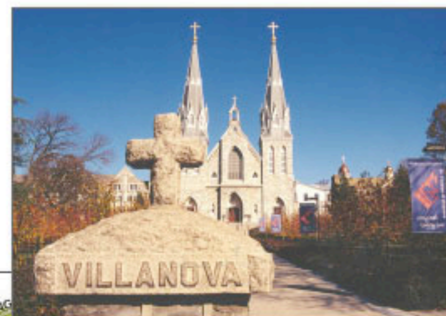
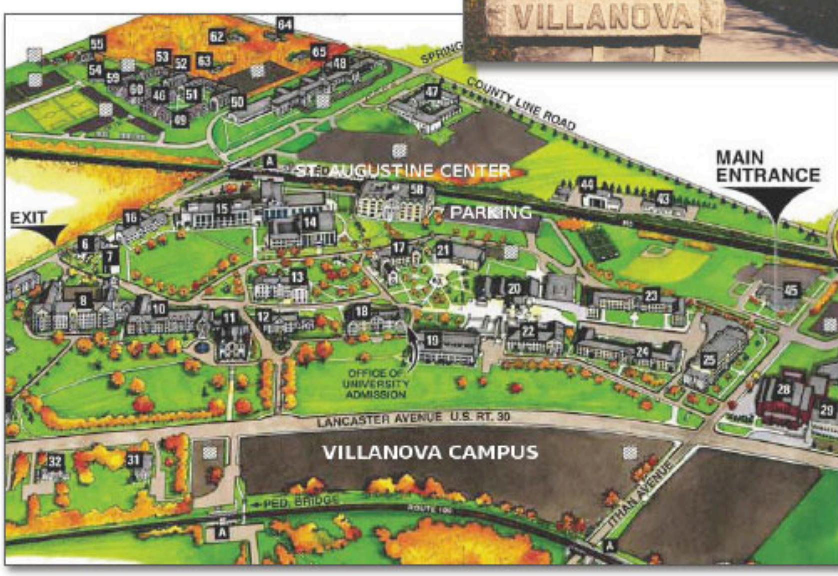
VILLANOVA
UNIVERSITY

CLIMATE ACTION PLAN





JANUARY 15, 2010

"You discover the earth's springing energy, its amazing beauty, its most excellent potency. But because it could not have such virtue in itself, or of itself, swiftly there flashes into your mind the conviction that not by any possibility of its own can the earth have come to be, but only from the hands of its Creator. This very truth that you have discovered is the earth's cry of confession, and to praise your Creator you make the earth's cry your own."

— Saint Augustine, Enarratio in Psalmum 144.13

"Start by doing what's necessary; then do what's possible; and suddenly you are doing the impossible."

— St. Francis of Assisi

"We need to care for the environment: it has been entrusted to men and women to be protected and cultivated with responsible freedom, with the good of all as a constant guiding criterion"

— Pope Benedict XVI, January 2008

"Global climate is by its very nature a part of the planetary commons. The earth's atmosphere encompasses all people, creatures, and habitats. The melting of ice sheets and glaciers, the destruction of rain forests, and the pollution of water in one place can have environmental impacts elsewhere. As Pope John Paul II has said, "*We cannot interfere in one area of the ecosystem without paying due attention both to the consequences of such interference in other areas and to the well being of future generations.*" Responses to global climate change should reflect our interdependence and common responsibility for the future of our planet. Individual nations must measure their own self-interest against the greater common good and contribute equitably to global solutions."

— Global Climate Change: A Plea for Dialogue, Prudence, and the Common Good
Statement of the United States Conference of Catholic Bishops, 2001

"Human understanding and control of natural processes empower people not only to improve the human condition but also to do great harm to each other, to the earth, and to other creatures. As concerns about the environment have grown in recent decades, the moral necessity of ecological stewardship has become increasingly clear."

— Cornwall Declaration, Interfaith Council on Environmental Stewardship

"In all things of nature there is something of the marvelous."

— Aristotle

"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

"It is no use walking anywhere to preach unless our walking is our preaching."

— St. Francis of Assisi

Acknowledgements

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The Committee would like to acknowledge the invaluable contributions and guidance of our former Chair and committee member, John Cacciola. We wish him well in his new career.

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The Stone House Group
Alteris Renewables
Penncat Critical Power

A Message from the President

Villanova University is a learning community unlike any other. Our mission, as a Catholic Augustinian institution, is rooted in the ideals of *Veritas, Unitas,* and *Caritas* (truth, unity, and love). These ideals are inextricably linked to the environment for two important reasons.

First, the earth and all its life forms inherently deserve our respect and our stewardship. As an academic community, we recognize the danger of ignoring the plight of our planet. We are committed to intellectual endeavors, actions, and policies that support our environment now and for generations to come.

Second, climate change is an issue of peace and justice. As we seek to serve others—and to show compassion for the poor and vulnerable—we recognize that the quality of life of every person worldwide is dependent upon the stability of our environment. As a university, we embrace the goals of clean water and air, the availability of nutritious foods, and the successful management of pollutants for the benefit of all people.

As we look to the future, we are implementing a new Villanova University strategic plan for 2010–2020. The cornerstone of this plan is a newly-refined mission statement, which includes the following enduring commitments.

To serve our students, alumni, and global community, we:

- *encourage students, faculty, and staff to engage in service experiences and research, both locally and globally, so they learn from others, provide public service to the community, and help create a more sustainable world; and*
- *respect a worldview that recognizes that all creation is sacred and that fosters responsible stewardship of the environment.*

In the following Villanova Climate Action Plan, you will read about Villanova's role as a signatory of the American College & University Presidents' Climate Commitment. You will learn about our approach to offsetting carbon emissions, becoming a climate-neutral campus, and accelerating research and education to help society re-stabilize the earth's climate. Above all, in light of Villanova's core Augustinian mission, I encourage you to consider the fundamental questions of our actions.

If not Villanova community members, who?
If not now, when?

Our work on behalf of the earth today is our shared practical and moral imperative.

Rev. Peter M. Donohue, OSA, President

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Executive Summary

Villanova University has been committed to sustainability for several years, and adopted an Environmental Sustainability Policy in 2004. The primary goal of this Policy is the incorporation of sustainable principles and practices within the University community, including conservation of natural resources, promotion of energy conservation, conscientious production and consumption of food, and adoption of green building standards. In June 2007, President Peter Donohue signed the President's Climate Commitment associated with the ACUPCC. 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 University 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 (or no later than 15 January 2010);
- 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).

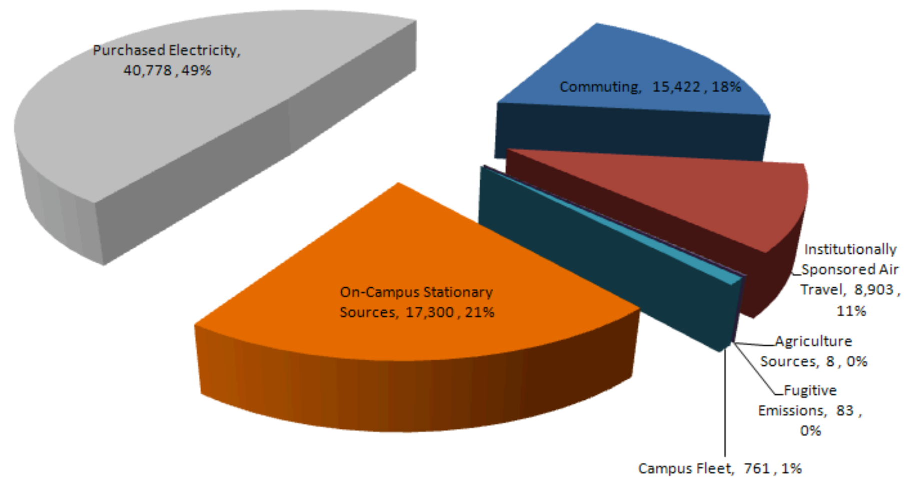
To implement the Commitment, Fr. Donohue established the President's Environmental Sustainability Committee, consisting of environmentally-minded faculty, staff and students from within the University community.

The publication of this climate action plan represents substantial progress on our path to climate neutrality as we now have a framework by which we believe that this goal is achievable. To that end, Villanova University has set a goal of the year 2050 to achieve net climate neutrality. Our gross campus emissions during fiscal year 2009 totaled 83,430 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	17,300
1	University Fleet	761
1	Refrigeration	83
1	Agriculture	8
2	Electricity	37,107
3	Faculty/Staff Commuters	15,422
3	Institutionally Sponsored Air Travel	8,903
3	Solid Waste	(214)
3	Transmission and Distribution Losses	3,670
Total Campus Emissions (FY 2009*)		83,040
Emissions Reductions		(0)
Net Campus Emissions		**83,040**

* Baseline year

The functional distribution of our emissions demonstrates that on-campus stationary sources (primarily heating) and purchased electricity represent 70% the emissions for the University.



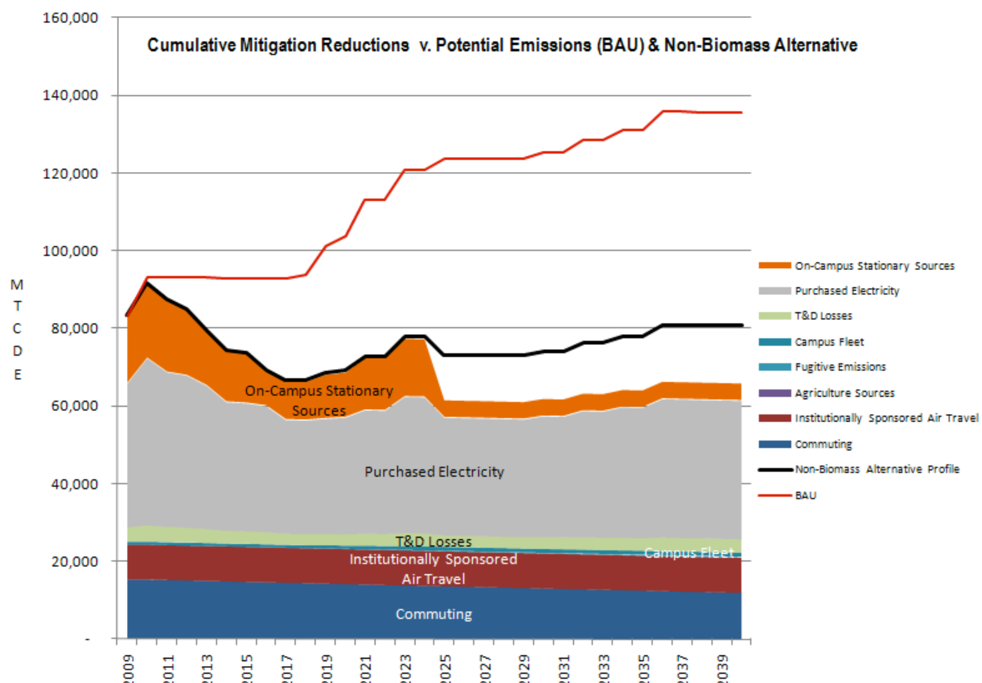
In order to achieve climate neutrality, we have analyzed a range of options that could help us achieve this goal. This process of analyzing data on energy and emissions was conducted in concert with campus growth under the Campus Master Plan developed by Villanova University. Ultimately, we have chosen an approach to climate neutrality that focuses on reducing the amount of energy consumed by the University, using the energy we do consume more efficiently, employing renewable 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:

- Chiller plants – we will develop a cooling plant 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.
- Modernization of the boiler plant to biomass – provides the single largest reduction in emissions for the campus by shifting our heating infrastructure from fossil fuels to a biogenic fuel source. We plan to continue to monitor the relative advantages of this strategy against any attractive alternatives that are developed from both an economic and environmental standpoint.
- Modernization of our heating infrastructure – will allow for cogeneration through the use of backpressure steam turbine, lowering our grid source electricity requirements.
- Installation of on-campus photovoltaic arrays – at least three sites on campus will be seriously considered as a viable source of renewable energy to support the electrical needs of the University.

- Reduction of end-use energy consumption – to include improvements of lighting fixtures and development of holiday and summer curtailment policies to reduce consumption of energy and emissions during times of relatively low occupancy.
- 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.

The following figure is a graphic representation of what our project emissions profile might look like in the future versus our potential Business As Usual (BAU) projected emissions. The BAU line represents what our future emissions may look like if we did nothing with regard to conservation, energy efficiency, etc., but did follow the campus master plan build-out. We considered several possibilities in our projections. The colored areas below the black line represent the sources of emissions remaining after implementation of our proposed mitigation strategies, working with the assumption that the proposed strategies will be implementable, and not barred by regulatory or financial impediments. The black line represents what our future emissions profile might be if we were able to implement all of our proposed mitigation strategies except conversion of our physical plant to biomass. Successful implementation of our CAP will thus reduce our emissions significantly from the BAU scenario, and we will be better able at that point to access the offsets needed to achieve full climate neutrality.



In addition, we will continue to develop and offer educational and research opportunities pertaining to sustainability and climate neutrality to students across campus, as well as develop effective outreach programs to both members of the campus community and to those in the wider community through conferences and distance learning courses. Villanova will continue to develop **educational opportunities** for undergraduate and graduate students through several approaches: (1) Continue to develop new inter- and cross- disciplinary programs and courses, to include those in science departments as well as in the humanities, social sciences, and business. (2) Establish further service learning opportunities. Villanova is among the top universities in the nation for the proportion of students who participate in such experiences, many of which have environmental themes (e.g., the activities of the Environmental Leadership Learning Community, the Engineers Without Borders group, and the Business Without Borders group). (3) Continue to support student organizations, including the Villanova Environmental Group (VEG), the Ecological Society of Villanova (ESV), Engineers Without Borders (EWB) chapter, Business Without Borders chapter, the newly formed student chapter of Engineers for a Sustainable World, and (for graduate students at the School of Law) the Environmental and Energy Law Society. (4) Expand environmental content in the development of programs for Student Orientation each fall. (5) Encourage students to participate in RecycleMania and other campus-wide initiatives. (6) Educate Villanova community members about sustainability and climate-neutral practices through university operations including Dining Services and Facilities. (7) Continue to sponsor national and international academic conferences on ecological and environmental issues.

Villanova faculty and students across all colleges are involved in and develop a wide range of **research projects** relating to sustainability and climate change. Villanova will continue to support these projects. In addition, the growth of new programs, and the attendant increase in financial support from the university as a whole, will expand research in the area of climate neutrality. Faculty members in the Colleges of Liberal Arts & Sciences and Engineering are pursuing individual research projects that have a bearing on climate neutrality and sustainability. Several of these projects are funded by external grants, including from the NSF. Villanova students will continue to participate in sustainability research both in and out of the classroom. In addition to formal research projects, students will continue to be involved in projects that have a strong environmental sustainability emphasis. Such student research projects currently include: increasing bicycling on campus; promoting recycling on campus; developing a green career fair; introducing organic and fair-trade clothing to the VU Shop; promoting donations at the end-of-the-year move; performing a sustainability assessment of White Hall; and improving water resources and reducing use of plastic. In addition, several centers and institutes are funded and supported by Villanova (e,g.. the Center for the Advancement of Sustainability in Engineering, and the Center for Global Leadership, and the Innovation, Creativity, and Entrepreneurship Center, both in the Villanova School of Business).

Villanova is committed to offering **Community Outreach** programs to members of the Villanova community and to those in the greater community. The university will build upon its current efforts in this area by continuing to: (1) sponsor national and international academic conferences on ecological and environmental issues; (2) sponsor departmental seminars, which are open to the entire Villanova community and public; (3) host events with state-wide attendees, such as the Commonwealth of Pennsylvania's Sustainable Stormwater conference; (4) support Earth Day events that educate the public about environmental sustainability and climate neutrality; and (5) proactively communicate—through print, news media coverage, social media outreach, and a frequently-updated website—to inform and educate the community about Villanova's sustainability initiatives.

Finally, we propose ways that we will fund our proposals in this plan, and specify ways that we will track our progress toward reaching our goal of climate neutrality by the year 2050. Villanova intends to update its GHG inventory annually, prepare a narrative summary every two years, and conduct a comprehensive review of the CAP to evaluate progress to date and to verify that previous assumptions remain valid (e.g., changes in technology, energy and environmental markets, and financing mechanisms). Most importantly, the review will allow for a re-evaluation of Villanova's ability to achieve its milestones and meet the target date for climate neutrality. Revisions to the CAP, including any modifications to milestones will be reported as part of this process.

List of Acronyms

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College & University Presidents' Climate Commitment
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 CO2 Equivalent
PECO	Philadelphia Electric Company
PESC	President's Environmental Sustainability Committee
PV	Photovoltaic
REC	Renewable Energy Certificates
RFD	Refuse Derived Fuel
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
VQI	Villanova Quality Improvement
WRI	World Resource Institute
WTE	Waste to Energy

1. Introduction

Villanova is the oldest and largest Catholic university in Pennsylvania, founded in 1842 by the Order of Saint Augustine. The Augustinian values of *Veritas, Unitas,* and *Caritas* (truth, unity, and love) guide intellectual and social life at Villanova to this day. In keeping with this Augustinian tradition—which emphasizes service to, and care for, one's community—Villanova integrates sustainability and respect for the earth into its curricula, research, and institutional policy and practice. Faculty, staff, and students across the Villanova campus and around the world recognize Villanova's role in addressing sustainability and the global climate crisis.

