A Blueprint for Carbon Neutrality in 2020

October 16, 2009

Bowdoin

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.

This reaffirmation by the College of long-held principles comes at a time when the consequences of inaction are no longer abstract or shrouded in uncertainty. Although study and deliberation must continue, our accumulated knowledge about the effects of climate change demands the identification and implementation of effective solutions that will protect the environment while advancing economic development and security here and abroad. It is clear that we must conduct ourselves in a manner that meets our needs today without jeopardizing the ability of future generations to meet their own.

Bowdoin's ongoing efforts on behalf of sustainability and environmental stewardship take place in our classrooms, on campus, in our coastal research facilities, and in the community.

- *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. Accordingly, the College will continue to incorporate environmental awareness into the daily lives of students, and will 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.*
- *In its daily operations, the College will continue to reduce waste and pollution through conservation, recycling, and other sustainability practices. These efforts will continue to include the investigation and implementation of new technologies and methods aimed at reducing Bowdoin's impact on the environment.*
- *Bowdoin will also maintain its leadership role in the community by applying research and volunteer effort toward indentifying and helping to solve the environmental challenges of Brunswick and Maine.*

It is clear that actions taken or dismissed today will define the future condition of our world and society. As educators, scholars, and citizens long dedicated to the common good and privileged to "count Nature a familiar acquaintance," we, the members of the Bowdoin community, pledge ourselves and our efforts to this cause and to a just and sustainable future.

In 2009, Bowdoin revised its Environmental Mission Statement recommitting the College to environmental awareness and responsibility, and to actions that promote sustainability on campus and in the lives of Bowdoin graduates.

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Bowdoin: A Blueprint for Carbon Neutrality in 2020

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.

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.

SECTION I—What Does Bowdoin's Carbon Footprint Look Like?

As a basic starting point for achieving carbon neutrality, the Climate Commitment Advisory Committee took an inventory of Bowdoin's 2008 greenhouse gas emissions (GHG). This inventory accounts for the six greenhouse gases specified by the Kyoto Protocol and uses the global warming potential of each gas to present results in a common unit: carbon dioxide equivalent (CO_2e). In 2008, Bowdoin was responsible for approximately 24,000 tons of CO_2e. That's the equivalent of the electricity used by 3,329 homes in one year.

More than a third of those emissions were derived from on-campus sources, such as heating, certain refrigerants, and College-owned vehicles (See Scope 1 in Chart 1). A smaller proportion of greenhouse gas emissions were from off-campus activities associated with the College, such as employee travel and commuting and waste disposal (See Scope 3 in Chart 1).

The single-largest source of Bowdoin's emissions were associated with the purchase and consumption of electricity (See Scope 2 in Chart 1)—an area in which the College has been identified as a Green Power Partner by the Environmental Protection Agency for its voluntary support of Maine renewable power projects.

Chart 1 breaks down Bowdoin's 2008 greenhouse gas emissions by three scopes used to categorize the greenhouse gas inventory.

Bowdoin's 2008 carbon footprint already reflects a significant investment in energy efficiency. Since 1970, Bowdoin's fuel consumption has been reduced by 50%—even with the campus doubling its square footage.

These improvements are a result of campus sustainability initiatives that have included conversion of heating systems from oil to natural gas, the use of green building practices in all new and renovated buildings, clean transportation alternatives, and many other energy-conservation strategies.

Bowdoin also has an existing and significant commitment to renewable energy credits. Renewable energy credits (RECs) are the "green attributes" of a unit of electricity, meaning power generated from a renewable source such as wind, hydroelectric, and solar power.

Bowdoin has effectively eliminated greenhouse gas emissions associated with 100% of its electricity usage since 2006 by voluntarily purchasing renewable energy credits for all electricity that is not already mandated to be green under Maine law, an additional 70%.

These renewable energy credits are sourced entirely from generators based in Maine, including the Worumbo hydroelectric project in Lisbon Falls and the wind power project in Mars Hill, Maine.

The College will keep its commitment to Maine renewable energy sources while striving to become carbon neutral through intensified energy conservation and on-campus initiatives. While Bowdoin's strategy is to address any remaining emissions (currently projected to be 23% in 2020) through the adoption of new technologies, additional RECs or appropriate carbon offsets are likely to be an unavoidable component to reach carbon neutrality.

Transmission Line Losses

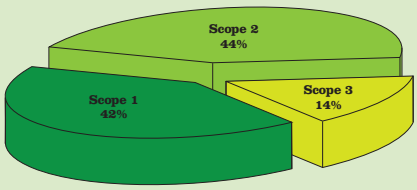
A percentage of Bowdoin's electricity purchase also is attributable to transmission line losses, which are an unavoidable consequence of purchasing electricity produced at remote generation facilities. In 2008, these accounted for 21% of the College's Scope 3 emissions. To offset these losses, Bowdoin must purchase, and the power plant must generate, about 6% more electricity than is actually used on campus. The best way to offset their associated carbon emissions is to reduce electricity consumption on campus.

