journey as well as modern changes to polar environments.

Climate Days

Several ES faculty and students contributed to the spring 2009 Climate Days events in collaboration with the Climate Commitment Advisory Committee (http://www.bowdoin.edu/sustainability/campus-involvement/discussion/april-climate-days.shtml).

Included in the events was a keynote address by Majora Carter, former director of Sustainable South Bronx, as part of the College's Common Hour lecture speaker series. In addition to her address, Environmental Studies faculty and staff of the McKeen Center met with Ms. Carter to talk about how to infuse topics such as climate change, sustainability and environmental justice into the Environmental Studies curriculum. The Climate Days Fair showcased student research and course work that focused on climate change.

Manufactured Landscapes

In collaboration with the Center for Common Good and Asian Studies, ES participated in the manufactured landscapes series (http://www.bowdoin.edu/mckeen-center/activity/2008/seeking-the-common-good-manufactured-landscapes.shtml) examining socioeconomic changes in China and their environmental and cultural implications.

3.2.4- New Climate Change Initiatives

The development of the new Earth System Science cluster within the Environmental Studies Program will allow Bowdoin to enhance and strengthen its teaching and research related to climate and environmental change. This group consists of faculty affiliated with ES from Biology, Chemistry, Geology, Physics, and Math.

3.3- Community Outreach

Bowdoin College has long held a tradition of civic engagement and commitment to the broader community as an educational institution. The College's first President, Joseph P. McKeen, established this precedent in his 1802 inaugural address when he stated that, "literary institutions are founded and endowed for the common good." With the establishment of the McKeen Center in 2008, Bowdoin brought the mission of civic engagement to the center of its academic mission. The Center works with faculty, staff and students to connect courses, research and service to local and global community needs. The Joseph McKeen Center for the Common Good provides opportunities for students to discover the ways in which their talents, passions and academic pursuits can be used for the benefit of society through public engagement. The McKeen Center offers students opportunities to explore themes of community responsibility, active citizenship and informed leadership through service and community engagement at the local, national and international levels. The Center encourages and assists faculty members in connecting their teaching, research and artistic endeavors to issues of the public good.

With increasing awareness of the urgency of the climate crisis it has become clear that Bowdoin's work to reduce greenhouse gas emissions is a vital part of this commitment to the common good. In recent years, the College has worked to spread awareness about climate change on campus, in the surrounding communities and state-wide. The College recognizes that outreach to its students, faculty, and neighboring communities is an important part of its goal to reach carbon neutrality and that as a leading institution in the Mid-Coast region and the State of Maine it has a responsibility to provide leadership in climate action initiatives on campus and beyond.

In recent years, Bowdoin's student body has been active in climate protection initiatives and has provided leadership and inspiration for action on campus. The College has begun to make a concerted effort to get faculty and staff involved in reducing the College's greenhouse gas emissions and energy use and realizes that reaching its goal of carbon neutrality will require participation by the entire campus. Volunteerism and community-based learning have long been vital parts of the College's commitment to the common good, but Bowdoin has recently begun to incorporate climate-focused programs into its community engagement projects.

3.3.1- Student Involvement and Participation

In recent years, Bowdoin students have provided strong leadership in campus climate action initiatives. Indeed, a group of determined students encouraged President Mills to sign on to the ACUPCC in 2007. The members of the Climate Commitment Advisory Committee, including the six student representatives, recognize the importance of engaging the student body in the College's drive toward carbon neutrality. Student involvement in campus and community action will be a major piece of the College's emissions reductions efforts.

Student Organizations

Bowdoin students are already involved in climate action in many ways outside of the classroom. Various student groups address the issues of climate and sustainability on campus. Sustainable Bowdoin's Student Eco-Reps are a group of sophomores, juniors and seniors who work to educate incoming first-year students and upperclass students about how to live more sustainably. They host the annual inter-dorm energy conservation competition as well as several other education and outreach events throughout the year. The Eco-Reps often focus specifically on ways to reduce one's own carbon footprint using educational tools such as door-to-door "dorm storming" to teach students how to reduce energy use in their dorm rooms, a campaign to get students to unplug their appliances during vacations, and encouraging students to go “trayless” in the dining halls and use reusable mugs. Green Global Initiatives, a new student organization chartered in the spring of 2009, focuses on spreading awareness about green jobs and the green economy while trying to reach beyond the traditional crowd of environmentally-minded students to get more people thinking about climate change and sustainability. Bowdoin’s environmental activism group, The Evergreens, has organized climate-focused campaigns and was involved in the organization of Step It Up, a nation-wide day of climate action in 2007. The Yellow Bike Club reduces car use on campus by providing its members with communal bikes for use on campus and in Brunswick. The Bowdoin Outing Club, the College’s largest student organization, has begun to focus recently on reducing its carbon impact by scheduling more local trips and having the new solar thermal system and the new boiler installed.

