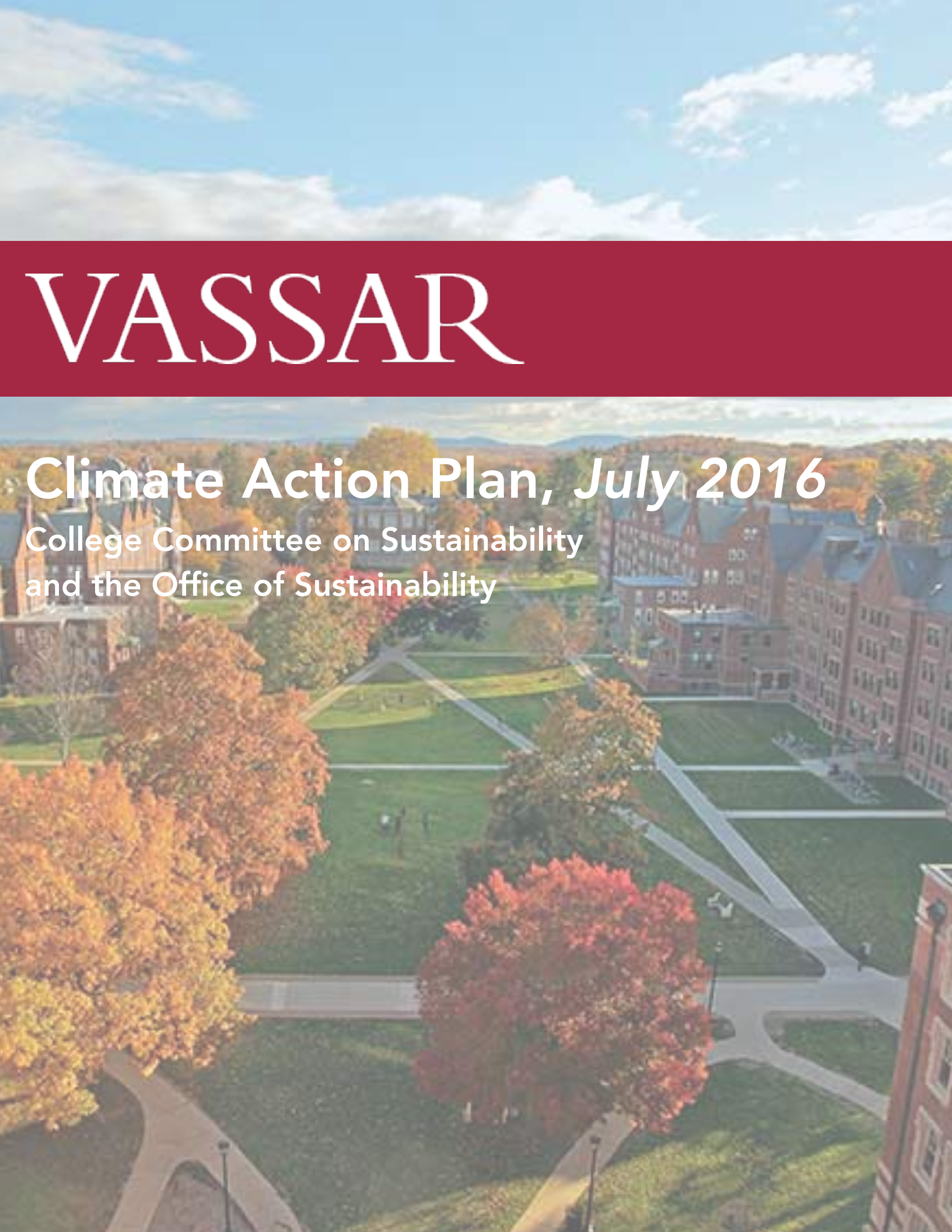

VASSAR

Climate Action Plan, *July 2016*

College Committee on Sustainability
and the Office of Sustainability

VASSAR COLLEGE
OFFICE OF THE PRESIDENT

August 12, 2016

Dear Members of the Vassar Community:

I am very pleased to present to you the document behind this cover letter, the Vassar Climate Action Plan. As I am sure you are aware, scientific studies over the past several decades have made it clear that the increase of greenhouse gases in the atmosphere has a negative on our planet which could become catastrophic if left unchecked. In order to slow and eventually stop the effects of global climate change, communities everywhere will have to develop alternative energy use patterns.

At Vassar, work that began over five years ago with the Sustainability Committee and which has been carried to completion by the Office of Sustainability has resulted in the present document, which details a plan for Vassar to become carbon neutral by the year 2030. This plan has been endorsed by the senior officers of the College, and has been presented to the Board of Trustees. It is ambitious and will require significant changes, but it is feasible.

I invite you to read the Climate Action Plan, and consider how to get involved and contribute. The broader the participation, the more effectively and rapidly we can achieve our goal of achieving carbon neutrality. I would also like to thank the Office of Sustainability for the substantial and important work that went into the writing of the Plan.

Sincerely,

Catharine Bond Hill
President

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Introduction

In Fall 2015, Professor David Orr of Oberlin College gave a lecture at Vassar on the "journey to sustainability." Though it is hard to establish one defining target for what it means to achieve sustainability, Orr stressed the importance of beginning on the journey regardless. Taking action on climate change and aiming for carbon neutrality is a vitally important waypoint on this journey and "No institutions in modern society are better equipped to catalyze the necessary transition to a sustainable world than colleges and universities…[with] access to the leaders of tomorrow and the leaders of today. What they do matters to the wider public."

At present global emissions are on track toward a global average of 3 degrees Celsius of warming or more, far more than the 1.5 degrees or less established as an urgent target by the Paris climate accord.[i] Increasing humanitarian and environmental crises have been observed at the current 1.2 degrees of warming, including destruction of coral reefs, drought-related refugee crises and energy shortages (such as losses of hydropower in the American West and loss of water for coal power in India and China), as well as storms, extreme fire seasons, crop failures, and urban heat stress and water shortages.[ii] According to the World Economic Forum, climate change is the single greatest threat to the global economy.[iii]

The International Energy Agency stresses that action is urgent now, because future energy systems depend on the paths we create now; all investments in built infrastructure, transportation, and energy systems made in 2016-2020 will lock in patterns of energy use for many decades.[iv] Failure to establish low-carbon and post-carbon pathways now will result in what climatologist James Hansen has called an act of extraordinary and witting intergenerational injustice.[v]

The 2016 Vassar Climate Action Plan builds on the 2011 Greenhouse Gas Reduction plan, which called for a 3% reduction in carbon emissions per year based on a 2005 baseline. The College's primary approach to achieving GHG reductions thus far has been the shift to natural gas and reliance on a relatively low-carbon gas and nuclear grid. This document outlines the framework and more deliberate actions that are needed to demonstrate regional and national leadership and set the trajectory of the college toward carbon neutrality.