Chart 1. Bowdoin's 2008 Greenhouse Gas Emissions

Scope 1
Scope 1 = 42% of Total 2008 Inventory
Onsite Fuel Combustion = 95% of Scope 1
College Vehicle Use = 4% of Scope 1
Fugitive Refrigerants = 1% of Scope 1

Scope 2
Scope 2 = 44% of Total 2008 Inventory
Electricity = 100% of Scope 2

Scope 3
Scope 3 = 14% of Total 2008 Inventory
Employee Commute = 57% of Scope 3
Transmission Loss = 21% of Scope 3
College Travel = 18% of Scope 3
Waste = 4% of Scope 3

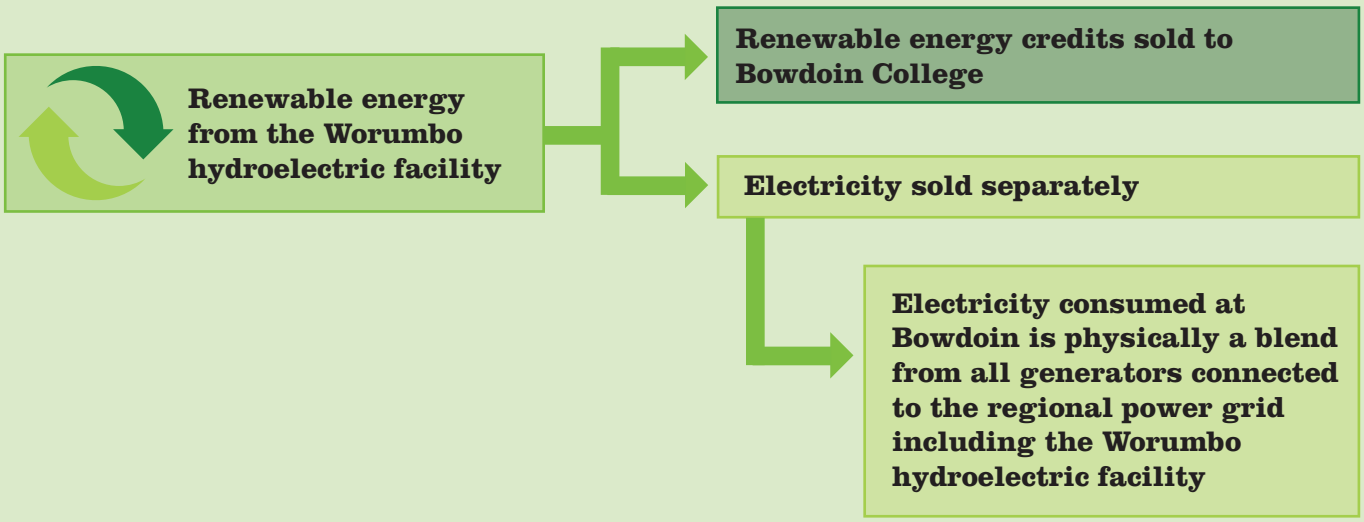


The inventory categorizes greenhouse gas emissions into the three scopes recommended by the ACUPCC in their Implementation Guide for colleges and universities.

What Are Renewable Energy Credits and Carbon Offsets?

Renewable energy credits (RECs) are a way of distinguishing renewable-based electricity from other electricity in the power grid. Renewable electricity providers produce one REC for every 1,000 kWh of electricity they generate. The environmental attributes are unbundled from the electricity and are sold separately. RECs are traded in voluntary and compliance markets, where buyers—such as Bowdoin College—effectively finance the costs associated with green energy generation by purchasing the green attributes. RECs are a way of insuring that green energy goes into the power grid and allow electricity users to directly offset greenhouse gas emissions associated with their consumption.

Carbon offsets are another form of emission reduction credits that allow a purchaser to support greenhouse gas reduction projects somewhere else by "buying" a ton of emissions reductions. These can be used to counterbalance those emissions you can't entirely reduce or eliminate—such as those associated with heating oil. Each carbon offset is equivalent to one ton of avoided CO_2e. Like RECs, offsets are traded in both compliance and voluntary markets and independent verification is required to insure that the carbon savings are real, permanent, additional, verifiable, and enforceable.



SECTION II—What Do We Have to Do to Become Carbon Neutral by 2020?

If the College were to operate under a business-as-usual approach, Bowdoin's greenhouse gas emissions would grow from approximately 24,000 tons in 2008 to 27,000 tons in 2020. This increase is mainly due to a projected expansion of the College from 2,000,000 gross square feet in 2008 to 2,200,000 gross square feet in 2020.

