HAVERFORD

CLIMATE ACTION PLAN

MARCH 6, 2012

Haverford College, while a non-sectarian institution, has Quaker origins which inform many aspects of the life of the College. They help to make Haverford the special college that it is, where the excellence of its academic program is deepened by its spiritual, moral, and ethical dimensions. These show most clearly in the close relationship among members of the campus community, in the emphasis on integrity, in the interaction of the individual and the community, and in the College's concern for the uses to which its students put their expanding knowledge.

- from the Haverford College Statement of Purpose

I suggest that you preach truth and do righteousness as you have been taught, whereinsoever that teaching may commend itself to your consciences and your judgments. For your consciences and your judgments we have not sought to bind; and see you to it that no other institution, no political party, no social circle, no religious organization, no pet ambitions put such chains on you as would tempt you to sacrifice one iota of the moral freedom of your consciences or the intellectual freedom of your judgments.

—President Isaac Sharpless, Haverford College Commencement, 1888

"Quaker business process and decision-making practice–with all its strengths and imperfections– has long served as a powerful connection to the College's Quaker roots. Taking the time to carefully hear and consider the wisdom in each of us can be cumbersome, but it often results in a stronger, more unified community of teachers, learners, and staff."

–Emma Lapsansky-Werner, Professor of History

"If we unbalance Nature, human kind will suffer. Furthermore, we must consider future generations: a clean environment is a human right like any other. It is therefore part of our responsibility towards others to ensure that the world we pass on is as healthy as, if not healthier than, we found it."

— The Dalai Lama

"Be patterns, be examples in all countries, places, islands, nations wherever you come; that your carriage and life may preach among all sorts of people, and to them; then you will come to walk cheerfully over the world, answering that of God in everyone"

– George Fox, 1656

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Executive Summary

Haverford College has been committed to sustainability for many years, with incorporation of sustainable principles and practices within the College community, including conservation of natural resources, promotion of energy conservation, conscientious production and consumption of food, and adoption of green building standards. Haverford's Committee on Environmental Responsibility was created in response to a Fall 2000 plenary resolution by the Haverford Student's Association and is comprised of a 10 member body of faculty, staff and students. The committee meets on a weekly basis to discuss and evaluate current and proposed environmental and sustainability issues at the College. Former President, Tom Tritton, signed the American College and University President's Climate Commitment (ACUPCC) associated with Association for Advancement of Sustainability in Higher Education (AASHE), in the summer of 2007, shortly before leaving office. In December 2007, President Steve Emerson resigned the commitment. The Commitment recognizes the unique role colleges and universities have in addressing the global climate crisis, and places into effect reduction measures including GHG emissions benchmarking, mitigation strategies, and campus and community initiatives.

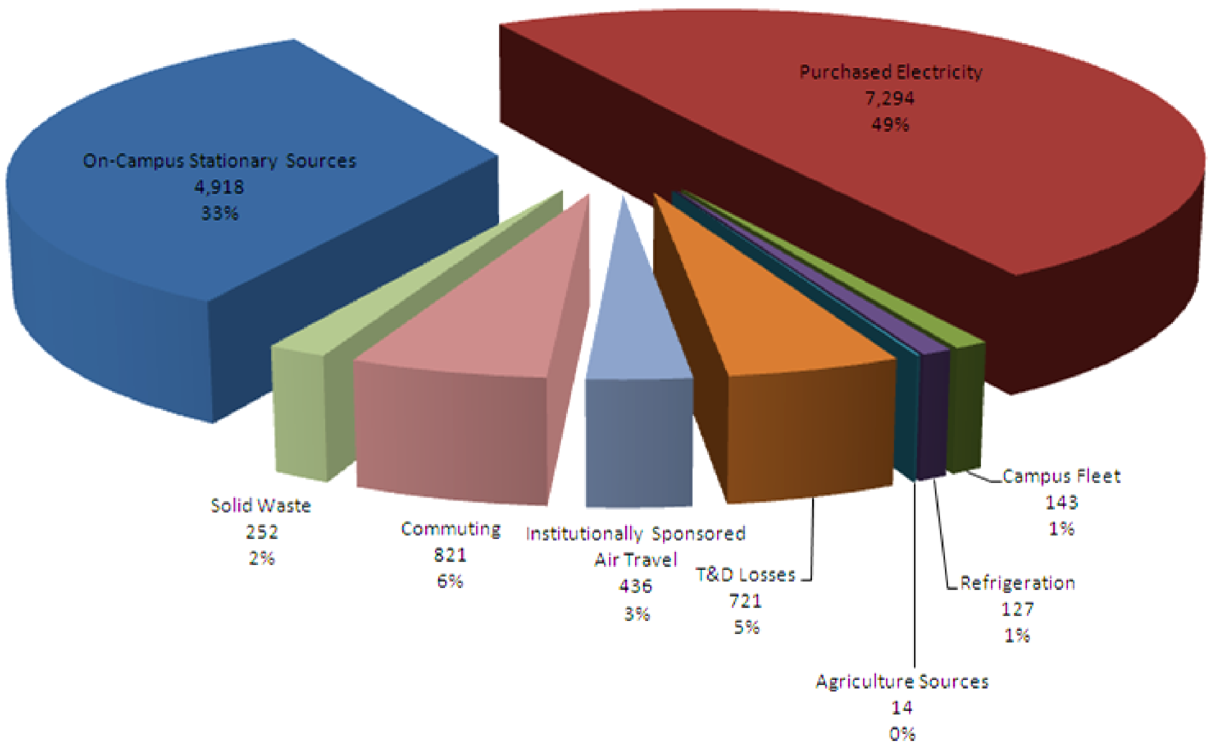
The Commitment obligated the College to:

- submit within two months information on the institutional structure for developing their climate action plans, including designating the institutional liaison and two tangible actions to be implemented before the end of year 2;
- report the results of their GHG emissions inventories within 1 year;
- submit their climate action plans within 2 years;
- update their GHG emissions inventories within 3 years and at least every other year thereafter (years 5, 7, 9 etc.);
- submit narrative reports describing progress in implementing their climate action plans within 4 years and at least every other year thereafter (years 6, 8, 10 etc).

The publication of this climate action plan represents substantial progress on our path to net climate neutrality as we now have a framework by which we believe that this goal is achievable. To begin, Haverford College has set a goal of the year 2017 to achieve a 9% reduction of "net" campus emissions. Our gross campus emissions during fiscal year 2011 totaled 14,726 metric tons carbon dioxide equivalents (MTCDE). The distribution of these emissions among the Scope 1, 2 and 3 categories defined by the ACUPCC are as follows:

Scope	Source	Emissions (MTCDE)
1	On-Campus Stationary Sources	4,918
1	College Fleet	143
1	Refrigeration	127
1	Agriculture	14
2	Electricity	7,294
3	Faculty/Staff Commuters	821
3	Institutionally Sponsored Air Travel	436
3	Solid Waste	252
3	Transmission and Distribution Losses	721
Total Gross Campus Emissions (FY 2011*)		14,726
Emissions Reductions (Renewable Energy Certificates)		(6,874)
Net Campus Emissions		**7,852**

* Baseline year



The functional distribution of our emissions demonstrates that on-campus stationary sources (primarily heating) and purchased electricity represent 87% (Purchased Electricity + On-Campus Stationary Sources + T&D Losses) of the emissions for the College.

In order to achieve climate neutrality, we have analyzed a range of options that could help us achieve this goal. This process of analyzing data on energy and emissions was conducted in concert with campus growth under the Campus Master Plan developed by Haverford College. Ultimately, we have chosen an approach to climate neutrality that focuses on reducing the amount of energy consumed by the College, using the energy we do consume more efficiently, employing renewable and alternative energy and using offsets as our final tool when all other reasonable means of emission reduction have been exhausted.

Highlights of the major mitigation strategies are as follows:

- Improve Efficiency of Existing Utilities – we will develop a utility strategy to include equipment that is not only environmentally responsible, but also has the flexibility to vary fuel sources as price points in the utility markets change with market demands and availability. Zoned or district utility plants will be evaluated against a central plant strategy to determine cost and environmental viability and impacts.
- Re-Commissioning of existing building systems to ensure efficient operations and reduced energy consumption.
- Renovation of existing buildings and construction of new buildings to higher energy standards – will allow us to provide modern campus facilities to our constituents while reducing energy and water consumption associated with existing and proposed campus buildings and building projects.
- Modernization of our heating infrastructure – will allow for cogeneration/trigeneration through the use of combined heat and power plants, lowering our grid source electricity requirements and providing hot water and chilled water to serve heating and cooling needs.
- Deployment of Renewable Energy Systems - Installation of on-campus photovoltaic arrays for at least three sites on campus will be seriously considered as a viable source of renewable energy to support the energy needs of the College.
- Reduction of end-use energy consumption – through enhancements to our campus Building Automation System. Many projects have been identified that will reduce the heating and cooling energy on campus and electricity consumption through improvements of lighting fixtures and controls. The development of holiday and summer curtailment policies to reduce consumption of energy and emissions during times of relatively low occupancy will also have a significant impact.
- Exploration of ways to reduce the Scope 3 emissions through implementation of incentives to use public transportation and improvements in the fuel efficiency of our campus fleet.

In addition to the above, we will continue to develop and offer educational and research opportunities pertaining to sustainability and climate neutrality to students across campus, promote research in these areas through institutional support both in funding and materiel, advertise our efforts through effective communication pieces on-line and in print format, and develop effective outreach programs to both members of the campus community and to those in the wider community through conferences and distance learning courses.

Haverford College has taken the first steps toward neutrality by:

- Incorporation of sustainable principles and practices within the College community, including conservation of natural resources, promotion of energy conservation, conscientious production and consumption of food, and adoption of green building standards.

- Enactment in 2005 of a building policy at Haverford College stating that all new construction will be environmentally friendly; by former University President Thomas Tritton.

- Purchase of all electricity from Renewable Energy sources since 2005.

- Becoming a signatory to the American College and University President's Climate Commitment (ACUPCC).

The College is committed to long-term climate neutrality and intends to set additional, interim targets to progressively lower emissions until climate neutrality is achieved, while continuing to develop at better understanding of its overall climate footprint.

To date the College has not set a specific date for reaching climate neutrality.

List of Acronyms

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College & University Presidents' Climate Commitment
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BAU	Business As Usual
CAAA	Clean Air Act Amendments
CAP	Climate Action Plan
CACP	Clean Air Cool Planet
CCC	Campus Carbon Calculator
CDE	Carbon Dioxide Equivalent
CER	Committee on Environmental Responsibility
CER	Certified Emissions Reduction
CO_2	Carbon Dioxide
CO_2e	Equivalent Carbon Dioxide
DCV	Demand Control Ventilation
eGrid	Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FY	Fiscal Year
GHG	Greenhouse Gas
GSF	Gross Square Feet
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
kW and kWh	kilowatt and kilowatt hour
LEED	Leadership in Energy & Environmental Design
MMBTU	1 million BTU, or thousand thousand BTU
MT	Metric Ton
MTCDE	Metric Tons CO_2 Equivalent
PECO	Philadelphia Electric Company
PESC	President's Environmental Sustainability Committee
PJM	Pennsylvania New Jersey Maryland
PV	Photovoltaic
REC	Renewable Energy Certificates
RFCE	Reliable First Corporation East
RPS	Renewable Portfolio Standard
T&D	Transmission & Distribution
USGBC	US Green Building Council
VAV	Variable Air Volume
VER	Verified Emissions Reduction
VMM	Virtual Met Mast
WRI	World Resource Institute
WTE	Waste to Energy

1. Introduction

The CAP is organized using the general format provided by the ACUPCC Implementation Guide, with one additional section at the end. The seven sections of Haverford's CAP are as follows: Section 1 – ***Introduction*** provides background about Haverford College and briefly describes why we have made this commitment. Section 2 – ***Campus Emissions*** and Section 3 – ***Mitigation Strategies*** present data on past emissions and include our proposed methods to reduce emissions and meet the goal of climate neutrality, respectively. We strive to conserve natural resources and promote energy conservation, adhere to green building standards, support the conscientious production and consumption of energy and food, and reduce waste. Section 4 – ***Educational, Research, Community Outreach Efforts***, describes how we as an educational institution are making sustainability part of our academic mission and culture both on and beyond campus. Haverford is committed to advancing its educational, research, and community outreach efforts toward the goal of creating an environmentally literate and responsible community. In a time when public understanding of global climate change is waning according to some recent polls, this need is more acute than ever. Section 5, ***Tracking Changes***, outlines milestones and targets for achieving our goals. The College assumes responsibility and accountability for its efforts in the area of sustainability, and is committed to tracking its progress as set forth in the CAP. Finally, an additional section (Section 6: ***Assumptions***) describes in part the assumptions made while developing the mitigation strategies.

Haverford's primary goals both support the CAP and extend beyond it, and stress the incorporation and expansion of sustainable principles and environmentally responsible fiscal practices within the College community. Understanding that the global climate crisis has no one solution, this document outlines Haverford's long-term commitment to identify and implement solutions to the climate crisis and to act responsibly as we fulfill our Quaker rooted mission.

2. Campus Emissions

Effective climate action planning requires an understanding of the greenhouse gases emitted by the College. Toward that end, Haverford undertook the task of collecting several years of data to calculate and categorize the College's greenhouse gases and their sources.

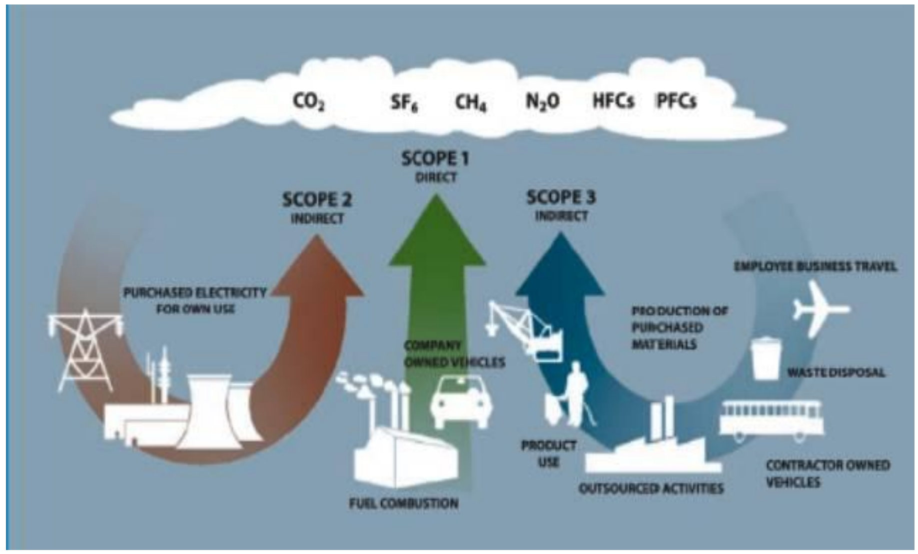
2.1 Methodology

The Campus Carbon Calculator, developed by Clean Air-Cool Planet (CACP), was used to calculate the greenhouse gas emissions. The calculator contains a series of spreadsheets created by Clean Air-Cool Planet and was developed in collaboration with others, including but not limited to, the Intergovernmental Panel on Climate Change (IPCC) Third Assessment, the U.S. Environmental Protection Agency's (EPA) Emissions & Generation Resource Integrated Database (eGRID), Energy Information Administration (EIA), and the World Resources Institute (WRI). Following IPCC and WRI guidelines, the emissions calculated for Haverford have been converted to metric tons carbon dioxide equivalent (MTCDE). This unit is used to report total releases by Scope (i.e., Sector) and summarize the Haverford greenhouse gas (GHG) inventory. A copy of the input data and summary information from the CACP calculator are provided in Appendix A, Greenhouse Gas Emissions Inventory. During the process of assessing our emissions the CACP calculator has undergone several revisions. The emissions inventory information presented in Appendix A was entered into and calculated with version 6.7, the most recent calculator available from CACP at the time this report was prepared.