Villanova has a rich history in the natural sciences and in promoting environmental awareness. Gregor Johann Mendel, the father of modern genetics, was an Augustinian abbot and botanist. The Villanova community embraced the inaugural Earth Day in 1970, and has since used this opportunity to host dynamic speakers and special events. In the early 1990s, the Villanova campus became a designated arboretum, housing approximately 1,500 trees of 250 different species, including a metasequoia tree—one of fewer than 30 trees of its type and size in the nation. Maintaining this arboretum is in itself a mitigation strategy, even if the benefits are not quantified here. Educators and researchers in all five colleges—the College of Liberal Arts & Sciences, the Villanova School of Business, the College of Engineering, the College of Nursing, and the School of Law—offer courses and conduct research relevant to environmental sustainability and climate change. Two green roofs have been installed in recent years – one on the CEER (Engineering Building) and Driscoll Hall (Nursing). To broaden dialog beyond the walls of the campus, Villanova has recently hosted two environmental conferences, *Catholic Social Teaching and Ecology* (9-11 November 2005) and the *International SustainAbility Conference* (22-25 April 2009).

Environmental responsibility is reflected in university operations as well. For example, Villanova Dining Services (VDS) has set into place many environmentally responsible and sustainable practices, including (1) purchasing and serving organic produce, organic fruits and organic groceries, and selectively choosing food items that are raised or grown sustainably (the largest retail food outlet on campus, the Belle Air Terrace, features a totally organic salad bar); (2) reducing waste by using reusable dishware in all dining halls and using 100% pre-consumer recycled plates and napkins in all University retail outlets on campus; (3) initiating a new recycling program which has resulted in a 98% reduction in the trash stream in the University's retail outlets on campus; (4) composting food waste in partnership with local farmers since the 1950s; (5) recycling 90% of frying oil fats (last year alone, approximately 9,000 gallons were recycled via an outside firm, RTI). In addition, environmental stewardship is often accompanied by participating in socially responsible initiatives, such as (1) providing Aqua Health Water in dispensers around campus, and donating 5% of all sales to *Catholic Relief Services* and the *Uganda Rural Fund*; and (2) purchasing and serving Fair Trade products since 2001, including coffee, chocolate, and rice.

An "Environmental Team" was established in the early days of the Villanova Quality Improvement (VQI) program implemented in the early 1990s. Several environmental initiatives were developed by this group, including a green purchasing policy, a Energy Star policy, and enhancement of recycling programs on campus. In 2004, Villanova University formally implemented the *Campus Environmental Sustainability Policy*, pledging the university to (1) conduct its activities in an ecologically sound, socially just, and economically viable manner; (2) support the concepts of sustainability in its curriculum, research, and related activities, preparing all members of the Villanova community to contribute to an environmentally sound and socially just society; and (3) function as a sustainable community, embodying responsible consumption, promoting ecological literacy and environmentally sound practices among its students, faculty, staff, and graduates, and supporting these values in the local community. In 2007, Father Peter M. Donohue, Villanova's 32nd president, signed the American College & University Presidents' Climate Commitment (ACUPCC), pledging Villanova's support for the ambitious goal of reducing greenhouse gas emissions and achieving climate neutrality.

To ensure that Villanova fulfills the Commitment and its associated goals, Father Donohue established the President's Environmental Sustainability Committee (PESC). The committee represents a subset of Villanova's environmentally-minded faculty, staff, and students. The initial charge of this committee includes the development of the Villanova Climate Action Plan (CAP), the details of which are described in the pages that follow.

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 Villanova's CAP are as follows: Section 1 – ***Introduction*** provides background about Villanova University 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. Villanova 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 – ***Financing***, describes the costs associated with implementing our mitigation strategies. Section 6, ***Tracking Progress***, outlines milestones and targets for achieving our goals. The university 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 7: ***Assumptions***) describes in part the assumptions made while developing the mitigation strategies.

Villanova'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 university community. To fulfill these goals, several subcommittees have been established as part of the PESC, including *Operations/Energy Use, Physical Environment, Transportation, Waste Minimization and Recycling, Academics and Student Life,* and *Communications*. These subcommittees include both PESC members as well as many other stakeholders from across the university.

Understanding that the global climate crisis has no one solution, this document outlines Villanova's long-term commitment to identify and implement solutions to the climate crisis and to act responsibly as we fulfill our Augustinian mission.

VILLANOVA UNIVERSITY
Commitment to Sustainability

2. Campus Emissions

Effective climate action planning requires an understanding of the greenhouse gases emitted by the University. Toward that end, Villanova undertook the task of collecting several years of data to calculate and categorize the University'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 Villanova 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 Villanova 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 6.4, the most recent calculator available from CACP at the time this report was prepared.

Data were obtained from several offices at Villanova including Facilities Management, Dining Services, Human Resources, Finance and Planning, and Institutional Research. The annual data reflect a period from June 1 through May 31, the Villanova fiscal year (June to May), 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. Villanova 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 7 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 University. 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 Villanova are not included, as they would fall outside of the 'Boundaries' of Villanova's control. In addition, the emissions resulting from off campus activities of students/faculty/staff are not estimated, although we include some projections below based on assumptions of all students living on campus. Villanova collected data for student, staff, and faculty commuting for the Fiscal Year (FY) 2008 only, and we include them here. Because only one year of data was collected, however, historic trends for commuting mileage and habits was not possible. These limitations do not imply that these sources of greenhouse gases are insignificant. The intent of the

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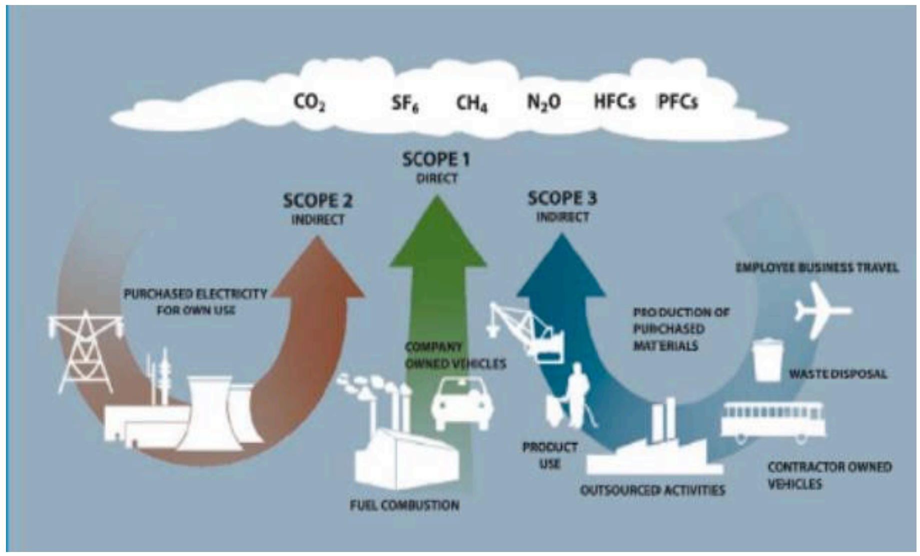
Commitment to Sustainability

inventory is to provide a basis on which to develop an environmentally and economically sound GHG management and reduction policy for Villanova University.

2.2 Sources of Greenhouse Gas Emissions

Figure 2-1 GHG Emissions and Scopes



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 University 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 Villanova 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. Villanova uses distillate fuel oils (#2 & #6) 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 University Fleet

Villanova University owns and operates vehicles to assist in the daily operations of the University. Through an examination of the composition of the university 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 University. 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

VILLANOVA UNIVERSITY Commitment to Sustainability

Scope 1

for the calculation of the resultant GHG emissions, often referred to as fugitive emissions.

Agriculture

Agricultural activities at Villanova 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 University 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 University 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 Villanova 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*

Villanova University 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 Villanova is incinerated at a Waste to Energy Plant, which results in an overall greenhouse gas benefit (net reduction). While the production of solid 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.

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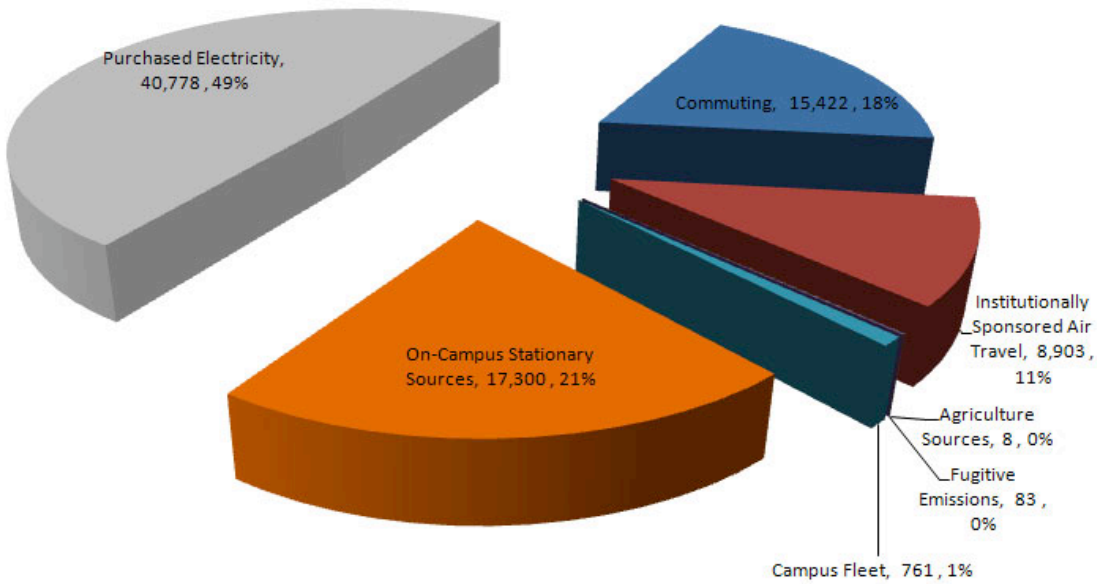
From the sum of these sources (or scopes), it is possible to obtain an estimate of our total GHG emissions. For fiscal year 2009, our campus emissions totaled 83,040 MTCDE, with zero offsets being purchased. A summary of GHG emissions by scope and sector is presented in Table 2-1. A functional distribution of emissions is presented graphically in Figure 2-2.

Table 2-1 Campus Emissions (FY 2009) Summary by Scope & Source

Scope	Source	Emissions (MTCDE)
1	On-Campus Stationary Sources	17,300
1	University Fleet	761
1	Refrigeration	83
1	Agriculture	8
2	Electricity	37,107
3	Faculty/Staff Commuters	15,422
3	Institutionally Sponsored Air Travel/Study Abroad	8,903
3	Solid Waste	(214)
3	Transmission and Distribution Losses	3,670
Total Campus Emissions (FY 2009*)		83,040
Emissions Reductions		(0)
Net Campus Emissions		**83,040**

* Baseline year

Figure 2-2 Campus Emissions (FY 2009) Functional Distribution



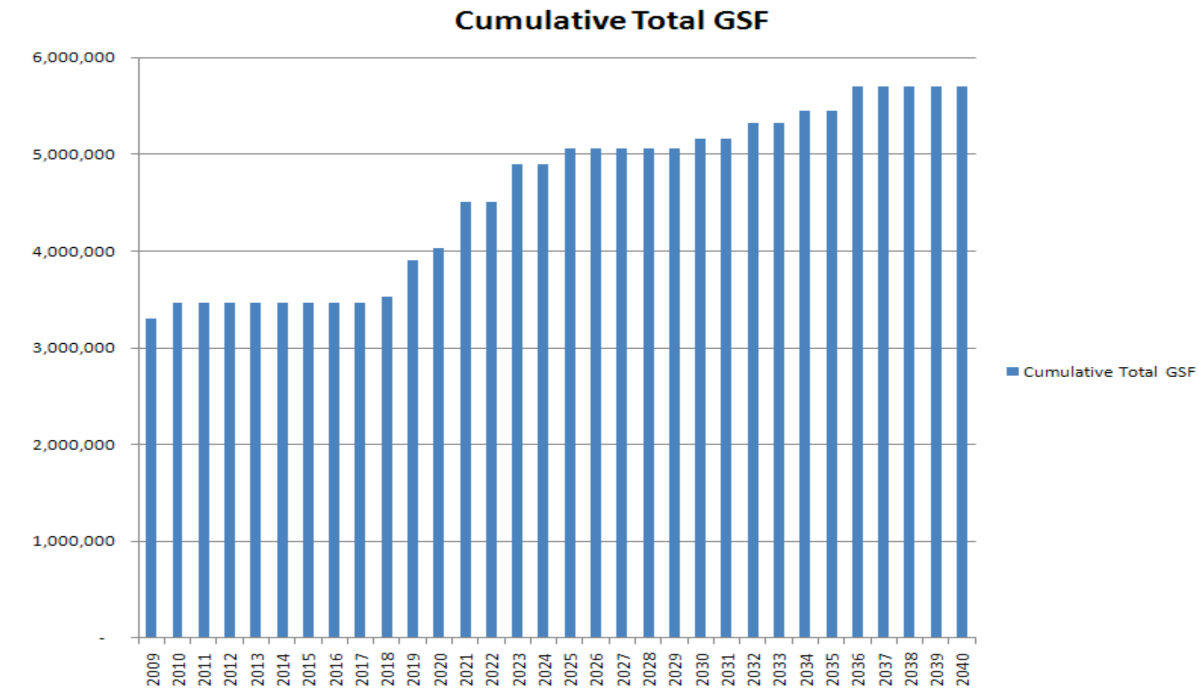
2.3 Campus Growth & Business as Usual Trends

2.3.1 Campus Growth

Villanova 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 campus growth is projected at approximately 2.4 million gross square feet (GSF). The current Campus Plan retains the historic and cultural centerpieces of the campus. Our intent is to make the campus more pedestrian friendly, providing easy access to our facilities, 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. Growth in campus GSF does not necessarily relate to growth in the overall land ownership of the University. Growth on a campus must be flexible and adaptable; with this understanding Figure 2-4 represents only one of a variety of possible scenarios.

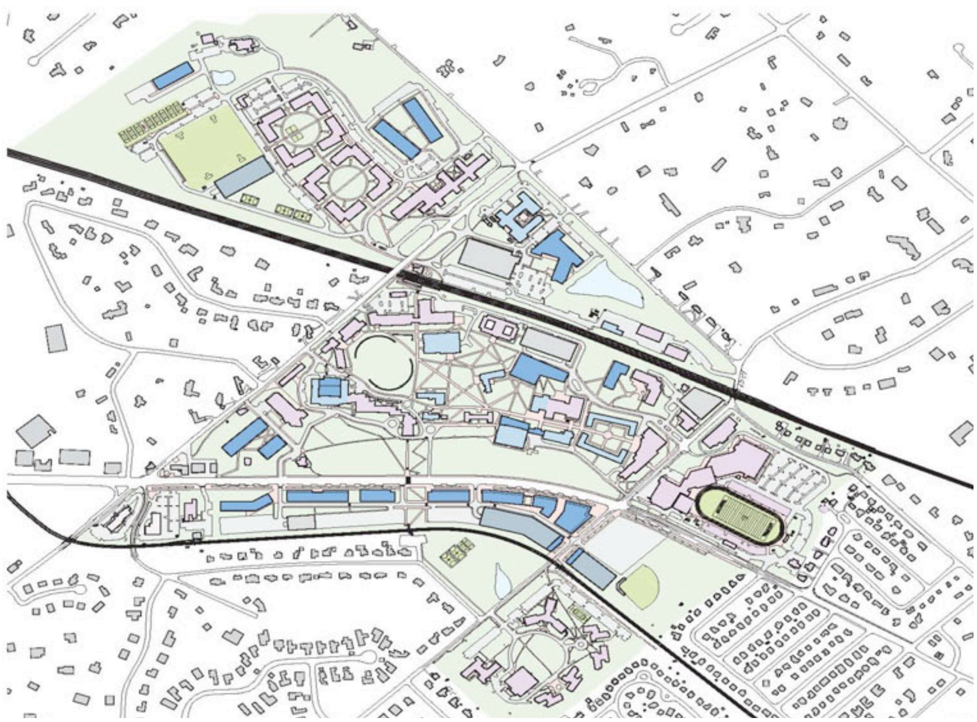
VILLANOVA UNIVERSITY Commitment to Sustainability

Figure 2-3 Cumulative Campus Growth in Gross Square Feet



One potential vision of the campus in the long term perspective is provided in Figure 2-4 below.