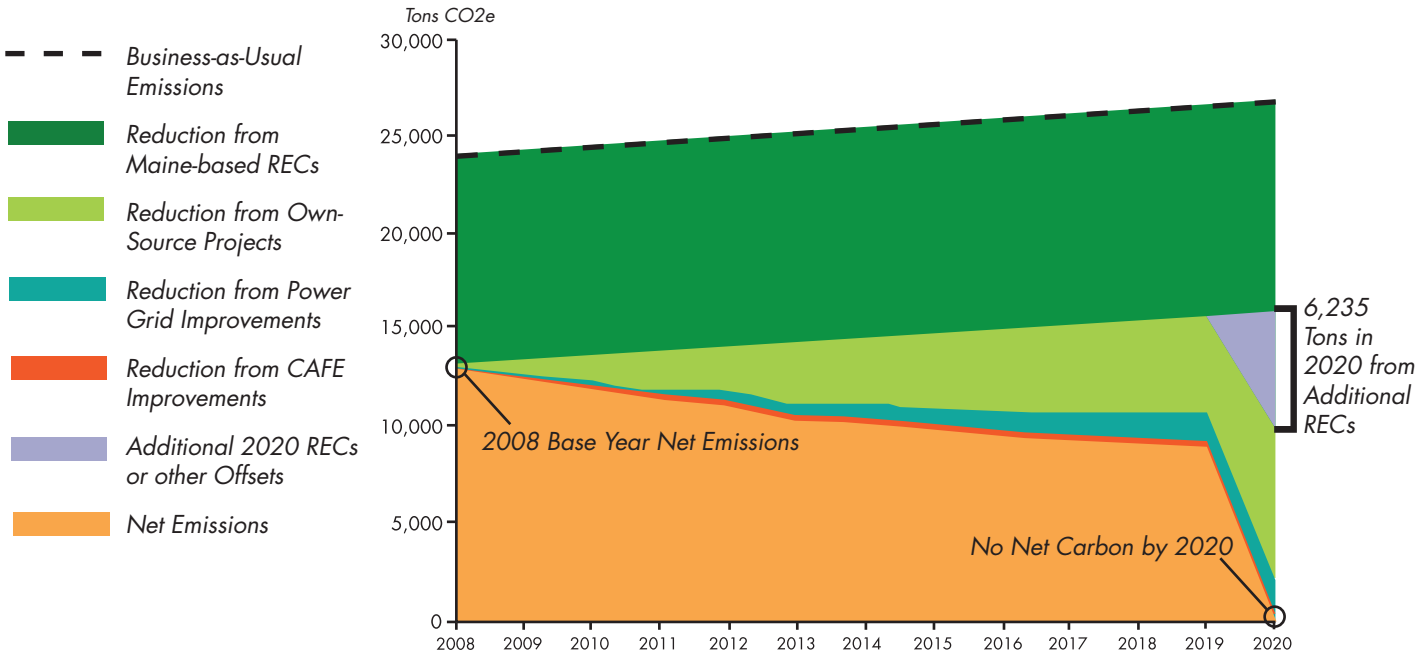
Bowdoin's Climate Commitment Advisory Committee has developed a pathway for achieving carbon neutrality that includes strong measures to reduce our carbon emissions. The crux of this planning rests in the balance between the energy efficiency measures we can implement on campus, the impact of future regulatory changes on the efficiency of the power grid, the effect of fuel-economy improvements for commuters, and, finally, the percentage of renewable energy credits and carbon offsets we will need to use to completely neutralize our carbon footprint.

The overall strategy for making Bowdoin 100% carbon-neutral by 2020:
Existing commitment to Maine-sourced renewable energy credits – 41%

- Own-source emission reductions – 28%
- Grid improvements – 7%
- Commuting improvements – 1%
- Any remaining balance (currently projected to be 23% in 2020) will be addressed through the adoption of new technologies and the purchase of additional renewable energy credits or appropriate carbon offsets

The trajectory of each of these strategies is mapped out in Chart 2.

Chart 2. Strategies for Achieving Carbon Neutrality by 2020



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.

BUSINESS AS USUAL

The business-as-usual scenario is depicted by the dashed black line across the top of Chart 2. This scenario assumes that Bowdoin's physical campus grows by 200,000 square feet by 2020. These growth estimates are based on the October 2003 Bowdoin Master Plan.

Percentage increase in CO_2e emissions: 12%

RENEWABLE ENERGY CREDITS

The dark green area shows the College's long-term commitment to support Maine-based renewable power projects in proportion to the campus's total electricity use in 2008. This level of renewable energy credit purchases has been carried forward and will account for 41% of the total reduction needed in 2020.