Participation in Climate Days

Students were also actively involved the spring 2009 Climate Days events. Many of the submissions for the Climate Matters contest were original ideas from students. Demonstrating the competition’s success at engaging the entire campus, the winning submission, a proposal to install green roofs on College buildings, was submitted by Brett Gorman ’11. The College has already begun implementing his plan and will soon be installing its first green roof on the steam plant. Sustainable Bowdoin’s student employees played key roles in organizing the climate fair, at which students presented research, class projects, and work by various campus organizations including the Eco-Reps and the Yellow Bike Club. At the “locavore” dinner, more than one-hundred student leaders facilitated discussions about sustainability at Bowdoin and the College’s commitment to carbon neutrality.

As Bowdoin College moves toward carbon neutrality, it will continue building upon the enthusiastic participation of its student body and striving to engage the entire college community in emissions reductions efforts. Plans for the near future include participation in the “Climate 350” international day of climate action, a sustainability-focused pre-Orientation trip sponsored by the McKeen Center for the Common Good, and a student-led trip to the Power Shift national youth climate action summit in Washington D.C.

Another project for the mid-to-long term would be a student-organized community weatherization program. This would allow students to connect with the surrounding communities through service while reducing greenhouse gas emissions and could even be a potential source of carbon offsets. Unity College, through a partnership with the Maine State Housing Authority, offsets air travel by its faculty with carbon credits from weatherization projects in Maine.

Though the College has not accounted for student transportation in its inventory, it is taking steps to reduce student driving. As of the fall of 2009, first-year students will no longer be allowed to have cars on campus, eliminating nearly 100 cars from campus. To accommodate first-years and other students without cars, the College continues to expand its alternative transportation options. Bowdoin’s membership with Zipcar (discussed in section 3.3.3), the Bowdoin Shuttle, and the Concord Trailways bus line that stops on campus provide convenient transportation alternatives that reduce student driving and reduce emissions.

3.3.2- Faculty/Staff Awareness and Participation:

While the involvement of students on campus and in the surrounding community will be critical to the College's efforts to reach carbon neutrality, the role of faculty and staff in those efforts must not be overlooked. In recent years the College has increased its outreach efforts for College employees, recognizing the importance of including the entire campus community in sustainability and emissions reductions initiatives.

Office Eco-Reps

In the summer of 2008, Sustainable Bowdoin launched its Office Eco-Reps program in an attempt to connect Bowdoin faculty and staff to the College's sustainability projects and get them more involved in energy conservation, recycling, and other sustainable behaviors. The program now includes over 40 volunteers from many of the offices and academic departments on campus. The Office Eco-Reps lead by example in their own workplaces and meet a few times per semester to discuss the sustainability issues that they want to tackle with their co-workers. They played an especially important role in spreading awareness among staff and faculty about the Climate Days events and the Climate Matters contest.

Offices Leading the Way

Beyond the Office Eco-Reps program, many offices on campus have taken strong initiative to make their operations more sustainable and reduce their environmental impact. For example, Bowdoin Dining and Bookstore Services has formed their own environmental committee and strives to lower its own carbon footprint by serving locally grown and organic foods as often as possible in the dining halls and stocking eco-friendly merchandise and supplies in the bookstore. Facilities Management has held a bi-annual gathering of managers with a trained facilitator to asses their environmental achievements, reflect on things they might have done differently, and develop goals for where they want to further improve their environmental performance. Information Technology has worked hard to do their part to reduce Bowdoin's energy consumption by upgrading to more efficient servers and computer equipment and purchasing the College's first electric plug in vehicle for transporting equipment around campus.

Moving forward, Bowdoin's faculty and staff will continue to play an important role in reducing the College's carbon emissions. Initiatives planned for the coming year include a campus-wide energy conservation outreach program, and developing an "eco-award" as part of the College's annual employee awards recognition ceremony. Mid term projects could include increasing the use of videoconferencing to reduce travel to meetings and expanding the faculty/staff carpooling program to reduce employee commute miles.

3.3.3- Civic Engagement and Climate Change:

The Environmental Studies Program has been a leader on campus in the area of civic engagement and in partnership with Sustainable Bowdoin has worked closely with the McKeen Center to develop innovative approaches to community engagement around the theme of climate change. There are six major opportunities for partnerships between Bowdoin College and the broader community on the topic of sustainability: community based learning and research, student summer and academic year fellowships, student volunteerism, off campus study experiences, faculty and staff service, and college engagement.

Community Based Learning

Community based learning (CBL) enables students to provide service directly as part of their academic work. CBL is a thread woven through all of the disciplines within Environmental Studies, humanities, social sciences, and natural sciences courses. Since 2000, 72 courses have incorporated CBL. Over 800 students have worked with over 25 organizations ranging from local communities, organizations, schools, state and federal agencies. Students have been active participants in the formation of new organizations, in developing curriculum on alternative energy for area schools, and in developing educational materials on energy efficiency and alternative energy for the use by area non profits. In the fall of 2009, the Environmental Studies program will offer its first capstone course which will focus on the development of climate action plans for two area communities. Students in this course will also be assessing this implementation plan in the process of learning how to develop climate action plans.