Figure 2-4 Potential Campus Growth



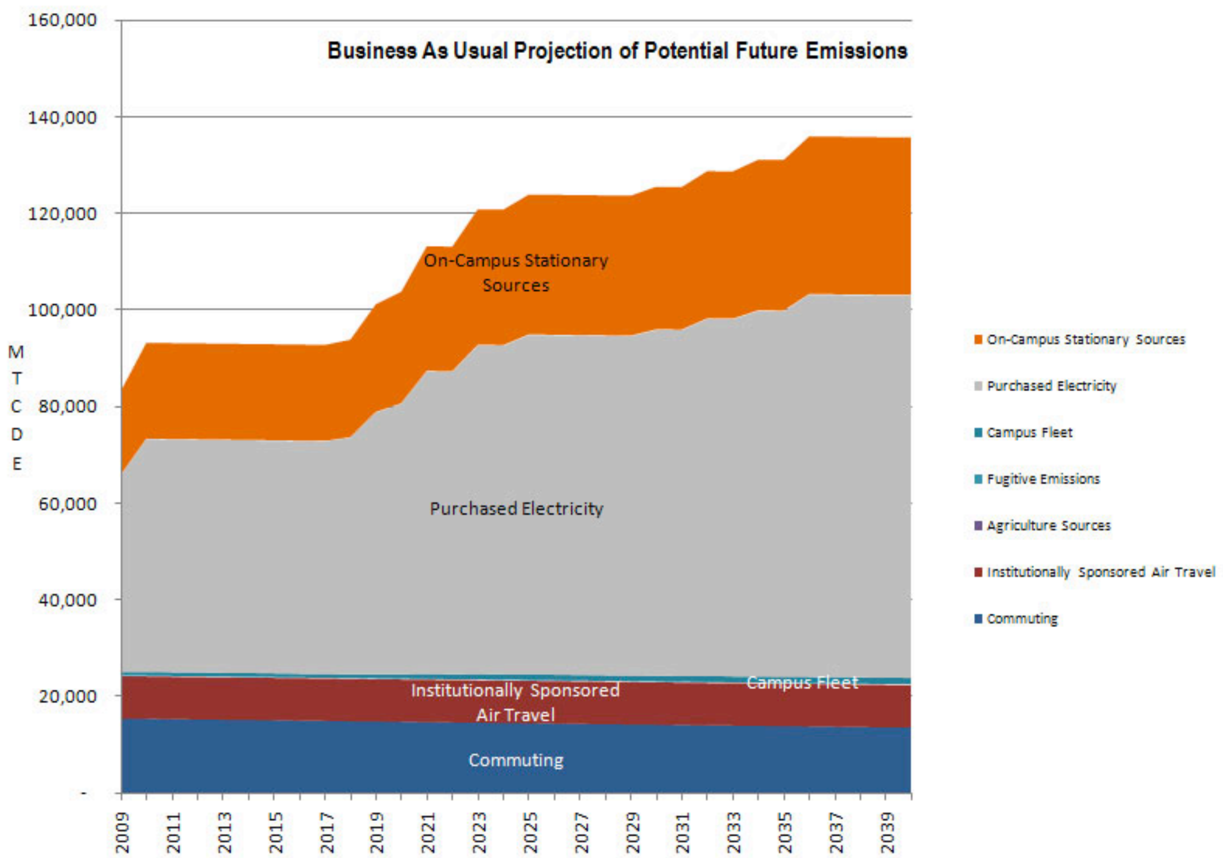
GHG emissions are directly tied to the amount of energy we consume. Buildings use electricity and fossil fuels for heating, air conditioning and lighting. As we add GSF to the campus, we increase the amount of energy consumed. While newer and renovated buildings may use energy more efficiently, they 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 global warming 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 2-5 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).

As demonstrated in Figure 2-5, 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 140,000 MTCDE by 2040. 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). While other emissions sources are also impotant, 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.

Figure 2-5 Business As Usual Projection



We ran additional projections to get a better sense of the impact of providing on-campus housing to more students, if we assume that we "own" the emissions of students living off-campus (not normally included in the estimates as per ACUPCC guidelines). These projections thus look beyond ACUPCC guidelines when those guidelines do not account for Villanova's particular circumstances. This proves important in the case of the BAU projections presented above. The combination of the ACUPCC's carbon accounting approach and Villanova's planned shift from off-campus to on-campus housing may generate a misleading trend in our GHG emissions under the BAU assumptions. With these new assumptions, the upper trend in Figure 2.5 would *underestimate* Villanova's *current* GHG emissions rather, and thus exaggerate the increase in emissions over time.

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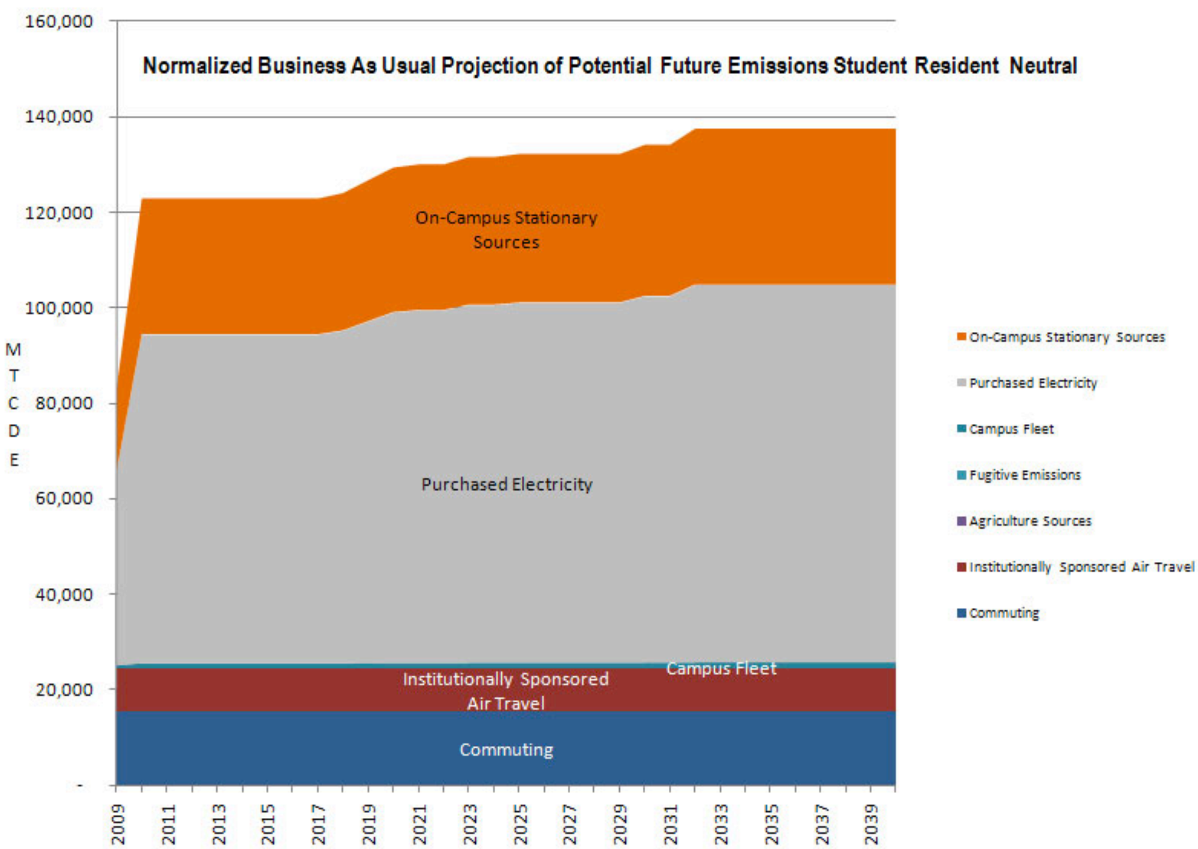
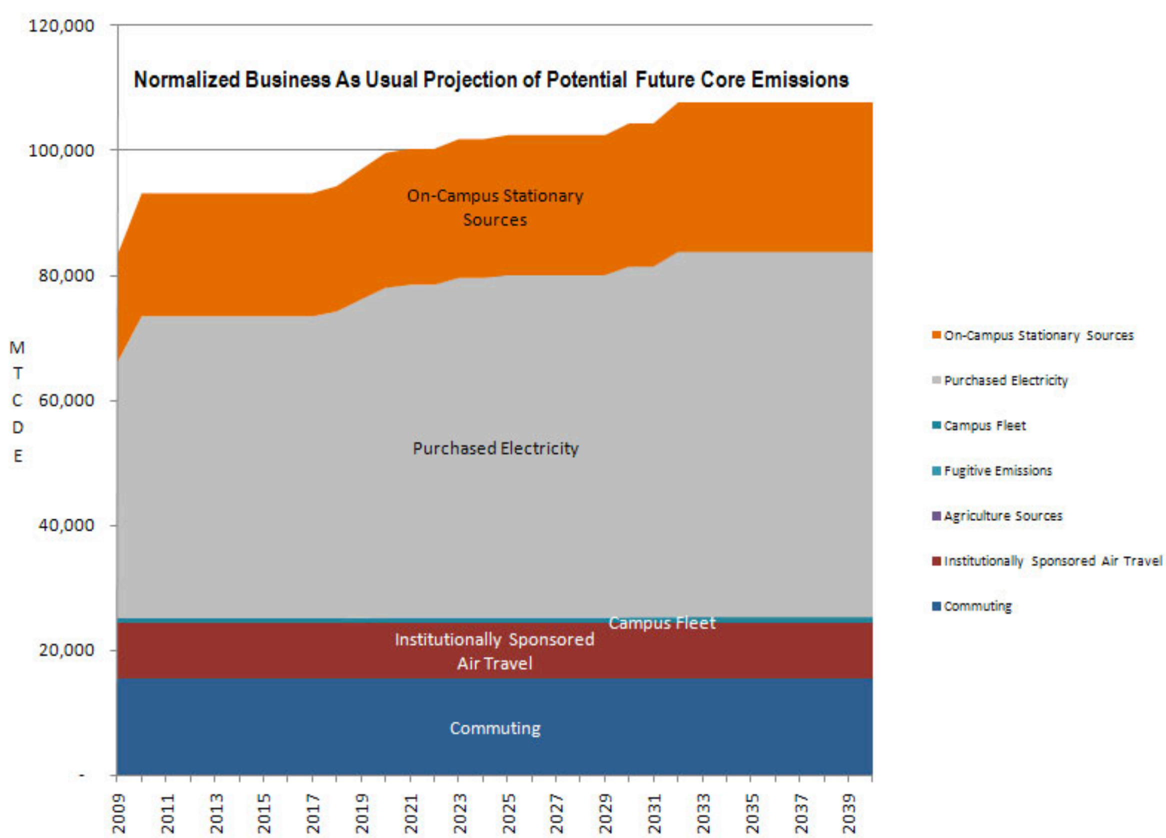
Figure 2.6 departs from the ACUPCC standards to illustrate our BAU projections under alternative accounting procedures. Specifically, the University's master plan calls for shifting 1200 students from off-campus to on-campus housing. For the calculation presented below, the residential GHG emissions of these students are assumed to be the same and to "belong" to Villanova whether off- or on-campus. Currently, the majority of Villanova students living off campus do not reside with their family but in local rental units that cater to groups of students. Thus, their residential GHG emissions (from heat and electric) are attributable to attending Villanova regardless of whether their residence is on-campus or in the surrounding community. Thus, the trends in this BAU reflect other changes with reduced commuting as students shift to on-campus housing, changes in instructional spaces, expanded air conditioning, etc.

Figure 2-6 BAU Emissions On/Off Campus Student Neutral



Comparing the two figures illustrates the different implications of the two accounting procedures. ACUPCC accounting standards do not count off-campus residential emissions even when students maintain a GHG-emitting residence away from home. Under this accounting system, Villanova's GHG emissions appear smaller when students live off campus and commute, larger when students live on campus and do not commute, reversing the true impact of providing more on-campus housing. This presents us with potentially perverse incentives to decrease our ACUPCC carbon footprint by increasing overall GHG emissions via additional commuting. Under the ACUPCC standard (Figure 2.5), we see a 45% increase in BAU GHG emissions over the period, two thirds of which is attributable to shifting 1200 students from off-campus to on-campus housing. If instead we treat the GHG emission of these students as "belonging" to Villanova whether off- or on-campus, there is a 10% increase over the period. This figure would be 12% if on-campus housing were not expanded (see Figures 2.6 and 2.7). Thus, the accounting procedure used by the ACUPCC might appear to penalize rather than encourage a more residential campus with less commuting.

Figure 2-7 Core Campus Emissions without new dorms or off campus students



3. Mitigation Strategies

Prior to the development of this CAP, Villanova University had prepared a Facilities Master Plan and a Utility Master Plan. These Master Plans allowed us to better define and understand the physical space and place of the University as it exists today, how it may evolve over the next thirty years, and the impact that changes on campus will have on our emissions profile and overall environmental footprint. The BAU projection provided in Section 2 takes into account the projected campus growth as based upon the Facilities Master Plan. As 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 both the Facilities Master Plan and Utility Master Plan, and development of the Climate Action Plan was inextricably 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 global warming 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 Villanova 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 GHG emissions for FY 08/09 were 76,543 MTCDE. At first glance, reduction of these emissions appears to be an insurmountable feat. 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.

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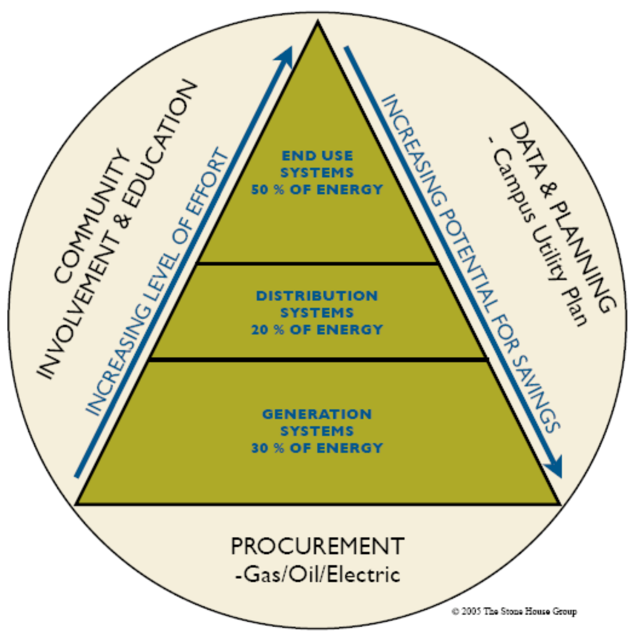
We approach the climate action planning process with three key steps to ensure a comprehensive approach: 1) Assess 2) Reduce 3) Offset. The first step in this process is to 'Assess' the current state of the institution. Assessment will encompass developing an understanding of the data (energy, the greenhouse gas inventory, and University operations for Villanova), 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 key 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.

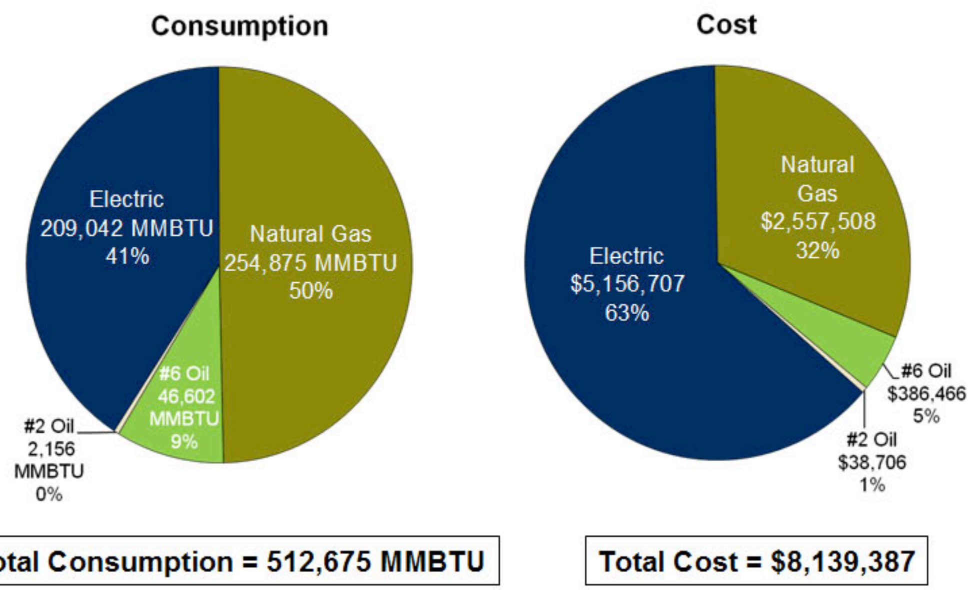
3.2 Energy Audit Overview

THE STONE HOUSE GROUP performed an energy assessment and evaluation of Villanova's campus beginning in April 2009. 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 building through a centralized building automation system. THE STONE HOUSE GROUP also reviewed and assessed the central steam plant and incoming electrical service. Overall, 2.4 million square footage of space was surveyed during the four month evaluation period. This equates to over 68% of the campus overall gross square footage and nearly 50% (35 buildings) of the 70+ buildings on campus. 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 age of the buildings surveyed ranged from 1849 to 2008. The energy audit also included a small 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 University's facilities staff, including the head of the maintenance department, superintendent of grounds, mechanical systems manager, steam plant operator, electrical supervisor and project coordinators. These individuals were very helpful in providing a better understanding of operations, scheduling, University policy, and the opportunities and limitations of the energy systems on campus.