Achieving carbon neutrality by 2030

Given the urgency of climate change, the College Committee on Sustainability calls for a goal of carbon neutrality by 2030. Net carbon neutrality is defined "as having no net greenhouse gas (GHG) emissions, to be achieved by minimizing GHG emissions as much as possible, and using carbon offsets or other measures to mitigate the remaining emissions."[vi]

Building on a growing body of knowledge

Although the 2030 target is less than 15 years away, there are several reasons to believe it is achievable. We have many current opportunities for emissions reductions, and new technological, financial, and policy approaches are continually emerging. Vassar is not making this journey alone. More than 670 colleges have adopted carbon neutrality commitments and both New York City and New York State are making significant progress. The NYC 80x50 plan calls for a 80% reduction of carbon emissions by 2050.[vii] Governor Cuomo's Reforming the Energy Vision Plan (REV) will result in 50% of the state's electricity produced by renewable sources and a 23% reduction in building energy consumption by 2030.[viii]

Tackling Climate change will require that we all take action in any way that we can. Leadership on climate action signals to others that progress is possible, and that together the climate crisis can be addressed. To this end, the CAP supports Vassar joining the Carbon Commitment, formerly known as the ACUPCC (American College & University President's Climate Commitment), which involves committing to a goal of carbon neutrality before 2050. While not all signatories have achieved their goals, all colleges that have made significant reductions thus far have been signatories and have had strong administrative leadership on sustainability and climate action. A 2015 assessment found that commitment signatories had 47% lower emissions (per square foot) than did non-signatory institutions.[ix]

How this plan was developed

The Climate Action Plan was developed over the course of the 2015/2016 academic year following a directive from President Hill. The Sustainability Office and the College Committee on Sustainability have worked with campus groups and experts in the field to develop a vision for the long-term management of the campus. This work builds on campus discussions of climate action held in 2014 and on the 2011 GHG reduction plan. Lessons learned from the current Campus Master Planning process, our on-going partnership with the Environmental Defense Fund's Climate Corps program, and alumnae/i are presented at the end of the document to provide additional context for these proposals.

Greenhouse gas emissions are assessed in three categories, or scopes, following designations standardized by the World Resources Institute Greenhouse Gas Protocol[x]:

Scope 1: direct emissions associated with on-site burning of fuels (oil and gas).
Scope 2: indirect emissions associated with purchased energy, primarily electricity.
Scope 3: Other indirect emissions, generally associated with waste & transportation (including JYA)

Based on this framework, the Office of Sustainability tracks the College's greenhouse gas emissions using the University of New Hampshire Sustainability Institute's Campus Carbon Calculator v8.0, an Excel-based platform that is used by a majority of colleges and universities

that publicly report their emissions. The Office of Sustainability compiles these data annually with support from Facilities Operations, the Office of International Programs, and the Office for Institutional Research.

The College's 2015 emissions breakdown is shown in Figure 1. Purchased electricity, the Central Heating Plant, and Walker Field House together are responsible for 65% of all emissions. Roughly 20% of total emissions fall under Scope 3, including emissions from air and car travel on college business, students' travel abroad for JYA, and employee commuting.

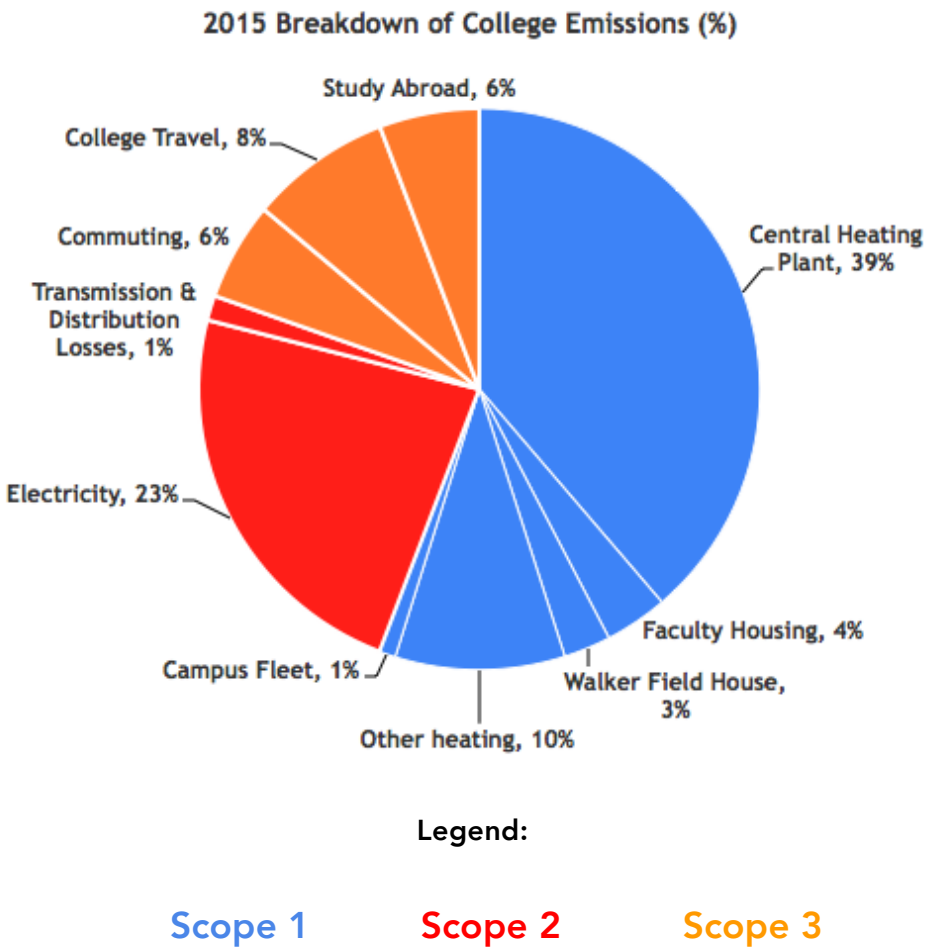


Figure 1: *Breakdown of college greenhouse gas emissions, 2015. In accounting for Scope 3 travel, we followed conventions in STARS college GHG accounting: for example, JYA travel is included, but not travel to or from home at the beginning or end of the semester. Transmission and distribution (T&D) losses are a normal loss in grid distribution of electricity.*

Since the adoption of the 2005 baseline, there has been a 33% reduction in the College's carbon footprint due to on-going efficiency measures and the transition of its central heating plant from fuel oil to natural gas (see Figure 2). This reduction has resulted in the avoidance of more than 10,000 MTCDE per year, from 31,604 MTCDE in 2005 down to 21,418 MTCDE in 2015.

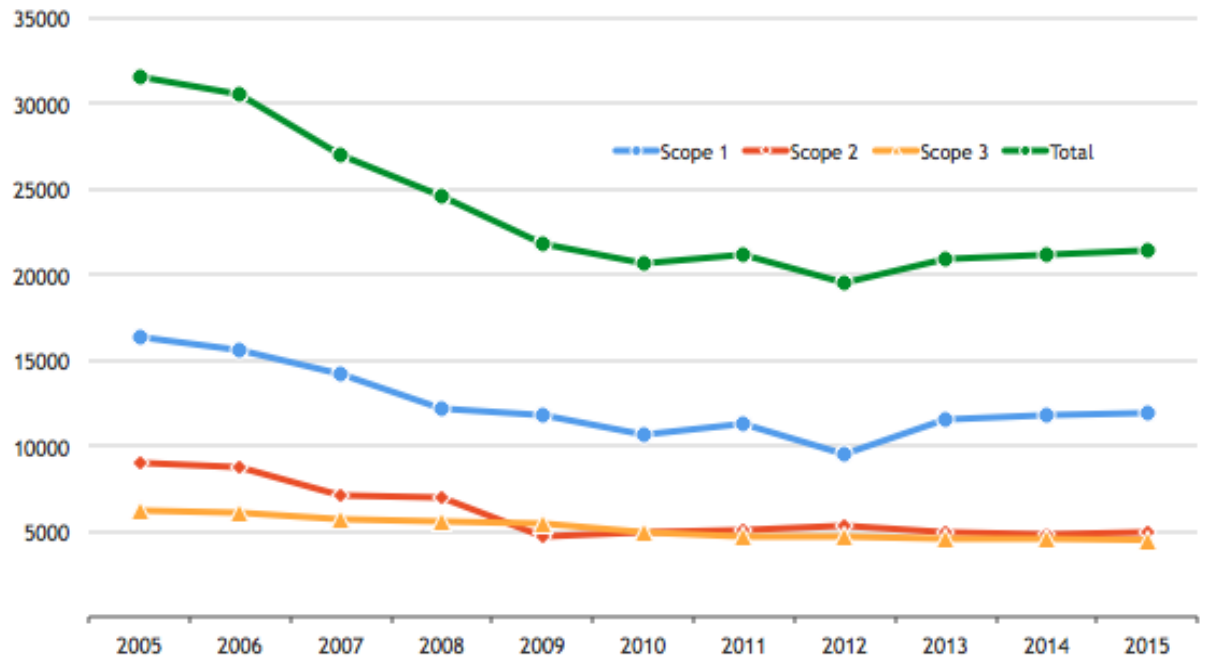


Figure 2: *Vassar GHG Emissions 2005 - 2015 (metric tons carbon dioxide equivalent, MTCDE). Scope 1 represents on-campus stationary fuel (oil, gas); scope 2 represents purchased electricity; scope 3 represents travel and other costs.*