Data were obtained from several offices at Haverford including Facilities Management, Dining Services, Human Resources, Finance and Planning, and Institutional Research. The base year data reflect a period from July 1, 2010 through June 30, 2011, the Haverford fiscal year (July to June), not the calendar year. As is typical of any data-gathering undertaking, data were not available for every year of the study for each sector or source. However, the data obtained were sufficient to interpolate and thereby complete a comprehensive emissions inventory. The available data were entered into the appropriate spreadsheets and emissions output determined. Haverford has now calculated greenhouse gas emissions for multiple years and while the quality of the input data has grown with each subsequent year, remaining assumptions used in the calculation of the GHG inventory are included in Section 6 of this report. The emission estimates for on-site energy generation and purchased energy are based on regional and national average emission factors for the various fuels used. Included in the waste section are emissions associated with the incineration of solid waste generated by the College. The refrigeration section examines the release of hydrofluorocarbon (HFC) and perfluorocarbon (PFC) refrigerants that are primarily sourced from the on-campus chilled water and refrigeration equipment, and which are collectively known as fugitive emissions.

As would be expected, there are several sources of emissions that are not included in this inventory. For example, the emissions generated by the production and transportation of materials purchased by Haverford are not included, as they would fall outside of the 'Boundaries' of Haverford's control. In addition, the emissions resulting from off campus activities of students/faculty/staff also fall outside of Boundaries. Haverford collected data for student, staff, and faculty commuting for the Fiscal Year (FY) 2011 only, and we include them here. Because only one year of data was collected, however, historic trends for commuting mileage and habits were not able to be established. These limitations do not imply that these sources of greenhouse gases are insignificant. The intent of the inventory is to provide a basis on which to develop an environmentally and economically sound GHG management and reduction policy for Haverford College.

Figure 2-1 GHG Emissions and Scopes



2.2 Sources of Greenhouse Gas Emissions

The WRI places GHG emissions sources into three different categories known as Scopes. Scope 1 emissions are those that are attributable to on-campus energy generation (heat, hot water, steam, and electricity), the campus fleet, fugitive emissions (refrigerant leaks) and agricultural activities. Scope 2 emissions are those associated with indirect sources of emissions such as purchased electricity, steam and chilled water. Scope 3 emissions are comprised of 'other' emissions such as College sponsored air travel, commuting, solid waste, and electrical transmission and distribution losses. These nine areas have been identified as the primary sources of greenhouse gas emissions on the Haverford campus. They are further described as follows:

Scope 1

2.2.1 *On-Campus Stationary Sources*

On-campus stationary sources, composing the majority of GHG emissions, include fuel consumed on campus to produce energy for heating and hot water. Haverford uses distillate fuel oil (#2 oil) and natural gas for on-campus energy production. Natural gas is used predominately at the campus central heating plant (although it has dual fuel capability - the ability to burn either fuel oil or natural gas) and fuel oil at small structures not served by the centralized infrastructure.

2.2.2 *College Fleet*

Haverford College owns and operates vehicles to assist in the daily operations of the College.

Scope 1

Through an examination of the composition of the College fleet, the total volume of gasoline and diesel fuels used to power these vehicles was calculated. Electrically powered carts are used on campus as well, and those emissions are included below under Electricity.

2.2.3 Refrigeration

Refrigerants are used for cooling in various areas of the College. The impact of refrigerants varies by type according to their 100 year global warming potential (GWP). Quantification of the loss of refrigerants over time and using the GWP for the gases allows for the calculation of the resultant GHG emissions, often referred to as fugitive emissions.

2.2.4 Agriculture

Agricultural activities at Haverford are limited to the application of fertilizer on the athletic fields, as an animal husbandry program does not exist. The nitrogen content of the fertilizer contributes to the emission of oxides of nitrogen, and also influences carbon dioxide emissions from soil-based microbes.

Scope 2

2.2.5 Electricity

The electricity sector of the inventory examines both the total amount of kilowatt-hours of electricity purchased by the College and the carbon intensity associated with the generation of the consumed electricity.

Scope 3

2.2.6 Faculty/Staff and Student Commuters

The total commuter miles driven annually by faculty, staff and students were calculated in order to determine the GHG emissions associated with this travel.

2.2.7 Institutionally Sponsored Air Travel/Study Abroad

The College sponsors travel for faculty, staff and students to various events throughout the year. Surveys of students, faculty, and staff were used to estimate air travel miles. Because Haverford encourages students to study abroad, air mileage associated with this activity is included. It is important to note that the ACUPCC does not require that study abroad be included in this calculation and may result in inconsistent comparisons when contrasting with other academic organizations.

2.2.8 Solid Waste

Haverford College generates waste (i.e. unrecyclable trash) through its daily operations. Depending on the method of waste disposal, solid waste may generate greenhouse gases, or rather, may reduce the emissions based upon a beneficial reuse of the material, or destruction of emitted greenhouse gases via flare or other control technology. Solid waste from Haverford is incinerated at a Waste to Energy Plant, which results in an overall greenhouse gas benefit (net reduction). While the production of solid

Haverford

Scope 3

waste yields us a GHG net reduction, we will continue to strive to reduce solid waste on-campus.

2.2.9 Transmission and Distribution Losses

A sub-component of Electricity, this sector represents the GHG emissions associated with losses of electricity between the generation sources and the end user. Because the electricity sector above deals only with end use consumption of electricity and the carbon intensity of generation, this category is a sector unto itself, as mitigation of purchased electricity via Renewable Energy Certificates (RECs) does not abate emissions from transmission and distribution losses.

From the sum of these sources (or scopes), it is possible to obtain an estimate of our total GHG emissions. For fiscal year 2011, our "net" campus emissions totaled 7,852 MTCDE. A summary of GHG emissions by scope and sector is presented in Table 2-1. A functional distribution of emissions is presented graphically in Figure 2-2.

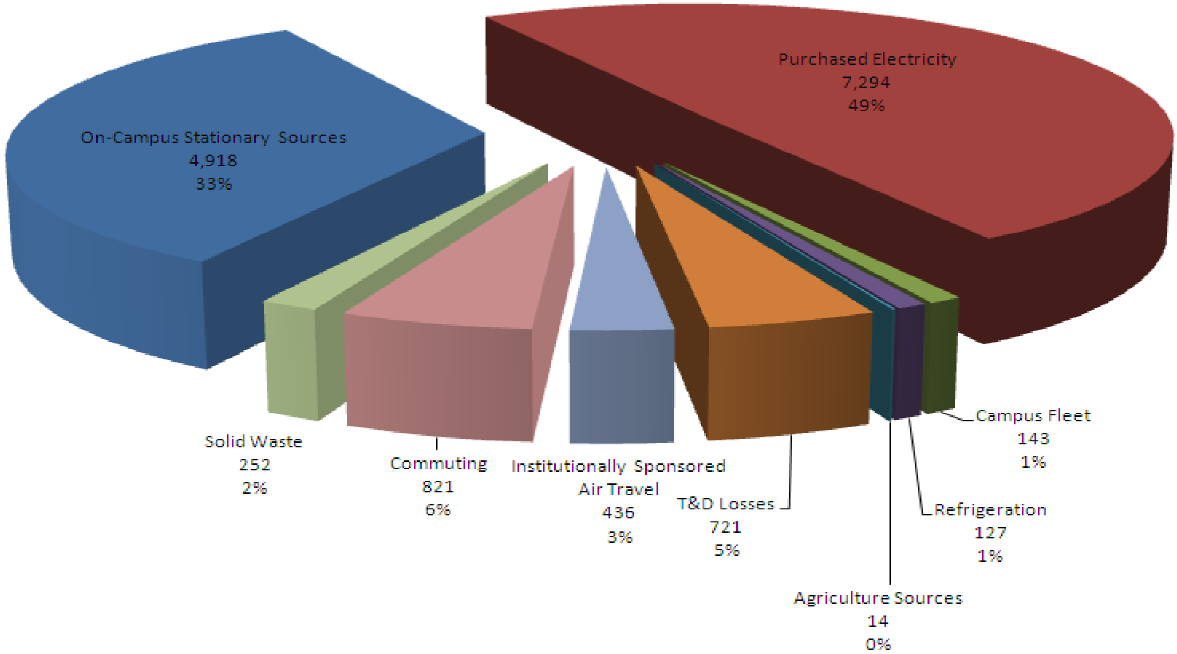
Table 2-1 Campus Emissions (FY 2011) Summary by Scope & Source

Scope	Source	Emissions (MTCDE)
1	On-Campus Stationary Sources	4,918
1	College Fleet	143
1	Refrigeration	127
1	Agriculture	14
2	Electricity	7,294
3	Faculty/Staff Commuters	821
3	Institutionally Sponsored Air Travel	436
3	Solid Waste	252
3	Transmission and Distribution Losses	721
Total Gross Campus Emissions (FY 2011*)		14,726
Emissions Reductions (Renewable Energy Certificates)		(6,874)
Net Campus Emissions		**7,852**

* Baseline year

Haverford

Figure 2-2 Campus Emissions (FY 2012) Functional Distribution



2.3 Campus Growth & Business as Usual Trends

2.3.1 Campus Growth

Haverford has developed a Campus Master Plan with assistance from consultants Venturi, Scott Brown and Associates. Their recommendations for future campus growth and utility infrastructure include the construction of new dormitories to bring students closer to campus. Recommendations for additional academic, research, athletic and campus life facilities were also made. Overall net campus growth is projected at approximately 1,000,000 gross square feet (GSF) which relates to a 700,000 GSF net gain for the college. As new resident halls are built on campus, the Haverford College Apartments with a square footage of 222,894 will be removed from the campus building stock. Also, the demolition of the Alumni fieldhouse and relocation of the Facilities Management Complex account for the difference between the 1 million GSF and 700,000 GSF net gains mentioned above. The current Campus Plan retains the historic and cultural centerpieces of the campus. Our intent is to make the campus more pedestrian friendly while providing an increased number of housing options so that more of our students may reside on-campus and take better advantage of the premier educational and social opportunities that we have to offer. Figure 2-3 presents a graphical representation of proposed future campus growth. Because the campus can currently be considered "space rich" with over 1,000 gsf per student, a focus of the College will be thoughtful use of existing space. Growth in campus GSF does not necessarily relate to growth in the overall land ownership of the College. Growth on a campus must be flexible and adaptable; with this understanding Figure 2-4 represents only one of a variety of possible scenarios.

Figure 2-3 Cumulative Campus Growth in Gross Square Feet

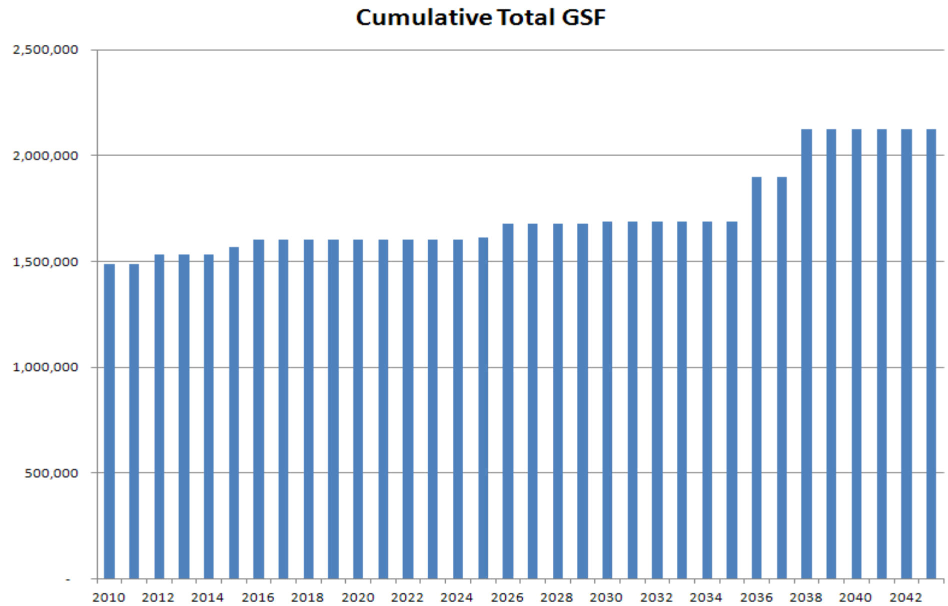


Figure 2-4 Gross Campus Growth in Gross Square Feet

Haverford College
"Future" Building Inventory - Campus Master Plan

	Building	Gross Sq Ft	Anticipated Construction Date	Predominant Use
1	Center for Culture and Media (Ryan Gym Addition)	38,300	2015	Academic
2	Whitehead Campus Center - Addition	9,000	2026	Academic
3	Roberts Hall - Addition	31,700	2016	Academic
4	Studio Arts Building	31,300	2026	Academic
5	Orchard Green Residence Hall	42,000	2012	Residence Hall
6	Central Power Plant	12,000	2026	Support
8	Student Residence Hall (on Oakley House Site?)	46,700	2030	Residence Hall
9	Faculty Residences on Old Railroad Ave	13,450	2026	Residences
11	Student Residence Hall North of Featherbed Lane	46,700	2036	Residence Hall
12	Student Residence Hall Souty of Featherbed Lane	42,000	2036	Residence Hall
13	Theater	42,650	2036	Academic
15	Student Residence Hall on Orchard Green	22,000	2030	Residence Hall
16	New Athletic Facility	130,491	2036	Athletics
17	New Facilities Management Complex	21,300	2036	Support
18	New Academic Building (or Library) on Field House Sit	108,000	2038	Academic
19	Alumni House	11,000	2025	Administrative
20	Academic Building (Science) on Field House Site	70,560	2038	Academic
21	Academic, Dining or Gallery on James House Site	31,000	2038	Academic
22	Observatory Addition	2,500	2038	Academic
23	Duck Pond Lane Student Residence Halls (2)	73,000	2038	Residence Hall
24	Faculty Residences on HCA site	59,100	2040	Residences
25	Natatorium	40,800	2050	Athletics
26	Featherbed Lane Student Residence Hall	52,000	2050	Residence Hall
27	Student Residence Hall or Admin near North Dorms	20,000	2050	Residence Hall
	Subtotal	**997,551**		

One potential vision of the campus in the long term perspective is provided in Figure 2-5 below.

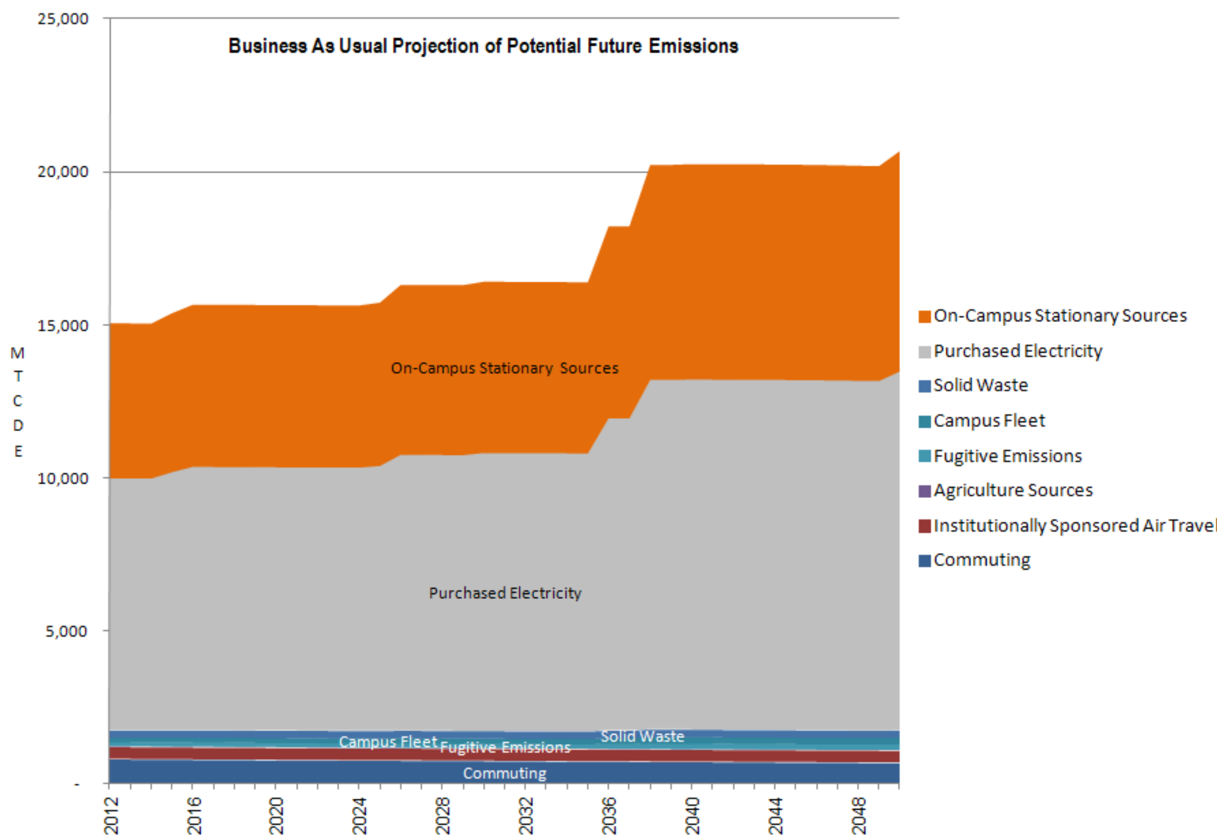
Figure 2-5 Potential Campus Growth

GHG emissions are directly tied to the amount of energy we consume. Buildings use electricity and fossil fuels for heating, air conditioning and lighting. As we add GSF to the campus, we increase the amount of energy consumed. While newer and renovated buildings may use energy more efficiently, they may also use more of it, as building codes now require larger amounts of conditioned air to be introduced into the structure, thereby requiring more energy for the conditioning of that air. While our campus building standards dictate that we build "green", even with the use of highly efficient systems some buildings may consume more energy than their older predecessors.