Percentage of overall CO_2e reduction: 41%

OWN-SOURCE CARBON REDUCTION

The light green area reflects carbon reductions that will be a direct result of energy-savings and emissions-reducing projects adopted on campus. They have been organized around six overarching areas: electricity conservation; physical plant operations; fuel switching; development of onsite renewables; energy improvements in new construction and renovated buildings; and behavioral changes among faculty, staff, and students. A detailed breakdown of these projects is presented in Chart 3.

Percentage of overall CO_2e reduction: 28%

POWER GRID IMPROVEMENTS

Bowdoin has chosen to account for certain emissions that, while not directly under its control, are directly related to its activities, such as the impact of local, regional, and national policy decisions. The blue area shows one such impact—the expected reduction in carbon intensity of the power grid. New England in general, and Maine in particular, has some of the most stringent laws in the United States supporting the addition of new renewable power generation. These laws have been particularly effective at driving the expansion of new wind power facilities in Maine. A direct result is that the power grid is becoming incrementally less carbon intensive over time. The long- term average load growth in Maine is approximately 1% each year and will essentially be met entirely by new renewable resources. The result is a progressively lower amount of carbon emitted for each unit of power generated in Maine. One thousand kWhs of electricity consumed today has an associated impact of approximately 0.58 tons of CO_2e. By 2020 this will be reduced to 0.46 tons of CO_2e per thousand kWhs.

Percentage of overall CO_2e carbon reduction: 7%

FUEL EFFICIENCIES FOR EMPLOYEE COMMUTERS

The red area shows the expected reduction in emissions from employee commuting, based on new corporate average fuel-economy (CAFE) standards passed by the federal government as well as its completed "cash-for-clunkers" program. These and other measures are accelerating fuel economy improvements in vehicles used by Bowdoin faculty and staff to commute. Bowdoin commuters are expected to track the regional fuel economy averages and increase at a pace of 1.6 mpg/year through 2016. Beyond 2016 a much more modest increase of 0.2 mpg/year has been modeled through 2020.

Percentage of overall CO_2e carbon reduction: 1%

ADDITIONAL RENEWABLE ENERGY CREDITS OR OTHER OFFSETS

An incremental purchase of renewable energy credits or another type of carbon offset is forecasted to be needed in 2020. This purchase will accommodate campus growth, the results of onsite carbon-reduction strategies of uncertain outcome, and any remaining CO_2e that must be eliminated to achieve neutrality. While it is a goal of this plan to avoid undue reliance on the purchase of offsets, it is estimated that an additional purchase will be needed to account for 6,235 tons of CO_2e in 2020.

Percentage of overall CO_2e reduction: 23%

NET GREENHOUSE GAS EMISSIONS

The orange area at the bottom of Chart 2 shows expected net emissions during each year of the analysis period. The orange area intersects zero along the x-axis in 2020 indicating that Bowdoin has successfully cut net emissions to zero. Actual emissions will need to be closely tracked each year and compared to the forecast that has been presented here to determine progress towards achieving neutrality by 2020. After 2020, and before if possible, Bowdoin will strive to reduce its reliance on renewable energy credits and carbon offsets through energy conservation, new technologies, and innovations.

Section III—What Measures Will We Take On Campus to Reduce Carbon Usage?

Strategies to reduce greenhouse gas emissions directly associated with campus operations offer the College one of its greatest opportunities for innovation. They also provide some of the most direct measures of progress in shrinking our carbon footprint.

Bowdoin has targeted decreases in its own-source greenhouse gas emissions that will reduce the College's 2008 Scope 1 and Scope 2 emissions reported in the greenhouse gas inventory (Chart 1) 28% by 2020.

This is an ambitious strategy given the short time frame in which the College proposes to become carbon neutral. It reflects a conscious choice to make Bowdoin's Carbon Neutrality Implementation Plan relevant to the people who comprise our campus today. We want to set goals that encourage our community to become active participants in helping the College achieve carbon neutrality.

Chart 3 depicts specific measures the College may take to reduce own-source emissions. The chart itemizes the CO_2e avoided by undertaking each measure and their respective costs per ton. Measures that have a negative cost per ton of CO_2e represent projects whose projected savings exceed the estimated cost of the project.

Chart 3. Own-Source Carbon Reduction Projects

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	-3,889	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	-80	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	170	TBD	2012	0.71%	0.63%
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		2,531			10.52%	9.41%
Total			7,688			31.97%	28.57%

It's important to understand that the feasibility and timetable for implementing many of these own-source projects are greatly influenced by a variety of financial metrics, including the future cost of electricity, oil, and natural gas; the discount rate used to determine whether a project has an acceptable payback; the capital cost to implement each project; and available financial resources. A rapid and sustained increase in the price of energy, a lower discount rate, or a decrease in equipment costs will likely accelerate the implementation of onsite generation and efficiency projects. In general, Bowdoin's current delivered energy prices have been used and escalated by 2% each year during the analysis period.