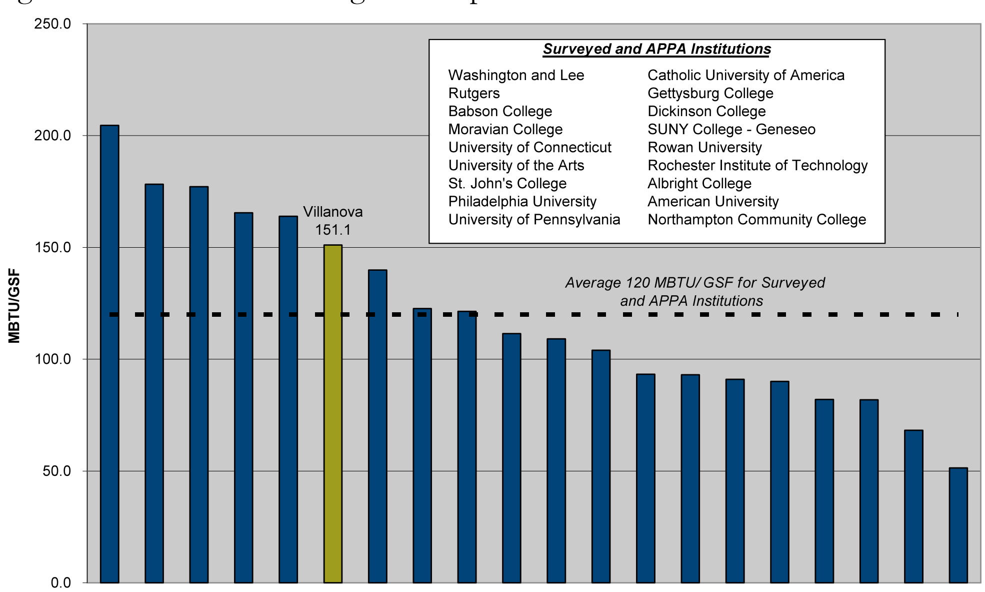
THE STONE HOUSE GROUP also conducted an analysis of Villanova's utility data for fiscal years 07/08 and 08/09. The results indicated that in FY08/09 Villanova consumed 512,675 MMBTU of energy at a cost of over $8.1 million. The campus energy consumption is comprised of approximately 59% fossil fuels and 41% electricity. Figure 3-2 outlines the cost and consumption by energy source.

Figure 3-2 Cost & Consumption by Source



Based on these same data, the campus as a whole used approximately 151 MBTU/GSF. Villanova 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 revealed that we consume approximately 30 MBTU/GSF more energy than the average for comparable institutions. Therefore, we believe there is significant opportunity to reduce energy consumption on a square footage basis. Figure 3-3, below, presents the results of our benchmarking study.

Figure 3-3 Benchmarking MBTU per GSF Results



Villanova University 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.

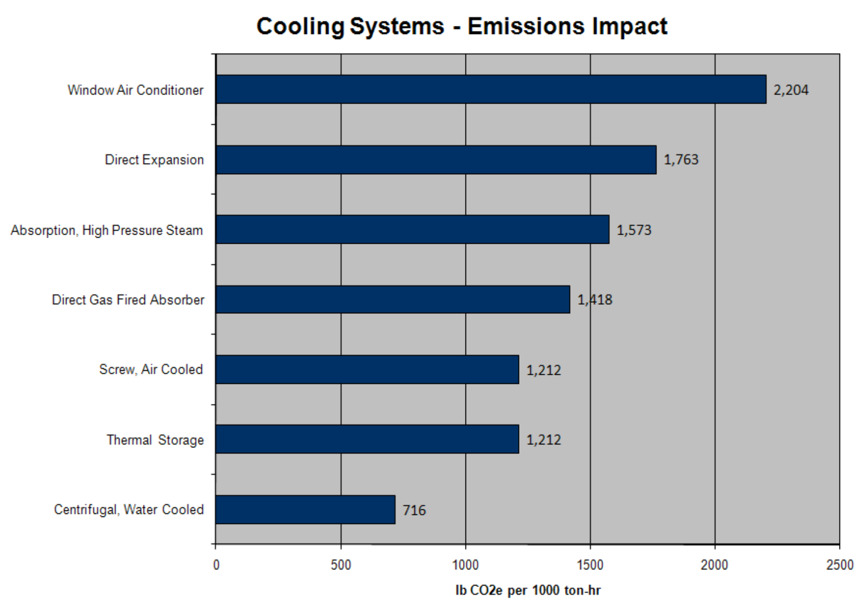
3.3 Generation and Distribution Energy Mitigation Strategies

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 Centralized Hybrid Chiller Plant

Villanova currently has five district chiller plants throughout main and west campuses with several other independent chiller locations on the main campus and the south campus. As a whole, we have over 5,000 tons of chiller capacity, and a wide variety of air-cooled, water-cooled, high pressure absorption, screw and reciprocating chillers. Villanova'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 smaller chiller plants 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 3-4 outlines the emissions impact of each type of cooling system.

Figure 3-4 Cooling Systems Emissions Impact

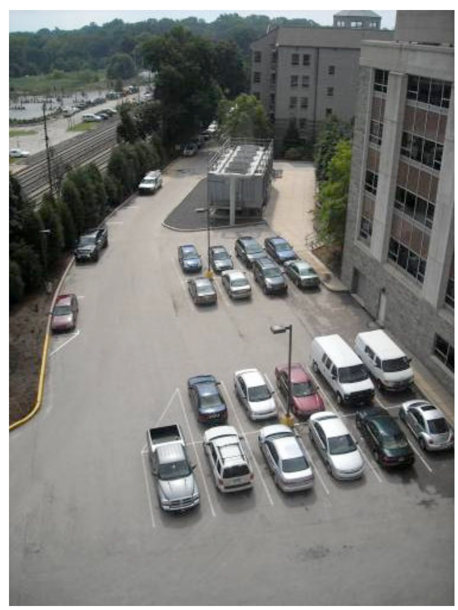


Window air-conditioning units are responsible for the emission of GHGs via their electrical consumption more than any other system, with 2,205 lbs of CO_2e (1 MTCDE) per 1000 ton-hr being released into the atmosphere. We have and use many window air conditioning units on-campus and our goal is to connect 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.

Even with the de-centralized cooling systems on campus, our existing chiller plant design includes strategies which have provided large cost savings in recent years. Our supplier, Philadelphia Electric Company (PECO) uses a demand ratcheted rate tariff which has trapped many institutions, especially those with 100% electric chiller plants, into a cycle of spiking electrical demand in the summer and paying increased consumption charges year-round. Our strategy was to avoid a magnified demand spike via the installation of fossil fuel driven steam absorption chillers. Although these units have an average emission impact of approximately 1,573 lbs of CO_2e per 1000 ton-hr, they provide us with the ability to control our peak kilowatt profile during the summer. Therefore, going forward, we will develop a centralized cooling plant 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.

We anticipate that one to two centralized chiller plants will be developed on the main campus. These plants would serve the main and west campus buildings with sufficient capacity to add additional load in future years. Mendel Hall and the Center for Engineering Education and Research (CEER) have been identified as two potential locations for the central cooling plants. Both locations have existing cooling equipment and sufficient space to expand. Figure 3-5, to the right, provides a view of the outdoor space behind Mendel Hall. This space is adjacent to the existing mechanical room in Mendel Hall and is the site of four large cooling towers for the Mendel chiller plant. A centralized plant would consist of hybrid chiller equipment including both high efficiency electric chillers and direct gas fired absorption chillers. These would allow us to reduce GHG emissions due to upgraded equipment, and at the same time still control cooling energy costs by having a hybrid (energy source alternatives) chiller plant.

Figure 3-5 Space at Mendel Hall



3.3.2 Central Steam Plant Opportunities

Currently, the central steam plant at Villanova provides high pressure steam for building heat (winter season), cooling via steam absorption chillers (summer season), and domestic hot water generation (year-round). There are four steam boilers which run on dual fuel (natural gas and #6 fuel oil).

Approximately 273,500 MMBTU of fuels were consumed at the central steam plant during FY 08/09, totaling nearly $2.6 million in energy costs and generating approximately 12,431 MTCDE in greenhouse gas emissions.

3.3.2.1 Reduction in Steam Distribution Pressures

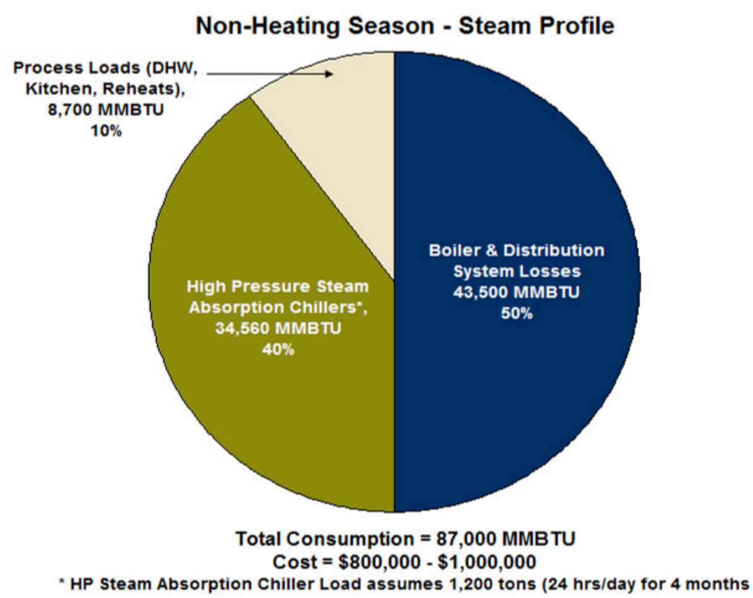
Our central steam plant currently operates year-round providing 125 psi steam throughout the main and west campuses. Pressure reducing valves located in the campus buildings reduce steam pressure before it is utilized for building or domestic water heating. There is significant energy loss in the distribution system during the winter months due to thermal and leakage losses.

We anticipate performing steam pressure reduction tests to determine if opportunities to reduce steam distribution pressures to campus exist. It is estimated that with a reduction of steam pressure from 125 psig to 60 psig that approximately 136 MTCDE emissions could be avoided annually.

3.3.2.2 Summer Shut-down of Central Steam Plant

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. The energy consumed by the campus high pressure steam absorption chillers was calculated assuming the connected load of 1,200 tons ran 24 hours/day for four months, as shown in Figure 3-6 below.

Figure 3-6 Non-Heating Season Steam Profile



Assuming 10% consumption for process loads (domestic hot water, kitchen, and variable air volume (VAV) reheats), the actual energy consumption at the steam plant over the four month period was used to calculate the loss in the system by deducting process loads and absorption chiller consumption. The analysis revealed approximately 50% of the energy consumed by the summer operation of the steam plant was lost through distribution and/or boiler operation.

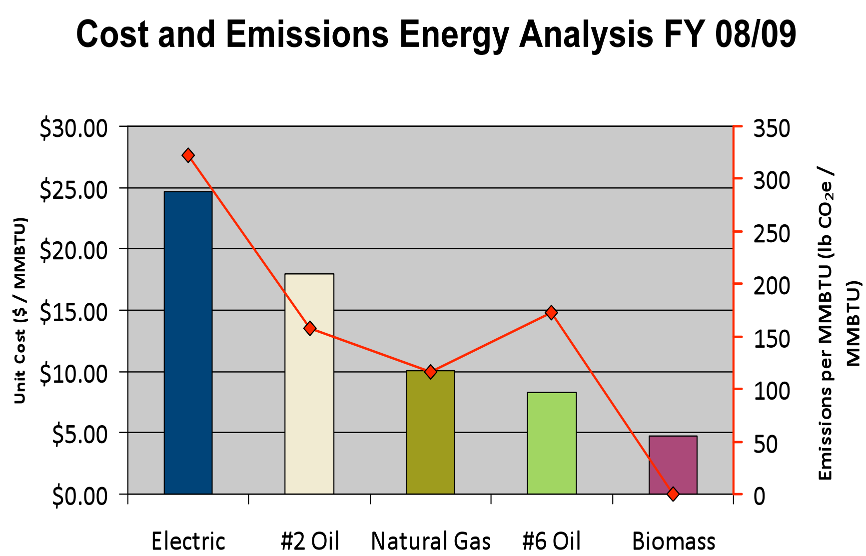
We are evaluating the de-centralization of summer processes, domestic hot water and absorption chiller use to facilitate a shut-down of the steam plant operation during summer months. Any new absorption chillers which would be installed at a new central chiller plant would be natural gas fired to negate the need for summer plant operation. 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 43,500 MMBTU's, or approximately 2,495 MTCDE emissions, would be avoided annually.

3.3.3 Evaluation of Fuel Alternatives

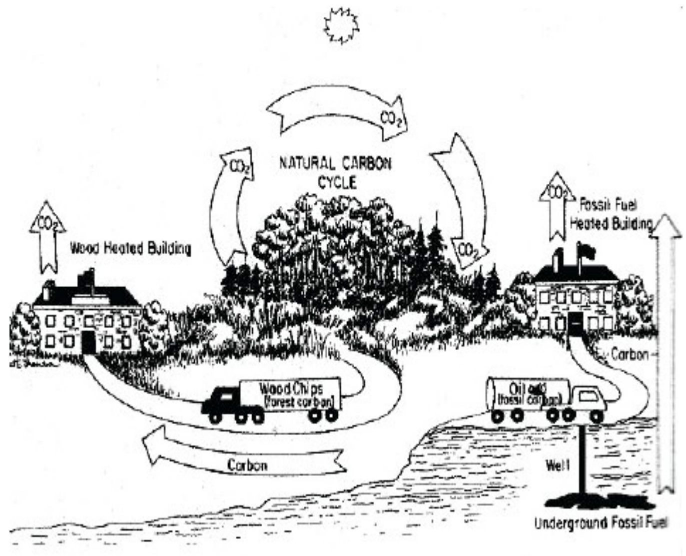
Fuel selection is a key component to the reduction of our carbon footprint. For each fuel source used to generate energy on-campus, the CDE released per MMBTU varies greatly. In addition, the unit costs of fuels are market driven and can fluctuate daily if a long term purchasing agreement is not in place. Figure 3-7 below 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 oils (#2 and #6) 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 FY08/09 Villanova paid an estimated $8.26/MMBTU for #6 fuel oil at the steam plant and $17.95/MMBTU for #2 fuel oil at the independent locations. Fuel oil selection at many institutions is a continuous trade-off between emission reduction and cost. As we move toward climate neutrality, we will pursue the reduction and eventual elimination of use of #6 fuel oil as an energy source due to high greenhouse gas emissions per MMBTU.

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 Villanova. 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 FY08/09 Villanova paid an estimated \$10.03/MMBTU for natural gas consumption; however, as history has shown, this unit cost can dramatically fluctuate with market conditions.



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

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.

We recognized the potential opportunity to significantly reduce our climate or environmental footprint with the utilization of biomass as an alternative fuel. Therefore, a specialized consultant was retained to evaluate 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 Villanova was excellent and the cost of biomass on a BTU basis was at a deep discount to hydrocarbon fuels. As shown in Figure 3-7 (above), it is estimated the biomass fuel could be purchased for a cost of \$4.73/MMBTU (based on \$25 per delivered ton).

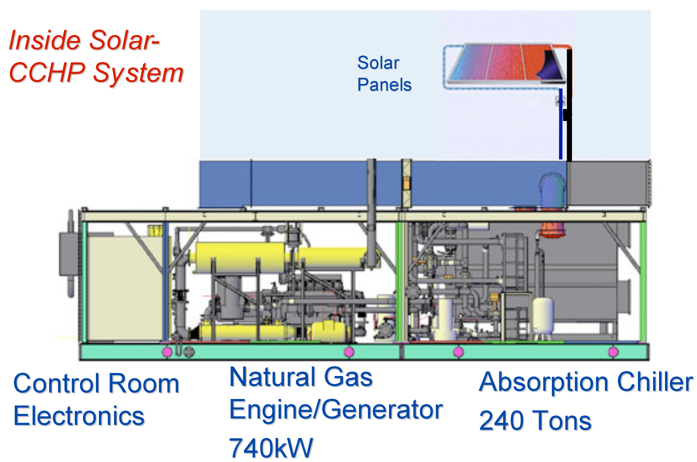
The biggest challenge to switching to a biomass fuel source is the logistics due to the location of the existing boiler plant. SEPTA will permit the adjacent rail line to be used for transportation of the biomass supply but a new rail switch will need to be installed at a cost of approximately \$1 million. Taking into account the transportation challenges with the location of the existing boiler plant, it was determined that we could migrate approximately 25% of our thermal load to renewable biomass energy, and ultimately reduce greenhouse gas emissions by approximately 2,858 MTCDE annually. This involves installing a base load biomass boiler at the heating plant, at an estimated cost of \$1.5 million, and using a staging area off campus for storage and delivery. As the campus growth continues to expand in the future a new thermal and electric biomass plant could be installed in conjunction with the construction of the buildings South of Lancaster Avenue.