Road map to carbon neutrality

Achieving carbon neutrality will require a combination of changes to Vassar's institutional practices and physical infrastructure, along with shifting campus culture and behavior patterns toward energy conservation. Below, we summarize five guiding strategies for emissions reductions. Then we identify several specific initiatives being implemented during or shortly after Summer 2016. Together, these give a sense of where the College stands now, and where it must go in the future to achieve the goals outlined in this document.

Five guiding strategies to reach neutrality

In order to create a virtuous cycle of continuous emissions reductions, there are five broad planes on which action must occur:

1. **Delineation of responsibility**
   The Sustainability Office will continue to be a clearinghouse and resource for carbon neutrality efforts on campus. However given the long term planning and financial resources that will be required for the College to ultimately reach this goal, it is important that Senior Officers and Trustees are familiar with these initiatives and how their leadership can contribute to progress. Annual reporting, goal setting, and regular review of the Climate Action Plan will ensure that the College remains on track.

2. **Resource allocation and accounting**
   Taking action towards carbon neutrality entails a more careful accounting of the College's practices. The social cost of carbon represents all of real but often hidden damages associated with Vassar's greenhouse gas emissions. In looking at current practices through a lens of sustainability, opportunities for improvement and progress may reveal themselves. To follow through on these opportunities, clear guidelines for securing capital funding for and tracking operational savings from efficiency and renewables projects are needed. Tools and systems like life cycle costing, carbon shadow pricing, an internal carbon charge, and/or a green revolving fund can help clarify funding mechanisms and solidify progress.

3. **Master planning**
   As Vassar's buildings and grounds evolve, it is important that energy efficiency and renewable energy generation practices become integral to the campus. This means starting all building construction and renovation with an expectation of low emissions. Green building standards can help achieve desired emission reductions for capital projects and building renovations.

4. **Energy management**
   To identify opportunities and measure progress, better collection and management of data, is needed. The primary example of this is building electricity sub-metering. Throughout society, institutions leading the charge to reduce emissions have

dedicated Energy Managers or Energy Management teams. For Vassar, engaging closely with energy management software and/or hiring consultants could prove to be the most cost effective solutions.

5. **Campus engagement**
   Vassar's greatest resource is its community of faculty, staff, students, and alumni. Reaching carbon neutrality can be an endeavor that involves of all of these groups. Vassar's mission first and foremost is to the education of our students, action on climate change fits with this directive. Initiatives such as dorm-wide competitions for energy use reduction, research into campus energy practices, and staff idea sharing can create a culture of sustainability behavior that leads to continuous improvement in emissions outcomes and an education for the 21st Century. Success stories and challenges should be shared widely both within and beyond Vassar's campus.

Short-term targets
In the next 2 years, the college will realize an additional 10% reduction in the College's GHG emissions, relative to 2015 emissions through the following projects that are already in progress:

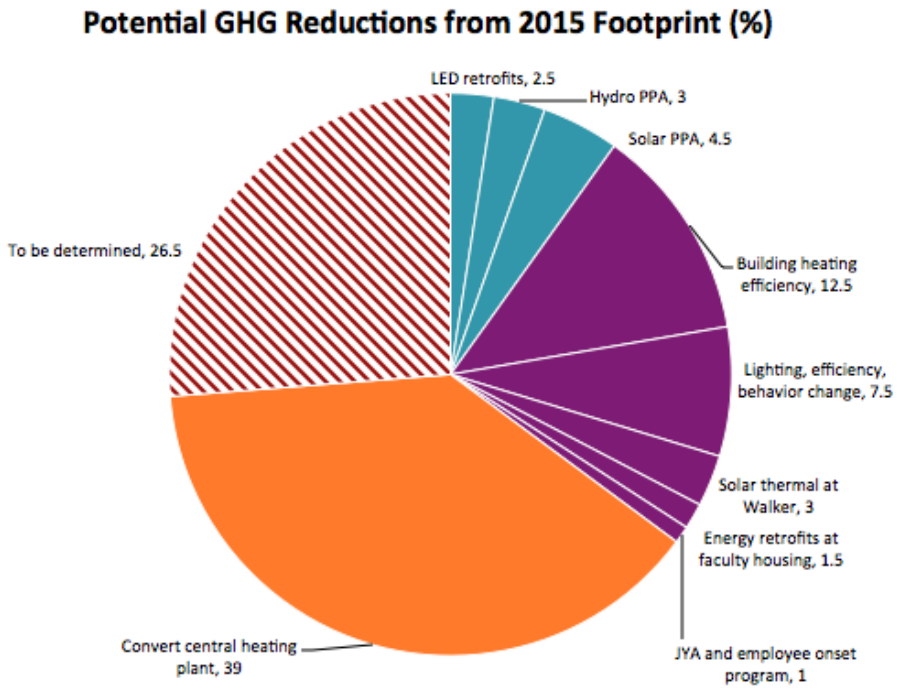
The LED parking lot lighting projects completed in Fall 2015 and the LED lighting initiatives in Walker, the Athletic and Fitness Center, Rockefeller Hall, Ely Hall, and Buildings and Grounds slated for completion in Summer 2016 will reduce campus electricity consumption by 1.5 million kWh and result in a 2.5% reduction of college emissions.

The two power purchase agreements the College made in Fall 2015 with a small-scale hydro facility in Beacon and a landfill solar field will cover more than 4.7 million kWh per year and result in a 7% reduction of college emissions.

Longer-term targets
Today, our understanding of every specific action needed is incomplete. Therefore this plan should be considered a living document that will require updating every 2-3 years as data are gathered and analyzed, impacts of our initiatives are measured, and new practices and technologies emerge for reducing emissions.

Future opportunities for carbon reductions in the medium to long term could account for an additional 25% reduction in emissions, based on Sustainability Committee's understanding of the sources of the College's emissions, the opportunities presented in the draft Campus Master Plan, and conversations with industry leaders. These potential reductions should be investigated iteratively as the Climate Action Plan is reviewed and updated.

In the long term, achieving neutrality will entail a concrete plan for the future of the Central Heating Plant, as it represents the single largest contributor to the campus carbon footprint.