2.3.2 Business as Usual

A construct of the climate change world, the Business As Usual (BAU) scenario assumes that the institution takes no steps or actions to mitigate its emissions; such BAU scenarios provide an idea of what the future emissions profile might look like should the institution elect to take no action with regard to climate change and climate neutrality. BAU does not take into account future regulatory demands that might affect fuel efficiency in cars and trucks, renewable energy standards for utility generators, potential technology breakthroughs or behavioral changes that might come about. It is intended to be a worst-case scenario based upon current consumptions and efficiencies. The BAU projection does take into account projected campus growth, both in terms of physical size and the number of faculty, staff and students. Figure 2-6 below provides a graphical representation of GHG emissions in the BAU scenario. The purchased electricity and on-campus stationary sources closely mirror the shape of the data presented in the cumulative Total GSF chart presented above, strongly suggesting that the BAU growth in emissions is directly related to the anticipated growth of the campus' physical size in terms of gross square feet (GSF).

Figure 2-6 Business as Usual Projection



As demonstrated in Figure 2-6, the majority of our GHG emissions are associated with purchased electricity, the campus heating plant and commuting. Our BAU scenario demonstrates a growth in GHG emissions to nearly 21,000 MTCDE by 2050. Figure 2-3 demonstrates the anticipated growth of the campus during the BAU period. BAU growth in emissions is directly related to the anticipated growth of the physical size, in terms of gross square feet (GSF). Due to limited data on energy usage intensity for higher education buildings, emissions projections have been estimated based on the limited information available from organizations like AASHE and EPA. While other emissions sources are also important, emissions reduction measures associated with a reduction in purchased electricity, the central heating plant and how we get to and from work will have the greatest impact on our GHG emissions profile in years to come.

3. Mitigation Strategies

Prior to the development of this CAP, Haverford College had prepared a Campus Master Plan along with consultants Venturi, Scott Brown and Associates and Andropogon Associates. This Master Plan allowed us to better define and understand the physical space and place of the College as it exists today, how it may evolve over the next forty years, and the impact that changes on campus will have on our emissions profile and overall environmental footprint. Haverford had also previously enlisted the support of Brinjac Engineering to provide Utility Master Planning services, which offered a framework from which to begin our energy analysis. The BAU projection provided in Section 2 takes into account the projected campus growth as based upon the Campus Master Plan. With any type of projection, prognostication can only be made within the limitations of information available as part of the planning effort. A significant effort went into the development of the campus build-out, including but not limited to, phasing of construction, building types and locations, implications with regard to future utility needs, demolition of structures, and campus building standards. Economics as well as ecology were evaluated in the Plan, and development of the Climate Action Plan is linked to both.

Greenhouse gas emissions are generally attributed to anthropogenic sources, and reducing them entails many strategies. Human activities, and in particular the use of fossil-based fuels, have caused, and continue to contribute to, the climate change phenomenon. Energy consumption is therefore directly related to GHG emissions. In order to mitigate the effect of energy consumption, we must adopt several different approaches to energy use: efficiency, renewable/biogenic sources, or modification of our behaviors so that we consume less energy. Each mitigation strategy proposed below falls into one of these three approaches to energy use reduction. Where data are presented as a range of values, we have used the more conservative (typically lesser) of the two values for inclusion in our projected future emissions profile so as to present a more conservative view.

The mitigation strategies presented below represent a variety of different projects proposed for the campus. These strategies are "anticipated" because not all of the proposed projects or strategies may be viable due to permitting, zoning, financial, and/or other constraints, both from within the Haverford community and from without. Federal, State and local government regulations and the impact of future regulations must be factored into which projects are ultimately undertaken and implemented.

3.1 Mitigation Strategy Overview

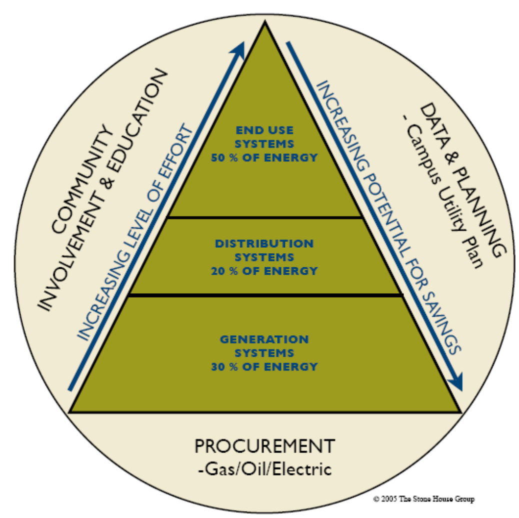
The goal of net climate neutrality can be a daunting task for any institution. Our gross GHG emissions for FY 10/11 were 14,726 MTCDE. At first glance, significant reduction of these emissions appears to be a difficult proposition. As set forth in both the Kyoto protocol and the ACUPCC implementation guide, a preference is given to reducing, reusing and recycling before offsetting. THE STONE HOUSE GROUP, our advisors in the climate action planning process, have developed a planning process to streamline the development of an environmentally responsible institution, making net climate neutrality an achievable goal.

We approach the climate action planning process with three key steps to ensure a comprehensive approach: 1) Assess 2) Reduce 3) Offset. The first step in this process is to 'Assess' the current state of the institution. Assessment encompasses developing an understanding of the data (energy, the greenhouse gas inventory, and College operations for Haverford), the foundation for providing a comprehensive approach to developing a plan for climate neutrality. Assessment also includes analysis to understand rate tariffs, system capacities, and procurement strategies. This has been summarized in Section 2.

The second step is to 'Reduce' emissions on the campus. The reduction analysis is completed via a campus energy audit (with primary focus on campus mechanical and electrical systems), utility strategy and a renewable energy study. We focus on three areas for project oriented reduction in emissions; generation systems, distribution systems, and end-use systems. Optimizing our generation systems is vital in reducing our environmental footprint. Conversion of fossil fuel to usable forms of energy has inherent losses, which need to be minimized. Maximizing efficiency, control and operation of generation systems is thus a key element under this system. Additionally, the decision to purchase grid electricity versus on-site renewable or co-generation options is critical.

Like generation, distribution systems are designed for peak or design target loads and can operate less efficiently with deviation from these loads. Energy can often be saved by modulating temperatures, pump speeds and pressures. End-Use systems consume over 50% of the energy for most campuses. Generation and distribution systems should be designed to ensure that individual buildings are supplied with enough energy to meet, but not exceed, the associated needs. At times, however, inefficient operation between control systems, limitations of central systems or outdated technology can raise energy usage and therefore emissions. Figure 3-1, to the right, outlines the six fundamental subsystems that are evaluated during an energy assessment and climate action planning process.

Figure 3-1 Six Energy Subsystems



Finally, 'Offset' is the last step in the climate action planning process. Once the optimal systems are in place and greenhouse gas emissions are minimized, the remaining emissions can be offset through the purchase of a variety of available offsetting instruments.

The purpose of the 'Mitigation Strategies' section of our Climate Action Plan is to address the 'Reduce' step of the process. We have analyzed currently available alternatives which would result in direct greenhouse gas emission reductions which include energy efficiency measures (for generation, distribution and end-use systems), fuel alternatives, renewable energy and other greenhouse gas reduction measures.

3.2 Energy Audit Overview

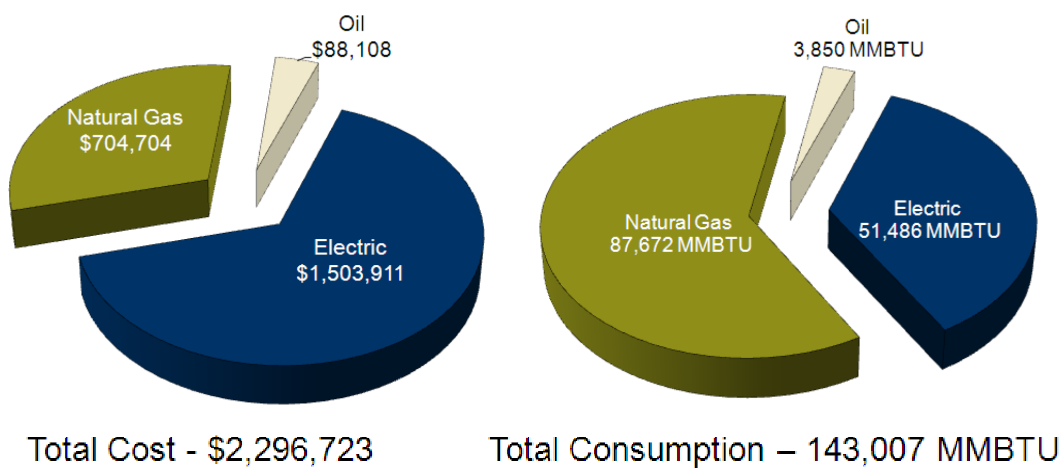
THE STONE HOUSE GROUP performed an energy assessment and evaluation of Haverford's campus beginning in June 2011. The on-site assessment of the buildings allowed us to gain a better understanding of the age, condition, energy consuming equipment installed, and functionality of the buildings through a centralized building automation system. THE STONE HOUSE GROUP also reviewed and assessed the central steam plant and incoming electrical service. Overall, 1.25 million square footage of space was surveyed during the two month evaluation period, equating to approximately 83% of the campus overall gross square footage. The selection of buildings to be surveyed was based upon identifying those deemed to be among the highest consumers of energy and thus had the highest potential for savings. The energy audit also included a sampling of residence halls, which, due to the size and similarity between the buildings and systems, were deemed a sufficiently representative sample.

In addition to the on-site inspections of individual buildings, THE STONE HOUSE GROUP met with several members of the College's facilities staff, including the Director and Assistant Director of Facilities, Assistant Director of Facilities, Grounds and Sustainability, and the boiler plant engineer. These individuals were very helpful in providing a better understanding of operations, scheduling, College policy, and the opportunities and limitations of the energy systems on campus.

THE STONE HOUSE GROUP also conducted an analysis of Haverford's utility data for fiscal years 08/09, 09/10 and 10/11. The results indicated that in FY10/11 Haverford consumed 143,007 MMBTU of energy at a cost of over $2.29 million. The campus energy consumption is comprised of approximately 64% fossil fuels and 36% electricity. Figure 3-2 outlines the cost and consumption by energy source.

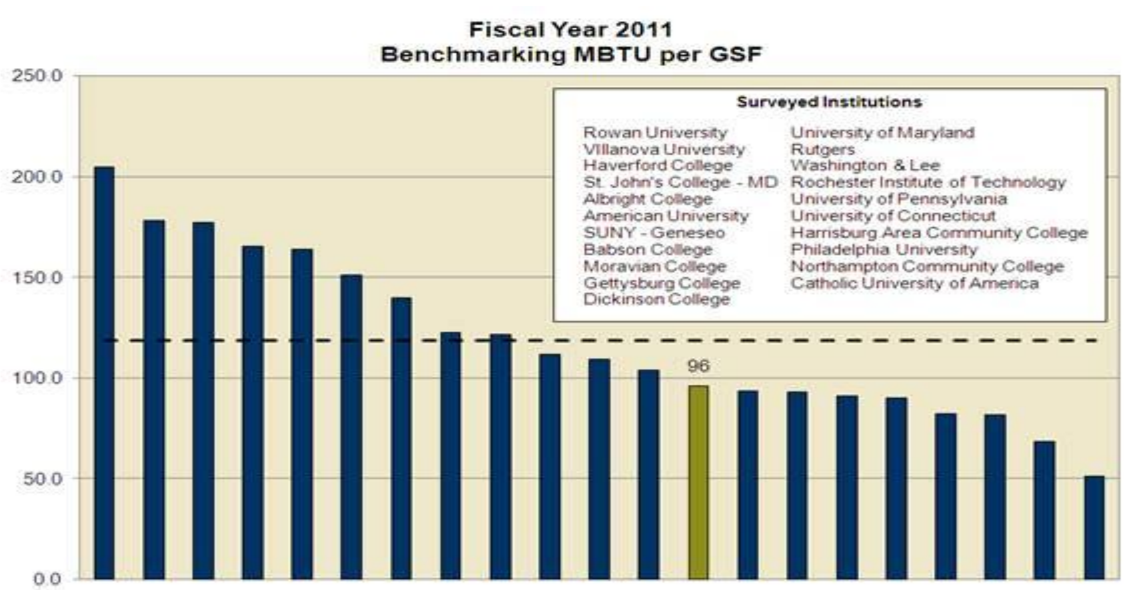
Based on these same data, the campus as a whole used approximately 96 MBTU/GSF. Haverford was compared to several other institutions, both in and outside of the geographical area to get some sense of the relative consumption of energy on campus; the results of this benchmarking study

Figure 3-2 Cost & Consumption by Source FY 10/11



revealed that we consume approximately 23 MBTU/GSF less energy than the average for comparable institutions. Therefore, while we perform better than average, we believe there is still opportunity to reduce energy consumption on a square footage basis. Figure 3-3, presents the results of our benchmarking study.

Figure 3-3 Benchmarking MBTU per GSF Results



Haverford College is not metered consistently at each building with condensate, chilled water, electricity or domestic hot water meters. Therefore, it is difficult to decipher precisely how much energy is consumed at each building. Additionally, we were not able to accurately determine how much of each fuel source is consumed for end-uses such as lighting, HVAC, water heating, etc. Therefore our climate neutralization of each fuel source must be analyzed on a campus-wide basis instead of building by building.

While the following project descriptions represent the complete analysis performed by THE STONE HOUSE GROUP, those selected by Haverford College to achieve their emission reduction target of 9% by 2017, considered Phase 1, have been listed in Appendix B: Energy Capital Investment Plan.

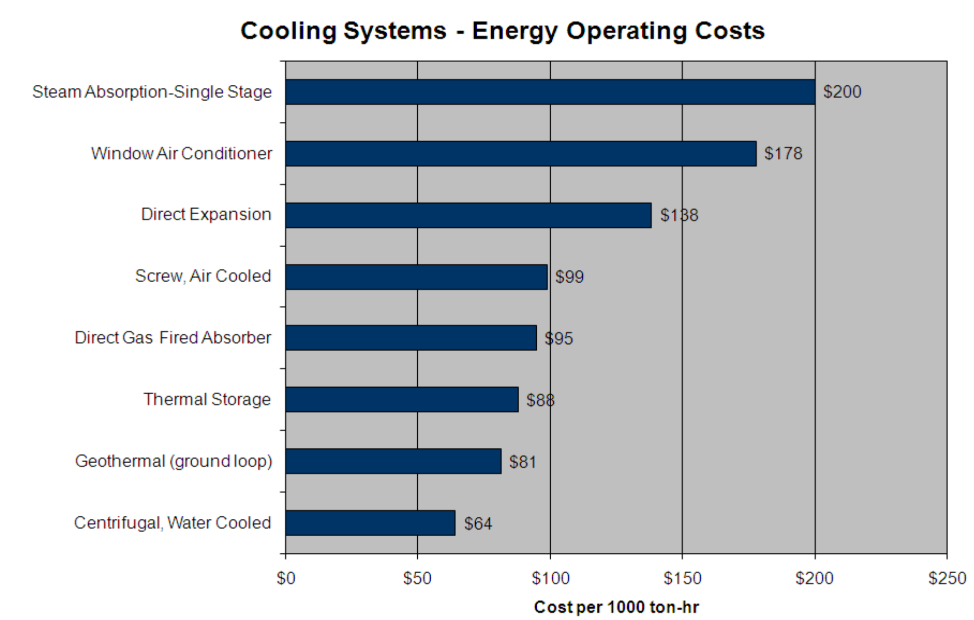
3.3 Generation and Distribution Energy Mitigation Strategies

There are large cost savings and greenhouse gas reductions to be gained by investigating alterative energy strategies for the central steam plant, district cooling plants, and electrical power generation systems on-campus. As discussed in the next section, there are also many energy efficiency improvements within the individual buildings (end-use projects) that can be implemented to reduce the overall campus demand for steam and electricity. Above and beyond the end-use reductions, however, consideration of how the campus steam and electrical energy is produced and delivered may result in significant additional cost and reductions in emissions. Efficiency improvements in the supply and distribution of these energy sources are critical in the reduction of GHG emissions.