Electricity Conservation

Bowdoin's electricity consumption is currently about 20,000 MWh per year. Nearly 45% of the electrical usage on campus is related to lighting. Bowdoin's Climate Neutrality Implementation Plan calls for the installation of compact fluorescent light bulbs (CFLs), more efficient fluorescent tube lighting, and LED lighting. These improvements will allow Bowdoin to reduce its electricity consumption by more than 2,000,000 kWhs per year and save over $285,000 in electricity costs and 1,200 tons of CO_2e annually by 2020.

Bowdoin's policy of replacing non-lighting electrical equipment with Environmental Protection Agency ENERGY STAR-rated alternatives has the potential to net a significant reduction in electricity consumption. Additionally, the College will set some 600 public computers to sleep-mode. These combined changes are projected to reduce electricity usage by almost 870,000 kWhs per year, and will offset nearly 510 tons of carbon emissions annually by 2020.

Physical Plant

Bowdoin is committed to greatly upgrading its energy efficiency by phasing in a series of improvements to its physical plant. Many of these focus on energy used for heating purposes, since the College's location and large number of buildings present ongoing and varied heating challenges. One of the most significant steps will involve the installation of a cogeneration facility in the heating plant. This backpressure turbine will capture energy that is currently wasted by a pressure relief valve located between the boilers and the steam distribution system and convert it into 1,600,000 kWh of "free" electricity—about 8% of Bowdoin's annual electrical requirements.

Other planned improvements include steam line replacement; boiler replacements; installation of new windows at the Hawthorne-Longfellow Library and Coles Tower; and possible replacement of the Coles Tower elevator with a Gen2 elevator. A Gen2 elevator would use half the electricity of a conventional elevator and capture and reuse energy that is associated with the braking process.

Fuel Switching

Bowdoin has already achieved significant energy efficiencies and cost savings by converting its central heating plant from oil to natural gas—reducing greenhouse gas emissions by over 1,000 tons of CO_2e per year. This trend in fuel-switching will continue as fifty-one perimeter buildings are converted from No. 2 oil to natural gas as heating equipment reaches the end of its useful life. The conversion of perimeter buildings to natural gas is expected to reduce emissions by an additional 410 tons of CO_2e per year by 2020. Where feasible, this schedule may be accelerated.

The operation of Bowdoin's vehicle fleet is another source of reduced consumption of fossil fuels. Currently, the College operates about sixty-one cars, vans, and trucks, of which five are hybrid gas-electric vehicles. The entire fleet will be converted to hybrids by 2020,

reducing emissions by 156 tons of CO_2e per year. As an alternative, the College will also explore conversion to electric vehicles and a battery recharging facility, which would yield even greater emission reductions.

The College also is committed to continuing experimentation with new low-carbon alternative fuel sources as they evolve—such as biofuels. Currently, biomass technologies, including wood pellets and wood chips, are prohibited by space and transportation constraints at the central utility plant, but evolving biofuels with higher energy densities may make these technologies feasible in the future.

New Construction and Renovation

There is an inherent tension between the need for physical growth of facilities on campus and the commitment to reduce greenhouse gas emissions produced by the College. Nonetheless, Bowdoin's sustainability standards for renovations and new construction have resulted in a significant reduction of greenhouse gas emissions since 2002, despite expansion of campus facilities. Several historic building renovations have garnered national attention for their energy-efficient designs, and two residence halls have earned Leadership in Energy and Environmental Design (LEED) silver certification, as has the new arena—the first collegiate hockey arena in the nation to receive LEED certification.

Bowdoin will strive to make near-term construction and renovation projects at least 20% more efficient than the average of the 2008 building stock, and to increase efficiency standards incrementally to achieve a 46% reduction of energy usage by 2020. The College will measure its progress by continuing to improve metering and monitoring capabilities on new and renovated buildings to gather information on electricity, water, and steam consumption, and to evaluate the performance of specific upgrades.

Behavioral Changes

Technological upgrades and conservation practices are critical, but they aren't the only solution to reducing Bowdoin's greenhouse gas emissions. A behavioral shift among the entire campus population will be needed if we are to reach carbon neutrality. Although it may seem like a small piece of Bowdoin's greenhouse gas picture, adoption of energy saving habits and reduced personal energy use remains one of the most cost-effective ways for lowering emissions. The continued spread of simple actions among the campus community, such as shutting computers and printers off at the end of each day, could produce a greenhouse gas reduction of 100 pounds of carbon dioxide per person, per year.

The College is installing a new energy-monitoring system that is anticipated to achieve at least a 5% electricity use reduction across campus by 2020. The system includes an easily understood graphical interface that allows building occupants to compare current and historical usage, as well as real-time feedback during energy conservation residence hall competitions. Through an enhanced campus-wide conservation outreach program, Bowdoin also will strive to create positive social norms on campus that encourage greater energy conservation and reduced greenhouse gas emissions.