Legend:

Short Term Targets	Medium Term Target	Long Term Targets
10%	24.5%	39%

Total Projected Emission Reduction from 2015 GHG Footprint: 73.5%

To Be Determined: 26.5%

Figure 3: *The sources of potential emission reductions in the short, medium, and long term based on the 2015 GHG Footprint of the College.*

Implementation timeline

The following timeline is offered to present the how the College might implement the guiding principles of the Climate Action Plan:

Climate Action Plan approved
Collaboration with EDF Climate Corps to develop building standards, Shadow Pricing and life cycle cost analysis protocols
Dorm electricity metering implemented
Lighting projects
Review of on-campus solar options
Campus Building efficiency audit

Presentation to the Board of Trustees
Campus communication about the CAP
Dorm energy competition utilizing dorm energy meters
Campus Master Plan adopted
Sustainability Committee establishes a Carbon Neutrality working group
Energy Management strategy is adopted
Categorization and evaluation of building energy retrofit opportunities

Summer interns and EDF Fellows continue to identify further efficiency and energy management opportunities

Presentation to new President about the role of the CAP

Review and update the 2016 CAP
Analysis of fossil-fuel free options for the Central Heating Plant

Review and update the 2020 CAP

CARBON NEUTRALITY ACHIEVED

Summary of proposals

The proposals below comprise a rough blueprint for how carbon neutrality might be achieved at Vassar within the next fifteen years. These proposals correspond to the five guiding strategies for emissions reductions outlined earlier in this document. Sections 1 and 2, covering Responsibility and Resources, address the "how" of carbon neutrality, while Sections 3, 4, and 5, address the "what" - i.e., specific projects that should be implemented.

1. Delineation of responsibility

To support the drive toward carbon neutrality, the College must adopt processes for transparency, accountability, review, and enforcement. By **transparency** we mean public communication of sustainability progress, challenges, decision-making processes, and priorities. Transparency can create invaluable insights and strengthen community engagement. By **accountability** we mean clear designation of who has the authority (or responsibility) to implement intended practices. For example, it is currently difficult to identify who has the authority to implement and track building energy efficiency improvements. Accountability allows a clear chain of command for inquiries, implementation, and follow-up, which could eliminate the unnecessarily long lag time for project implementation. **Enforcement** means having reward and response mechanisms for ensuring that college policies are followed. In the long run, plans without enforcement mechanisms are often wishful thinking. In addition, this plan should be **reviewed** every five years, with annual goal setting and evaluation.

Administrative leadership is a necessary first component of a Climate Action Plan because it is senior officers who decide priorities in college operations and in project funding. Senior officers therefore will need to engage closely in goal setting and reporting on progress in order for the College to achieve carbon neutrality (Table 1).

Table 1: Senior officer responsibilities and areas in which climate action targets are applicable

Senior Officer	**Jurisdiction**
President	General oversight and reporting to the Board of Trustees
VP for Finance and Administration	B&G - Utility expenditures, Energy Efficiency, Central Heating Plant, Facilities, Grounds,
Dean of Strategic Planning and Academic Resources	Sustainability Office, Athletics, Admissions, Master Planning
Dean of the College	Campus Events, JYA Travel, Student Behavioral Change, Residential Life, Vehicle fleet

VP for Alumni Affairs and Development	Development Travel, Reunion, Fundraising for sustainability costs
Dean of the Faculty	Faculty Travel, Sustainability Curriculum, Teaching spaces and resources
VP for Communications	Communication support

Setting administrative goals and targets

At least one Senior Officer meeting each year should focus on sharing progress made in each area, as well as for benchmarking and developing new goals for further emissions-reduction progress. The Sustainability Coordinator should be invited to attend this meeting; and other interested parties should be invited to attend as well, so that relevant people are kept updated on progress and needs in various parts of the college. It follows that this reporting of progress toward carbon neutrality should also be shared with the Board of Trustees regularly.

Ambitious targets are needed to dramatically reduce emissions, so it is important that there is shared responsibility in setting these annual goals.

The Office of Sustainability will report on progress and/or the challenges faced annually to the President, Faculty and Vassar Students Association, and will review and substantially update this plan every five years. It will be the responsibility of the Sustainability Coordinator to request that the President schedule a reporting meeting each year.

The Sustainability Office will continue to have responsibility for monitoring the College's carbon footprint and for supporting each Senior Officer in identifying and addressing the opportunities for reductions in each of their areas.

2. Resource allocation

Securing funding for emissions reduction initiatives is one of the biggest challenges facing Vassar today. Simultaneously, the costs of climate change are not properly paid for by those creating the emissions. An increasingly common strategy to address both of these issues involves organizations applying an internal price to carbon emissions. The most effective way to achieve this, which Vassar should strive to implement, is by an internal carbon charge in conjunction with a Green Revolving Fund. Short of this, Vassar can implement a carbon shadow price system in conjunction with Life Cycle Costing Analysis. Each method is described below. Furthermore, additional resources for emission reductions can be readily secured through external grant and incentive funding, as well as dedicated alumni gift-giving campaigns.

The Social Cost of Carbon

The social cost of carbon is an estimate of the cumulative dollar value of climate change impacts, including impacts to health, property damages, lost agricultural production, and other long term and widespread impacts. The US Environmental Protection Agency has estimated the social cost of carbon as $37/MTCDE. The Stern Report estimates the cost at $100.

Estimates of the social cost of Vassar's greenhouse gas emissions for 2015, in $/MTCDE, are given in **Table 2.** Nominally, Vassar could pay the market rate of $10/MTCDE to a carbon-offset company tomorrow to become net carbon neutral for a cost of $215,000 (including all scopes). This is only 0.00004 percent of operating costs. However, buying offsets from a third party produces no long-term savings and no institutional learning. Designating that amount of funding to an on campus carbon fund would support on-campus carbon reduction strategies, feasibility studies, behavior change programs, and support for capital projects.

Table 2*. Cumulative college carbon charges using three estimates of the social cost of carbon for 2015. Cost as a proportion of the 2015 utility budget ($3,563,117) and operations budget ($134,917,934).*

Scope	MTCDE	Cost ($ thousands)			Percentage of utility budget			Percentage of operating budget		
		$10	$37	$100	$10	$37	$100	$10	$37	$100
1 (fuel)	11,967	$120	$443	$1,197	3.40%	12.40%	33.60%	0.00002%	0.00009%	0.00025%
2 (electric)	4,955	$50	$183	$496	1.40%	5.10%	13.90%	0.00001%	0.00004%	0.00010%
3 (travel)	4,495	$45	$166	$450	1.30%	4.70%	12.60%	0.00001%	0.00003%	0.00009%
Sum	21,417	$215	$792	$2,143	6.10%	22.20%	60.10%	0.00004%	0.00016%	0.00044%

Potential Applications of the Social Cost of Carbon Framework
The social cost of carbon can also be used to refine carbon pricing in terms of a carbon fee, which would have the advantage of targeted incentives and disincentives.

The carbon charge approach was outlined in a white paper produced in 2015 by the Sustainability Office and an interdisciplinary team of URSI, FORD and EDF Climate Corps Fellows.[xi] The paper available for download on the Office of Sustainability website.[xii] Ideally, a carbon charge assigns a price to carbon consumption (calculated MTCDE), and rewards GHG reductions and penalizes GHG increases as GHG emissions change. Carbon charges have been used successfully to reduce carbon emissions and improve efficiency in companies, such as Facebook, Google, Microsoft, and Disney, and by states (e.g., Sweden, Denmark) and provinces (e.g., British Columbia). Tax (or fee) proceeds are invested in efficiency improvements.

The carbon tax rate ($/MTCDE) is normally set according to estimates of the social cost of carbon.

Alternatively, Vassar could establish a green revolving fund as part of the college's operating budget. Projects can be prioritized according to their payback time, Net Present Value, Savings to Investment Ratio, GHG reductions to investment ratio, or other chosen metrics. Money saved from the operating budget due to GRF projects would be reinvested back into the fund to provide for future projects. Accounting, finance, and budget officers in collaboration with the Sustainability Office will assess costs and benefits of GHG reduction options.

The size of a fund is ultimately an arbitrary decision, but a reasonable decision framework is to tie it to the social cost of carbon as estimated by the U.S. EPA and various other sources.