3.3.1 Cooling Strategy

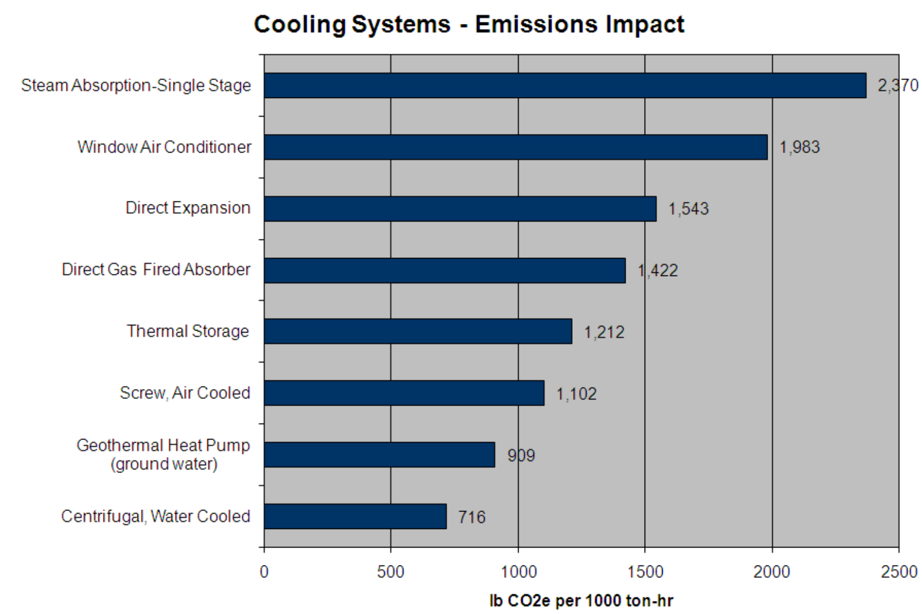
Haverford currently has most of their academic, administrative and athletic facilities air conditioned on campus and the desire to provide air conditioned buildings continues to rise. Most of the buildings have individual chillers installed that serve the building they are located in. There is not a central chiller plant for the campus at this time and the increased chiller capacity of independent systems leads to increased refrigerant emissions and reduced operating efficiency

Figure 3-4 Cooling Systems – Energy Operating Costs



since the cooling systems are not operating at peak load most of the summer. Figure 3-4 on previous page shows the cost per 1000 ton-hour for different cooling system technologies. The largest chiller system on campus is located in the Science Center and is the most efficient system, Centrifugal Water Cooled chillers operating at $64 per 1000 ton-hour. The campus also has a number of air cooled screw and reciprocating chillers, direct cooling (DX) rooftop equipment and window air conditioning units. Haverford's gross square footage has steadily grown over the years and with the growth came an immediate requirement for additional cooling capacity. The expansion has resulted in individual cooling systems scattered throughout campus and the de-centralized strategy for campus cooling. Additionally, there have been many older buildings which have been retrofitted for cooling with smaller air-cooled and/or direct expansion (DX) systems and window air-conditioning units. Figure 3-5 outlines the emissions impact of each type of cooling system.

Figure 3-5 Cooling Systems Emissions Impact



Single stage steam absorption chillers are shown with the largest emission of GHGs, with 2,370 lbs of CO_2e (1 MTCDE) per 1000 ton-hr being released into the atmosphere. We have and use many window air conditioning units on-campus and our goal is to connect the window a/c and direct expansion systems into chiller systems in the future. Although temporary, these cooling solutions were sufficient in the short term to satisfy our cooling loads. Now, however, our commitment to moving toward climate neutrality necessitates a more cohesive, campus-wide strategy with special attentiveness to the future equipment emission profiles.

Therefore, moving forward, our first opportunities will be sought to move from point of use cooling systems (window AC units) to building wide or based systems. If the progressively greater capital requirements hurdles can be met, then multi-building, zoned or a centralized campus cooling plant will offer progressively greater efficiency and lower operating cost. We will develop a centralized cooling strategy to include equipment that is not only environmentally responsible, but also has a high efficiency and low operating cost over the life of the system.

We anticipate that multiple zoned or district cooling plants will be developed on the main campus. These plants would be zoned by geographic location and would provide flexibility and redundancy for the campus cooling systems. By connecting buildings to a district cooling plant the installed capacity (tons of cooling) can be reduced through the benefit of system diversity. This strategy will reduce emissions by reducing the tons of refrigeration capacity on campus and the district chiller systems will be energy efficient cooling systems that operate within a peak range of efficiency.

3.3.2 Central Steam Plant Opportunities

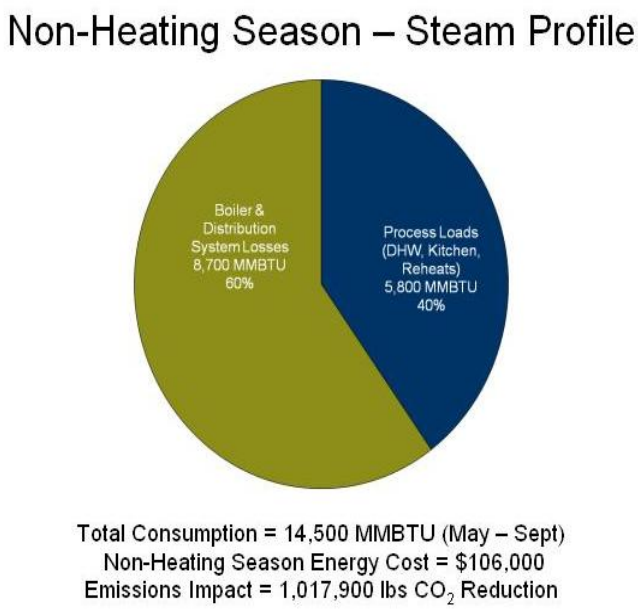
Currently, the central steam plant at Haverford provides low pressure steam (22-35 psig) for building heat (winter season) and domestic hot water generation (year-round). There are four steam boilers (3x350BHP and one 100BHP) which run on dual fuel (natural gas and #2 fuel oil). The 100BHP steam boiler is non-functional and abandoned in place. Approximately 69,419 MMBTU of fuels were consumed at the central steam plant during FY 10/11, totaling nearly $554,000 in energy costs and generating approximately 3,746 MTCDE in greenhouse gas emissions.

3.3.2.1 Reduction in Steam Distribution Pressures

Our central steam plant currently operates year-round providing 22-35 psi steam throughout campus. Typically, central plants tend to deliver steam at higher pressures, so that when pressure reduction strategies are employed, an energy and associated environmental benefit are realized. In our case, this has already been done, so no further reduction in delivery pressures can be made.

3.3.2.2 Summer Shut-down of Central Steam Plant

Figure 3-6 Non-Heating Season Steam Profile



Our non-heating season steam profile was analyzed to determine the approximate boiler and distribution system losses which occur while operating the central steam plant during summer months, as shown in Figure 3-6. The analysis revealed approximately 60% of the energy consumed by the summer operation of the steam plant was lost through distribution and/or boiler operation.

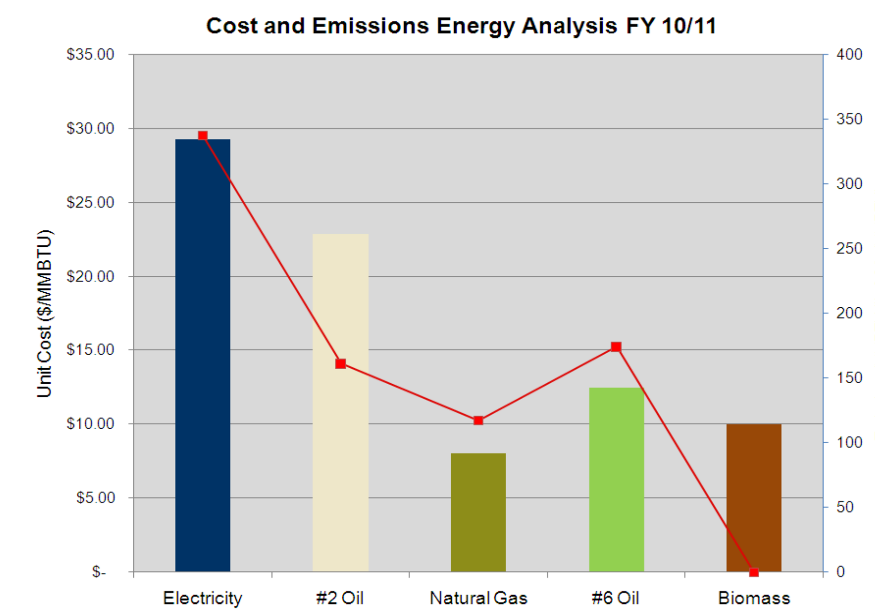
We are evaluating the de-centralization of summer processes, process and domestic hot use to facilitate a shut-down of the steam plant operation during summer months. Localized domestic hot water, kitchen and VAV reheat equipment would be installed at each building. Use of heat recovery chillers would be made at certain locations to supplement building re-heating demands during summertime.

With moving forward with the decentralization of the heating plant for summer operation, we estimate that 8,700 MMBTU's, or approximately 462 MTCDE emissions, would be avoided annually.

3.3.3 Evaluation of Fuel Alternatives

Fuel selection can be a key component to the reduction of our carbon footprint. For each fuel source used to generate energy on-campus, the CDE released per MMBTU varies greatly. In addition, the unit costs of fuels are market driven and can fluctuate daily if a long term purchasing agreement is not in place. Figure 3-7 summarizes both unit cost and emissions per MMBTU of energy for each fuel source. Both of these factors can greatly influence our decision with regard to fuel selection. Fuel oil (#2) and natural gas are used as a thermal energy source for our main steam plant as well as at other independent locations throughout campus. Other than coal, fuel oil has the highest emissions profile of the fossil fuel sources primarily available. Fuel oil #2 and #6 emit approximately 161 and 174 lbs of CO_2, respectively, for each MMBTU consumed.

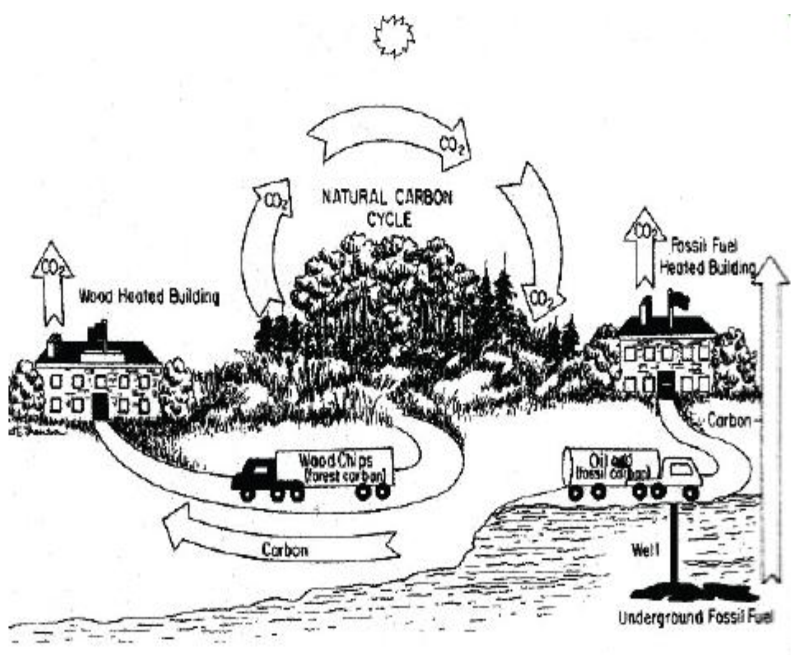
Figure 3-7 Unit Cost & Emissions per MMBTU



In the United States, 70% of our fuel oil is imported. That percentage is likely to continue to increase and along with world-wide demand increases, cause rising costs and market volatility in the future. The use of fuel oil as an energy source for steam boilers often requires emissions to be closely monitored and, in many cases, emission control equipment to be installed. Throughout FY10/11 Haverford paid an estimated $22.68/MMBTU for #2 fuel oil at the steam plant and $23.78/MMBTU for #2 fuel oil at the independent locations. Fuel oil selection at many institutions is a continuous trade-off between emissions reduction and cost. As we move toward climate neutrality, we will pursue the reduction and eventual elimination of use of #2 fuel oil as a fuel source to reduce greenhouse gas emissions per MMBTU of energy consumed.

Natural gas is the cleanest fossil fuel available, with approximately 117 lbs of CO_2 being emitted for each MMBTU consumed. Current pricing and availability have recently made this the most attractive fossil fuel source for many institutions, including Haverford. Haverford College has in place long term contracts for both its electric and natural gas commodities. Haverford College utilizes natural gas as the thermal energy source for the main steam plant, accounting for 96% of campus heating load and oil is only used in rare instances as a back up at the main steam plant and in a handful of small building boilers. The drawback to using natural gas as a primary fuel source is that, similar to fuel oil, natural gas is non-renewable. The quantity of natural gas available is fixed and the amount being consumed throughout the world is rapidly increasing. Throughout FY10/11 Haverford paid an estimated $8.04/MMBTU for natural gas; however, as history has shown, this unit cost can dramatically fluctuate with market conditions.

There are many options available as alternatives to fossil fuels, including biomass fuels. The most beneficial advantage of switching to a renewable fuel source is the dramatic reduction in greenhouse gas emissions as compared to fossil fuels. Fossil fuels, when burned during the combustion process, give off large amounts of carbon dioxide, along with carbon monoxide, nitrogen oxides, sulfur dioxide and particulate matter. These emissions contribute to the diminishment of the earth's ozone layer, increased acidic soil and water, and many other destructive environmental factors. Biomass fuels are organic materials made from plants and animals and include wood, crops, manure and some garbage. The biomass contains stored energy and when burned, the chemical energy is released as heat. Direct combustion of biomass works very well for generation of thermal energy (steam or hot water). The emissions from burning waste wood products is far less (and more environmentally friendly) than fossil fuels. Limited amounts of sulfur and nitrogen oxides are released and the carbon that is emitted to the atmosphere is generally absorbed by photosynthesis in new wood growth.



THE CARBON CYCLE: Biomass Heated Buildings vs. Fossil Fuel Heated Buildings

We recognized the potential opportunity to significantly reduce our climate or environmental footprint with the utilization of biomass as an alternative fuel. Therefore, we evaluated biomass alternatives for both the thermal and electric applications at the central steam plant. Results from the analysis indicated the support infrastructure for biomass (woody biomass chips) in the area surrounding Haverford was good and the cost of biomass on a BTU basis was comparable to hydrocarbon fuels, although more expensive then natural gas. As shown in Figure 3-7 (above), it is estimated the biomass fuel could be purchased for a cost of $10/MMBTU (based on $25 per delivered ton).

The biggest challenge to switching to a biomass fuel source is the logistics due to the location of the existing boiler plant. Taking into account the transportation challenges with the location of the existing boiler plant, it was determined that at this time switching our central plant to a biomass facility was not feasible. The increase in truck traffic on-campus is deemed to be a safety issue, as well as a nuisance, and would burden our transportation infrastructure.

3.3.4 On-Campus Electricity Generation

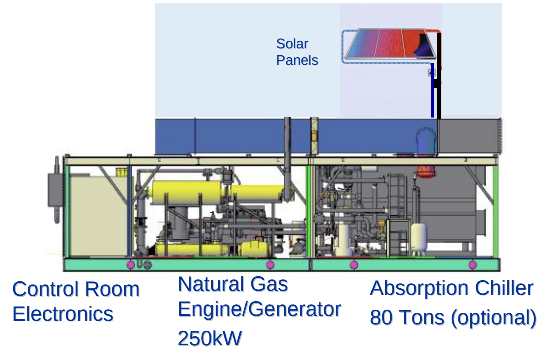
Our regional electric grid utility asset mix is moderately carbon intensive. Coal, with the highest emissions profile of any fossil fuel, is the number one fuel source for power plants in Pennsylvania (45%). The carbon intensity of the grid supplied electricity in the PJM/RFCE zone averages 1.15 pounds of CO_2e per kWh. Through a strategy of generating our own power with zero or lower carbon intensity, we can significantly reduce our carbon footprint when compared to buying grid power. The reduction of purchased grid power will ultimately play a major role in the College's move toward carbon neutrality. During our analysis, we primarily focused on two power generation strategies for the College's campus: co-generation and renewable energy opportunities.