The ES core courses include service learning projects, such as analyzing phosphorus pollution, water quality, and land history of the Androscoggin and Kennebec Rivers. The Environmental Studies Psi Upsilon summer fellowship program offers 6-10 students per year the opportunity to conduct research with community partners.

Summer Fellowship Program

In 1989, Bowdoin College alumni established the Psi Upsilon Environmental Fellowship Program to provide opportunities for Environmental Studies majors to gain work experience with area nonprofits and municipalities while also serving to strengthen partnerships between the College and the greater Brunswick and Maine communities. Over the 10 years that this program has been in place, 68 students have provided valuable assistance to organizations while gaining experience in the environmental field. Many of these projects have had an important sustainability component. Students have calculated the carbon footprint for the Nature Conservancy and the Natural Resources Council of Maine, developed a Climate Action Plan for the City of Bath, Maine, researched mid-coast Maine communities' responses to climate change, provided support for a new regional transit system, and developed educational and outreach materials on alternative energy. Students on many occasions elect to follow up on their summer experience by either continuing to volunteer with the organizations or looking more in depth through an independent study at a topic of interest sparked by their summer experience.

Academic Year Internships and Volunteerism

Bowdoin College students are engaged in a wide range of volunteer activities and internships during the course of the academic year. In 2008, Bowdoin community members donated roughly 43,000 volunteer hours to community organizations as researchers, problem-solvers and workers. As part of an annual Common Good Day in the fall and EcoService Day in the spring, students have worked with area organizations on projects ranging from trail building, to starting up the College's organic garden. In addition, students lend their time and energy to a range of organizations. During 2008, students researched Maine's energy infrastructure for the Office of the Governor, wrote a primer on the implementation of carbon emissions trading under the Regional Greenhouse Gas Initiative, evaluated the potential for tidal power on the Sheepscot River, worked with area high schools and middle schools to educate students about home energy audits, researched sustainable transportation approaches for Maine, and participated in a Maine climate conference with other college students. These experiences provide Bowdoin students with the chance to further their connections to the greater Brunswick community while engaging and learning more about the topic of sustainability.

Off-Campus Study

Over half of Bowdon students elect to spend a semester or year studying off-campus in locations ranging from Kenya, to Costa Rica or Tasmania. Many of these programs provide students with the opportunity to engage with the community they are living in through service or independent research. As in the case of summer fellowships, Bowdoin students often bring their off-campus study experiences back to Bowdoin through independent research and honors projects. Interest in REDD (Reducing Emissions from Deforestation and Forest Degradation in developing countries) as part of an independent project in Australia laid the foundation for a student's Honors Project on Carbon Markets and REDD. Research on forest management practices in Chile led to one student's presentation of a paper at a conservation finance forum in Chile. Students have also researched support for alternative energy systems in Costa Rica, or the role of carbon finance programs in sustainable forest practices in Madagascar. Beyond the academic experience, students have also taken advantage of opportunities to connect climate change in other ways through looking at sustainability practices in Israel while working for a non-profit in Tel Aviv, or serving as an observer for the Montreal Climate Conference.

Faculty and Staff Service

In addition to integrating community based projects into their courses and lives, Bowdoin College faculty and staff are active members of the greater mid-coast community and contribute to dialogs on climate change and sustainability at the local, regional and national levels. At the national level, faculty members have testified on the impacts of climate change, and at the state level, faculty has served as a science advisor in the development of the Maine Climate Action Plan. At the local level, staff and faculty have served in a number of ways though participating in the Mid-Coast Collaborative Access to Transportation advisory committee as part of developing a local community bus route, or volunteering numerous hours as part of a regional weatherization program.

College Engagement

In addition to having an active role at the local, state and federal level through faculty and student initiatives, the College plays a vital role in the broader Brunswick community. There are several opportunities for the College to connect with the greater Brunswick community in addressing climate change at the local level. The College has been actively involved in the development of a new regional transportation system, the Mid-Coast Collaborative Access to Transportation which not only will provide more opportunities for local public transportation, but is also intended to include several hybrid buses. In addition, when Bowdoin implemented the first Zipcar program in the mid-Coast region, the zip car vehicles were made available to members of the Brunswick community. The cars are parked centrally on campus making them easily accessible to both the Bowdoin College and Brunswick communities. As a result of the success of this program, the College has added a third Zipcar for the fall of 2009.

Bowdoin College recognizes that climate change cannot be solved solely through campus based initiatives, and that as an institution, Bowdoin must be an active member of the broader local, state and national communities. By providing opportunities for faculty and staff to actively contribute to the dialog on climate change, the College becomes better informed while sharing its expertise on climate change. Through its active civic engagement programs, Bowdoin is helping to expose students to the broader themes and challenges of climate change while developing leadership among students who will need to continue to take an active role in solving climate change.