Vassar has, in principle, had rotating green funds in the past, targeted almost exclusively at gathering community suggestions for sustainability improvements. While community engagement is an important priority in many green funds, the primary weaknesses observed by Sustainability Committee members have included 1) lack of expertise among community members, who propose well-meaning but impracticable or ineffective projects, 2) lack of a dedicated budget line that could be directly charged for projects proposed, and 3) lack of follow-through by staff--chiefly Buildings and Grounds staff--who are charged with developing and implementing proposals but who have many other priorities and responsibilities. Points 1 and 2 are probably important contributors to point 3.

Adopting a shadow pricing policy

A shadow price is a theoretical value assigned to purchases of infrastructure or equipment. This price is calculated, though not actually charged, at the point of purchase, to correspond to the life-cycle environmental and financial costs of the project or equipment. A shadow

price allows the college to quantify those increased emissions in dollar terms and project the social cost of its capital projects.

In the context of carbon reduction, a shadow price is the projected cost needed to buy one MTCDE at the social cost of carbon. That cost is added in calculating to the operating cost over time. For example, compare a mini-SUV (20 mpg) and an electric Nissan Leaf (0.3 kwh/mi; Figure 4). The gas vehicle has a lower initial cost, but its higher operating costs make it more costly after 5 years (solid blue line). Adding in a cost for carbon emissions as a shadow price (at $37/MTCDE) makes the gas vehicle still more expensive (dashed blue line), and the electric vehicle is cheaper after only 4 years.[xiii]

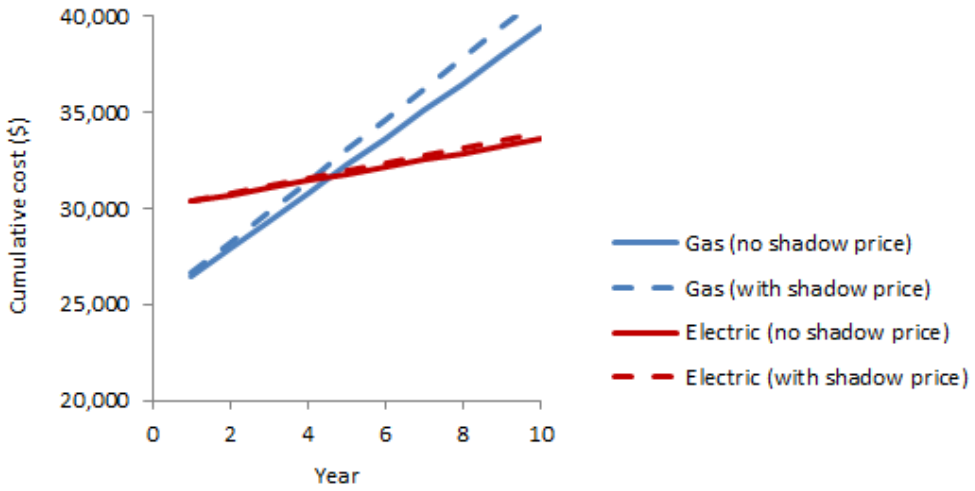


Figure 4: *Example of how shadowing pricing would affect vehicle procurement decisions*

The Budget Office should require that both operating costs (over 5-10 years) and a shadow price be included in capital requests above a specific threshold (to be determined in the first year of the CAP). A shadow price should be used in the planning and budgeting process for all renovation and construction projects on campus, ; including the purchasing process for vehicles, computing and other IT purchases, and others to be determined. The Sustainability Office will develop a life cycle costing tool in Summer 2016 and will offer trainings for Buildings & Grounds, interested students and faculty, and the Budget Office on how to use and apply it.

3. Master planning

Building renovation & construction standards

As we anticipate building renovations under the Campus Master Plan, it is critical that high standards of building efficiency be standard policy. While it is easy with tight budgets to value-engineer efficiency measures out of projects, long term energy savings and GHG reductions require that efficiency measures remain a priority. Standards, that is, policy rules that provide baseline expectations, are an important tool. During the first two years of the CAP, the Office of Sustainability will ask Facilities Operations to participate in identifying, or developing, building and renovation standards for the college. Examples exist that can be followed, for example from Middlebury's "LEED-MC +" standards.[xiv]

A target date of 2030 for carbon neutrality conforms to the 2030 Challenge established by the non-profit organization Architecture 2030, which sets out a timeline of targets to decrease and eventually eliminate fossil fuel consumption and carbon emissions in the built environment through renewable energy generation and increasing energy efficiency. Cities, college campuses, architecture and engineering firms, the American Institute of Architects (AIA), the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), and government agencies have adopted the 2030 Challenge. The Architecture 2030 Challenge provides a valuable framework for measuring carbon reduction progress and for how to approach forthcoming building renovations.[xv]

Building performance

Given the structure of the campus and our Central Heating Plant, the Climate Action Plan will not be adopting the 2030 Challenge's targets for individual building performance, but instead, will use their benchmarks for comparison and a measurement of progress at the campus level. The 2030 Challenge and the Department of Energy's Energy Star program nationally track energy usage across building types.

The current average Energy Use Intensity (EUI) for U.S. Colleges at the campus level is 104. EUI is measured by kBTU per square feet per year; in 2015 Vassar's EUI was 125 however our electricity-heating mix differs marginally from this basis. The CAP supports the adoption of this framework and the use of their 50% (52 EUI) reduction goal.

This parallel approach ensures that along with a reduction in Vassar's fossil fuel energy usage, there is a complementary reduction in actual energy usage. A reduction in fossil fuel use could be achieved without reduced energy consumption simply by replacing the campus energy system with renewable power generation, however decreasing energy consumption overall reduces the investments necessary in transitioning Vassar's power system. It is furthermore within the spirit of the Climate Action Plan and Vassar's goals for improving sustainability.

To reach this goal, there are two primary recommendations:

First, the CAP underscores the findings of the 2015 Campus Master Planning study that determined the College currently has adequate square footage to meet its programmatic and support needs. Accordingly, the Climate Action Plan therefore strongly recommends that construction of new square footage be discouraged unless it is unequivocally determined that the existing physical plant cannot be adequately repurposed for emergent needs.

Second, to achieve reductions in energy use, all major renovation and construction projects should:

1. Be designed with a goal of improving building EUI by 20% from the baseline for its building type
2. Utilize the Passive House Institute principles primarily and supplement with Leadership in Energy and Environmental Design (LEED) Gold standards as a design framework, even if formal certification is not pursued.[xvi]
3. Utilize a life cycle cost analysis (LCA) tool to price out options for building design choices so that both operation and carbon costs are appropriately factored into construction decisions.

Given that renovation and construction represent long-term investments compared to many other campus decisions, any physical plant work planned in the next 1 – 10 years will significantly impact whether carbon neutrality is in fact attainable. The strategic use of resources, staff time and money, is required if we are to move beyond short-term thinking for the campus physical plant.

In order to ensure that improvements to energy efficiency and other sustainability concerns are integrated into a project's design, the Climate Action Plan requires the Office of Sustainability be included in the process of designing any new construction or major renovation once they are approved.

The central heating plant

The Central Heating Plant (CHP) is responsible for 39% of the College's emissions. The largest single challenge in achieving a fossil-fuel free future for the college is a transition plan for the Central Heating Plant and campus steam loop. There are a number of options for doing so, however further research and consultation from expert engineers in the field will be required to appropriately develop a transition plan for the Central Heating Plant.

Given the significant amount of embedded heating and cooling infrastructure on campus, and its impact with respect to both campus comfort and the environment, it is vital that the central heating plant is core to a carbon neutrality strategy. Aging and replacement timing of infrastructure can be calculated into plans for this transition.