3.3.4 On-Campus Electricity Generation

Our current electric utility provider, PECO, relies on a generation resource mix that is very 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 PECO zone averages 1.213 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 University's move toward carbon neutrality. During our analysis, we primarily focused on two power generation strategies for the University'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 Villanova generates and distributes high pressure steam (125psi); however, the steam passes through a series of pressure reducing valves (reducing pressure to 30 psi or less) at each building before being 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. An additional benefit from pressure reduction at the central steam plant, would be savings on energy loss from high pressure distribution throughout campus. A specialist was retained to complete a preliminary analysis of feasibility, steam turbine size and estimation of electrical generation potential. Preliminary analysis predicted that a steam turbine installed at the central plant could generate approximately 2.5-3.3 million kWh annually. This would result in a GHG emissions reduction of 1,315 to 1,815 MTCDE annually.

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In addition to the steam back pressure turbine planned for the central plant, we also evaluated opportunities for Combined Heat & Power and Trigen (heat, power and cooling) 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 Trigen exist at Mendel Hall (Science Center) and St. Mary's Hall. Overall we anticipate that 2 MW of Trigen systems, could be installed in a phased strategy to reduce the long term operating costs and resulting emissions for the University. The projects identified would yield a reduction of approximately 6,350 MTCDE annually.

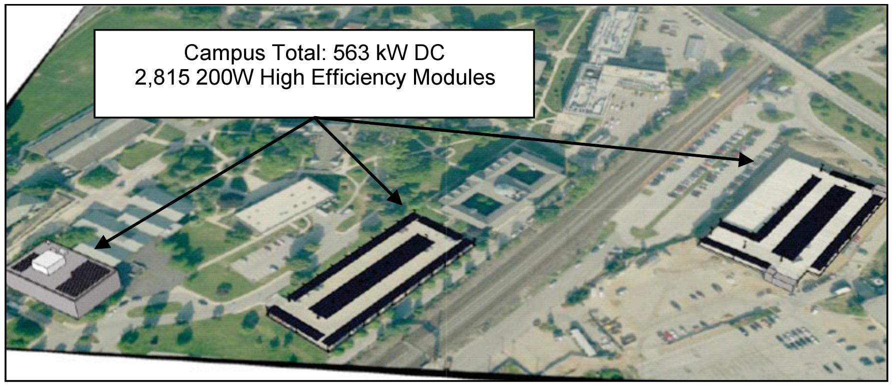
3.3.4.2 Renewable Energy Opportunities

Renewable energy is energy generated from natural resources such as sunlight, wind, 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 pending 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. Figure 3-8 outlines the recommended locations on campus for the PV arrays. The recommendation was to install a 39kW array on the Connelly Center roof, 256kW array on the Law School Carport, and a 268kW array on St. Augustine Center carport. In total, the campus would have 563kW of photovoltaic panels connected for electrical generation. It is estimated, based on regional weather data, that these arrays would produce nearly 582,000 kWh annually. This translates into a reduction in greenhouse gas emissions of approximately 396 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.

Figure 3-8 On-Campus PV Array Locations



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 Villanova'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.

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 Villanova, and will be incorporated 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 08/09 was 61.3 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 18.3 million kWh of electricity at a cost of $1.5 million 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

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power densities. It was determined that the lighting technologies currently installed at Villanova vary greatly from building to building. In a majority of the academic, administrative and residential spaces a mixture of T-12 and T-8 (32W) fluorescent lighting was observed. The maintenance staff noted that for most buildings, the T-12 fixtures and ballasts were only replaced when failure occurred, and it was difficult to determine the overall percentage of lighting that had been converted to the T-8 fixtures and ballasts. In a majority of the buildings, the lighting has switched control and no occupancy sensors had been retrofitted to the space. In the new construction buildings, such as the Driscoll Nursing Building, occupancy sensors controlled lighting for most classrooms and office spaces. After analysis of the lighting throughout campus, it is our intent to complete a campus-wide conversion of all remaining T-12 lighting fixtures and ballasts to T-8 (28W) lighting. The top priority buildings that were identified for conversion (based on high percentage of T-12's still installed) were Connelly Center, Dougherty Hall, John Barry Hall, Tolentine Hall and St. Augustine Center. Additionally, campus-wide installation of occupancy sensors for all classrooms and offices will be pursued. The University is currently working with a lighting consultant to identify the best opportunity for installation of the occupancy sensors.

For the large, open spaces such as the gymnasiums and pool area, where specialized lighting was required, we retained a lighting consultant to evaluate and recommend energy efficient lighting strategies. The University has metal halide lighting currently installed for all these spaces. Lighting control was limited and we found most of the lighting energized at full capacity with no occupants in the space during the walkthrough. The spaces evaluated included the two practice gyms in the Davis Center facility, the Nevin Fieldhouse, the pool, and the Butler Annex. The lighting consultant made recommendations for replacement of the metal halide lights with a combination of T5 high output lights and T-8, 6 lamp fixtures. All of the replacement lighting has dimmable capabilities and occupancy sensor control. This will enable the space to be only partially lit for cleaning or during periods of no occupancy, which will result in energy savings. It was estimated that as a result of the lighting conversion of these five recreational spaces, approximately 252,000 kWh ($21,200 energy cost) will be saved annually, resulting in a greenhouse gas emissions reduction of approximately 116 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. A majority of the residential buildings on main campus are not mechanically ventilated or cooled; heating is provided by steam or hot water perimeter radiation in most cases.

Although in most cases, the buildings on Villanova's campus are not individually metered, it is estimated that the science buildings (Mendel Hall and CEER) 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. As a result, we focused on energy recovery opportunities at these locations. It is anticipated that we will complete installations of glycol run-around loops from laboratory exhaust to preheat the outside air for air-handling units in both of these locations. It is estimated that this project for both Mendel Hall and CEER would yield approximately 40,000 MMBTU savings ($389,000 in energy cost) annually, which results in approximately 2,087 MTCDE of greenhouse gas emissions reductions.

The existing air-handling units at Villanova range in age from a few years to over twenty years old. To avoid the potential for high first costs, we focused in many cases on opportunities to reduce energy consumption with the existing equipment versus having to install all new modernized equipment with updated technology. We anticipate the installation of CO_2 sensors and demand control ventilation (DCV) for several air-handling units on campus. Opportunity locations for these improvements include Connelly Center, Falvey Library, and St. Thomas Church. The CO_2 sensors and DCV improvements would reduce outside air heating and cooling loads and the associated high energy costs during periods of low use. The upgrades would also improve the air-handling unit functioning by more accurately controlling for outside air intake. It is estimated that this project (for locations listed above) would yield approximately 7,500 MMBTU savings ($73,000 in energy cost) annually, which results in over 400 MTCDE in greenhouse gas reductions.

In addition to the energy strategies described above, we also identified opportunities for installation of economizers, occupancy sensors tied into HVAC terminal units, variable speed drives for air handling systems and hot & chilled water pumping systems, DDC controls for apartment thermostats, air-handling unit reset, etc. These projects are described more fully in Appendix B.

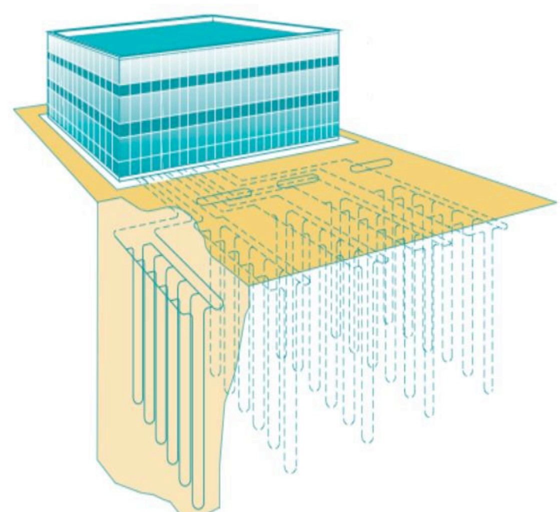
3.4.3 Holiday Curtailment and Scheduling Initiatives

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 2009 reveals that approximately 1,134 MTCDE emissions could be avoided via holiday curtailment programs.

Campus Wide Temperature Reductions and Building Scheduling and 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. Our policy with regard to building access and use is such that we strive to ensure that our students, faculty, and staff have access to facilities as needed. Understanding that some of our students and faculty study and work into the wee hours, while others are early risers, our scheduling of building hours has been relatively relaxed. Aggressive scheduling of buildings occurs when hours of access to building, or floors of buildings, is limited, thereby allowing the buildings systems to be set to an unoccupied/standby mode or reduced temperature set point. Lowering a building's temperature uses less steam, and reduces GHG emissions. Estimates of emissions reductions range from 5-10%, or approximately 3,950 MTCDE depending on how aggressively we choose to schedule buildings while balancing the need for access.

3.4.4 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 physical 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.



Source: RETScreen® International, Clean Energy Project Analysis

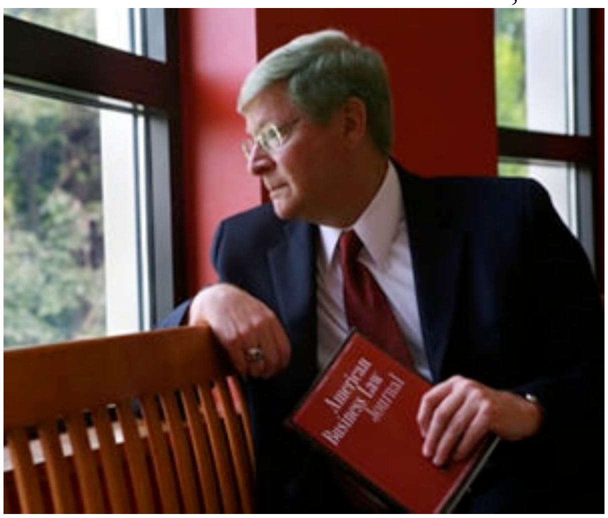
3.5 Other Campus Related Greenhouse Gas Mitigation Strategies

3.5.1 Fugitive Emissions Refrigerant Fluids

Villanova University has a substantial cooling load on campus however the use of high pressure steam absorption chillers has significantly reduced the quantity 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 0.1 percent, or 83 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 substantial factor in our environmental footprint. As demonstrated in the functional distribution chart in Section 2, emissions from this source comprise 11 percent or 15,422 MTCDE of overall GHG emissions.



Currently we provide access to two (2) different SEPTA rail lines and one (1) SEPTA bus line. Additionally, a free campus shuttle available to all faculty, staff, and students includes stops at or near each of the on-campus public transportation stops during its regular loop. As an incentive to encourage the use of public transportation, the University has implemented a Commuter Benefit Plan, which allows all faculty and staff to pay for eligible transit expenses through pre-tax payroll deductions. Additional mitigation strategies to be undertaken include the following: adding more stops to the Villanova shuttle 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 Villanova 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, develop stricter policies that further restrict student car use on-campus, develop a "parking diet" to phase out parking spaces needed on campus, and the development of local living incentives (rental properties available to faculty and staff) to encourage walking/bicycling to and from campus. The estimate of GHG emissions avoided through implementation of some or all of the above strategies is estimated at 10 to 15 percent or 1,542 to 2,286 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 12 percent of overall GHG emissions, or 8,903 MTCDE. Institutionally sponsored air travel is part of the campus life here at Villanova, 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 1,946 short tons of waste in FY 2008, the last year that complete data had been obtained for this source. The waste is disposed of at a waste to energy (WTE) plant for incineration. A WTE plant converts waste-to-energy, producing electricity from the waste. As the waste is not landfilled, it does not generate methane and thus GHG emissions are avoided. Additionally, because of its beneficial re-use, our waste disposed of at the WTE plant generates an offset or reduction in emissions equivalent to 214 MTCDE. Despite the interesting paradox that by generating less waste we concurrently create less beneficial offset, we remain committed to minimize our overall waste generation to reduce our broader environmental footprint.

While not included in the CACP calculator, we have other waste minimization programs in place on campus. Our food services department conducts a composting program, which diverts approximately 90 tons per year of food waste to the composting stream as opposed to disposal at a landfill or WTE. We also compost and or recycle all of our landscape waste.

A comprehensive recycling program has been established with a Recycling Coordinator on the Facilities Management staff that manages recycling programs for paper, cans, bottles, computers, ink jet cartridges and fluorescent light bulbs. Additionally, construction debris is recycled on most new or renovation projects on campus. We are also participants in the Recycle Mania program.

Our Facilities Management Office attempts to re-use furniture throughout campus by maintaining an inventory of furniture needs on campus and items that are either kept in storage or may becoming available through a renovation project. Our Recycling Coordinator also manages a program to sort through the large volume of items left behind by students during the end-of-year move out and donates them to local charities. Items include furniture, food, clothing and books.

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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 University. GHG emissions for this sector are 3,670 MTCDE, or 4 percent of our overall GHG emissions. Transmission and distribution (T&D) losses are generally 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 13,260 MTCDE. The concurrent reduction in emissions attributable to T&D losses will be approximately 1,194 MTCDE.

3.5.6 Campus Fleet

Villanova, 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 over 150 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 761 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 Villanova' commitment to the environment. Emissions avoidance estimates are 10 percent or 76 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 8 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

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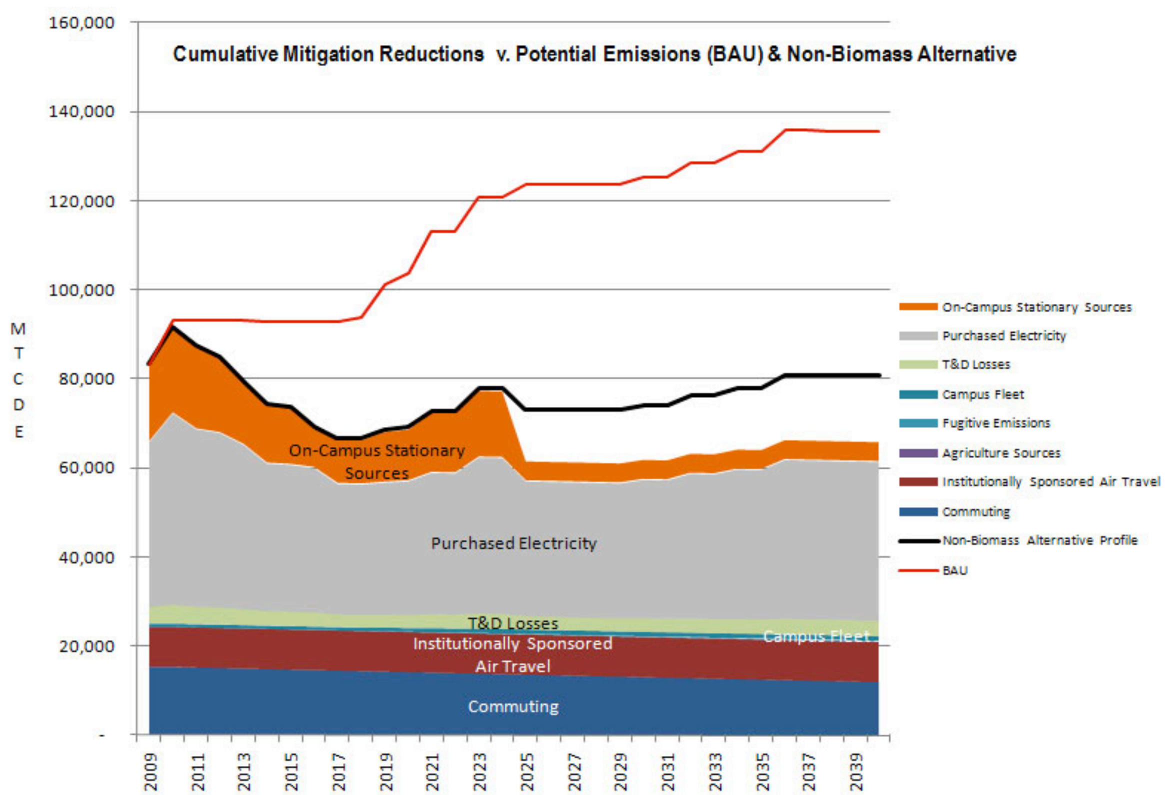
Villanova has implemented a green building policy for all new construction and renovation on campus. This policy states that all new and renovated projects shall achieve the equivalency of a LEED Silver certification. Typically, LEED-like projects result in a 30 percent energy reduction as compared to a baseline model as set forth by ASHRAE. As of this writing, the campus energy consumption per GSF at Villanova is 151 MBTU or 151,000 British Thermal Units (BTU) per GSF. We anticipate that green building measures would reduce energy consumption to 80 MBTU/GSF on an average. This would result in a reduction of approximately 26,725 MTCDE. Using construction cost data from RSMeans' Building Construction Cost Data 2009, and assuming a cost increment of 2 percent per green building, we arrive at a cost of approximately 11.4 million dollars to implement this measure across all proposed new construction and renovation projects at the University.