3.3.4.1 Co-Generation

Co-generation involves the simultaneous production of electricity and thermal energy, which allows for high efficiency in fuel conversion when concurrent thermal and electrical loads exist. Co-generation of steam and electricity is far more efficient than separate production of either on a stand-alone basis. An increasingly common co-generation technology is the integration of a steam turbine into a steam boiler and distribution system. Steam turbines are commonly utilized as pressure reducing stations in systems where steam is generated at a high pressure and distributed at a lower pressure. The steam system at Haverford is rated to generate high pressure steam (150psi); however, it is currently generated and delivered at low pressure (22-35 psig) to be utilized for the building heat and/or domestic hot water application.

We have investigated the installation of a small pressure reducing steam turbine into the steam main to extract electrical power. Preliminary analysis predicted that a steam turbine installed at the central plant could generate approximately 700,000 kWh annually when the boilers are operated at a higher pressure. This would result in a GHG emissions reduction of 365 MTCDE annually, but had a payback period of 15+ years. Although the electrical generation of this system will be reduced by the non-heating season decentralization of the plant we believe this system is still viable for the campus as the campus expands. We recommend this project is considered in the future as the campus heating (steam) load increases due to the planned growth of the Master Plan.

In addition to the steam back pressure turbine proposed for the central plant, we also evaluated opportunities for Combined Heat & Power (CHP) and Combined Cooling Heat & Power (CCHP) for the campus. In order for these systems to be cost effective they need to have a constant base load where the heat that is reclaimed from the engine jacket and exhaust stack is put into the building heat system, domestic hot water (DHW) or cooling applications. Based upon the results of the building evaluations, the best opportunities for Combined Heat & Power and CCHP exist at the Marian E. Koshland Integrated Natural Sciences Center (CCHP) and the Dining Center (CHP). Overall we anticipate that a 250 kW CCHP and a 65 kW CHP system could be installed to reduce the long term operating costs and resulting emissions for the College. The projects identified would yield a reduction of approximately 1060 MTCDE annually.



3.3.4.2 Renewable Energy Opportunities

Renewable energy is energy generated from natural resources such as sunlight, wind, water and geothermal heat. 'Renewables' are undoubtedly the next generation in source energy because, unlike the earth's limited supply of fossil fuels, natural resources are readily available and naturally replenished. In the past, the transition to renewable energy versus fossil fuels has been slowed by high first costs to install the infrastructure. Many commercial and institutional customers were deterred by the low return on investment and 50+ year payback projections. Today, however, the economics of installing and operating these unique renewable energy systems has changed. Local, state and federal grants along with wide-spread tax incentives and depreciation benefits have inspired many organizations to take a second look at the renewable energy alternatives to purchasing grid power. Additionally, the de-regulation of Pennsylvania's electric markets will indisputably reduce the payback period of installing renewable energy systems. With the incentives listed above, and our commitment to climate neutrality, the evaluation of renewable energy opportunities was inevitable.

The first and most promising renewable energy technology that was evaluated was photovoltaic or solar electricity. The sun's energy has the ability to produce electricity without emissions, moving parts or fuel. Photovoltaic (PV) cells, made of very pure semiconductor grade silicon, are used to generate an electrical current when photons of sunlight knock loose electrons on the PV cell. The photovoltaic effect produces DC (Direct Current) electricity, which is converted to AC (Alternating Current) by an inverter. The PV arrays are interconnected with the electrical grid in order to allow for net metering when the quantity of electricity produced does not match the demand required.

A consultant was retained to evaluate the most effective locations to install photovoltaic arrays on-campus. The analysis yielded three locations which would serve as ideal candidates for installation of PV arrays. The recommendation was to install a 250kW array on the Alumni Field House roof, a 122kW array on the Douglas B. Gardner Integrated Athletic Center, and a 1MW ground mounted array in the open space of the Ryan Pinetum. In total, the campus would have 1.472 MW of photovoltaic panels connected for electrical generation. It is estimated, based on regional weather data, that these arrays would produce approximately 1.685 million kWh annually. This translates into a reduction in greenhouse gas emissions of approximately 931 MTCDE annually. Additional PV opportunities exist on campus, as well as the potential for future installation on new construction projects. The three presented here are the best opportunities that were identified.

Wind and solar thermal technologies were also evaluated for implementation into existing campus buildings. Wind energy is the conversion of airflow into electricity by use of a wind turbine. Wind turbines generally range anywhere from 600kW to 5MW in size and electricity generation is a direct function of wind speed and volume in a region. Therefore, prior to installation of a wind turbine, careful analysis of the wind power density of the specific location is crucial to establishing effectiveness of wind turbine placement. It was determined from preliminary analysis of Haverford's campus location that a wind turbine was not a viable option for renewable energy at the current time due to lack of a consistent wind resource on the campus. In addition, the aesthetic impacts of turbines are a concern when considering this option.

Solar thermal applications use radiation from the sun to produce heat energy. The most common applications of solar thermal energy are heating swimming pools, domestic water heating, and space heating for buildings. A solar hot-water panel uses the sun's energy to heat the fluid, which is then transferred to a storage vessel. Solar thermal applications would be viable at Haverford, and will be considered for incorporation in any new construction and/or major renovations going forward.

3.4 End-Use Mitigation Strategies

3.4.1 Lighting

Our total electric consumption for FY 10/11 was 15.1 million kWh. Due to the limited building electrical sub-metering, it is difficult to determine exactly how much of the total campus electrical consumption can be attributed to lighting. However, we estimate that approximately 25 - 30% of our overall electrical consumption, or approximately 3.78 million kWh of electricity at a cost of $354,850 per year, is attributable to campus lighting. The STONE HOUSE GROUP conducted a careful analysis during building walkthroughs of the existing lighting technologies, hours of operation, daylighting opportunities, lighting controls, maintenance strategies, and lighting power densities. It was determined that the lighting technologies currently installed at Haverford vary greatly from building to building; however, most of the observed fixtures were already relatively energy efficient. Two buildings, Chase Hall and Ryan Gymnasium, were identified as having T-12 and metal halide fixtures, and a recommendation to upgrade those fixtures immediately was made. In a majority of the academic, administrative and residential spaces the lighting has switched control and no occupancy sensors had been retrofitted to the space. Campus-wide installation of occupancy sensors for lighting and heating controls will be pursued. It was estimated that as a result of the occupancy sensor retrofit approximately $15,000 will be saved annually, resulting in a greenhouse gas emissions reduction of approximately 84 MTCDE.

3.4.2 Heating Ventilation and Air-Conditioning

The HVAC systems installed throughout campus vary greatly from building to building. A majority of the academic and administrative buildings are mechanically heated and cooled through a variety of systems including, steam and hot water perimeter radiation, variable air volume and fan coil terminal reheat units, air-handling and rooftop units for ventilation with steam, hot water, and chiller water coils and some direct expansion cooling. Heating is provided by steam or hot water perimeter radiation in most cases.

3.4.3 Retro-Commissioning

Although in most cases, the buildings on Haverford's campus are not individually metered, it is estimated that the Athletic Center and the Science Center are the most energy consuming buildings on campus. The high energy consumption is due to the large amounts of outside air being brought in for required ventilation in the laboratory spaces. Review of the HVAC systems for these buildings indicated a number of systems that were not operating properly therefore increasing energy use in the buildings. Retro-commissioning is the process of inspecting and testing the sequences of operation of the HVAC systems to ensure they are operating as designed and intended. Through the retro-commissioning process control enhancements can be made to optimize energy performance and to implement new technologies that were not available when the buildings were constructed. The College plans to re-commission all of the energy intensive buildings / systems on the campus over the next 10 years to ensure the systems are operating at their peak efficiency.

3.4.4 Building Automation System Upgrades

The College does a very good job of controlling the energy use in the buildings through aggressive equipment scheduling and temperature setbacks during unoccupied periods. However, there are a number of limitations with the existing Automatrix BAS and there are control enhancements that can be made to the HVAC systems to allow for more optimized control of our energy use. The energy projects identified during the audit are detailed in the Energy Capital Investment Plan and include the following:

- Occupancy sensors to control HVAC systems
- Variable frequency drives for constant flow pumps and fans
- Improved sequences of operation for systems via demand controlled ventilation of outdoor air or morning warm-up / cool-down cycles.
- Cooling plant optimization through lead / lag chiller staging and condenser water optimization
- Installation of programmable thermostats
- Optimization of heat recovery wheel operation
- Installation of variable geometry dampers on exhaust stacks in Science Building to save exhaust fan energy

Many of the control projects identified have very quick payback periods and are important to reduce the base load energy consumption of the campus. The projects are described more fully in Appendix B.

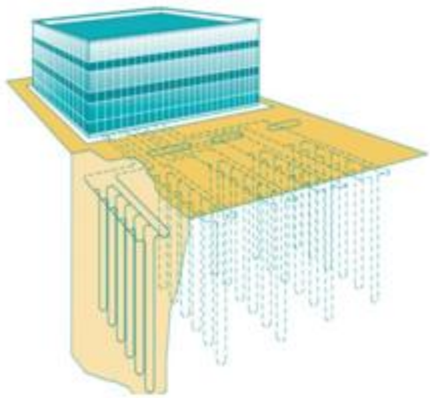
3.4.5 Holiday Curtailment and Scheduling Initiatives

Holiday Curtailment Programs or rollback programs occur when we aggressively reduce building temperatures during holidays (e.g. Winter & Spring Breaks). Greenhouse gas emissions reductions are estimated at 15 - 20 percent during the curtailment period. Analysis of our energy consumption for FY 10/11 reveals that approximately 50 MTCDE emissions could be avoided via holiday curtailment programs.

Campus Wide Temperature Reductions and Building Scheduling may result in additional reduction in GHG emissions. While not exact, a rule of thumb is that for every degree a thermostat is lowered in the heating season results in a fuel savings of approximately one percent. We at Haverford have instituted a fairly aggressive scheduling and temperature control program however we will evaluate those areas where improvements could be made. Estimates of emissions reductions are approximately 2.5%, or approximately 350 MTCDE depending on how aggressively we choose to schedule buildings while balancing the need for access.

3.4.6 Geothermal Heat Pumps

Geothermal heat sources, more correctly known as ground source heat pumps, were evaluated as part of our net climate neutral strategy. Consideration was given to the current costs of fuels (both electricity and fossil fuels on an energy equivalency [MMBTU] basis), risks associated with open well



systems verses efficiency losses of closed loop systems, as well as to efficiencies that are created by an ability to connect to the central physical plant. Using calculation methodology set forth by J Hanova and H Dowlatabadi in their study entitled *Strategic GHG reduction through the use of ground source heat pump technology* and published by the Institute of Physics in its Environmental Research Letters (Environ. Res. Lett. 2 (2007) 044001 (8pp)), it was concluded that at current fuels costs, with the ability to connect to the physical plant, the installation of ground source heat pump systems are not a financially attractive option. However, at stand alone small buildings that are not able to connect to the central heating plant, it may well prove advantageous to install ground source heat pump technology at some or all of these structures as they need to be renovated, as deferred or cycle maintenance dictates, or as a study/research opportunity. Efficacy of ground source heat pumps will continue to be evaluated going forward, as continued cost escalation of fuels could make this technology more financially attractive.

3.5 Other Campus Related Greenhouse Gas Mitigation Strategies

3.5.1 Fugitive Emissions Refrigerant Fluids

Haverford College, like most Colleges, has a substantial cooling load on campus. These refrigeration and cooling demands have their attendant quantities of HFC (hydro fluorocarbon) refrigerants installed on campus and their resulting emissions. Future growth on-campus will require additional cooling capacity consistent with campus standards. As demonstrated in the functional distribution chart in Section 2, emissions from this source comprise 1 percent, or 127 MTCDE, of overall GHG emissions. It is anticipated that if and when additional chilled water capacity is needed/added, that equipment efficiency, longer equipment life cycles, and decreased fugitive emission rates would result in a zero net increase of GHG emissions from this source. Further, we are committed to the procurement of air conditioning equipment with environmentally responsible refrigerants, those with the lowest possible global warming and ozone depleting potentials possible. At this time, we anticipate that the emissions from refrigeration sources to be *de minimus* and will be neutralized via the purchase of offsets.

3.5.2 Faculty/Staff and Student Commuters

Emissions from faculty, staff and student commuting to and from campus fall within our GHG inventory boundaries, and such commuting is part of the current way of life. We also recognize that changing the way we view commuting and how we approach changing habits and lifestyles with regard to this issue may be one of the most difficult challenges we face. Our emissions with regard to commuting are a factor in our environmental footprint. As demonstrated in the functional distribution chart in Section 2, emissions from this source comprise 6 percent or 821 MTCDE of overall GHG emissions.

Currently we have access to two (2) different SEPTA rail lines and one (1) SEPTA bus line. Additionally, the Blue Bus, a free campus shuttle available to all faculty, staff, and students provides transport between Haverford, Bryn Mawr and Swathmore College. As an incentive to encourage the use of public transportation, the College has in place a TransitChek commuter benefit program that the College offers to employees to help with the cost of commuting on public transportation. Additional mitigation strategies to be considered include the following: adding more stops to the Blue Bus schedule that provide access to conveniences such as malls, pharmacies, and grocery stores, partner with car share programs (i.e. Zip Car) or rental car agencies to reduce the number of vehicles on-campus, work with SEPTA to provide discount fares for Haverford staff faculty and students to encourage ridership, create incentives for carpooling, vanpooling and local bus use, and create a web-based tool to facilitate carpooling. Additional strategies include reserving desirable parking spaces for hybrids, electric vehicles and/or carpools, encourage telecommuting and/or compressed work schedules where appropriate, and develop a "parking diet" to phase out parking spaces needed on campus. The estimate of GHG emissions avoided through implementation of some or all of the above strategies is estimated at 10 percent or 82 MTCDE over the next ten years based upon 2009 mileage and fuel economy figures. We expect that future regulatory actions with regard to vehicle fuel economy, changes in how we live and commute, as well as other as yet unforeseen technological advances may well drive the avoided emissions up another 5 to 10 percent.

3.5.3 *Institutionally Sponsored Air Travel*

As is demonstrated by the functional distribution chart in Section 2, our GHG emissions from institutionally sponsored air travel comprises 3 percent of overall GHG emissions, or 398 MTCDE. Institutionally sponsored air travel is part of the campus life here at Haverford, and is directly tied to our sports programs, our encouragement of faculty in their continuing education via attendance of conferences and seminars, and as a way we stay connected to research, projects, colleagues and other colleges and universities. As we recognize that air travel has a greater effect on global warming as high altitude emissions have a greater effect with radiative forcing, cleaner fuel sources and technologies will be developed. We will also further investigate attending meeting and seminars on the world-wide-web as means of reducing our air travel while staying connected. However, at this time, we anticipate that emissions attributable to air travel will be neutralized via the purchase of offsets.

3.5.4 *Solid Waste*

We generated 1,175 short tons of waste in FY 10/11. Sixty seven percent (67%) of the waste is disposed of at a waste to energy (WTE) plant for incineration. A waste to energy plant convert's waste to energy; which then produces electricity. Because the waste is not landfilled, it does not generate methane and thus GHG emissions are avoided. Thirty-three percent (33%) of our waste is landfilled and does generate GHGs in the form of methane. We were unable at the time of this writing to determine whether or not that methane is flared or otherwise recovered, so we assumed that the gas was untreated and eventually vented to atmosphere. Because of its beneficial re-use, our waste disposed of at the WTE plant generates an offset or reduction in emissions, which reduces our emissions from solid waste disposal to 252 MTCDE. We remain committed to minimize our overall waste generation to reduce our broader environmental footprint.

Our grounds department conducts a composting program, which diverts approximately 277 tons per year of lawn/grounds waste to the composting stream as opposed to disposal at a landfill or WTE. This activity generates an emissions avoidance of 106 MTCDE. The College is currently studying the logistics of potentially composting Dining Center food waste. The challenge of food composting is an issue the college hopes to address in the future.