Biomass:
Middlebury College in Vermont, Colgate University in New York, and the Hotchkiss School, a preparatory boarding school in Connecticut have all made investments in a biomass facility for their campuses. This conversion is easiest to justify when standard boilers are nearing the end of their lifetime. The Hotchkiss School calculated that the replacement cost of their fuel oil-based CHP on campus was $10 million. As an alternative, the school raised $12 million to construct a brand new biomass facility to connect with their steam loop. The new facility is LEED Certified, features a green roof for stormwater management, and is designed specifically to facilitate using the space for educational tours and student coursework.[xvii]

Geothermal – Ground Source Heat Pumps
Heat pumps transfer and concentrate heat from a warm source to a cool source. In winter, when the ground is warmer than the air, a fluid circulated through the ground captures heat, which is then concentrated in a heat pump and used to heat a building. In summer, when the ground is cooler than the atmosphere, heat is transferred from a building to the ground.[xviii] The largest costs in ground-source geothermal are drilling geothermal wells and converting steam-style radiators to hot water or hot air systems. The greatest energy uses are electric pumps that move fluid through the system and compressors that condense refrigerant fluids in the heat pump.

In 2015-16 the Sustainability Office worked with a team of graduate students from Bard MBA in Sustainability to study options for transitioning our campus from fossil fuels to renewable energy sources. Their recommendation centered on developing clustered geothermal nodes across campus, retrofitting groups of buildings when strategic. Over 20 to 40 years the campus would gradually phase out the CHP and phase in geothermal energy, utilizing the savings along the way to support the financial investment.

Air-Source Heat Pumps
Air-Source heat pumps can provide both heating and cooling needs for a building and are run on electricity, which can be provided by renewable sources. As buildings are renovated a local system, not on the Central Heating Plant, could be installed. The electrification of heating systems has been pointed to as a possible long-term transition off of fossil fuels. The US Department of Energy reports that air-source heat pumps can provide cost savings and efficiency gains over oil or electric resistance heat sources.[xix]

Renewable fuel Oil
Fuel oil can be created from almost any organic matter under heat and pressure. Enysn, a company in upstate New York has developed a method for utilizing agricultural and paper pulp waste and biomass material to create a biomass-based fuel oil. Such a product would be usable in our central heating plant and existing steam infrastructure. Investment would be needed to install a new stainless steel storage tank, piping from the tank to the CHP, and an additional fuel switch mechanism like we currently have for natural gas and backup #6 oil. This

would likely be the most cost effective option for reducing the emissions of the CHP, but would have the least educational benefits for the campus.[xx]

Anaerobic digestion

Anaerobic digestion is a proven technology that utilizes anaerobic bacteria (which live in an oxygen-free environment such as a slurry of organic material) to digest compost and produce methane. The methane can then be burned like natural gas (which is mainly methane) to produce heat or electricity. Biogas, or purified methane from anaerobic digestion, is commonly produced from agricultural and municipal waste in Europe and at some dairy operations in the U.S. Such a system could be flexibly sized to match the compost input and the desired electricity output. Utilizing compost from campus dining, such a system could demonstrate a closed loop energy model for the campus.

Solar thermal

Solar hot water heating is proposed below for hot water heating for athletic facilities, but like geothermal or air-source heat pumps, solar thermal is used in Europe to produce hot water for space heating. Hot water heating is less widely used that solar photovoltaic energy because it requires plumbing. However in a building re-design it could be an effective design feature because it captures and delivers heat relatively inexpensively.

Solar thermal heat should be thoroughly investigated when the Walker Field House and pool are evaluated for renovation or new construction.

4. Energy management

Campus electricity metering

In Summer 2016, the Sustainability Office and Buildings & Grounds will be implementing building-level electricity metering in all the Residential Houses and Senior apartments. Building metering systems (BMS) provide socio-technical feedback that has the capacity to promote energy-saving behavioral change by students, particularly within the context of a residential college.

Building-level electricity metering makes it possible to productively target buildings with poor energy performance and efficiency. Without this data, sustainable strategies and renovations cannot be focused on the worst-performing structures.

Moving forward, all new buildings and major renovations should include installation of building-level electricity meters. Overtime, metering should be added to existing buildings to expand campus energy management capabilities.

Energy efficiency

Energy efficiency is often the most cost-effective and most important strategy for carbon reduction. The College has made many investments in efficiency over the decades. These efforts should continue but at an accelerated rate in order to reduce electricity and heating demands. While much of this work dovetails with issues linked to the strategies in the Master Planning section above, there are numerous opportunities, such as lighting retrofits across the campus that can be implemented to save the college money and to reduce its emissions.

To date the biggest hurdle to implementing efficiency projects has been the unknown timeline that both the Sustainability Office and project vendors have to navigate as part of the capital project process.

Electricity

Recent and forthcoming LED lighting retrofits for the Parking Lots, AFC, the Pool, Buildings & Grounds, and Rocky Hall represent a 5% reduction in our total electricity usage. This is just the beginning of opportunities for saving electricity usage.

Future opportunities include dorm lighting retrofits, analysis of usage of window air conditioner units, and more.

Heating

Extensive work over the last 5 years has been done to improve the insulation of the steam lines that loop campus. A problem not yet addressed though that has been well documented is the issue of overheating of dorms in the winter, the current solution to which is opening

windows. Though a more energy efficient solution to this problem still eludes the Sustainability Office, technology and behavior change both hold promise. For example: a new company in New York City has begun selling radiator covers, which function roughly like an oven mitt to help regulate heat. According to their website, buildings that have implemented their system have reduced heating by 30%.[xxi] [xxii] Student education about the thermostat control rooms in each dorm hallway may also improve the overheating situation. Most academic buildings also offer opportunities to improve efficiency. Better heating management greatly improves the working and living environment of our buildings, in addition to reducing carbon emissions and costs.

At Mt. Holyoake a heating retrofit project that improved insulation in the attics and basements of their historic dorms reduced the heating load by 30%. The project architect referred to this as putting hats and boots on buildings.

Faculty housing

For most of 130 or more homes and apartments in the college's employee housing program, utilities are included in monthly rent. Consequently many residents have little awareness of their personal energy usage or the energy infrastructure of their homes. In total the natural gas and fuel oil used to heat these properties represents 4% of the College's carbon footprint. There should be opportunities to offer residential energy audits either performed by trained students or professionals to improve efficiency and comfort in faculty housing. Partnerships with Central Hudson or NYSERDA could offer incentives to leasehold properties to implement efficiency measures.

On campus renewables

In 2016, the Vassar Solar Initiative formed to explore and advocate for on-campus renewable energy options. In February 2016 they presented to the Buildings & Grounds Committee of the Board of Trustees and received approval to issue a RFP for solar PV at South Lot, Ely Hall, the new Townhouses, the Vassar Barn, and the Collins Field Station. The proposals for these locations will be available in July 2016 and could present valuable opportunities for reducing carbon emissions, while also engaging the campus community of the benefits of renewable energy.

On-campus renewables provide educational opportunities to students and employees, demonstrate the College's commitment to changing its own practices and infrastructure to respond to the threat of climate change, and have the added benefit of reducing carbon emissions, all while saving money in the long run.

5. Campus engagement

Education

Climate action strategies offer rich opportunities to use the campus as a laboratory for learning and teaching about sustainability, climate change, and climate responses. The effects of climate change will touch the life of every Vassar student, and the College has an obligation to deepen curricular and co-curricular opportunities for students to become educated and engaged around the future of the planet.

While the Sustainability Office has been able to document more than 100 courses in the College's curriculum that address sustainability broadly defined, the Sustainability Office and Committee are committed to encouraging and assisting faculty with further developing courses or course modules that educate students about the scientific and social facts surrounding climate change.