Onsite Renewables

The College plans to make increasing use of onsite renewable energy generation, including geothermal heating and cooling, heat pumps, and solar power and thermal systems. Currently, geothermal heating and cooling systems are successfully in use in Osher and West halls, as well as in Studzinski Recital Hall, and are helping to reduce our carbon footprint.

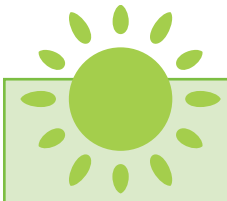
Implementing new technologies is not necessarily trouble free. A recent geothermal installation at the Bowdoin College Museum of Art created significant operational and

financial challenges. The Carbon Neutrality Implementation Plan includes an analysis by College engineers describing the geotechnical and operating issues with the Bowdoin College Museum of Art geothermal system. These "lessons learned" will aid us in understanding and implementing future geothermal systems. We will share this information with colleges, universities, and other interested institutions.

A small solar thermal system recently installed on the Schwartz Outdoor Leadership Center is providing a demonstration site for what may be extensive solar-thermal installations at Greason Pool and Thorne Hall—the two largest users of hot water on campus. Those installations could avoid about 90 tons and 80 tons of CO_2e per year, respectively.

While current renewable energy technologies may not contribute a dramatic reduction in our carbon footprint compared to the financial investment required, they are an important part of the College's environmental mission to be a place where new renewable-energy innovations can be tested and developed. They also present an opportunity to fulfill our educational mission in a new way—by explaining to our students and others how we take risks and resolve problems.

Solar photovoltaic (PV) power has long been recognized as a critical source of renewable energy for the future, but costs have been prohibitive to date.



New advances in solar photovoltaic (PV) technology have greatly increased efficiency and cut costs. This trend is expected to continue and could equalize the costs between grid-based electricity rates and solar PV production in the next 5 to 10 years—especially if electricity prices continue to increase.

Bowdoin hopes to phase in solar PV installations on campus until they provide about 15% of electrical use. A potential 6,300-square-foot solar array on the roof of Farley Field House is estimated to be capable of generating 128,000 kWh of electricity, offsetting 76 tons of CO_2e per year.

The College also is investigating the cost benefits associated with a significant ground-mounted solar electricity system that could be installed on land at the Brunswick Naval Air Station that the College may acquire. Projections for a 10-acre ground mounted system would produce approximately 3,500,000 kWh per year and displace 2,000 tons of CO_2e annually. At current industry prices, it would cost about $10 million to install and would produce electricity at nearly double the current delivered cost; however, production costs could drop to market parity within a decade.

Section IV—How Can We Enrich the Academic Program to Increase Environmental Literacy?

The Bowdoin Climate Neutrality Implementation Plan includes an analysis of Bowdoin's unique strengths in environmental education and begins shaping a blueprint for deepening opportunities for climate change research and innovation among students, faculty, staff, and alumni.

Weaving throughout these discussions are benchmarks for continuing to raise Bowdoin's profile as an incubator of new technologies, cutting-edge climate-change research, and capitalizing on our coastal connections to develop forward-thinking educational approaches for increasing environmental literacy.

The plan also recognizes the important role that community outreach plays in Bowdoin research, service, and academic programs. It evaluates new avenues for increasing opportunities to build sustainable communities both locally and on a global scale.

Environmental Literacy

Bowdoin's academic program is keenly focused to help students develop the skills and creativity that will be required of a new generation of leaders, policymakers, entrepreneurs, and artists faced with the perilous challenges ahead. Courses designed to increase environmental literacy are interwoven throughout the curriculum, with highly multidisciplinary examinations of the physical, social, and geopolitical issues associated with climate change.

Recent courses linked directly to climate change and sustainability include Global Change Ecology; Food and Agriculture; Building Healthy Communities; Gulf of Maine and Bay of Fundy; Marine Conservation Ecology; Earth Climate History; Paleo-oceanography; Environmental Education; Sustainable Architecture; Coral Reef Biology; Sustaining Maine's Northern Forest; and Telling Environmental Stories.

Many courses within the arts and humanities are geared toward understanding the tensions between economic growth and ecological degradation, the power of the arts to communicate about our deepest connections to the world, and the insights civilizations past and present bring to bear on these issues.

The Climate Neutrality Implementation Plan targets several key areas of projected growth in the academic program that will widen the impact of Bowdoin's environmental literacy efforts and give students new opportunities to connect their learning with real-world environmental challenges.

Encouraging Interdisciplinary Collaboration

Because climate change is happening so rapidly, disciplines across the Academy will need to be reinvigorated within an environmental context. In recent years, Bowdoin has brought leading environmentalists to campus and developed several education initiatives linked to climate change and sustainability, including symposia on indigenous environmental knowledge; cultural and social responses to climate change; and polar responses to a warming world.