3.4- Summary and Recommendations

Faculty and students across campus actively engage in courses, off-campus study, summer fellowships, civic engagement, and primary research examining climate change and the environment. Environmental Studies will work closely with other departments to increase environmental literacy and continue developing climate-focused courses with a special emphasis on community-based and service learning. Building on the success of Climate Days, the College will devote a week each year to focus on climate-related issues and the College’s climate commitment. Students, faculty and staff will continue to play important roles in the College’s climate protection initiatives through energy conservation outreach programs, the Eco-Reps programs, etc. The College will also investigate community projects such as compact fluorescent bulb distribution and weatherization as a source of carbon offsets. Sustainable Bowdoin will expand its student Eco-Rep program to the rest of the 22 campus dorms and its employee carpooling initiative to include a greater portion of the campus. In the long term, the College will strive to be a national leader among liberal arts colleges in climate action and education.

By 2020

- Strive to be a national leader in the role of liberal arts education in preparing students for a world that will experience wide ranging impacts of a warming world.

- Work closely with academic departments to infuse the topics of climate change and sustainability throughout the curriculum. Community based learning will continue to provide opportunities to engage students and faculty with the local community and provide students the experience to address the topic of climate change.

- Continue to offer co-curricular programming in order to inform Bowdoin faculty, staff and students about climate change and provide opportunities for members of the Brunswick community to continue to learn more about this topic.

- Connect with Bowdoin College alumni working in the field of climate change and sustainability in order to keep abreast of evolving technologies and initiatives and to connect students with future internship or employment opportunities in this field.

- Build upon the success of the first Climate Days. This could include an annual lecture by a prominent speaker from the environmental community focused on climate action, an annual themed meal similar to the "locavore" dinner, and/or other events designed to engage students and employees in the College's commitment.

- Participate in national climate action events such as "Climate 350" and Power Shift.

- Develop a sustainability and climate-focused pre-Orientation trip that will introduce first-year students to climate action and the College's commitment to carbon neutrality.

- Organize an educational outreach program to promote energy conservation across campus.

- Develop an "eco-award" to promote energy conservation and environmentally friendly behaviors among faculty and staff as part of the annual employee recognition program.

- Develop a wider array of first year courses that can provide more academic opportunities for environmental literacy among Bowdoin students.

- Explore models such as "writing across the curriculum" as a mechanism for integrating more content focused on climate change and sustainability throughout the curriculum.

- Continue to support faculty and student scholarship on topics related to climate change.

- Explore the potential for acquiring carbon offsets through the development of community based energy efficiency programs that could involve faculty, staff and students similar to the programs at Brown University and Oberlin College. The capstone course offered by the Environmental Studies Program in which students will craft community climate action plans could provide a framework for moving this type of program forward.

- Expand the student Eco-Rep program to include one Eco-Rep for each of the 22 dorms on campus. Possibilities also exist for the creation of a renewable energy technology club, led and organized by students.

- Increase the use of videoconferencing to reduce travel to meetings and conferences and expand faculty/staff alternative transportation options to reduce employee commute miles.

- Secure funding for faculty and student scholarship.

- Provide opportunities for faculty, staff and students to be active participants in the identification of solutions at the local, state and federal levels.

4.0 – Financing Options

The cost of implementing the specific initiatives outlined in sections 2 and 3 of this report ranges from no net new cost to the College (e.g. continuing educational programs already in existence) to estimated costs in the millions (e.g. major building renovations and the boiler/cogeneration project). This section of the report provides an overview of the financing options the College has successfully used or plans to use in the near future and recommends financing options for potential future exploration. In addition, the total estimated cost, possible sources of funding and any relevant historical information (i.e. any historical investment data and any lessons learned) is detailed for each initiative if known. Project costs, when given, are based on the best data currently available and will change over time based on market conditions, technological developments and other factors. Since costs and funding sources will change, this outline is intended to provide a macro view of the potential costs (and in some cases, savings) associated with achieving carbon neutrality and actual project cost projections should be revised as the report is updated.

In response to the turmoil in the current economic environment, the College has taken several steps to control costs. For the purposes of this report, the most significant of these steps are holding operating costs flat for at least the next two years (2010 and 2011) and putting new major capital projects on hold. We will also take advantage of favorable pricing to accomplish projects and stimulate the local economy. The energy savings and emission reducing initiatives selected to be completed in the next several years will need to generate operating budget savings, be funded within existing budgets or have external sources of funding such as gifts or grants.

4.1 – Overview of Financing Options

The College has successfully used a number of the financing options outlined below to support carbon reducing programs and projects similar to those outlined in the report. The College has also identified two new strategies to implement starting in 2010. To achieve complete climate neutrality, the College will need to identify additional funding sources in the future. Based on a review of strategies employed at other colleges and universities as well as the creative ideas of students, faculty and staff, the College plans to explore some specific funding strategies to evaluate their possible use in the future.

4.1.1 – Financing Options Successfully Used to Date:

Annual Operating Budget

Several initiatives outlined in sections 2 and 3 of this report are already funded in the College's annual operating budget. Examples include: renewable energy credits to offset the carbon associated with the College's electricity usage, summer fellowships that place students in 10 week stipend fellowships often focusing on some dimension of climate change, Environmental Studies faculty and staff, McKeen Center initiatives, Sustainable Bowdoin activities and student organizations such as Green Global Initiatives, Evergreens, and the Yellow Bike Club.