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 be verified emissions reductions (VER) or certified emissions reductions (CER).

Our future emissions profile, assuming the implementation of the above referenced GHG reduction strategies, is presented in Figure 3-9, Emissions Profile: Post CAP Strategies Implementation. With

Figure 3-9 Emissions Profile: Post CAP Strategies Implementation



the implementation emissions reduction strategies, approximately 63,000 MTCDE remain to be to be offset after 2025. This number increases with further campus growth to approximately 69,000 MTCDE remaining to be offset at the end of our study period.

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

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$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

"You must not deal only with the symptoms. You have to get to the root causes by promoting environmental rehabilitation and empowering people to do things for themselves. What is done for the people without involving them cannot be sustained."

— Wangari Maathai, Nobel Peace Prize laureate

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

Villanova University is committed to making sustainability an essential component of the educational experience for all students. The University has already implemented a number of programs that provide environmental educational experiences at many levels from academic majors to one-time seminars.

Environmental Learning Community. Freshmen in all Colleges may elect to spend their first year in a number of academic learning communities. In 2006 the University introduced an Environmental Leadership Learning Community. This program invites first-year students to live in a residential community and share their class experiences in the first-year Augustine and Culture Seminar. Through specially-designed sections of the Augustine and Culture Seminar (a year-long interdisciplinary class required of all freshmen), students focus on texts from the Ancient to the Modern period that raise critical perspectives on the environment. They are encouraged to make connections between their academic pursuits and the choices they make in their day-to-day lives. Students in the Environmental Leadership Learning Community:

- attend a series of lectures, films, and/or community service focused on environmental concerns;
- enroll in one of the designated sections of the Augustine and Culture Seminar associated with the learning community;
- live in Katharine Hall in a co-educational setting with their Augustine and Culture Seminar classmates; and
- learn from professors who work together to focus on issues of the environment as they relate to multiple aspects of scientific, engineering, business, political, and religious thought.

This past year, students in the learning community took a day-long fieldtrip to visit Saul High School's new organic Community Supported Agriculture (CSA) farm and the organic CSA in west Philadelphia, Mill Creek Farm. Experiences at the farms and with the farmers impressed the students very much; most of them had never seen some of the plants they encountered, had previously believed that

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farms could only be large industrial endeavors, and were fascinated by the organic growing techniques, solar panels, and composting toilet they saw. Another activity was a tree-planting at a nature preserve near campus during the University's Day of Service in late September.

Department of Geography and the Environment. In 2007 the College of Arts and Sciences established a new Department of Geography and the Environment linking an existing B.A. degree in Geography with new B.A. Environmental Studies and B.S. Environmental Science degrees. Several new courses have been developed, and add to others already established, including Environmental Science I and II and Seminar in Environmental Issues. The first Environmental majors graduated in Spring 2009 and student interest has grown rapidly. The Department now has approximately 60 majors in the three degrees.

Courses in a Variety of Departments in all Four Undergraduate Colleges. Departments across the University offer a wide-range of environmentally-related courses (Table 4-1). Students may encounter these through their majors, minors, concentrations, general education requirements, or elective classes. For example, the College of Engineering at Villanova University offers a curriculum that provides students an opportunity to work on applied projects relating to renewable energy and water resources in a classroom setting and significant volunteer opportunities exist which introduce students to service projects both locally and internationally (see below). Since the early 1990's, Villanova has been involved in creating solar powered cars, and participated in and won major national races. More recent activities involve supporting clean water supply efforts in third world countries, and a geothermal well for a "green" dorm (Fedigan Hall, wells completed Fall 2009). The topics of sustainable water and energy are included in many undergraduate classes.

Table 4-1: Sample of recently offered sustainability-related courses available across campus.

BIOLOGY

Introductory Ecology
Higher Vertebrates
Conservation Biology
Environment and Human Health
Field Ecology and Evolution
Global Change Ecology
Biogeochemistry

BUSINESS

Corporate Responsibility & Regulation
Global Business Ethics
Leadership and Ethics

CIVIL & ENV. ENGINEERING

Principles of Sustainable Development for Industry and Society
Environmental Engineering Science
Water Resource Planning and Management
Renewable Energy Systems

GEOGRAPHY AND ENVIRONMENT

Environmental Science I and II

Environmental Chemistry
Environmental Policy and Management
Geotechniques
Geographic Information Systems
Global Change in Local Places
Natural Resources and Conservation
Land Use Management
Seminar in Environmental Issues

GLOBAL INTERDISC. STUDIES

Global Environmental Justice Movements

HISTORY

American Environmental History

NURSING

Principles of Nutrition
Nursing and Health Promotion

PEACE AND JUSTICE

Caring for the Earth
Global Poverty and Justice

PHILOSOPHY

Environmental Ethics
Politics of Nature
Ecofeminism

SOCIOLOGY

Sustainable Development in Latin America

THEOLOGY

Christian Environmental Ethics

In addition, Villanova offers a wide variety of graduate courses for advanced degrees in sustainability, especially in the Colleges of Engineering and Law. Most of the courses in the former College are in the Department of Civil and Environmental Engineering (CEE) and associated with a new Master's Program in Sustainability.

Some representative courses offered through CEE include:

CEE 7010: Lake, Stream, and Wetland Ecology
CEE 7011: Hazardous Waste Management
CEE 7111: Introduction to Hydraulic Engineering. and Hydrology
CEE 7211: Water Resource Planning Management
CEE 7502: Introduction to Environmental Engineering Processes
CEE 7511: Microbiology for Environmental Engineers

CEE 7513: Fate & Transport of Contaminants
CEE 7514: Industrial Pollution Prevention
CEE 7701: Aquatic Chemistry for Environmental Engineers
CEE 7829: Principles of Sustainable Development for Industry and Society
CEE 8103: Geosynthetics
CEE 8104: Geoenvironmental Engineering
CEE 8311: Environmental Geology (Summer)
CEE 8501: Surface Water Hydrology
CEE 8502: DE, Watershed Modeling
CEE 8507: Environmental Fluid Mechanics
CEE 8508: Urban Hydrology & Storm Water Management
CEE 8510: Groundwater Hydrology
CEE 8512: River Mechanics & Engineering
CEE 8707: Physical & Chemical Treatment Processes
CEE 8708: Biological Treatment Process

Life Cycle Analysis (new in Spring 2010)

4.1.2 Service Learning Opportunities and Student Organizations

Several service learning opportunities exist at Villanova. Villanova is among the top universities 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 (Table 4-2). International volunteer experiences provide students with an opportunity to apply engineering principles to assist low-income developing communities worldwide. International project partners include; Engineers Without Borders projects in Kenya and Thailand, the Water for Waslala project in Nicaragua, the Amigos de Jesús project in Honduras and the SITMo project in the Philippines. 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 triple-bottom-line sustainability. 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).

Table 4-2: Representative Service learning opportunities with an environmental emphasis currently available at Villanova.

Sustainable Vision Program (SITMo, Philippines)
The Province of Ifugao, Philippines is a very mountainous area rich in natural beauty, culture, biodiversity and, unfortunately, incredible poverty. The main source of income in Ifugao is farming, particularly rice, coffee, and betel nuts. The rice terraces of Ifugao were inscribed in 1995, as a UNESCO (United Nations Educational, Scientific and Cultural Organization) World Heritage Site, and are generally recognized as one of the largest man-made systems of irrigation worldwide. Despite this natural wonder, modern influences and economic conditions have caused younger generations to abandon their cultural heritage in search for a better standard of living. Villanova student design teams have been working with the Save the Ifugao Rice Terraces Movement Organization (SITMo) and the Provincial Governor's Office of Ifugao since 2007. The primary focus of these projects is to mobilize renewable energy projects for rural development. The SITMo organization has been working to reverse the trend of young people leaving the rural communities of Ifugao province by creating opportunities for both economic progress and improved access to basic needs. Villanova University has established a partnership with SITMo to provide technical assistance to local inventors in Ifugao for the development of innovative solutions to poverty alleviation.
Community Water Supply Project, Nicaragua
Since March of 2004, the Villanova University's Engineering Department has been sending groups of undergraduate engineering students to Waslala to identify projects directly related to water supply problems in this area. These students travel to Nicaragua over spring break and perform assessment activities in rural areas in the outskirts of the town of Waslala which is approximately 8 hours north of the capital city of Managua. The group is mandated with the task of identifying potential projects and building relationships with local partners and organizations in Waslala. This project gives students an opportunity to assess, design and build water resource development projects in communities who currently have no potable drinking water supplies. Students work with local community partners and learn first-hand applications of engineering principles. Recent student design projects have focused on renewable energy projects for rural electrifications. A recent senior design team has initiated a project to design and construct a 40kW micro-hydro electrification facility for a small community of 80 households who have no access to electricity. Students who work on these issues are oriented to the complex issues of international development as well as how they apply to the situation in Waslala, Nicaragua.
Amigos de Jesús
The undergraduate program in Civil Engineering includes service learning opportunities to support a Catholic orphanage in Honduras. The annual trip to Amigos de Jesús is a part of a service-learning course that is an outgrowth of the spring semester Senior Capstone Design Project in Structural Engineering. For the past seven years, students in that course have worked on various structural designs for a Catholic home for abused and abandoned children in Honduras. Each Spring Break, a portion of the class travels to Honduras with the professors on an engineering service trip where they work on the construction of those designs. The mission trip is co-sponsored by the Department of Civil & Environmental Engineering, the College of Engineering, and Campus Ministry. The trip incorporates all aspects of a service learning

experience (preparation, service, reflection, and celebration). A recent design project included a computer laboratory for an eight building school complex on the Amigos de Jesús site. The bilingual school will serve the children at Amigos de Jesús and the surrounding villages. Villanova students and faculty constructed the ten foundations for the building in March. To date, all eight buildings have been designed by students in the structural engineering capstone course over the past three years. Two buildings are operational and three others are under construction.

International Programs in Health

The undergraduate program in Nursing sponsors trips that concentrate on health promotion in developing countries with limited access to health care. Often these deal directly or indirectly with environmental issues. For example, in 2010, Villanova students will be travelling to Ecuador and Peru in two different programs. The latter course is run through Washington State University. To quote from their brochure, "This course provides an experience in global health care in the Amazon region of Peru. Students will apply assessment skills in planning and implementing health care to individuals and communities. The program will provide an excellent opportunity to analyze the cultural, social, environmental, and economic factors that can influence health care."

4.1.3 Student Organizations

A number of student organizations have also been created around areas of interest generally tied to sustainability. The Villanova Environmental Group (VEG) 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. In addition, the group organizes field trips to environmental education sites. VEG presents an open forum for anyone who has questions, concerns, and ideas regarding the constant changes in the environment.

The Ecological Society of Villanova (ESV), founded in 1994 by a group of biology undergraduates, is a student organization that focuses on ecology and environmental science. Activities include:

- meetings to share information about ecological issues and environmental action;
- field trips to regional sites for natural history observation, environmental education, service, and recreation; and
- sponsorship of invited speakers and other events with ecological and environmental themes.

The Engineers Without Borders (EWB) chapter at Villanova is a very active organization which provides students an opportunity to provide technical engineering assistance on various development projects. To date, EWB-Villanova has been involved with international projects in Kenya and Thailand as well as local projects in both Philadelphia and New Orleans. This organization is entirely managed by student volunteers and partners with local and international organizations to assist with the delivery of sustainable infrastructure projects and livelihood development programs.

In 2008, students formed a Business Without Borders chapter within the Villanova School of Business. The organization is affiliated with Net Impact

Undergrad, a higher-education program that seeks to encourage undergraduates around themes of corporate social responsibility, social entrepreneurship, green business, and other topics related to the ways in which business can be used to make a positive impact on the world. The mission of the Villanova group is to equip, educate, and inspire Villanova School of Business students to use their business skills for lasting social and environmental good. To fulfill this mission, Business without Borders Net Impact Undergrad Chapter will 1) empower undergraduate students to use their skills to positively impact their surroundings, 2) help them put their beliefs into action through sustainability efforts, and 3) enlarge their network with other like-minded individuals who have demonstrated their commitment to social corporate responsibility.

Also newly formed is a student chapter of Engineers for a Sustainable World, which is involved with conducting Home Energy Audits as an outreach service project for the local Villanova community, and with a Bio-diesel production facility that processes used cooking oil for use as fuel on Villanova's campus.

Graduate students at the Villanova School of Law have an Environmental and Energy Law Society, which is dedicated to exploring the effects and prospects of law relating to the environment and energy. The group is primarily concerned with US energy policies and the environmental consequences they produce.

In addition to these student groups described above, Villanova students are active members of the President's Environmental Sustainability Committee. This committee is charged with leading the effort to achieve the goals of the Presidents' Climate Commitment including the production of this report.

4.1.4 Student Orientation and Other University-wide Initiatives

All students are also exposed to issues of climate neutrality and sustainability through University-wide initiatives. New Villanova students receive a sustainability pamphlet as part of their orientation at the beginning of the school year. It addresses sustainability overall as a part of campus life, and specifically addresses energy and resource use reduction. Residence students regularly take part in RecycleMania competitions. 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. Last year four dormitories took part in a Student Energy Conservation Competition. Katharine Hall reduced its electricity consumption by 20 percent; Maguire Hall reduced its hot water usage by 64 percent and hot water energy by 55 percent; and Caughlin Hall reduced its cold water usage by 51 percent.

To broaden dialog beyond the walls of the classroom, Villanova has recently hosted two national/international environmental conferences, *Catholic Social Teaching and Ecology* (9-11 November 2005) and the *International SustainAbility Conference* (22-25 April 2009). In addition, individual colleges have hosted smaller conferences. In 2008, for example, the College of Nursing hosted a regional program entitled 'Greening of a Community Health Curriculum: Promoting Environmental Health.' The program was intended for community health nurse educators and supported by an unrestricted educational grant from Health Care without Harm. The course provided an opportunity for faculty to interact and learn strategies that will assist with the integration of environmental health concepts into didactic and clinical nursing courses.

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.

A new academic Minor in Sustainability Studies program was approved by the VPAA's office in July 2009. Dr. Andrea Welker, Dr. Frank Galgano, and Dr. Paul Rosier are working to implement the program for the Fall 2010 semester. The minor will offer students an opportunity to take environmental courses in the College of Liberal Arts and Sciences and the College of Engineering; the broader goal is to add new courses from the colleges of Nursing and Business and to offer a foundational course, Introduction to Sustainability Studies.

Other goals include:

- Developing additional courses (work with the departments of Geography and the Environment, Biology, Chemistry, Arts and Humanities, and others)
- Possibly add a course (or segment to preexisting a course) in the core curriculum with opportunities to develop science sections for Liberal Arts
- Add an environmental segment to orientation
- Expand upon courses in the *Environmental Leadership Learning Community*
- Continue to encourage faculty to develop inter- (or cross-) disciplinary courses, modeled after those which have already been formed at Villanova
- Work with all colleges on campus (including Law School) to plan more educational forums, seminars, and special talks on sustainability

4.2 Research

4.2.1 On-going Research

Villanova 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. On the student side, Villanova students participate in sustainability research both in and out of the classroom. Research opportunities exist in the sciences, engineering, humanities, social sciences, and business. Students work independently, in groups, or as partners with faculty. Students produce poster exhibits, traditional research papers, and lab reports. Students present their research to the campus community, such as during the annual Earth Day symposium, and they present their work at professional conferences. The following is a sampling of student projects.

- First-Year students enrolled in the Environmental Learning Community write a research paper on an aspect of sustainability.
- Students enrolled the Environmental Science II course pursue research projects related to sustainability, such as air quality on campus, plastic bag use in the University Shop, biodegradable food containers in the residence halls, expansion of the off-campus shuttle route to minimize

campus commutes, and tips for easy do-it-yourself energy audits in dorm rooms.

- Students enrolled in Conservation Biology partner with the professor to study various species, such as the Cozumel Thrasher, the White-Breasted Thrasher, and the Chickadee.
- Undergraduate student teams, under the direction of a faculty member, learn how to perform home energy audits using newly-purchased equipment provided by the Department of Chemical Engineering.
- Students regularly write research papers in courses such as American Environmental History, Global Environmental Justice Movements, and Natural Resources.

In addition to these more formal research projects, several students from a variety of units on campus are involved in projects that have a strong environmental sustainability emphasis. For example, the following students are involved in projects during the 2009-2010 academic year.

Student Projects for the 2009–2010 Academic Year

Project: Increasing Bicycling on Campus

Student: Megan Needham, Philosophy, College of Liberal Arts & Sciences.