The College is exploring several new approaches to encourage interdisciplinary collaboration among faculty and programs so that Bowdoin can help lead discussions about new frontiers in climate change scholarship and research.

The Environmental Studies Program is extending its outreach to other academic programs, including Earth System Science (biology, chemistry, geology, physics, math), Africana Studies (Africana studies, history, sociology/anthropology), and Psychology. It is hoped that these multidisciplinary clusters will lead to new courses, research, or a shared speaker series around the topic of climate change.

Expanded Sustainability Research Opportunities

Core courses in the Environmental Studies Program engage students directly with important sustainability research affecting the region, including service learning projects analyzing phosphorous pollution, water quality, and land history of the Androscoggin and Kennebec rivers.

Bowdoin's two off-campus research stations—the Bowdoin Scientific Station on Kent Island and the Coastal Studies Center (CSC) on Orr's Island—also offer students and faculty unique opportunities for coastal ecology studies. Bowdoin's Merrymeeting Bay/Kennebec Estuary Research Program has involved dozens of Bowdoin faculty and students since 2001 and is yielding significant field data to help state and federal restoration efforts of this unique estuarine waterway.

The College is in the process of developing expanded missions for these coastal field stations and programs. Among the possibilities is the development of a summer institute at the CSC, where scholars and students from around the country could participate in courses and research related to coastal issues and the environment.

Strengthened Community Outreach

Students, faculty, and staff at the College are developing innovative approaches to solving climate change at the local, regional, and national level, and will continue to do so through community-based learning and research; student summer and academic year fellowships; student internships and volunteerism; off-campus study experiences; faculty and staff service; and College-community engagement.

Beginning in fall 2009, the Environmental Studies Program will offer its first capstone course, which will focus specifically on the development of climate action plans for two area communities. Other ongoing community action programs include Psi Upsilon Environmental Fellowships and Common Good Day.

This year, the student chapter for Habitat for Humanity is working to connect students on campus with a regional weatherization program. Students will be trained in weatherization techniques and then participate in projects to weatherize homes of low income residents. This initiative is just one example of how students can participate in community service while also having a direct impact on reducing energy usage in the community. In cooperation with the Joseph McKeen Center for the Common Good, the Environmental Studies Program and Sustainable Bowdoin will identify other opportunities for students to engage with area agencies in order to work directly on projects that can contribute to the reduction of greenhouse gas emissions both on and off campus.

Broadened Campus Engagement

The College will strive to create a campus culture in which sustainability practices become a deeply ingrained part of daily routines. Among areas of discussion is the creation of an educational outreach program to promote energy conservation across campus. A critical component of the climate plan is to share our vision and experiences, as well as our successes and failures, with the greater Brunswick community, alumni, parents, and other audiences.

Building on the success of the 2009 Climate Days, the College will continue to devote time each year to focus on climate related issues and the College's climate commitment. Other plans for the near future include development of a sustainability-focused pre-Orientation trip; expanding the reach of the student EcoRep program to each of the 22 residence halls on campus; participation in national climate action events such as "Climate 350" and Power Shift; and increased use of videoconferencing to reduce travel to meetings and conferences.

Connections with Bowdoin alumni will be strengthened to connect students with future internship or employment opportunities with those working in evolving technologies, green businesses, scientific research, and other initiatives related to climate change.

Bowdoin's Cluster of Climate Change Experts

Bowdoin is a leader among liberal arts colleges in the breadth of its faculty expertise in climate change, which spans boreal, atmospheric, marine, Arctic, and Antarctic environments. Bowdoin faculty research has made significant contributions to the climate change literature and continues to garner millions of dollars in external grant funding from organizations including the National Science Foundation and National Aeronautics and Space Administration (NASA).

Current primary areas of climate research include:

- Elevated CO_2 in forest ecosystems
- Impact of climate warming on high-latitude ecosystems
- Analysis of global changes in atmospheric CO_2 and O_2
- Changes of marine plankton communities and productivity
- Climate policy
- Understanding relationships between climate and Inuit cultures of Labrador and Greenland
- Investigating the polar ice cap as an archive of past atmospheric mercury

SECTION V—What Is the Cost of Erasing Our Carbon Footprint?

Bowdoin 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.

Given the turmoil of the current economic environment, the College has elected, among other measures, to put new major capital projects on hold and to keep operating costs flat through 2011. Energy-savings and emissions-reducing initiatives selected to be completed in the next several years will therefore need to generate operating budget savings, be funded within existing budgets, or have external sources of funding, such as gifts or grants.