Use of Projected Annual Operating Budget Savings

Several energy conservation or carbon reducing initiatives with a payback of 0 – 3 years have been funded within the existing annual operating budget, justified through a direct reduction in expense. The conversion of satellite boilers from #2 distillate oil to natural gas has dominated this category of projects. When the implementation of carbon reducing initiatives will result in significant and short term budget savings, the College plans to consider funding these projects within the approved annual operating budget.

Capital Projects

Major capital projects, such as new construction and significant renovation projects, are typically funded outside the operating budget through gifts, grants and long-term debt. Recent capital project carbon reduction achievements include: energy conservation resulting from the renovation of the six brick first-year residence halls, Adams Hall and the Bowdoin College Museum of Art; major investments in geothermal systems at Osher and West Halls, Studzinski Recital Hall and the Bowdoin College Museum of Art; and LEED certification for Osher and West Halls, Watson Arena – the first newly constructed arena in the United States to receive LEED certification[57] – and the soon to be completed Peter Buck Center for Health and Fitness.

Fundraising

The College recently concluded the largest fundraising campaign in its 215-year history, raising a total of $293 million dollars for financial aid, the academic program and student life. The Bowdoin Campaign included funding for the Environmental Studies program, McKeen Center for the Common Good activities and new building construction as well as other climate-related initiatives.

Grants

A number of external grants have been used to fund carbon reducing initiatives. In 2009, the College applied a $75,000 grant from the Bingham Foundation to upgrade the lighting in Morrell Gymnasium, to install, with additional support from a Class of 2009 gift, solar thermal hot water at the Schwartz Outdoor Leadership Center, and to weatherize several of its faculty rental houses. With funding from Efficiency Maine, a State of Maine program that provides cash incentives to businesses to save energy and money and improve the environment, the College completed several lighting upgrade projects. Efficiency Maine rebates in 2009 totaled nearly $30,000. Grant funded educational initiatives include three Mellon Global Scholars and Mellon Global Symposia as well as climate research supported by the NSF, NASA and others. The College recently formed a "green grants committee" to actively explore grant funding opportunities for carbon reducing initiatives.

4.1.2 – Additional Financing Options Identified:

Use Major Maintenance and Capital Renewal Budget Savings

Starting in 2010, the College may use some savings from approved budgeted major maintenance projects to fund unbudgeted but important energy conservation projects on a case-by-case basis and taking into account other financial requirements.

Pilot Projects

By partnering with manufacturers of new energy saving products to test these products at Bowdoin, the College could evaluate new technology at no cost or at reduced cost.

4.1.3 – Financing Options for Further Exploration:

Fundraising

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[57] The full article may be viewed at http://www.bowdoin.edu/news/archives/1bowdoincampus/006465.shtml.

The College may consider exploring opportunities to engage alumni and friends who may be interested in supporting the College's commitment to achieve carbon neutrality by 2020.

Internal Revolving Loan Fund

The College may consider establishing a separate revolving fund for energy-saving and emission-reduction projects to provide a mechanism that would allow energy savings or other operating budget savings (e.g. savings from budgeted major maintenance projects) to help finance the costs of efficiency improvements or other carbon reducing initiatives. By consolidating savings into one fund, the College could centrally track the costs and savings associated with specific initiatives. For example, costs to convert a boiler from heating oil to natural gas could have a simple payback of less than one year. After the upfront costs of the boiler conversion are recouped, there may be additional "savings" associated with lower fuel costs and increased efficiency compared to the budgeted cost of operating the heating oil boiler. These additional savings could be tracked and used to fund another efficiency project without having a budget impact.

Energy Service Companies (ESCos)

The College may consider contracting with an ESCo which would implement energy-savings initiatives on a performance-contracting basis. An ESCo would provide third-party financing as well as guarantee savings in energy costs. To date, the College has not chosen to contract with an ESCo due to its high credit rating and ability to access debt markets at a lower cost of capital.

4.2 – Identified Costs Associated with Specific Initiatives and Potential Sources of Funding

A complete list of all carbon reducing initiatives identified in sections 2 and 3 follows. This section provides a financial overview of each initiative (e.g. estimated project costs, savings projections, and possible funding sources), if known, and summarizes, if relevant, any experience the College has implementing similar initiatives. The initiatives discussed in this report often serve a number of important and complementary goals. In addition to reducing carbon emissions Bowdoin undertakes projects to: expand educational opportunities, improve services, reliability, comfort and safety; reduce operational costs; and strengthen ties to the community. Fortunately, these goals are often complementary. However, meeting diverse goals sometimes means undertaking initiatives that do not have attractive paybacks in traditional economic terms. Net present value (NPV) and rate of return calculations are important but may not fully capture all of the intangible benefits of certain projects. The NPV for replacing specific sections of underground steam line that have reached the end of their useful life, for example, is negative \$1.3 million and the rate of return is negative 1%. While the project needs to be completed for infrastructure reliability reasons, it would not be chosen based on favorable NPV and rate of return calculations. For this reason the financing section does not provide NPV and rate of return information for each project. Instead the focus has been placed on an estimate of avoided cost per ton of CO_2e.[58] This is the key variable that Bowdoin will consider – along with the other factors discussed above – as it decides when to proceed with each of the initiatives discussed below.