3.5.5 *Transmission and Distribution Losses*

As noted in Section 2, this sector is a subset of electricity and is generally not accounted for in the electricity sector. The purchase of green power or RECs does not mitigate emissions associated with transmission and distribution losses, as regardless of the type of electricity consumed, there are losses inherent in the process of conveying electricity to the College. GHG emissions for this sector are 761 MTCDE, or 5 percent of our overall GHG emissions. Transmission and distribution (T&D) losses are generally

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estimated at nine percent of the end use consumption of electricity. Due to the employment of mitigation strategies above, we estimate an overall electrical emissions reduction of approximately 1,631 MTCDE. The concurrent reduction in emissions attributable to T&D losses will be approximately 147 MTCDE.

3.5.6 Campus Fleet

Haverford, like any institution of higher education, has need of a fleet of vehicles, a necessity for maintenance of lawns, buildings, and roads. Our fleet includes different pieces of equipment from trucks to lawn care and snow removal implements. As demonstrated in the functional distribution chart in Section 2, campus fleet emissions are 143 MTCDE and comprise one percent of our greenhouse gas emissions. Mitigation strategies include increasing the number of electric vehicles in the fleet, the use of B-20 biodiesel fuel where applicable for at least six months of the year, increase the fuel economy of gas-powered vehicles, simplify/combine delivery and trash/recycling routes on campus, centralize vehicle purchasing to maximize capital for "greener" vehicles, develop a vehicle sharing system across departments to reduce rentals, develop a transportation purchasing policy to set "greener" standards, and encourage the president to purchase a hybrid vehicle as a means of demonstrating Haverford' commitment to the environment. Emissions avoidance estimates are 10 percent or 14 MTCDE.

3.5.7 Agricultural Sources

Very little agriculture activity that has emissions implications takes place on-campus, and is limited to the application of fertilizers on athletic fields. Emissions associated with this agricultural activity totals 14 MTCDE. While the potential exists that an alternate fertilizing strategy could be employed, or that all athletic fields could be converted to a synthetic substitute such as an infill field, we anticipate that this *de minimus* source of emissions will be neutralized via the purchase of offsets, as this is economically the more attractive solution to a comparatively small issue with regard to GHG emissions.

3.5.8 Green Building

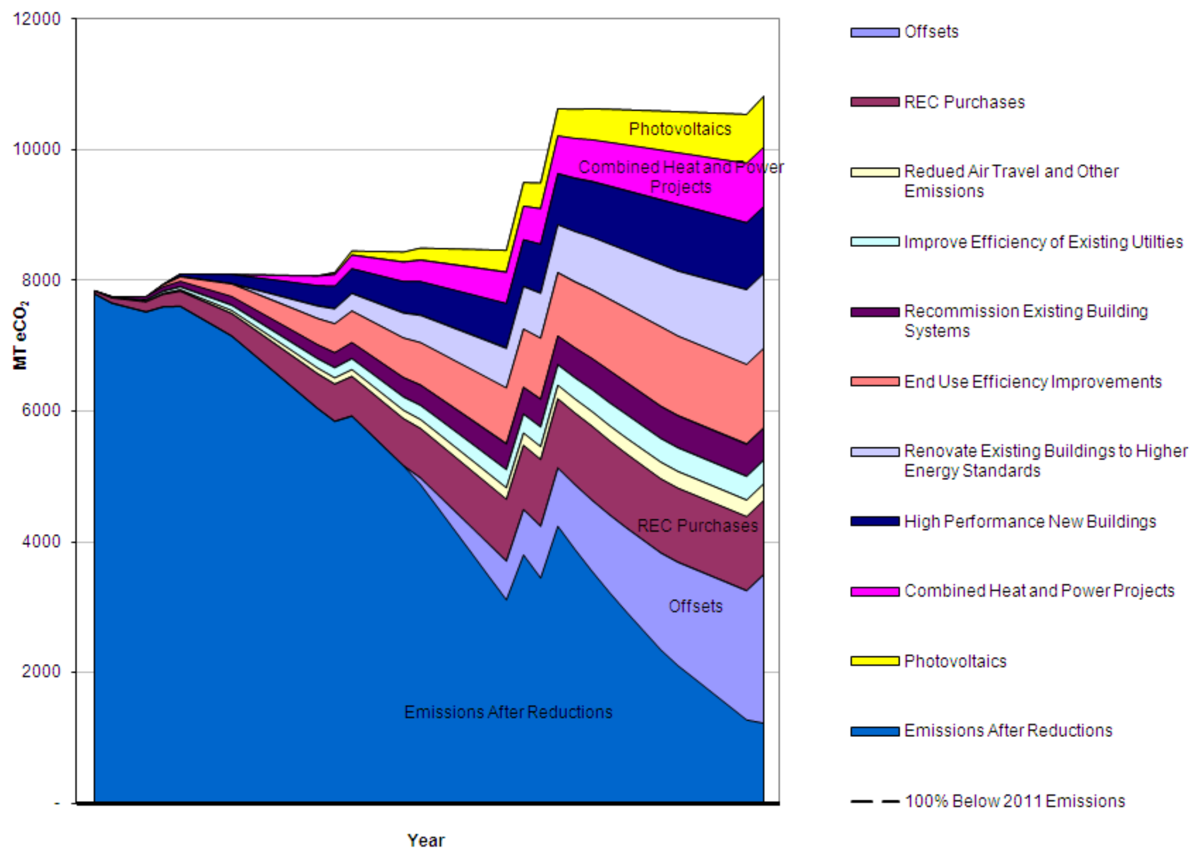
Haverford has implemented a green building policy for all new construction and renovation on campus. This policy states that all new and renovated projects shall achieve the equivalency of a LEED Gold certification. Typically, LEED-like projects result in a 30 percent energy reduction as compared to a baseline model as set forth by ASHRAE. As of this writing, the campus energy consumption per GSF at Haverford is 96 MBTU or 96,000 British Thermal Units (BTU) per GSF. We acknowledge that newer buildings with code required outdoor air minimums may use more energy than some of the older buildings on campus. In light of that, we anticipate that green building measures would reduce energy consumption to 80 MBTU/GSF on an average. Over the course of the next 40 years, we anticipate that a majority of the existing building stock at the campus will be renovated to LEED standards as well. This would result in a reduction of approximately 2,170 MTCDE by 2050.

3.5.9 *Offsets*

As stated in sections above, we do anticipate the purchase of offsetting products to manage those items we cannot reduce to climate neutral via technological, behavioral, and policy changes we will implement. With that said, it is our goal to reduce our emissions through all other means before the purchase of additional offsets, whether they are verified emissions reductions (VER) or certified emissions reductions (CER).

Our mitigation project reductions, assuming the implementation of the above referenced GHG reduction strategies, is presented in Figure 3-9, Emissions Profile: Post CAP Strategies Implementation.

Figure 3-9 Emissions Profile: Post CAP Strategies Implementation



As stated above, we desire to reduce, reuse and recycle, as well as implement other identified mitigation strategies, prior to undertaking the use of offset instruments to attain a climate neutral status. Understanding this, we also realize that at some point we must purchase offset instruments in order to attain net climate neutrality. When considering offsetting, we must consider the type and quality of offset instrument we purchase. We must take into consideration the following factors:

- Additional- Non BAU or wouldn't have otherwise occurred.
- Not Cause Leakage: when action is taken for a particular project it does not cause an increase in emissions elsewhere.
- Must pass a Barriers Analysis, which is where it must be proved that a significant impediment to a project (financial, regulatory, etc.) has been surmounted.
- Real - Sourced from Tangible Projects that have occurred or will imminently occur
- Measurable - Reductions are Objectively Quantifiable
- Permanent – Reductions unlikely to be reversed, with reversals immediately replaced
- Verifiable – Third Party Verified to a set Standard
- Enforceable – Backed by Legal Instruments; Defines Creation, Transparency, Exclusive Credit Ownership

At the time of this writing, the United States is a voluntary compliance market for offsets, meaning that there is no regulatory mechanism in place to date. An excellent example of a regulated market is that of the European Union; which is a signatory to the Kyoto Protocol. Under the regulatory scheme of the Kyoto Protocol and the European Trading System (ETS), emissions limits are set, and offsets may be purchased to meet emissions reduction goals. The available type and quality of offsetting instruments is regulated by the Kyoto Protocol and its governing bodies. Basically there are two types of available offsets: Clean Development Mechanism (CDM) and Joint Implementation (JI) projects. These two products are known in climate change parlance as Certified Emissions Reduction (CER) offsets. Because the United States is a voluntary compliance marketplace, other offsetting products are available and are known as Verified Emissions Reduction (VER) offsets. All of the VERs are considered to meet the above listed bulleted items, however, there are varying verification standards in use which may allow variance in what offsetting products are verifiable, which may lead to some variability in quality of the offsetting instrument.

Costs of offsetting instruments also vary. The basic unit of tradable offset is the MTCDE. Cost variance of offsets is dependent on the offset project type, location, verification standard and upon market forces of supply and demand. At this time, costs of offsets range from about $4.50 per MTCDE to approximately $16.00 per MTCDE. The following table provides a comparison amongst RECs, VERs, and CERs:

Table 3-1 Offsetting Matrix

	Renewable Energy	Verified/Voluntary Emissions	Certified Emissions Reductions
Verification Standard	Green-E Energy	Gold Standard Green-E Climate California Climate Action Registry (CCAR) Voluntary Carbon Standards (VCS) Climate, Community, Biodiversity Alliance (CCBA) Chicago Climate Exchange (CCX) Offset Protocols	Clean Development Mechanism (CDM) Joint Initiative (JI)
Types	Wind Biogas Landfill Gas Biomass Geothermal Solar Low Impact Hydro	Wind Biogas Biomass Photovoltaics Energy Efficiency Waste Water Treatment Coal Mine Gas Utilization Methane Capture NOx Reduction Afforestation Waste Gas Treatment Reforestation Sustainable Forestry	Wind Biogas Biomass Photovoltaics Energy Efficiency Waste Water Treatment Coal Mine Gas Utilization Methane Capture NOx Reduction Afforestation Waste Gas Treatment Reforestation
Additional?	No	Yes, Maybe not as stringent an analysis as a Compliance Market Program. More Projects available that would not make it in a Compliance Market	CDM: Yes, Internationally Recognized Standard (Kyoto) for Compliance Market JI: Not Necessarily Additional, Additionality not a Requirement
Domestic	Yes	Yes	CDM: No JI: Yes
International	No	Can Be	CDM: Yes JI: Not Required
Developing Country	No	Can Be	CDM: Yes JI: Not Required
Tied to Carbon Dioxide Equivalents	No	Yes	CDM: Yes JI: Yes
Cost	\$3.00-\$6.00/MWh	\$4.50-\$16/MT CO_2e	\$4.50-\$16/MT CO_2e

4. Educational, Research, and Community Outreach Efforts

This section of the CAP describes educational, research, and community outreach efforts aimed at making climate neutrality and sustainability a part of the curriculum and/or other educational experience for all students. It also documents efforts to expand research, community outreach and/or other efforts toward achievement of climate neutrality.

4.1 Curriculum and other Educational Experiences

4.1.1 Current Offerings and Programs

Haverford College is committed to making sustainability an essential component of the educational experience for all students. The College has already implemented a number of programs that provide environmental educational experiences at many levels from academic majors to one-time seminars. Haverford College, in collaboration with Bryn Mawr and Swarthmore Colleges, established a Tri-College Environmental Studies program in the Fall 2011. Students are introduced to concepts of sustainability in the introductory course to the minor, which is co-taught with a scientist and non-scientist. Additional coursework addressing sustainability is also offered in the physics, chemistry, anthropology and political science departments. The three colleges are actively working to expand offerings in other department by providing funding for faculty course development grants.

4.1.2 Service Learning Opportunities and Student Organizations

Several service learning opportunities exist at Haverford. Haverford is among the top colleges in the nation regarding the proportion of students who participate in such experiences. While most have a social and/or religious theme, some have explicitly environmental themes. For example, various service learning volunteer opportunities exist which introduce engineering students to particular projects. International volunteer experiences provide students with an opportunity to apply engineering principles to assist low-income developing communities worldwide. These projects often entail working directly with local community members for the design and construction of schools, water supply systems and small-scale electrification projects using renewable resources. Issues in sustainability are introduced during these projects and include the concept of the triple-bottom-line. This includes understanding the need for protecting natural resources (environmental-sustainability), using appropriate technology to solve local problems (socio-cultural-sustainability) and building the capacity of local stakeholders for operation and management of infrastructure projects (financial-sustainability).

4.1.3 Student Organizations

A number of student organizations have also been created around areas of interest generally tied to sustainability. The Committee for Environmental Responsibility (CER) is a group of student activists who participate in projects on campus, locally, and globally. Some examples include conducting several petitions throughout the year to achieve sustainability both on campus and in the State of Pennsylvania, campus-wide initiatives such as a light bulb exchange, and participating in the annual Earth Day.

4.1.4 Student Orientation and Other College-wide Initiatives

All students are also exposed to issues of climate neutrality and sustainability through College-wide initiatives. Over a 10-week period, schools report recycling and trash data which are then ranked according to who collects the largest amount of recyclables per capita, the largest amount of total recyclables, the least amount of trash per capita, or have the highest recycling rate. With each week's reports and rankings, participating schools watch how their results fluctuate against other schools and use this to rally their campus communities to reduce and recycle more. Students helped draft and promote the Green Office Program, an initiative designed to help departments reduce their carbon footprint. The college also collected abandoned student bikes and donated them to the Devereux Foundation for refurbishing. Devereux's bike program focuses on assisting developmentally disabled individuals in the acquisition of the skills needed to secure successful competitive employment in the community. Refurbished bikes are resold to students during the first week of classes in September.

4.1.5 Planned Future Actions

Efforts are underway to make sustainability part of curriculum for all students and to increase the variety of ways in which students can become involved in these issues.

4.2 Research

4.2.1 On-going Research

Haverford faculty and students in all four undergraduate colleges are involved in a wide range of projects relating directly or indirectly to sustainability and climate change. For example, faculty member Joshua Schrier received external funding for his research examining the nanostructure of materials used in alternative energy devices and Helen White received funding to examine the fate of oil from the *Deepwater Horizon* oil spill. With this and internal support, faculty are able to fund research experiences for students during the semester and summer term.

4.3 Community Outreach

4.3.1 Planned Future Efforts

Future plans include continuing to develop pieces on climate neutrality and sustainability for the College website and possibly printed media to inform and educate the Haverford community about the initiatives on campus. These pages will be updated often to include a schedule of upcoming events and to feature progress being made on campus to reduce carbon footprint.

5. Tracking Changes

5.1 Policy & Technical Changes

We anticipate that the future will hold changes that affect not only how we use energy, but how it is generated and distributed. One area where we anticipate future change is the establishment of a nationwide Renewable Portfolio Standard (RPS). It is anticipated that the Federal government will require electrical generation utilities to ensure that a certain percentage of their generation assets are from renewable sources such as wind, solar, or hydropower facilities. This RPS is a means to encourage the development and use of renewable energy technologies on a commercial scale, and will help reduce the carbon intensity of our electrical grid. As of today, many states have established an RPS, and have targets that require greater percentages of renewable energy generation assets over a given time period.

A second area of anticipated change is the implementation of GHG emissions standards and limitations by the U.S. EPA, or the adoption of Cap and Trade legislation by the Federal government. It is apparent that the EPA's recent endangerment finding with regard to GHGs would allow the six principle GHGs to be regulated under the Clean Air Act Amendments. This would set emissions standards for GHGs on a nationwide basis, barring the adoption of Cap-and-Trade legislation, which many would deem less of an economic burden than implementation of new standards under the CAAA by the EPA.

Another anticipated development is the move toward distributed generation systems and the development of a "smart grid". Distributed generation is where smaller, more numerous, yet closer to end user sources of electrical generation are used. This effectively puts the generation asset closer to the end user, thereby reducing the T&D losses associated with our current grid system. Smart Grid technologies are currently being researched and developed. It is hoped that the outcome of the this process would be the intercommunication amongst generation and distribution points to better allocate the use and availability of grid based assets, providing greater efficiencies and economy of use.

Technological changes will likely have a great impact in the future. Bio-based photovoltaic cells and fuels, carbon capture and sequestration technologies, advanced fuel cell technologies and efficiency improvements of heating, cooling, electrical, and transportation equipment are likely to provide sustainable alternatives to our energy needs. What form or within what timeframe these technological changes will occur in is a matter for great anticipation and speculation.