As currently reported in the College's STARS Report, Environmental Studies, Earth Science & Geography, Science, Technology, & Society, and Urban Studies are the only departments that formally include learning outcomes on sustainability. In 2014, 67 of 612 graduates majored in these 5 departments.

The Office of Sustainability proposes the distribution of a campus-wide **Sustainability Literacy Test**. The test would be administered to the freshman class, once at the beginning of the year and once at the end of the year in order to get a sense of the culture of sustainability at Vassar. Following the lead of countless other colleges and universities and STARS Reporting practices, the Sustainability Office will collect annual data to measure the College's progress in regards to increasing student knowledge regarding sustainability.

Many of the questions the College faces with regards to planning for climate change are inherently multidisciplinary and well suited to collaboration. The student body should be actively encouraged to participate and be engaged with long-term management questions through course work, URSI and Ford programs, independent studies and work-study positions.

Additionally, the Sustainability Office proposes working closely with the Fieldwork Office to increase the number of opportunities for placements with organizations that address the effects of climate change, as well as with the Career Development Office to target sustainability-related job placement opportunities.

College travel

An additional significant source of carbon emissions for the College originates from student and employee travel.

Student JYA travel
In 2014 JYA travel contributed 1,231 MTeCO2 to Vassar's carbon footprint (5.5% of the total). The JYA Office is supportive of working with the Sustainability Office to find options for offsetting emissions associated with student travel. After collaboration, both the Sustainability Office and the JYA Office are committed to the funding carbon-reduction projects on campus and in the Poughkeepsie community. While this approach would not necessarily provide a 1-to-1 local emissions reduction, it could forward sustainability efforts on campus and off campus to further the development of good relations between the College and its neighbors. This approach is already implemented at other schools in the country with projects unique to each community and city. Such projects would bring awareness to the climate change and sustainability efforts, thus engendering behavioral changes. These projects would be implemented and developed with the assistant organizations that work within the Poughkeepsie community, including Habitat for Humanity, Dutchess Outreach, VELLOP, and others.

Both Offices will rely on students and the college to generate funds for the project. Such mechanisms could include: student donations, Vassar matching student contributions, and grant writing, amongst others. However, such funding mechanisms shall be reconsidered depending on experience and the implementation of projects.

Employee travel
In 2014, employee air travel by faculty and administrators contributed an estimated 1,746 MTeCO2 to Vassar's carbon footprint (8% of the total). These emissions would provide an easy place to implement a carbon tax scheme.

While the Sustainability Office recognizes that much scholarly, recruiting, and fundraising work in higher education is best conducted face-to-face, employees should be encouraged to expand virtual meeting options, and to make efforts to consolidate and coordinate trips whenever possible.

Employee commuting
While a somewhat difficult category to capture accurately, employee commuting is also included in the College's Greenhouse Gas (GHG) Inventory. Currently, employees, faculty, administrators, and staff, do not pay a fee to park on campus. As parking strategies are reviewed in the Campus Master Plan, the Sustainability Office encourages establishing an employee parking fee both to offset the carbon associated with commuting and, perhaps, to further incentivize carpooling.

Parking fees could be earmarked to support the development of bike infrastructure, electric car charging stations, or other transportation-related initiatives.

Carbon offsets

The purchase of carbon offsets should be a last resort for achieving carbon neutrality. While doing so is likely an inevitability in the initial stages of moving forward, it is an approach that should be phased out as completely as possible over time, as offsets represent an outsourcing of carbon emissions reductions, rather than a committed move by the College to adapt its infrastructure, policies, and behavior to the realities and imperatives of addressing climate change. Money should be invested in campus initiatives that reduce carbon emissions.

There are opportunities to engage students to recognize their JYA carbon impact through opportunities like tree planting. Although they may not lead to direct or measurable carbon reductions, they can be implemented to accompany offsets and can be determined in future opportunities.

Innovation & leadership

A lot can and will change from now until 2030 and above all the Climate Action Plan calls for the continual evaluation of solutions to carbon neutrality on campus. The College has a role to play in identifying novel emissions reduction targets and modeling solutions to climate change.

While continuing to support and utilize partnerships, like EDF Climate Corps, the college should work to increase transparency and data sharing amongst institutions, industry experts, and general populace. Vassar can and should think beyond traditional institutional boundaries to collaborate broadly and engage with state and nationwide emissions targets and policies.

Conclusion

This document has outlined a number of options for achieving carbon neutrality by 2030. Most of these proposals have myriad co-benefits, such as greater comfort in office and living spaces, more transparent management and communication methods, or more strategic approaches to decision making. Nearly all of the proposals outlined above involve costs, but most involve savings as well. As we adopt more inclusive methods of accounting for costs and benefits, we expect that we will gain better insights into which of the proposals outlined here are most effective and have most lasting value. These changes will be instrumental in helping Vassar maintain its role as a leader in the twin objectives of social and environmental transformation.

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Appendix I

Lessons learned from the 2015 Campus Planning Studies

In 2014-2015 the College worked with consulting group Dober Lidsky Mathey (DLM) to develop a campus Master Plan; a report of their findings was published in November 2015. "The objective of this initiative has been to develop a plan for the future that addresses programmatic, facility, and campus needs for the next 15 years."[xxiii] It is during these same 15 years that Vassar will have to lay the groundwork for carbon neutrality. The finished Master Plan will have large implications for the physical plant and infrastructure of the college, so it is important that climate action is thoroughly included in the final report.

Of the findings outlined in the report, the following are the Sustainability Committee's major takeaways from the process.

No Additional Net Assignable Square Feet - Based on DLM's assessment the college has enough space to meet its mission and programmatic goals. Yes, there are exceptions to the statement but it is a powerful concept that Vassar should adopt. The College should prioritize and make strong investments in our existing facilities before expanding the campus footprint. Adopting a policy like this would have beneficial climate, environmental, and community benefits.

Space Optimization - "Vassar College schedules its classrooms less intensely than any college with which we are familiar. The average classroom utilization rate for regularly scheduled classes was 12 hr/wk this past spring [2015] and 13 hr/wk this past fall [2014]."[xxiv] This relates closely with recommendation number one and emphasizes the importance of managing our existing square footage optimally before constructing new space.

The Vassar Inn and Conference Center - Following the principle's above, it is important that the campus prioritize existing square footage before building new facilities and expanding maintenance demands. That said, there are a number of benefits that better event space options could bring to the campus and broader Poughkeepsie community, however this new space would need to be designed with sustainability principles from the outset. As the conversation on this project continues 'The Oberlin project' should serve as a prime example for how this may strengthen community relationships and regional sustainability.

Parking, Traffic Flow, and Landscape - Both the 2011 MVVA plan and the DLM plan discuss the importance of the Vassar landscape. Developing a pedestrian oriented campus is a core priority and brings a number of environmental, social, and community health benefits.

Lessons learned from EDF Climate Corps

In summer 2014 and 2015, Vassar Sustainability has worked with EDF Climate Corps to identify and implement a number of energy management projects on campus. "EDF Climate Corps is the premier fellowship program from Environmental Defense Fund. We recruit and train top graduate students and embed them in leading organizations to provide expert hands-on support for your energy management initiatives."[xxv] The college's recent energy

efficiency projects were all identified with assistance from summer Climate Corps fellows, along with the background research for the campus carbon charge proposal.