My project focuses on orienting the Villanova community to the emission-free and health-promoting practice of biking. In order to promote bike riding on and off campus among students and faculty, we must first make Villanova's campus more accommodating to cyclists. The most immediate adjustment is the addition of bike racks throughout campus, which will provide safe, convenient storage for current bikers and increase visibility and awareness of biking as an option to passersby. Eventually, we hope to initiate a bike sharing program on campus to allow students to utilize bikes as a time- and energy-efficient method of transportation. Whether the bikes would be used to make the trek from Bartley to Tolentine within the 10-minute break between classes or for a quick trip to the local CVS or Borders, a bike share program would provide students and faculty with an easily-accessible alternative to their current, less efficient systems of travel.

Project: Promoting Carpooling

Student: Laura Nikkel-dumyahn, Civil and Environmental Engineering, College of Engineering

Working with the Villanova Public Safety Department, I am looking into possible incentives for students, faculty, or staff to carpool such as prime parking spots or discounted parking passes. Although I have feasible ideas on how to reward carpooling, I am still looking into means by which to ensure that those who agree to carpool actually do so. An alternate route which I have come up with is increasing parking rates for on-campus students to discourage the use of individual cars. Finally, I am investigating the means by which commuter students travel to and from their homes in order to promote public transportation and carpooling in this sense as well. This could involve a shuttle to the airport on travel days that possibly could serve other nearby schools as well.

Project: Promoting Recycling on Campus

Student: Kevin Pickowicz , Chemical Engineering, College of Engineering

Villanova has a good recycling system in place. As of 2007, Villanova was recycling 24% of the waste generated. While Villanova has recycling bins on campus, buildings with heavy traffic such as Connelly--which generate a lot of waste--do not have many recycling bins. The goal for this project is to make recycling a simpler process for students. Some project ideas include investigating single-stream recycling; improving recycling bins with either multiple slots for various waste and recyclables or pictures displaying accepted recyclables; increasing the availability of recycling bins; and promoting on campus awareness of recycling.

Project: Promoting Recycling on Campus

Student: Hector Santamaria, Civil and Environmental Engineering, College of Engineering

I have adopted a project to develop the recycling program. In order to increase the amount of recyclable material, it would be convenient for each resident student to have an individual recycling bin in his/her residence hall room. I plan to work closely with Facilities Management to bring this project to reality. It is imperative that Villanova provide its student body with the necessary tools for recycling in order to meet our goal for a sustainable campus.

Project: Developing a Green Fair

Student: Ajay Ramesh, Business, Villanova School of Business

My project is to develop and host a "Green Fair" in spring 2010 within the Villanova School of Business. The event would involve a panel followed by a networking session with companies tied to a Green Initiative. Companies would range from marketing firms that advertise using environmentally-friendly means to hedge funds that invest in green technologies. The purpose of the fair would be to raise awareness about green technologies and companies within the business school. Panelists would represent these companies and discuss issues related to their experience and to future initiatives in this field. Villanova students are known for their philanthropic efforts, and this panel will raise awareness about major waste problems occurring at our school and surrounding community. Overall, the purpose of this project is to show the connections between business and green initiatives.

Project: Introducing Organic and Fair-Trade Clothing to the Bookstore

Student: Christina Riley, Biology, College of Liberal Arts & Sciences

I am interested in introducing organic and fair-trade clothing into the University Shop and eventually integrating it into the athletics apparel as well. Organic cotton is certified to be grown without the use of any synthetic agricultural chemicals such as fertilizers or pesticides. Its production also promotes and enhances biodiversity and biological cycles, and reduces soil erosion. Non-organically grown cotton has been proven to have detrimental effects on the environment as well as negative health effects on those who grow and manufacture this clothing. Most organic cotton is grown in developing areas in Asia and Africa and can be bought utilizing fair-trade practices. The phasing-in of organic cotton clothing options to the University Shop is the feasible method of introducing environmentally-friendly clothing. In addition, students are made more aware of the environment by being provided with an opportunity to make a responsible environmental choice rather than being forced to make such as choice as the only available option.

Project: Promoting Donations at the End-of-the-Year Move

Student: Christine Simmons, Chemistry, College of Liberal Arts & Sciences

My project is to create a large donation service at the end of the academic year, involving several trucks from donation services placed at strategic places on campus. This will greatly reduce our waste stream during student move-out in the spring, and help give still-usable items to those in need in our community.

Project: Performing a Sustainability Assessment of White Hall

Student: Mara Tsudis, Chemical Engineering, College of Engineering

My project within Engineers for a Sustainable World is to perform a sustainability assessment of White

Hall. As chemical engineers, we spend a lot of time in White Hall in lab and in class. It has come to our attention that the building could be using less energy and implementing more sustainable practices. The first step is to quantify the different waste and energy streams produced by the building. We will be looking at the electricity use, HVAC use, chemical disposal, and waste streams. After quantifying all of these streams, we will seek ways to reduce emissions by the end of the year. We will then make appropriate changes to the building to help reduce these emissions further. Some of the projects will include changing lights to LEDs and CFLs, minimizing chemical and other waste, and trying to complete several renovations on the building.

Project: Improving Water Resources and Reducing Use of Plastic

Student: Dan Willette, Chemical Engineering, College of Engineering

In an effort to build awareness and reduce the amount of plastic bottle waste, I will head a plan to examine the availability and accessibility of clean drinking water that can be used to refill water bottles. While there are currently a few dining halls with quality sources of water, the goal is to expand the availability of free sources of water for students and faculty. Along with expanding locations of drinking water, another goal is to test the water fountains already in place to ensure that they have proper filtration and the quality one would expect from a drinking fountain. With help and efforts from members of a new organization, Engineers for a Sustainable World, we hope to accomplish these goals in the spring semester of 2010.

A number of faculty members in the College of Liberal Arts and Sciences are pursuing individual research projects which have a bearing on climate neutrality and sustainability. Several of these projects are funded by extramural funding, including NSF. These projects include:

- Carbon accumulation and decomposition dynamics in northern boreal, western Canadian peatlands under future predicted scenarios of global climate change.
- Greenhouse gas production from a variety of ecosystems, including rainforest soils in Hawaii.
- Integrating the effects of sea level rise and salt water intrusion on tidal freshwater marsh stability.
- Effect of climate change on distribution and abundance of sea urchins.
- Coupling microbial populations and community compositions to biogeochemical rates under a changing climate.
- Physiology of bleached and recovering corals.
- Christmas Trees and Soil Carbon Storage: Maximizing Ecosystem Management and Sustainability in a Future Carbon Economy.
- Dynamics of Mangrove-Saltmarsh Ecosystems in the Face of Climate Change.
- 'What the world will need to survive': American Indian Environmentalism in a Global Age: Native American sustainability discourse and programs from the 1960s to the present.
- Sustaining both the ecology and the culture of the people and the temperate forest in southern Chile: At the world's only station for field philosophy, housed at the *Parque Etnobotánica Omora Center for Biocultural Conservation and Environmental Ethics*, in Cape Horn, Chile.
- Medieval writings on the sanctity inherent in the natural world: the presence of ecological awareness in medieval Christian thought.

4.2.2 Centers and Institutes

The ***Center for the Advancement of Sustainability in Engineering*** (VCASE) was established in the fall of 2009 within the College of Engineering and a new research structure was developed. VCASE seeks to protect and restore our environment through research on the integration of sustainability principles in engineering practice. To meet *"the needs of the present without compromising the ability of future generations to meet their own needs"* mandates an inclusive, interdisciplinary, systems approach to research using the campus infrastructure as a test bed. VCASE follows Villanova's Sustainability Policy of supporting the concepts of sustainability in its curriculum, research, and activities, to contribute to an environmentally sound and socially just society. The primary specialties of the Research Center encompass renewable energy, bio-energy, environment, and water. Most of these areas have a current successful track record of research that is integrated into the educational components and the campus infrastructure. For example, regarding water, the Villanova Urban Stormwater Partnership has a long-term integrated study into the performance of green stormwater infrastructure using the campus as a living laboratory. Current projects include a green roof, stormwater wetland, bioinfiltration rain gardens, and pervious pavements. This program is nationally known and a statewide conference on sustainable stormwater is held at Villanova, biennially.

The ***Center for Global Leadership*** is housed in the Villanova School of Business, and was created to advance ethical and responsible global leadership for the betterment of business and society. One of the emphases is the role of nonprofit organizations in promoting environmental and social goals.

Also, located in the Villanova School of Business is the ***Innovation, Creativity, and Entrepreneurship Center*** (ICE Center). Although sustainability and climate neutrality is not the main focus of the ICE, the Center is interested in projects, initiatives, and businesses having to do with entrepreneurial ways to address issues of sustainability. To that end, they co-sponsor the "Social Entrepreneurship Competition" being run out of the engineering school, sponsor some of the activities of the student group Business Without Borders, co-sponsor the "Beyond Ideas" program, and contribute to travel of faculty involved with a project in the Philippines involving fresh water and sustainability for small villages.

4.3 Community Outreach

4.3.1 Special Conferences, Seminar Series and Earth Day

Villanova has recently sponsored two national/international conferences involving specialists from around the nation that were open to faculty/staff, students, and the local community - *Catholic Social Teaching and Ecology* (9-11 November 2005) and the *International SustainAbility Conference* (22-25 April 2009). The latter conference featured a keynote address by Robert F. Kennedy Jr., more than 25 panel discussions on a diverse set of subjects relating to sustainability, a dramatic play about environmental activist Rachel Carson, and student discussions on sustainability. Conference panels included talks by scholars, educators, government and industry representatives, students, and activists from across the United States and around the world, as well as participants – faculty and students – from all four of Villanova's undergraduate colleges as well as the School of Law. In 2008, the College of Nursing hosted a regional program entitled 'Greening of a Community Health Curriculum: Promoting Environmental Health.' The program was intended for community health nurse educators and supported by an unrestricted educational grant from Health Care without Harm. The course provided an opportunity for faculty to interact with other faculty and

VILLANOVA UNIVERSITY Commitment to Sustainability

learn strategies that will assist with the integration of environmental health concepts into didactic and clinical nursing courses.

Several seminars offered by a variety of departments on campus pertain to environmental issues. First and foremost of these was a dedicated series on global climate change sponsored by the Department of Geography and the Environment in Spring 2009 for Environmental majors as well as interested faculty, staff, and students. Faculty from across the campus delivered a series of lectures on issues ranging from seasonal climate variations to patterns of sea level rise to energy resources in the Canadian prairie. In addition, several seminars sponsored by the Departments of Biology and Chemistry in the College of Arts and Sciences as well as by the Department of Civil and Environmental Engineering in the College of Engineering feature talks that are pertinent to climate change.

The Villanova Urban Stormwater Partnership (VUSP) holds the Commonwealth of Pennsylvania's Sustainable Stormwater conference biennially since 1998. Typically 300 stormwater professionals attend this event. In addition, the faculty of the VUSP serves on the state water advisory board.

Villanova University has been celebrating Earth Day since 1970. The Earth Day team comprises faculty, staff and students. Each year the team organizes an Earth Day celebration consisting of educational displays (highlighting Villanova student research), eco-vendor exhibits, eco-friendly Dining Service offerings, an environmental film, a Keynote speaker by a prominent activist, scholar or NGO representative, and community discussions about pressing environmental issues. In addition, VEG students promote environmental issues during a post-Earth Day BBQ and concert for students.

4.3.2 On- and Off-campus Communications/Outreach and Ratings

Publications. Villanova is extremely proactive in its communication of the university's sustainability efforts—conveying news about initiatives in the classroom to campus construction and beyond. One of the ways in which Villanova successfully communicates is through its own publications, including *Villanova Magazine*. Below is a sampling of sustainability coverage in a recent edition.


Mapping the Route to a Green Villanova


Villanovans in Green Careers

The Answer Is "Blowing in the Wind"

Sustainability

Body Burden:
A Health Promotion Priority

Body Burden: The Toxins We Encounter in Our Everyday Lives

***Website*.** In addition to sharing its sustainability news with stakeholders via print media, Villanova has a public website dedicated to the university's commitment to sustainability. This site is managed and frequently updated by the President's Environmental Sustainability Committee (PESC) to ensure accuracy and to promote green initiatives in a timely manner. The site also serves as an information center for conferences, competitions, and other special events. Below is the landing page of the President's Environmental Sustainability Committee (PESC) website.

Social Media Outreach. Villanova seeks not only to *inform* its stakeholders through communication efforts, but also to *engage* them in the university's efforts to support a more sustainable world. Through the university's Facebook and Twitter pages, which are both managed by a member of the President's Environmental Sustainability Committee (PESC), Villanova seeks to continue to interact further with stakeholders.

News Media Coverage. In addition to the information shared with the university's stakeholders worldwide through print and online media, Villanova also makes its faculty and administrators are also available to media representatives in their coverage of sustainability issues. Below is a sampling of green media coverage on philly.com in which Villanova's efforts were highlighted, authored by a *Philadelphia Inquirer* staff writer.

philly.com
anything & everything philly

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Posted on Wed, Oct. 7, 2009

Area campuses turning green in many ways

By Lini S. Kadaba

Inquirer Staff Writer

Area campuses have shown a commitment to green living with a variety of green dorm projects.

Here's a sampling:

Villanova University renovated an 80-year-old residence hall - the school's first green dorm. It boasts furniture made of recycled materials, two rain gardens that capture roof runoff (with displays that show the quantity), and lights fitted with motion sensors. Showers automatically shut off after eight minutes, though students can pull a cord to continue. "But it's a reminder that you've been in there for a while," said Robert Morro, associate vice president for facilities management.

Princeton University's first "green roof" on a dorm (in the newly rebuilt Butler College housing complex) includes monitors for students to track energy performance and storm water runoff compared with coventional roofs.

This year, the **University of Pennsylvania** will sign up student "eco-reps," who will encourage green behavior among peers. The school also plans to build a green, mid-rise dorm that would include, among other features, recycling chutes next to the trash chutes.

West Chester University expanded its "district geothermal system" to two new freshman dorms that also feature recycled materials,

Intra-Industry Sharing of Best Practices. As a signatory of the American College & University Presidents' Climate Commitment (ACUPCC), Villanova is deeply committed to sharing best practices with others in higher education, so that all universities may work together to fight the global climate crisis. Accordingly, Villanova provides information for industry dissemination as frequently as possible. Below is an article about curricular change, which recently appeared in the Association for the Advancement of Sustainability in Higher Education (AASHE) Campus Sustainability Perspectives Blog.


AASHE Association for the Advancement of Sustainability in Higher Education

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Programs
Professional Development
Resource Center
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Campus Sustainability Perspectives Blog

Villanova University: A Curricular Commitment to Sustainability

Submitted by Niles Barnes on September 2, 2009 - 9:40am
in Climate

By Bethanie Anderson, Senior Communications Associate and Member, President's Climate Commitment Core Team, Villanova University

Villanova launched an innovative Year of Sustainability in 2008–09 that involved the entire campus community—students, faculty, staff, and alumni alike. Through curricular development, along with research and service initiatives, the year highlighted our crucial and shared responsibility to care for the environment. The year was led by an interdisciplinary executive committee of faculty members in collaboration with the Presidents' Climate Commitment Core Team, and culminated in the International SustainAbility Conference featuring Robert F. Kennedy, Jr. "Our intention was that the year would help to bring a new era of environmental responsibility to our campus," said Dr. Francis Galgano of the Year of Sustainability Executive Committee. "Our hope was to strengthen the foundation of the Villanova Commitment to Sustainability for generations to come."

The goals that Dr. Galgano describes are already being realized, and not only by the "usual suspects" in the university's science departments. From business and nursing to engineering and the arts, the whole Villanova community embraces a commitment to sustainability at both the curricular and extracurricular levels. At Villanova, the Catholic Augustinian tradition—

2010 Princeton Review Rating. Villanova participates in the Princeton Review Green Rating, which is published every July. Among almost 16,000 college applicants and parents surveyed by The Princeton Review, 66 percent of respondents overall said "they would value having information about a college's commitment to the environment." Accordingly, this rating represents each college's performance across criteria ranging from curricular initiatives to construction projects, distilled to a numerical score on a scale of 60 to 99. Only schools with a score of 99 make the Green Rating Honor Roll. Villanova is making excellent progress toward its goal of inclusion in the Honor Roll, moving from a score of 81 in 2009 to 92 in 2010.

2010 Green Report Card. Villanova is proud of its recent grade in the annual *College Sustainability Report Card*, having progressed from a "C" in 2008 to a "B" in 2009 to a "B+" in 2010. The grade is based on performance across 48 sustainability indicators including food and recycling, student involvement, and endowment investment policies. The *Report Card* is published by the Sustainable Endowments Institute, a special Project of Rockefeller Philanthropy Advisors. It identifies colleges in the US and Canada that exemplify best practices in environmental responsibility. Villanova earned an "A" in several categories, including food and recycling. Villanova was also honored as an "Endowment Sustainability Leader," a title given to only 12 colleges that earned an average grade of "A-" or better on three endowment management categories: transparency, investment priorities, and shareholder engagement.