5.2 Tracking Progress

The purpose of this section is to define, subsequent to the adoption of this Climate Action Plan (CAP), a process by which we can track progress toward our goal of achieving net climate neutrality, as defined in the ACUPCC Implementation Guide, Page 29, v1.0, dated September, 2007. Assessment of progress toward this goal is not limited to the achievement of net climate neutrality alone; it also includes a method by which we can determine our success integrating sustainability into the fabric of the College and the community's collective knowledge.

In order to follow our progress on our journey to net climate neutrality it is important that we have a method by which to measure progress. As Peter Drucker has ingrained into our conventional wisdom the paradigm that, what gets measured gets managed, this too holds true for our emissions inventory. We endeavor to update our greenhouse gas emission inventory every other year. It is our intention that with each new report the accuracy of the data contained in the inventory will be subsequently improved. Along with the updated inventory, we will prepare a narrative reporting the following:

- Mitigation strategies undertaken
- Campus emissions
- A comparison of emissions with emission projections contained in the CAP
- Explanations for significant difference between emissions and projections, and possible remedies

Every five years the CAP will be reviewed more holistically to evaluate progress to date, but more importantly to verify assumptions contained in the previous edition of the CAP are still valid. This more detailed review of the CAP will also provide an opportunity for a review of changes in technology, energy & environmental markets, and financing mechanisms. Most importantly this review will allow for a re-evaluation of our ability to achieve our milestones and targets. Revisions to the CAP including any modifications to milestones (to either earlier or later dates) will be reported to the ACUPCC as part of this process.

5.3 Target Dates for Emissions Reductions

Based upon the implementation of the Campus Master Plan and upon the implementation of the mitigation strategies as detailed above, Haverford will have reduced its emissions by 9 percent over 2011 emissions levels by the year 2017. Throughout this process, we anticipate beginning the purchase of offset instruments to further our goal of net climate neutrality.

The Campus Master Plan projects increasing the size of the campus to 2.18 million GSF, and provides housing, academic and campus life spaces that ensure that Haverford College remains a premier facility and recognized leader for higher education. With this growth also comes the need for increases in infrastructure and physical plant capacity. We understand the relationship between energy consumption, campus growth, and greenhouse gas emissions continues to evolve, and will further investigate energy conservation and reduction strategies. We also understand that in order to achieve net climate neutrality, we assume that future technological changes will help us attain our goal without excessive purchase of

Haverford

offsetting instruments. In order to allow sufficient time to investigate our alternatives, and sufficient time for technological and societal changes to take place, we have not set a date for net climate neutrality at this time.

6. Assumptions

The following is a listing of assumptions and *a priori* conclusions that were used in the collection of data, analysis of data, projection of future campus greenhouse gas emissions, and effects of mitigation strategies, all of which have been included in the preceding climate action plan. Assumptions are organized by section of this report.

6.1 Campus Emissions

- College owned faculty housing were not included in the GHG emissions inventory, nor in the energy audits conducted as part of this CAP.
- Our business as usual and mitigation strategies as presented in this CAP reflect the fuel mix in use for FY 2011 at the central plant.
- Air Travel is reported for student travel only, and does not reflect institutionally sponsored air travel for faculty and or staff attendance at conferences, etc.
- Commuting data was not collected for student to and from school and incidental personal travel while living on-campus.
- Commuting data for faculty and staff was calculated from home address zip code for each faculty or staff member. Using the center of zip code to campus distance was determined to be the most efficient method of calculating the commuter mileage. The average over all distance commuted per trip was used in the CACP calculator.
- Commuter travel was assumed to be 50 weeks per year.
- Window unit air conditioners were assumed to have a per unit charge of 0.75 pounds of R-22 refrigerant.
- Air conditioners and chiller systems were assumed to have a leakage rate of five percent per year.

6.2 Mitigation Strategies

- Major mitigation strategies are estimated at full cost, inclusive of design and construction fees.

- All mitigation strategy costs are figured in 2011 dollars and estimated annual savings are based on FY 2011 unit cost of energy savings.

- The emissions projection for on-campus stationary sources does reflect the potential remaining emissions from faculty housing.
- Each kW of proposed solar project is assumed to produce 1,100 kWh.

- Installation costs for the proposed 1MW solar system is assumed to be $3.50/W and for the smaller proposed projects is assumed to be $4.00/W.

- We assume that the value of SRECs for the proposed solar systems to be $50/REC in years 1-15 of operation, and that the SRECs provided by Pennsylvania Alternative Energy Portfolio Standard will be extended beyond its current life cycle.

- Paybacks and benefits of solar projects assume a 3% energy cost escalation and a 0.5% panel degradation rate.

- For CHP and CCHP projects we assumed a cost of $2,000/kW installed, and operating up time of 8,500 hrs/year.

6.3 Other/Miscellaneous

- The presented Business as Usual Case set forth in Section Two utilizes the 2011 regional fuel mix and electrical grid region as default values (eGrid Region RFCE). The associated emissions values for these two items were subsequently normalized to MBTU per Gross Square Foot for each of the two commodities, and projected growth in square footage and year was then applied to generate the emissions growth model/projection of both on-campus stationary sources and purchased electricity.

- The presented Business as Usual Case as set forth in Section Two and the associated projection that shows the effects of mitigation strategies in Section 3 has not been normalized for student and faculty/staff growth. These numbers remain constant as we do not anticipate growing the institution in term of these two factors. The FY 2011 values used are 1,177 full time students, 3,137 summer school students, 148 faculty and 394 staff.

Appendix A Greenhouse Gas Emissions Inventory

Clean Air Cool Planet Calculator: Date Input Sheet

On this Worksheet: Enter data related to emissions. If a column does not apply or the data is unavailable, leave it blank.

MODULE
WORKSHEET
UNIVERSITY

Fiscal Year	Population					Physical Size			Other On-Campus Stationary Sources			Direct Transportation Sources: University Fleet		Refrigerants & Chemicals: Refrigerants & Chemicals			
	Full Time Students	Part-Time Students	Summer School Students	Faculty	Staff	Total Building Space	Total Research Building Space	Steam Efficiency	Residual Oil (#5-6)	Distillate Oil (#1-4)	Natural Gas	Gasoline Fleet	Diesel Fleet	HFC-134a	HFC-404a	HCFC-22	Other
	#	#	#	#	#	Square feet	Square feet	%	Gallons	Gallons	MMBtu	Gallons	Gallons	Pounds	Pounds	Pounds	Pounds
1990																	
1991	1,159	0		128													
1992	1,147	0		117	314	1,186,156	48,520			14,796	57,241						
1993	1,113	0		107	312	1,186,156	48,520			6,746	60,264						
1994	1,138	0		107	312	1,195,747	65,150			16,319	69,773						
1995	1,083	0		109	317	1,242,364	68,216			85,341	62,905						
1996	1,109	0		111	325	1,257,761	68,216			23,836	67,898						
1997	1,115	0		110	326	1,258,658	68,216			141,220	61,530						
1998	1,137	0		109	329	1,259,596	68,216			33,439	72,977						
1999	1,147	0		109	332	1,259,722	68,216			23,547	68,946						
2000	1,147	0	3,515	109	335	1,261,265	68,216			34,832	67,655						
2001	1,118	0	3,515	118	342	1,267,220	68,216			50,140	70,081						
2002	1,135	0	3,515	112	355	1,267,132	68,216			173,820	59,839						
2003	1,138	0	3,515	111	361	1,343,668	139,351			15,942	71,750			100	0	88	1
2004	1,105	0	3,355	113	366	1,392,069	187,752			18,451	90,197	11,856	2,424	100	0	88	1
2005	1,163	0	3,415	115	367	1,392,069	187,752			448,983	21,060	13,379	2,817	100	0	88	1
2006	1,172	0	3,415	129	368	1,386,801	187,752			67,585	78,557	12,724	2,660	100	0	88	1
2007	1,168	0	3,137	124	375	1,490,278	187,752			183,020	41,590	12,386	2,617	100	0	88	1
2008	1,168	0	3,137	128	381	1,490,284	187,752			68,068	59,780	13,265	3,102	100	0	88	1
2009	1,168	0	3,137	128	381	1,490,284	187,752			11,853	83,198	13,688	2,696	100	0	88	1
2010	1,190	0	3,137	128	381	1,488,472	187,752			11,853	83,198	12,515	4,100	100	0	88	1
2011	1,177	0	3,137	123	491	1,488,472	187,752			27,697	87,672	12,515	3,050	100	0	88	1

--- Scope 2 Emissions Sourc					--- Scope 3 Emissions Sources ---								--- Offsets ---	
Agriculture Sources				Purchased Electricity, Steam, and Chilled Water	Commuting - click here to enter data	Directly Financed Outsourced Travel		Solid Waste						
Fertilizer Application				Electricity	Faculty / Staff Commuting	Air Travel		Incinerated Waste (not used for on-campus power)		Landfilled Waste			Offsets with Additionality	Non-Addition
Synthetic	% Nitrogen	Organic	% Nitrogen	CLICK TO SET eGRID SUBREGION	Automobile	Faculty / Staff	Students	Mass Burn	Refuse Derived Fuel (RDF)	No CH4 Recovery	CH4 Recovery and Flaring	CH4 Recovery and Electric Generation	On-campus Composting	Green Power Certificates
Pounds	%	Pounds	%	kWh	Miles	Miles	Miles	Short Tons	Short Tons	Short Tons	Short Tons	Short Tons	Short Tons Compost	kWh
					-									
					-									
				6,493,815	-									
				6,384,866	-									
				7,192,976	-									
				8,096,936	-									
				8,504,914	-									
				8,268,007	-									
				8,427,120	-									
59,100	1.86%	3,700	0.05%	8,877,984	-									
28,950	1.28%	10,700	0.30%	8,924,333	-									
22,150	0.74%	33,150	0.25%	9,444,943	987,660									
22,800	1.48%	13,950	0.35%	9,708,971	4,004,640								277	
39,000	2.33%	16,750	0.20%	12,116,944	4,048,110								277	
29,200	0.87%	9,700	0.15%	12,616,588	4,108,050								277	
25,600	0.37%	40,850	7.50%	13,842,236	4,133,430								277	
13,749	11.80%	79,050	7.50%	14,685,607	4,259,250		539,736	624		234			277	
13,749	11.80%	34,400	7.50%	15,741,484	4,277,880		539,736	624		234			277	
13,749	11.80%	50,000	7.50%	13,968,277	4,363,200		539,736	624		234			277	7,000,000
13,749	11.80%	23,999	7.50%	14,408,818	4,363,200		539,736	751		265			277	14,000,000
13,750	11.80%	24,000	7.50%	14,849,359	2,031,750		539,736	879		296			277	14,000,000
13,750	11.80%	24,000	7.50%	15,089,539	2,031,750		561,053	879		296			277	14,000,000

Note: The Clean Air Cool Planet Calculator contains more data columns than shown. Those columns not applicable to Haverford College have been hidden.

Clean Air Cool Planet Calculator: Carbon Dioxide Equivalent Summary Sheet

On this Worksheet: Total emissions summarized by scope and category.

MODULE	
WORKSHEET	
UNIVERSITY	

Fiscal Year					Scope 2	Scope 3				Offsets							
	Other On-Campus Stationary	Direct Transportation	Refrigerants & Chemicals	Agriculture	Purchased Electricity	Faculty / Staff Commuting	Directly Financed Air Travel	Solid Waste	Scope 2 T&D Losses	Additional	Non-Additional	Total Scope 1	Total Scope 2	Total Scope 3	Total Offsets	Total Emissions	Net Emissions
	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2
2008	3,847.5	149.7	126.6	17.5	6,751.8	1,762.8	419.0	207.1	667.8	(106.5)	-	4,141.4	6,751.8	3,056.8	(106.5)	13,949.9	13,843.4
2009	4,521.9	149.4	126.6	22.3	6,964.7	1,762.8	419.0	229.7	688.8	(106.5)	-	4,820.2	6,964.7	3,100.4	(106.5)	14,885.3	14,778.8
2010	4,521.9	153.1	126.6	14.3	7,177.6	820.9	419.0	252.2	709.9	(106.5)	-	4,815.8	7,177.6	2,202.0	(106.5)	14,195.5	14,089.0
2011	4,917.9	142.5	126.6	14.3	7,293.7	820.9	435.6	252.2	721.4	(106.5)	(6,767.1)	5,201.2	7,293.7	2,230.0	(6,873.6)	14,725.0	7,851.4
2012	4,914.5	151.6	134.8	3.4	5,954.5	1,540.2	438.7	234.8	588.9	(114.9)	(6,958.0)	5,204.2	5,954.5	2,802.6	(7,072.9)	13,961.3	6,888.4
2013	4,914.5	151.6	134.8	1.9	5,954.5	1,540.2	438.7	234.8	588.9	(114.9)	(6,958.0)	5,202.7	5,954.5	2,802.6	(7,072.9)	13,959.9	6,886.9
2014	4,914.5	151.6	134.8	0.2	5,954.5	1,540.2	438.7	234.8	588.9	(114.9)	(6,958.0)	5,201.0	5,954.5	2,802.6	(7,072.9)	13,958.2	6,885.2
2015	5,037.4	155.3	138.2	(1.7)	6,103.6	1,578.8	449.7	240.6	603.6	(117.8)	(7,132.2)	5,329.2	6,103.6	2,872.8	(7,249.9)	14,305.5	7,055.6
2016	5,139.2	158.5	141.0	(4.0)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,434.7	6,226.9	2,930.8	(7,396.4)	14,592.4	7,196.0
2017	5,139.2	158.5	141.0	(6.4)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,432.2	6,226.9	2,930.8	(7,396.4)	14,589.9	7,193.5
2018	5,139.2	158.5	141.0	(9.2)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,429.5	6,226.9	2,930.8	(7,396.4)	14,587.2	7,190.7
2019	5,139.2	158.5	141.0	(12.2)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,426.5	6,226.9	2,930.8	(7,396.4)	14,584.2	7,187.7
2020	5,139.2	158.5	141.0	(15.5)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,423.2	6,226.9	2,930.8	(7,396.4)	14,580.9	7,184.5
2021	5,139.2	158.5	141.0	(19.0)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,419.7	6,226.9	2,930.8	(7,396.4)	14,577.4	7,180.9
2022	5,139.2	158.5	141.0	(22.8)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,415.9	6,226.9	2,930.8	(7,396.4)	14,573.6	7,177.1
2023	5,139.2	158.5	141.0	(26.8)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,411.8	6,226.9	2,930.8	(7,396.4)	14,569.5	7,173.1
2024	5,139.2	158.5	141.0	(31.2)	6,226.9	1,610.7	458.8	245.5	615.8	(120.1)	(7,276.3)	5,407.5	6,226.9	2,930.8	(7,396.4)	14,565.2	7,168.8
2025	5,174.5	159.6	141.9	(35.7)	6,269.7	1,621.8	461.9	247.2	620.1	(121.0)	(7,326.3)	5,440.3	6,269.7	2,950.9	(7,447.3)	14,660.9	7,213.7
2026	5,385.7	166.1	147.7	(40.6)	6,525.5	1,687.9	480.8	257.3	645.4	(125.9)	(7,625.2)	5,658.9	6,525.5	3,071.3	(7,751.1)	15,255.8	7,504.6
2027	5,385.7	166.1	147.7	(45.7)	6,525.5	1,687.9	480.8	257.3	645.4	(125.9)	(7,625.2)	5,653.8	6,525.5	3,071.3	(7,751.1)	15,250.7	7,499.5
2028	5,385.7	166.1	147.7	(51.0)	6,525.5	1,687.9	480.8	257.3	645.4	(125.9)	(7,625.2)	5,648.5	6,525.5	3,071.3	(7,751.1)	15,245.3	7,494.2
2029	5,385.7	166.1	147.7	(56.6)	6,525.5	1,687.9	480.8	257.3	645.4	(125.9)	(7,625.2)	5,642.8	6,525.5	3,071.3	(7,751.1)	15,239.7	7,488.6
2030	5,427.3	167.4	148.9	(62.5)	6,576.0	1,701.0	484.5	259.3	650.4	(126.9)	(7,684.2)	5,681.0	6,576.0	3,095.1	(7,811.1)	15,352.1	7,541.0
2031	5,427.3	167.4	148.9	(68.7)	6,576.0	1,701.0	484.5	259.3	650.4	(126.9)	(7,684.2)	5,674.9	6,576.0	3,095.1	(7,811.1)	15,346.0	7,534.9
2032	5,427.3	167.4	148.9	(75.1)	6,576.0	1,701.0	484.5	259.3	650.4	(126.9)	(7,684.2)	5,668.5	6,576.0	3,095.1	(7,811.1)	15,339.6	7,528.5
2033	5,427.3	167.4	148.9	(81.7)	6,576.0	1,701.0	484.5	259.3	650.4	(126.9)	(7,684.2)	5,661.8	6,576.0	3,095.1	(7,811.1)	15,332.9	7,521.8

Note: The Clean Air Cool Planet Calculator contains more data columns than shown. Those columns not relating to Haverford College have been hidden.