There have been two major learnings from working with EDF, the need for clarity around capital project funding and the opportunity sustainability holds for student engagement. A core priority of this Climate Action plan entails outlining mechanisms for tracking and accountability in reaching carbon reduction goals. Too often student and employee ideas are stifled or forgotten because of unclear decision making processes and a broad lack of understanding how they might secure funding, be it a capital project or small scale opportunity for operational efficiency. The Vassar campus community is full of creativity but the processes for funding are muddied and unclear, stifling innovation.

Lessons learned from Vassar alums in the sustainability field

The Sustainability Interns led informational interviews with two Vassar alums - Jake Arlein and Mark Brownstein - to receive feedback on our CAP draft. Jacob Arlein, a project manager at Stok (formerly Environmental Building Strategies) in San Francisco, recommended following specific energy reduction goals so we have a way to measure our progress. He stressed the importance of student engagement and visibility, especially surrounding metering. He suggested reducing construction of new buildings, instead focusing on retrofitting buildings to be net-zero energy efficient. His opinions on energy sources alternative to the Central Heating Plant were as follows: biogas is kind of an offset in that it is based on contract purchasing; biomass is more direct and on-site than biogas; and it would be ideal to replace the CHP with a cogeneration or trigeneration plant (electricity, heating, and cooling) of geothermal and solar, coupled with biomass to be completely renewable.

Mark Brownstein, the Vice President of the Climate and Energy Program at the Environmental Defense Fund, focused his critiques on the CHP and the feasibility of changing our infrastructure. He recommended that we work with a mechanical engineer to understand how to make the most financially-responsible decisions, focusing on the effectiveness of what we spend money on. He stressed the importance of knowing how tight the gas delivery system in the CHP is because leaks can undercut the carbon benefit that we think we're getting. He proposed looking into short-term ways to improve the efficiency until we switch sources. He also said we need to be attentive about biomass particulates that affect the net-carbon cost, if that is the source we end up using.

Appendix II

Future Opportunities

We acknowledge that this document is not comprehensive and have included the following section in an effort to indicate what we hope to tackle in the years to come.

Food

Though not directly included in our greenhouse gas inventory, the majority of food sourced for campus dining operations has large amounts of fossil fuels embedded in its production and distribution. Through the AASHE STARS platform we track food purchases on how 'local' (250 miles) it is and for any 3rd party verifications (Humane, MSC, Rainforest Alliance, etc).

As of 2014, Vassar campus dining sources 24% of our food with this criteria. In comparison with our regional peers this number is on trend, however we believe there are always opportunities for improvement. As the campus dining transition takes place over the next 18 months a new goal should be evaluated and set.

The Campus Wild Pledge, a new initiative by the Center for Biological Diversity, provides one possible framework calling for a 20% reduction in the purchase of animal-based products.[xxvi]

Water

Vassar Buildings & Grounds has installed low flow fixtures across campus over the last decade and has made significant progress on reducing campus usage of potable water.

The Vassar Environmental Research Institute, the Environmental Cooperative, and the Office of Sustainability would all like to improve storm water management on campus. While the Vassar campus will not face direct threats from sea level rise and coastal flooding, the Climate change data indicate that the region will continue to see an increase in large concentrated storm events, placing pressure on storm water management infrastructure on campus and in Poughkeepsie.

Thus far the only strategies employed on campus have been the construction of rain gardens at the TA's and TH's in 2010 and the introduction of 'no-mow' zones in spring 2014. The new integrated science center incorporated the extensive design of rainwater retention basins, a rainwater cistern for irrigation, and the restoration of the Fonteyn Kill wetland. During the 2015-2016 academic year two Sustainability Interns led the development of a grey water reed bed for a laundry machine at the TH's to pilot how the college might reduce its impact on the local sewer system.

A full storm water management plan for the campus should be developed to establish goals for reducing impermeable surfaces, implementing 'green' infrastructure, and supporting

resiliency efforts in Poughkeepsie. This work will begin in Summer 2016 in collaboration with URSI and a DEC Hudson River Estuary Program planning grant, but will require long-term support from Facility Operations and Campus Master Planning to develop campus in a manner that supports climate resiliency goals.

Waste management
Vassar tracks trash and recycling annually and has almost daily numbers for compost. Since 2006 Vassar has composted (2 million) pounds of food scraps and disposable serving ware. The Sustainability Office's SWAPR program is one of the college's longest running sustainability programs, however due to fire safety policy changes in 2012, the program has struggled to remain cost neutral.

As part of a resiliency initiative the college should actively study what a zero-waste campus would look like. Zero-Waste is generally defined as having a garbage diversion rate above 90%; our current recycling and compost efforts, not including construction, place the college at a diversion rate of about 30%.

LEED standards outline specifications for the diversion of construction waste and should be adhered to, as outlined above in the building standards section.

Campus Landscape and the Arboretum
Using the Tree Campus USA and the ArbNet Arboretum frameworks, the newly formed Arboretum Committee is leading stewardship of the campus landscape. While efforts such as the re-naturalization of underutilized turf areas have been undertaken, landscape development at Vassar has largely occurred in a piecemeal fashion. The Campus Master Plan should strive to encompass and prioritize parameters related to climate change and create a comprehensive landscape management and utilization plan, that considers the landscape in terms of ecological significance alongside the logistical and economic functioning of the institution.

The manifestation of such a plan in practice should include efforts to identify and visually represent areas of current and potential ecological niches, logistical management concerns, and current use. In this way the college would have the ability to comprehensively assess the landscape across multiple parameters, so as to plan naturalization efforts in areas with greatest success potential, reduce lawns, garden beds, and other areas requiring carbon intensive practices like mowing or products like fertilizers, and to evaluate the true cost (economic, ecological, etc.) of maintenance for the campus.

Personnel / Administrative education
Vassar's employees are one of the college's greatest assets, more training and professional development opportunities need to be made available to faculty, administrators, and staff to

ensure that everyone who would like to be involved in sustainability efforts on campus is well versed in the sustainability topics and relevant skills for their position.

As hiring opportunities arise in Facility Operations, Budget and Finance, and Dean of Strategic Planning Areas, interest in and track record of sustainability should be incorporated into the interview process, so as to foster a long-term culture of sustainability on campus.

Sustainable Investing

In order to maintain a livable climate for society, we, collectively, need to limit climate change below 2 degrees Celsius of warming. By 2050, we will know whether we have succeeded or failed at managing the impacts of climate change. Given that the College's endowment is one of the key players in ensuring the college's prosperity through 2050 and beyond, there should be some consideration to the role that these investments play in supporting the kind of society we wish to live and work in.

There is a growing body of work by investment firms, academics, and advocates studying this issue. In addition, the college should evaluate expanding the carbon shadow price policy to apply to the college's direct investments.

Endnotes

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[x] http://www.ghgprotocol.org/

[xi] Participating students included Sophie Bedecarre Ernst, James Falino, and Jackson Miller; staff and faculty included Alistair Hall (Sustainability Coordinator), Mary Ann Cunningham (Geography), Ben Ho, and Paul Ruud (Economics),

[xii] http://sustainability.vassar.edu/docs/9-15InternalCarbonAccountingataSLAC.pdf

[xiii] If each car lasts 8 years (the typical warranty for EV batteries) the cumulative savings of an electric vehicle would be would be approximately $4,600, excluding oil changes and other maintenance. Assumptions in this example are as follows: a gas mini-SUV rated at 22 mpg but getting 20 mpg in city driving, and a mid-range electric car (0.3 kwh/mi), both driving 12,000 mi/year, 1 gallon of gas = 17.68 lb CO2; 1 kwh = 0.91 lb CO2; social cost of carbon = $37/MTCDE; gas cost = $3.00/gal., electricity cost = $0.10/kW;. Cost of driving comes to $0.12/mile for gas and $0.03/mile for electric. College charge for mileage, to represent maintenance on gas vehicles, is $0.55 per mile.

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