Several funding alternatives are under consideration:

Annual Operating Budget Savings and Allocations

A major source of revenue will be realized through reductions in expenses that are a direct result of several energy conservation initiatives on campus. These annual operating budget savings can be applied to such projects as conversion of oil-fired boilers in perimeter buildings to natural gas. In addition to budget savings, allocations approved during the annual budget process may fund carbon-reducing initiatives. For example, energy conservation projects are funded within the deferred maintenance budget each year.

Fundraising

The recently completed Bowdoin Campaign included substantial funding for academic programs, student opportunities, and new building construction. The College may consider further ways to engage alumni and friends who are interested in supporting the College's commitment to achieve carbon neutrality by 2020.

Grants

A growing number of foundations and organizations are granting support for climate change research and advances in renewable energy generation at colleges and universities. The College recently formed a "green grants" committee to actively explore these grant funding opportunities for greenhouse gas reducing initiatives.

Long-term Debt

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. Long-term debt, with possible grant funding, is being used to finance the boiler replacement and cogeneration project at the central utility plant.

Pilot Projects

The College is identifying ways in which it could partner with manufacturers of new energy saving products to test and evaluate new technology at no cost or reduced cost. For example, the College recently partnered with a lighting company to test new LED technology at several locations on campus.

Energy Service Companies (ESCos)

The College may consider contracting with an ESCo, which would implement initiatives with guaranteed energy savings on a performance-contracting basis, and provide third-party financing. To date, the College has not made use of performance contracts due to its strong credit rating and its ability to access debt markets at a lower cost of capital than most ESCos.

Prioritizing Project Implementation and Financing

The cost of implementing the specific campus-based initiatives outlined in Chart 3 ranges from no net new cost to the College to estimated costs in the millions. It will be an ongoing, shifting process to determine the financial feasibility of many of these projects, since those costs will likely change over time based on market conditions, technological developments, and other factors.

Many of Bowdoin's strategies for achieving carbon neutrality can be accomplished through procedures and expenditures that are already part of the College's operations. Most of the academic initiatives proposed in the Climate Neutrality Implementation Plan can be accomplished through allocated annual departmental budgets or student organization budgets, with possible additional funding from grants. Behavioral changes can be implemented at no additional cost.

Some projects will be undertaken and financed as part of scheduled maintenance and replacement and many will pay for themselves over time. Scheduled maintenance projects include conversion of College boilers from higher carbon distillate oil to natural gas; lighting improvements; Coles Tower elevator replacement; purchase of hybrid vehicles; and replacement of equipment and appliances with Energy Star-rated models.

Other projects will require substantial investment and, as a result, will necessitate review and approval by the administration and the board. Details of some of those initiatives are outlined in Chart 4.

Chart 4. Projects Requiring Substantial Investment

Project: Complete the cogeneration and boiler replacement at the central utility plant

Investment strategy: Total project cost is approximately $3 million, with expected annual savings of approximately $230,000 in avoided energy costs beginning in 2012. Long-term debt and possible grant funding will finance this project.

Project: Replace single-pane windows in Coles Tower and H–L Library

Investment strategy: Estimated total cost of these projects is $2.1 million, with annual savings estimated to exceed $37,000. Given the high cost and modest energy and carbon impact, these projects would occur only when the condition of the existing windows necessitates replacement. The College would likely treat them as capital projects and seek funding through major maintenance, long-term debt, and external grants.

Project: Repair and upgrade of the underground steam distribution system

Investment strategy: This initiative is driven by the need to improve reliability of existing systems. Project costs are estimated at $2,060,000, with increased energy cost-savings estimated at over $40,000 annually. Because of the investment required, the project is scheduled to be completed in three phases and will be funded over time within the major maintenance budget.

SECTION VI—What Do We Have to Do to Remain Carbon Neutral After 2020?

Once carbon neutrality has been achieved in 2020, the Climate Commitment Advisory Committee recognizes that Bowdoin's work will not be finished. The College will continue to grow, making carbon neutrality an ongoing challenge.

The committee recommends that the long-term goal of the College should be to reduce its reliance on renewable energy credits and carbon offsets and increase onsite renewable energy and efficiency to remain carbon neutral. The Carbon Neutrality Implementation Plan contains several recommendations for energy conservation and building renovations after 2020 (see Chart 5). If funded and implemented, these post-2020 projects could reduce the need for renewable energy credits and carbon offsets significantly—even after accounting for the expected growth of the College. By 2050, these projects could double the impact of onsite efficiency and renewable energy projects toward carbon neutrality.

Chart 5. Post-2020 Carbon Reduction Projects

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	-80	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)	787	N/A	Ongoing	3.27%	2.92%
	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			7,413			30.83%	27.55%
Cumulative Total Including Pre 2020 Projects			15,101			62.80%	56.13%

Recognizing that it is difficult to predict what technologies may be available in ten years, it will be important for the College to regularly reassess the steps being taken to maintain carbon neutrality and adapt to the needs and opportunities of an ever-changing world.

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