The cost per avoided ton of CO_2e for each project was presented in table format in section 2.4.2 and is not repeated here. The projects with negative costs save the College money and should be fast-tracked. The initiatives with positive costs should be implemented – all other things being equal – in order of least to greatest cost.

By 2020 Projects

- By 2020 achieve a 100% reduction from the business as usual scenario from all sources. (From 27,000 tons to 0 tons of CO_2e)

- Improve metering, tracking and auditing capabilities of greenhouse gas emissions and energy usage on campus.
  - The initial cost of the selected energy monitoring and display package is $56,000. Ongoing annual maintenance costs starting in year two are $5,000.
  - As an educational tool that will increase awareness and promote energy conservation in the College's largest buildings, we are modeling annual savings in excess of $5,000. Based on the experience of other schools, who have reported energy reductions between 10% and 50%, we hope to achieve greater savings.
  - The College has added utility meters over the years primarily through capital projects (major renovations and new construction) and a small allocation within the major maintenance budget. This software package will allow the College to monitor on a real-time basis the energy performance of its major facilities.
  - The College plans to use projected savings in the annual operating budget to fund both the upfront investment as well as the ongoing annual maintenance fees.

- Complete the repair and upgrade of the underground steam distribution system.
  - The total project is estimated to cost $2,060,000 and is scheduled to be completed in three phases.
  - Due to increased efficiency, energy cost savings are estimated at more than $40,000 annually; however, this project was driven by the need to improve reliability.
  - The first phase of the steam line replacement is funded out of the 2010 major maintenance budget. Future phases are likely to be funded within the major maintenance budget.

- Complete the cogeneration and boiler replacement project for the campus central utility plant.
  - The total project cost is approximately $3,000,000.

[58] Cost per avoided ton of CO2e was calculated by dividing the estimated NPV of a project by the estimated annual CO2e savings. NPV calculations assume a discount rate of 6%. Detailed calculations for each project are saved in an Excel file for review, update and improvement in future iterations of this report.

    - Expect annual savings of approximately $230,000 (avoided electricity costs) beginning in 2012.
    - While the College plans to use long-term debt to finance the project, it is also exploring possible grant funding.

- Continue the conversion of College facilities from higher carbon distillate oil to natural gas. Continue to collect and use fry oil produced by dining services.
    - Since these conversions will most likely take place as boilers reach the end of their useful life, the College is not incurring a new unbudgeted expense. Equipment and installation costs would be included in the major maintenance budget as part of the normal life cycle replacement schedule.
    - This project results in savings from two primary sources: reduced fuel usage and emissions from higher efficiency boilers and reduced cost (at current market rates) and emissions associated with using natural gas instead of heating oil. Once completed this initiative will save 540 tons CO_2e per year at a cost of negative $77 per ton CO_2e.
    - To date, the College has replaced 20 oil boilers in its satellite facilities with natural gas boilers and has funded the conversion costs through annual operating budget savings. Although the relative cost of #2 oil and natural gas will fluctuate over time, it is possible that the conversion schedule will be accelerated if the cost of boiler replacements prior to the end of their useful lives can be financially justified by expected fuel cost savings.

- Evaluate solar thermal for the two largest users of hot water on campus: Greason Pool and Thorne Hall.
    - Total costs, savings, etc. to be determined during RFP process.
    - The recently installed solar thermal system on the Schwarz Outdoor Leadership Center cost approximately $11,500, with an estimated annual energy savings of $216. The cost per ton of avoided CO_2e is $330. While the project will have a relatively small impact, the installation will provide good working experience with solar thermal systems and provide valuable educational information.

- Implement all conservation measures that have attractive economic returns immediately. These include setting inactive public computers to sleep mode, weatherization and various lighting upgrades.
    - The cost of individual projects ranges from no new net cost in the case of Information Technology staff changing public computers to sleep mode to $20,000 to convert entirely to compact fluorescent light bulbs.
    - Project savings also varies widely from $1,000 per year for the public computer setting modifications to $100,000 per year for switching to compact fluorescent bulbs.
    - The College has successfully weatherized faculty houses using grant funding from the Bingham Foundation and annual operating budget savings and College houses within the major maintenance budget, upgraded lighting in several facilities with Bingham and Efficiency Maine grant funding and set inactive public computers to sleep mode using Information Technology's existing operating budget.

    - These measures will likely continue to be funded by savings in the annual operating budget, grants through Efficiency Maine and other organizations and major maintenance allocations.

- Begin a pilot project to evaluate the performance of diode bulb lighting as soon as practicable. Monitor improvements in the technology and the experience of other institutions with diode lights. Plan for widespread adoption of diode lighting as a replacement to compact fluorescent lights.
    - The pilot project is expected to have little or no cost due to a planned partnership with a manufacturer. Future costs and financing options have yet to be determined.