Appendix B Energy Capital Investment Plan

Haverford College
Climate Action Plan
Energy Capital Investment Plan - *Phase 1 Projects*

NUM	ENERGY SUB-SYSTEM	PROJECT	BUILDING	ESTIMATED COST	ESTIMATED GAS REDUCTION MBTU	ESTIMATED ELEC. REDUCTION KWH	ANNUAL SAVINGS	FOSSIL FUEL EMISSIONS IMPACT (MT CO_{2e})	ELECTRICAL EMISSIONS IMPACT (MT CO_{2e})	PAYBACK PERIOD	ROI %	PHASE	COMMENTS
1	4. Distribution	The condenser water pumps are equipped with VFDs but are balanced at the triple duty valves. Open the valves and set VFDs to control for the required flow.	Athletic Center	$ 1,000	-	17,904	$ 1,647	0.0	9.5	0.6	165%	1	
2	3. Generation	Consider using a wet bulb approach temperature setpoint for the cooling tower fan control (two stage). Currently the cooling tower setpoint is 70 F, which is not achievable for much of the cooling season.	Athletic Center	$ 1,000	-	5,036	$ 463	0.0	2.7	2.2	46%	1	
3	5. End Use	Perform retrocommissioning for the Athletic Center. Multiple instances of incorrect damper positions, improper heat wheel controls and erroneous sensor readings were observed. See separate list provided for specific instances noted.	Athletic Center	$ 40,000	598,829	97,033	$ 14,706	33.4	51.5	2.7	37%	1	
4	4. Distribution	Steam may be leaking at the control valve to the hot water heat exchanger. Consider manually isolating valves in the summer months at this location and others.	Barclay	$ -	50,000	-	$ 483	2.8	0.0	0.0	100%	1	
5	5. End Use	Replace old exit lights throughout with LED.	Campus	$ 7,000	-	31,536	$ 2,901	0.0	16.7	2.4	41%	1	
6	5. End Use	Install energy misers at vending machines throughout.	Campus	$ 4,500	-	18,375	$ 1,691	0.0	9.8	2.7	38%	1	NOTE: It will be necessary to consult the vendor
8	4. Distribution	Install VFDs in place of the supply and return guide vanes or replace the unit and provide VFDs.	Chase	$ 10,000	-	12,123	$ 1,115	0.0	6.4	9.0	11%	1	use 5 and 7.5 HP fans
9	4. Distribution	Install a VFD at the cooling tower fan (10 HP) and improve the chilled water optimization and control sequences. Provide a setup OA lockout if unoccupied cooling is desirable and restric schedule (currently 4:00 - 22:30).	Dining	$ 6,500		11,078	$ 1,019	0.0	5.9	6.4	16%	1	
10	5. End Use	Replace metal halide lights (7 row by 15 fixtures each).	Field House	$ 52,500	(159,998)	75,293	$ 5,383	-8.9	40.0	9.8	10%	1	400W MH (455 W) to 4 lamp T5HO (234 W) one for one replacement. Accounts for decreased hourly usage by eliminating long warm-up. Consider also optimum circuit arrangement.
11	4. Distribution	Investigate the ability to valve shut the steam line at Lloyd (serving Founders) during the summer months. Alternatively, command heat exchanger control valves closed.	Founders	$ -	25,000	-	$ 241	1.4	0.0	0.0	NA	1	
12	5. End Use	Commission the AHUs. The supply fans (identical) discharge into a common duct header, but the fans are operating at different speeds. Adjust the controls for a common VFD speed output. The same applies to the chilled water valves (one observed at 100%, th	Library	$ 22,000	128,593	64,826	$ 7,205	7.2	34.4	3.1	33%	1	
13	3. Generation	Improve chiller operating sequences: Raise lag chiller start percent. Stage chillers evenly. Provide schedule with unoccupied OA lockout. Raise OA lockout (currently 45 F). Use approach temperature (currently high/low fan speed but VFD display) Unless ded	Science	$ 10,000	-	48,000	$ 4,416	0.0	25.5	2.3	44%	1	

Haverford College
Climate Action Plan
Energy Capital Investment Plan - *Phase 1 Projects*

NUM	ENERGY SUB-SYSTEM	PROJECT	BUILDING	ESTIMATED COST	ESTIMATED GAS REDUCTION MBTU	ESTIMATED ELEC. REDUCTION KWH	ANNUAL SAVINGS	FOSSIL FUEL EMISSIONS IMPACT (MT CO_{2e})	ELECTRICAL EMISSIONS IMPACT (MT CO_{2e})	PAYBACK PERIOD	ROI %	PHASE	COMMENTS
14	4. Distribution	Convert the MAU supply fans to VFD control from inlet guide vane control (equipped with both VFDs and vanes).	Science	$ 40,000		245,061	$ 22,546	0.0	130.0	1.8	56%	1	
15	4. Distribution	Convert the hot water pumps to variable flow.	Science	$ 7,000	-	39,210	$ 3,607	0.0	20.8	1.9	52%	1	
16		Retro-commission the Science Building (all wings).	Science	$ 75,000	1,102,267	198,454	$ 28,895	61.5	105.3	2.6	39%	1	
17	4. Distribution	Install variable geometry discharge dampers at the exhaust fans and close the bypasses.	Science	$ 80,000		156,839	$ 14,429	0.0	83.2	5.5	18%	1	
19	4. Distribution	Convert the chilled water pumps to variable flow.	Science	$ 10,000	-	16,114	$ 1,482	0.0	8.6	6.7	15%	1	FCUs have 2-way valves, but AHUs have 3-way valves (w valves at bypasses). Currently, chilled water pumps may be indexed with chiller. ChW 20 HP, condenser 15, booster 20
20	4. Distribution	Provide VFDs at the condenser water pumps. Control for condenser water dT and minimum flow.	Science	$ 12,500	-	20,422	$ 1,879	0.0	10.8	6.7	15%	1	
21	4. Distribution	Convert the domestic booster pumps to variable flow.	Science	$ 8,000		13,070	$ 1,202	0.0	6.9	6.7	15%	1	
22	5. End Use	Provide demand controlled ventilation at the Auditorium unit (AHU-4). Note: A CO2 sensor is already installed, but it does not appear to limit the OA when conditions are satisfied. Fur further savings, implement a fan cycling sequence.	Stokes	$ 1,500	95,000	1,750	$ 1,078	5.3	0.9	1.4	72%	1	
23	5. End Use	Commission the large systems.	Stokes	$ 23,000	231,903	60,123	$ 7,769	12.9	31.9	3.0	34%	1	
24	5. End Use	Improve the operating parameters at AHU-1 (see further detail in Scheduling/Setpoint log). Implement an unoccupied dehumidification sequence (units will cycle without OA and in full cooling; further sensors required) and leaving the AHUs unoccupied for th	Union	$ 1,000	-	12,000	$ 1,104	0.0	6.4	0.9	110%	1	
25	4. Distribution	AHU-3 exhibits a small temperature increase over the coils, with only the chilled water valve open (100%). Review steam valve control and manually isolate steam valves at units during warmer months.	Whitehead	$ -	17,500	2,500	$ 399	1.0	1.3	0.0	100%	1	
26	4. Distribution	Install a VFD at the cooling tower fan.	Whitehead	$ 8,000		20,052	$ 1,845	0.0	10.6	4.3	23%	1	40 HP
27	4. Distribution	Provide VFDs at the AHUs and remove the inlet guide vanes.	Whitehead	$ 11,000		15,316	$ 1,409	0.0	8.1	7.8	13%	1	
28	5. End Use	Install occupancy sensors for increased control of HVAC equipment (standby mode when no occupancy)	Campus	$ 50,000	647,668	66,489	$ 12,500	36.1	35.3	4.0	25%		
29	5. End Use	Install occupancy sensors for the bathrooms, and vacancy sensors for the storage areas adjoining the shop area (wall mounted at current light switch locations).	Facilities	$ 375		619	$ 57	0.0	0.3	6.6	15%		
30	5. End Use	Install occupancy sensor to control lighting (and potentially HVAC) at offices, conference areas and bathrooms.	Stokes	$ 3,750		4,641	$ 427	0.0	2.5	8.8	11%		
31	5. End Use	Install occupancy sensors for lighting control.	Sharpless	$ 9,000		10,920	$ 1,005	0.0	5.8	9.0	11%		
32	5. End Use	Install occupancy sensors at the classrooms and offices.	Gest	$ 1,000		1,092	$ 100	0.0	0.6	10.0	10%		

Haverford College
Climate Action Plan
Energy Capital Investment Plan - *Phase 1 Projects*

NUM	ENERGY SUB-SYSTEM	PROJECT	BUILDING	ESTIMATED COST	ESTIMATED GAS REDUCTION MBTU	ESTIMATED ELEC. REDUCTION KWH	ANNUAL SAVINGS	FOSSIL FUEL EMISSIONS IMPACT (MT CO_{2e})	ELECTRICAL EMISSIONS IMPACT (MT CO_{2e})	PAYBACK PERIOD	ROI %	PHASE	COMMENTS
33	5. End Use	Install occupancy sensors to control lighting at applicable locations (some lighting control is effective).	Thorne	$ 800		728	$ 67	0.0	0.4	11.9	8%		
34	5. End Use	Install occupancy sensors at the office light switch locations.	Founders	$ 7,500		6,825	$ 628	0.0	3.6	11.9	8%		
	PHASE 1: Haverford College Phase 1 Selected Projects			$ 503,925	2,736,761	1,273,428	$ 143,698	153	676	3.5	29%		

Net Campus Emissions: *7,852 MTCDE*
Target Reduction: 9% in 5 Years *707 MTCDE*
Phase 1 Emission Reduction % *828 MTCDE* *10.5% Reduction*

Haverford College
Climate Action Plan
Energy Capital Investment Plan - ***Phase 2 Projects***

NUM	ENERGY SUB-SYSTEM	PROJECT	BUILDING	ESTIMATED COST	ESTIMATED GAS REDUCTION MBTU	ESTIMATED ELEC. REDUCTION KWH	ANNUAL SAVINGS	FOSSIL FUEL EMISSIONS IMPACT (MT CO_{2e})	ELECTRICAL EMISSIONS IMPACT (MT CO_{2e})	PAYBACK PERIOD	ROI %	PHASE	COMMENTS
7	3. Generation	Turn off the steam system during the summer. Install independent systems at buildings served (domestic hot water heaters, hot water boilers).	Campus	$ 350,000	6,566,150	-	$ 57,027	366.3	0.0	6.1	16%	2	
18	3. Generation	Install 250 kW CCHP unit for cooling, heating and electric	Science	$ 450,000	(7,400,287)	2,082,500	$ 99,352	-412.8	1105.0	4.5	22%	2	See separate CHP analysis. Analysis includes 50% ACE grant & 10% FITC funding
PHASE 2: Haverford College Phase 2 Projects				$ 800,000	(834,137)	2,082,500	$ 156,379	(47)	1,105	5.1	20%		

Appendix C Calculations and Conversions

Energy

Energy Type	FY 10/11 Consumption	Conversion Factor	Total MMBTU
Electricity	15,089,539 kWh	0.003412 MMBTU/kWh	51,486
Natural Gas	855,334 CCF	0.1025 MMBTU/CCF	87,672
Oil	27,697 gal	0.139 MMBTU/gal	3,850

Direct Transportation

Fleet Fuel Type	Gallons
Diesel	3,050
Gasoline	12,515

Fuel data recorded from delivery records.

Refrigerants

Refrigerant Type	Total Pounds	Pounds of Refrigerant Loss at 5% Leak
HFC-134a	2000.5	100
HFC-404a	1.5	0.075
HCFC-22	1752	88
Other**	23.9	1

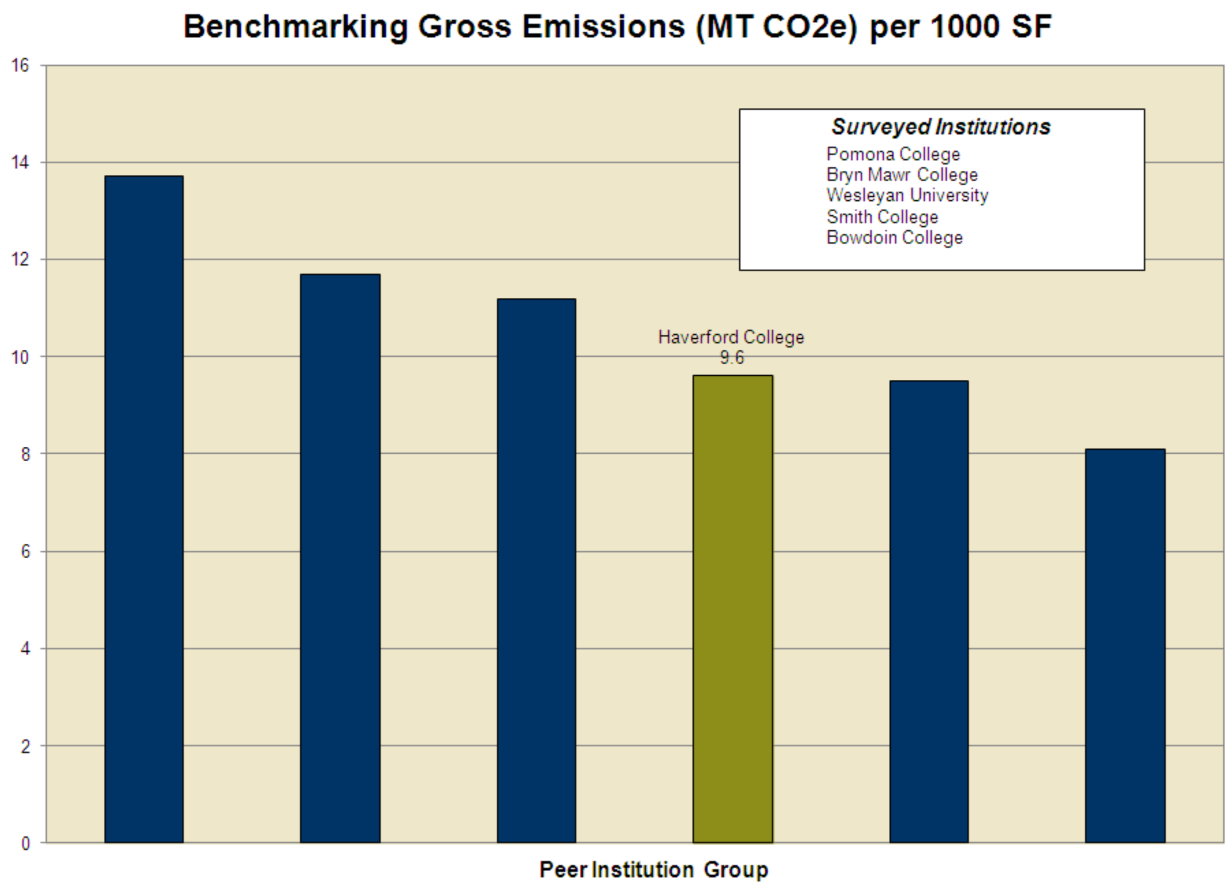
Total pounds of refrigerant collected from equipment inventory, including window units, kitchen equipment and chillers. Refrigerants are reported as the quantity lost through equipment use that has to be refilled. As a standard, a 5% leak rate is assumed. **Other refrigerants are comprised of R-410a, R508B and R12.

On Campus Composting

Green Waste	Cubic Feet	Short Tons
Wood Chips	4,500	41.6
Leaves	31,500	200.5
Green Waste	21,600	43.2
Total		**285.3**

With a composting rate of approximately 97% of the total green waste, Haverford College composted 277 short tons of organic waste in FY 10/11.

Appendix D Peer Institution Comparison



Amherst College, Mount Holyoke College, Wellesley College and Williams College, while considered peer institutions, have not signed the ACUPCC and do not have comparable data available.