- Update the greenhouse gas inventory each year and this action plan every second year.
    - While costs for the inventory and plan updates have not yet been determined, they will likely be budgeted during the annual operating budget process.

- Establish new efficiency standards/targets for renovations and construction.
    - The development of standards/targets will be completed using existing resources. These standards/targets are expected to produce significant annual energy savings as well as emissions reductions. The savings will be phased in over time as new space is constructed and renovated. By 2015, the savings compared to the business as usual scenario are expected to be about 450 tons of CO_2e. By 2020 savings are expected to be about 950 tons of CO_2e. By 2050 savings are expected to be about 5,160 tons of CO_2e.

- Work closely with academic departments to infuse the topics of climate change and sustainability throughout the curriculum. Community based learning will continue to provide opportunities to engage students and faculty with the local community and provide students the experience to address the topic of climate change.
    - Funding to derive from existing academic department budgets, the McKeen Center budget and possible grants.

- Continue to offer co-curricular programming in order to inform Bowdoin faculty, staff and students about climate change and provide opportunities for members of the Brunswick community to continue to learn more about this topic.
    - Could be funded within existing academic department operating budgets.

- Connect with Bowdoin College alumni working in the field of climate change and sustainability in order to keep abreast of evolving technologies and initiatives and to connect students with future internship or employment opportunities in this field.
    - Could be funded within existing operating budgets.

- Build upon the success of the first Climate Days. This could include an annual lecture by a prominent speaker from the environmental community focused on climate action, an annual themed meal similar to the "locavore" dinner, and other events designed to engage the students and employees in the College's commitment.

- 2009 Climate Days activities cost approximately $15,000 and were supported by endowed funds. Future events could be supported through the annual operating budget, endowed funds, grants or gifts.

- Participate in national events such as "Climate 350" and Power Shift.
  - These activities could be funded within the existing operating budget through support from student organizations and/or departmental budgets.

- Develop a sustainability and climate-focused pre-Orientation trip that will introduce first-year students to climate action and the College's commitment to carbon neutrality.
  - If structured like existing pre-Orientation trips, this initiative should be covered by the existing pre-Orientation budget.

- Organize an educational outreach program to promote energy conservation across campus.
  - This activity could be funded within the existing operating budget through support from student organizations and/or departmental budgets.

- Develop an "eco-award" to promote energy conservation and environmentally friendly behaviors among faculty and staff.
  - This activity could be funded within the existing operating budget as part of the College's annual service and award recognition program.

- Replace single pane windows in Coles Tower and Hawthorne-Longfellow Library.
  - The estimated total cost of these projects is nearly $2,100,000.
  - Annual savings are estimated to exceed $37,000.
  - Given the high cost and modest energy and carbon impact of these projects, the College would undertake these projects only when the condition of the existing windows necessitates replacement. At that time, the College would likely treat these as capital projects and seek funding through a combination of major maintenance, long-term debt, and external grants.

- Make efficiency a key criterion when the Coles Tower elevator needs to be replaced at the end of its useful life.
  - Since the elevator would be replaced at the end of its useful life, the College would not be incurring a new unbudgeted expense. Equipment and installation costs would be included in the budget as part of the normal life cycle replacement schedule.
  - If replaced with Gen2 or better equipment, annual energy savings would be between 9 and 13 MWh per year and emissions would be reduced by 5 to 8 tons of CO_2e per year.

- Monitor improvements in diode tube lighting technology and plan for widespread adoption of diode lights as a replacement to super T8 fluorescent tube lighting once costs have been cut in half from today's levels.
  - Project costs and savings estimates should be determined when costs reach desired levels. Funding sources will likely include the major maintenance budget, annual operating budget savings and grants.

- Consider geothermal HVAC systems or new heat pump technologies at all new building projects. Implement mechanisms to better evaluate payback and performance metrics compared to an equivalent facility without geothermal systems.
  - Implementation costs and associated savings should be evaluated on a project-by-project basis.
  - When the College initially selected geothermal systems for Osher and West Halls, its engineering consultants modeled annual energy cost savings in excess of $54,000. After the buildings were completed the consultants looked at their actual energy usage and concluded that they were 17.5% more efficient, generating annual savings near $82,000. While the College has seen gains in efficiency over what was originally modeled, it has also encountered engineering and geotechnical issues. At the Museum of Art, significant problems have arisen in connection with the geothermal system, including well, pump and other system failures. Repairs to the museum's geothermal system have been costly. Bowdoin should consider the geotechnical and engineering challenges it has faced in addition to proven energy cost savings when it evaluates future projects. The lessons learned should be shared with the college community and other institutions.

- Develop a wider array of first year courses that can provide more academic opportunities for environmental literacy among Bowdoin students.
  - Could be funded within existing academic department operating budgets.

- Explore models such as "writing across the curriculum" as a mechanism for integrating more content focused on climate change and sustainability throughout the curriculum.
  - Could be funded within existing academic department operating budgets.

- Continue to support faculty and student scholarship on topics related to climate change.
  - Could be funded within existing academic department operating budgets.

- Explore the potential for acquiring carbon offsets through the development of community based energy efficiency programs that could involve faculty, staff and student volunteers similar to programs at other colleges and universities. The capstone course offered by the Environmental Studies Program in which students will craft community climate action plans could provide a framework for moving this type of program forward.

  - Could be funded within existing academic department operating budgets, McKeen Center budget and/or supported by student organization funds.

- Expand the student Eco-Rep program to include one Eco-Rep for each of the 22 dorms on campus. Possibilities also exist for the creation of a renewable energy technology club, led and organized by students.
  - This activity could be funded within the existing operating budget through support from student organizations and/or departmental budgets.

- Increase the use of videoconferencing to reduce travel to meetings and conferences and expanding faculty/staff carpooling program to reduce employee commute miles.
  - Could be funded within existing operating budgets.

- Use only Energy Star rated or better equipment when replacing any non-lighting equipment on campus.
  - Since the equipment would be replaced at the end of its useful life, the College would not be incurring a new unbudgeted expense. Equipment and installation costs would be included in the budget as part of the normal life cycle replacement schedule. Equipment that is replaced as a result of contracting with an outside entity to provide a service (e.g., copiers/printers, laundry, vending, etc.) could be addressed at no cost to the College during the contract negotiation process.

- Prioritize the purchase of hybrid vehicles within the College-owned fleet when current vehicles are up for replacement with the goal to be 100% hybrid by 2020.
  - This initiative could be funded within the operating equipment portion of the annual operating budget. The College has a multi-year vehicle replacement plan that is currently part of the operating equipment budget. This plan is reviewed and revised annually. If existing funding levels are not sufficient to support the conversion to 100% hybrid, a request for additional funding could be made during the budget process.

- Consider planning for a potential 2,000 kW solar PV installation on land that will be acquired at the Brunswick Naval Air Station.
  - Since the property at BNAS has not been acquired and construction plans are not in place, solar PV will be explored in the future under a cost-benefit analysis. The project would be considered viable if PV installation and operating costs are equal to or less expensive than purchasing electricity off the grid.

Beyond 2020 Projects

- By 2050 achieve a 36% reduction in purchased renewable energy credits or carbon offsets required to maintain neutrality. (From 17,200 tons in 2020 to 11,000 tons of CO_2e in 2050)

- Expand the existing educational efforts of campus faculty, staff and students in order to affect behavioral changes that lead to sustained reductions in energy usage and associated carbon emissions.
  - Could be funded within existing operating budgets or submitted as a request during the annual operating budget request process.

- Finish the conversion of College satellite facilities from higher carbon distillate oil to natural gas.
  - See similar initiative above in By 2020 Projects.

- Pursue building envelope and HVAC system improvements for each renovation and new building project. Attempt to achieve a 70% improvement by 2030 compared to current building stock. The 70% improvement is consistent with the provisions in the Waxman-Markey bill that is currently being debated in the U.S. Congress.
  - Address this during the capital project identification and budgeting process. Capital projects are likely to be funded by long-term debt, gifts and/or grants.

- Monitor the improvement of full electric vehicles and begin to phase in their use as soon as the technology becomes commercially viable.
  - See hybrid vehicles bullet. Provided the technology becomes commercially viable, this initiative could be funded within the College's operating equipment budget as outlined above.

- Continue to support high quality renewable energy projects and carbon reduction projects with a sustained commitment to renewable energy credits and/or carbon offsets. Prioritize local projects that have an impact on the local economy and air-shed.
  - Provided increased costs associated with renewable energy credits or carbon offsets are offset by annual operating budget savings (through utility savings, major maintenance savings or other operating savings), the increased commitment could be funded through the annual operating budget. Depending on total commitment, additional funding sources should be explored.

- Strive to be a national leader in the role of liberal arts education in preparing students for a world that will experience wide ranging impacts of a warming world.
  - Implementation costs and associated savings should be evaluated on a project-by-project basis.

- Secure funding for faculty and student scholarship.
  - This initiative could be supported through fundraising, grants and/or the annual operating budget.

- Provide opportunities for faculty, staff and students to be active participants in the identification of solutions at the local, state and federal levels.
  - This initiative could be supported through fundraising, grants and/or the annual operating budget.

- Identify opportunities to continue to educate ourselves as members of a global community.
    - This initiative speaks to College's long held tradition of civic engagement and does not necessarily require additional funding to implement.

4.3 – Financing Overview

The College has successfully implemented and funded a wide variety of energy-savings and emissions-reducing projects in recent years. Primary sources of funding have included annual operating budget allocations, identified operating budget savings, debt financing, fundraising and grants. The College may also fund energy conservation projects with realized budget savings from completed major maintenance projects. Additional funding strategies used successfully by other colleges and universities as well as creative ideas brought forth by the campus community will be explored in the future.

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Access to Bowdoin Studies, Audits and Work Papers

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