Aspirational Rankings. In addition to its ongoing participation in the Princeton Review Green Rating and the Green Report Card, Villanova University is currently pursing inclusion in the Sierra Club's "Cool Schools" national ranking, Greenopia's national college ranking, and—at the local level—the Lower Merion Township "Go for the Green" awards.

4.3.3 Planned Future Efforts

Future plans include continuing to develop pieces on climate neutrality and sustainability for the University website and possibly printed media to inform and educate the Villanova 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.

Efforts will also be made to coordinate with students and student groups on campus (e.g., students in courses such as Environmental Science I and II, and in student groups such as the Ecological Society of Villanova) to better advertise events and opportunities on campus.

A student chapter of Engineers for a Sustainable World has recently been started at Villanova. This group will be involved with conducting Home Energy Audits as an outreach service project for the local Villanova community. They are also involved with a Bio-diesel production facility which processes used cooking oil for use as fuel on Villanova's campus.

Greener Partners recently met with Villanova leadership to discuss prospects for giving Villanova students opportunities to be involved with Main Line farming endeavors and growing-related service projects. Greener Partners runs Skunk Hollow Farm, near campus, does substantial food justice- and gardening/farming-related outreach in the Philadelphia metropolitan area, and also is involved with eco-restoration. Greener Partners also is looking for college students to help with a farming summer camp and serve as mentors for a high school program.

Feedback from participants in and attendees of the 2009 International Sustainability Conference indicated support for a follow-up conference in 2011 or 2012. Conference organizers will assess the benefit of organizing another conference. We will continue to assess need in the local and national arenas to optimize the conferences so that overlap and competition is avoided.

5. Financing

This Climate Action Plan (CAP) is matched in ambition only by the space growth to be undertaken in the coming years as outlined in the Villanova University Campus Master Plan. Both of these goals will require careful attention to financing. These endeavors may be viewed as being at odds, but if properly implemented they are supportive of each other, if not complementary.

The cumulative present cost of mitigation strategies identified in the CAP is $38,400,000. Major mitigation strategies, both technical and operational are summarized in the following table:

Table 5-1 Mitigation Strategy Major Projects Cost, Savings, and Returns

Mitigation Strategy	Cost (2009 $)	Annual Savings[1] (2009 $)	ROI (%)
Technical Projects			
Install Steam Turbine at Heating Plant (HP)	$1,000,000	$218,662	22%
Decentralized HP for Summer Operations & Create Hybrid Chiller Plant	$3,210,000	$568,395	18%
Combined Heat & Power Systems at Mendel, St. Mary's, & HP	$6,000,000	$248,836	4%
Install Biomass Boiler at HP	$1,500,000	$250,000	17%
New Central Heat Plant (biomass thermal & electric)	$17,500,000	$2,078,193	12%
Building Automation Systems (BAS) Upgrades	$1,500,000	$262,500	18%
Install Energy Recovery for Mendel & CEER Ventilation Systems	$1,340,000	$388,973	29%
Renewable Energy Projects	TBD	TBD	TBD
Operational Improvements			
Improve Equipment Scheduling through BAS	$100,000	$612,000	612%
Develop Holiday Curtailment Program	$50,000	$204,000	408%
Set Heating & Cooling Temperature Policy for University	$20,000	$81,000	405%
Total	**$32,220,000**	**$4,912,559**	**15%**

[1] Annual savings were calculated using current electric rates and not predicted energy rate increases associated with PECO deregulation.

Major mitigation strategies are estimated at full cost, inclusive of design and construction fees. The fees are fully burdened, not including various incentives that are available from state and federal governments, local utilities, the regional grid operator, and the sale of various environmental attributes (ex. RECs, NO_x, CO_2).

The cost of mitigation strategies does not account for cross over between financial planning and allocations for cycle and deferred maintenance, modernization, and capital renewal. The fact that many mitigation strategies will address these issues effectively lowers their cumulative present cost.

We recognize that in some cases it may be mutually beneficial for mitigation strategies to be owned by independent third parties. This is most common in the area of renewable energy (photovoltaic & wind energy systems), as for profit organizations ability to take advantage of substantial tax and depreciation benefits. For this reason renewable energy projects are carried as TBD in the table of major mitigation strategies. The third party owner approach allows us to generate/purchase green power at the lowest possible cost while maintaining capital available for implementation of the Campus Master Plan and other CAP strategies.

Understanding the limitations of budgeting cross over, the potential for third party ownership, and the dynamic nature of both the Campus Master Plan and Climate Action Plan we have chosen a financing approach that provides flexibility. In this vein we are proposing to set up an internal investment account from which CAP mitigation strategies will be financed. The account will initially be financed through two different mechanisms. The first will be a near term capital allocation of approximately $4 million dollars to fund the high ROI energy projects to jumpstart the program. The technical and operational projects that have the highest ROI and greatest environmental impact will be funded to reduce campus energy consumption and their resulting emissions. The second mechanism by which the CAP account will be funded is energy savings. We plan to hold the energy budget constant going forward assuming that consumption will decrease allowing savings to be banked in the CAP account. The energy budget will be corrected annually for both campus growth (gross square feet) and fluctuations in energy unit costs. This financing strategy provides a self funding mechanism where utility cost savings are reinvested in CAP projects thereby reducing the University's requirement for future capital investment.

We believe this financing approach provides greater incentive for energy conservation, will enhance student engagement, and provides the flexible framework that will further support implementation.

6. Tracking Changes

6.1 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.

6.2 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 University and the community's collective knowledge.

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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 annually. It is our intention that with each year the accuracy of the data contained in the inventory will be subsequently improved. Along with the updated inventory, we will prepare a narrative summary on a biennial basis (once every two years) reporting the following:

- Mitigation strategies undertaken for each fiscal year
- 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 achieve our milestones and target date for climate neutrality. 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.

6.3 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, Villanova will have reduced its emissions by 24 percent over 2009 emissions levels by the year 2025 After this date, we anticipate beginning the purchase of offset instruments to further our goal of net climate neutrality.

The Campus Master Plan projects increase the size of the campus to 5.8 million GSF, and provides housing, academic and campus life spaces that ensure that Villanova University 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 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 set the year 2050 as our target date for net climate neutrality.

We will endeavor to verify our progress in the year 2025, when we anticipate that our GHG emissions will be reduced by approximately 24 percent. This date is the logical mid point in our journey to the net climate neutral date of 2050.

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7. 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.

7.1 Campus Emissions

- Small, independent buildings located along Black Friar Lane, and County Line Road were not included in the GHG emissions inventory, nor in the energy audits conducted as part 'of this CAP. It is anticipated that they will be included in future GHG inventories.

- The fuel mix in use for FY 2009 at the central plant will continue to be used in the ratios present during FY 2009 going forward. Our business as usual and mitigation strategies reflect this fuel mix.

7.2 Mitigation Strategies

- Major mitigation strategies are estimated at full cost, inclusive of design and construction fees. The fees are fully burdened, not including various incentives that are available from state and federal governments, local utilities, the regional grid operator, and the sale of various environmental attributes (ex. RECs, NO_x, CO_2).

- All mitigation strategy costs are figured in 2009 dollars, with no escalation factors having been applied.

- The emissions projection for on-campus stationary sources does reflect the potential remaining emissions from small or independent houses along Black Friar Lane and County Line Road.

7.3 Financing

- All mitigation strategy costs are figured in 2009 dollars, with no escalation factors having been applied.

- Annual savings were calculated using current electric rates and not predicted energy rate increases associated with PECO deregulation

7.4 Other/Miscellaneous

- The presented Business as Usual Case set forth in Section Two utilizes the 2009 national fuel mix and electrical grid region as default values. 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 has not been normalized for student and faculty/staff growth. These numbers remain

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constant as we do not anticipate growing the institution in term of these two factors. The FY 2009 values used are 9,613 full time students, 2,955 part time students, 3,862 summer school students, 980 faculty and 1,550 staff.

Appendix A Greenhouse Gas Emissions Inventory

MODULE	Summary
WORKSHEET	Total Emissions in Metric Tonnes CO_2 Equivalents
UNIVERSITY	Please enter university name on 'Introduction' sheet

Fiscal Year	Scope 1							Scope 2		Scope 3									Offsets								
	Co-gen Electricity	Co-gen Steam	Other On-Campus Stationary	Direct Transportation	Electric Fleet	Refrigerants & Chemicals	Agriculture	Purchased Electricity	Purchased Steam / Chilled Water	Faculty / Staff Commuting	Student Commuting	Directly Financed Air Travel	Other Directly Financed Travel	Study Abroad Air Travel	Solid Waste	Wastewater	Paper Purchasing	Scope 2 T&D Losses	Additional	Non-Additional	Total Scope 1	Total Scope 2	Total Scope 3	Biogenic	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	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2	MT eCO_2
1990	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1998	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1999	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2003	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2007	-	-	18,831.4	759.5	1.3	82.5	7.5	41,648.2	-	-	-	8,903.4	-	-	(225.5)	-	-	4,119.0	-	-	19,680.9	41,648.2	12,796.9	-	-	74,126.0	74,126.0
2008	-	-	16,626.4	-	-	82.5	7.5	34,046.5	-	4,876.8	10,545.2	8,903.4	-	-	(214.1)	-	-	3,367.2	-	-	16,716.4	34,046.5	27,478.6	-	-	78,241.5	78,241.5
2009	-	-	17,300.0	-	-	82.5	7.5	37,107.7	-	-	-	8,903.4	-	-	(125.7)	-	-	3,670.0	-	-	17,390.0	37,107.7	12,447.6	-	-	66,945.3	66,945.3

Appendix B Energy Capital Investment Plan

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Energy Capital Investment Plan

	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR
I. DATA												
1	Develop monthly energy reports (tie to cash)	Campus	In Progress	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
2	Develop equipment inventory & operating schedule	Campus	Planned	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
3	Develop energy capital investment plan	Campus	In Progress	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
4	Develop an emissions inventory for the campus	Campus	In Progress	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
5	Metering and Monitoring throughout Priority 1 Buildings - install electric,condensate, chilled water & domestic submeters	Mendel, CEER, Falvey, St. Mary's, Bartley	Planned	1	200.0	N/A	N/A		N/A	N/A	N/A	2011
6	Metering and Monitoring throughout Priority 2 Buildings - install electric,condensate, domestic submeters	Pavilion, St. Augustine, Tolentine, Connelly, Dougherty	Planned	2	200.0	N/A	N/A		N/A	N/A	N/A	2014
7	Metering and Monitoring throughout Priority 3 Buildings - install electric,condensate, domestic submeters	All Remaining Campus Buildings	Planned	3	300.0	N/A	N/A		N/A	N/A	N/A	2017
8	Review PECO Evaluator demand profile	Campus	In Progress	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
9	Consolidate electric (9) and natural gas (23) bills for small independent meters onto main meter bill	Campus	Planned	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
10	Install deduct meters on cooling towers and irrigation systems to avoid sewer charges.	Campus	Planned	1	TBD	TBD	TBD		TBD	TBD	TBD	2011
SUBTOTAL:					700.0							

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	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR
II. PROCUREMENT												
1	Expand demand response program by joining PJM Capacity and Synchronous Reserves programs to increase incentive payments from CSP.	Campus	Planned	1*	20.0	90.0	N/A		5.0	0.2	450%	2010
2	Negotiate transport gas contracts in deregulated marketplace to take advantage of low market pricing conditions.	Campus	Planned	1*	25.0	300.0	N/A		5.0	0.1	1200%	2010
3	Negotiate electric contracts (deregulated marketplace)	Campus	Planned	1	25.0	N/A	N/A		5.0	N/A	N/A	2011
4	Electric meter consolidation of high tension service	Campus	Planned	1	TBD	26.9	TBD		TBD	TBD	TBD	
5	Connect main electric meters to BAS	Campus	Planned	1	60.0	N/A	N/A		N/A	N/A	N/A	2011
6	Develop demand management program	Campus	Planned	1	250.0	135.5	N/A		25.0	1.8	54%	2011
7	Develop gas / oil procurement strategy based on cost & emissions	Boiler Plant	Planned	1	N/A	N/A	N/A		N/A	N/A	N/A	2010
8	Purchase "Green" power contract for 20% of electricity consumption on campus.	Campus	Planned	1					N/A	N/A	N/A	2015
SUBTOTAL:					380.0	552.4	0.0	0.0		0.7	145%	

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	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR
III. GENERATION												
1	Installation of back pressure steam turbine for electricity generation at central plant (Assumes 200 psig inlet and 50 psig outlet)	Boiler Plant	Planned	1	1000.0	218.7	-313.9	3258.2	25.0	4.6	22%	2012
2	Centralize district cooling into 1-2 main chiller plants. Expand Mendel Chiller plant and connect adjacent buildings into centralized system. Decentralize central heating plant for summer operation & create hybrid chiller plant at buildings with high efficiency electric and direct gas fired absorption chiller systems.	Mendel Hall, Bartley & CEER	Planned	2	3210.0	568.4	7807.6	-1237.2	30.0	5.6	18%	2015
3	Installation of 39kW photovolatic panels on roof for electric generation (Alteris estimate)	Connelly Center	Planned	3	192.0	4.2		62.3	25.0	46.0	2%	2020
4	Installation of 256kW (Law School Carport) and 268kW (SAC Carport) photovolatic panels on roof for electric generation (Alteris estimate)	Law School / SAC Carport	Planned	3	2574.0	56.1		836.5	25.0	45.8	2%	2020
5	Install heat recovery chiller (50 ton estimate) and recover heat to VAV reheats in summer	Bartley Hall	Planned	2	70.0	8.0	96.2		20.0	8.8	11%	2018
6	Install chiller plant optimization program & expand BAS chiller plant controls	Bartley Hall	Planned	2	75.0	13.5	162.1		15.0	5.6	18%	2018
7	Install heat recovery chiller (50 ton estimte) and recover heat to VAV reheat or domestic water during summer months.	St. Augustine Center	Planned	1	70.0	21.3	255.8		20.0	3.3	30%	2017
8	Provide a run around loop for energy recovery from exhaust streams back into AHUs to preheat outside air.	Mendel Hall	Planned	1	840.0	295.7	3559.0		20.0	2.8	35%	2013
9	Install heat recovery chiller (80 ton estimate) and recover heat to VAV reheats summer months.	Mendel Hall	Planned	1	112.5	30.9	371.8		20.0	3.6	27%	2013
10	Install chiller plant optimization program & expand BAS chiller plant controls	Mendel Hall	Planned	1	100.0	34.1	410.6		15.0	2.9	34%	2013
11	Install Tri-Gen system at Mendel (740 KW) - Phase I	Mendel Hall	Planned	1	1750.0	77.2	-2771.2	7389.9	20.0	22.7	4%	2013
12	Install Tri-Gen system at Mendel (500 KW) - Phase II	Mendel Hall	Planned	2	1350.0	51.4	-1845.6	4921.7	20.0	26.3	4%	2018
13	Install Tri-Gen system at St. Mary's Hall (740 KW)	St. Mary's	Planned	2	1750.0	77.2	-2771.2	7389.9	20.0	22.7	4%	2016
14	Install Combined Heat & Power (CHP) system (250 KW) at Boiler Plant to preheat boiler feed water.	Boiler Plant	Planned	3	1000.0	43.0	-833.6	2496.6	20.0	23.3	4%	2020
15	Provide run-around loop for lab exhaust to recover heat to VAV reheats, domestic hot water, or preheat for OA in air handling units.	CEER	Planned	1	500.0	93.3	1122.4		20.0	5.4	19%	2015
16	Add electric stack chiller (2x 50 tons) with heat recovery to domestic hot water tank.	St. Mary's	Planned	2	140.0	42.5	633.4		20.0	3.3	30%	2018

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	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR
17	Install chiller plant optimization program & expand BAS chiller plant controls	St. Mary's	Planned	2	75.0	12.0	178.4		15.0	6.3	16%	2018
18	Replace existing Weil McLain boilers with two 2,000 MBH condensing boilers.	Conference Center	Planned	2	62.2	11.3	135.4		25.0	5.5	18%	2018
19	Install heat recovery chiller system (70 ton estimate) to recover heat back into domestic hot water tank.	Conference Center	Planned	2	97.5	25.9	311.6		20.0	3.8	27%	2018
20	Program TOD schedules for hot water and chilled water systems serving Academic, Administrative and Athletic Facilities. (ie. Pavilion CHW system runs whenever OAT is > 45 F even if building is unoccupied).	Campus	Planned	1	50.0	25.0		372.5	15.0	2.0	50%	2012
21	OTHER PV INSTALLATIONS on South Campus or CEER, etc	Stanford Hall and CEER	Planned	3	TBD	TBD	TBD		TBD	TBD	TBD	
22	Install Biomass boiler at Boiler Plant to reduce long term heating costs and emissions from generation sources. Estimated at 25% of boiler plant heating profile (Phase I).	Boiler Plant	Planned	1	1500.0	250.0	6296.9		40.0	6.0	17%	2012
23	Convert central plant operations to Biomass Facility (primary fuel source) or build new central plant across Lancaster Avenue based on development of Parcel 1, 2 & 3 lots.	Boiler Plant	Planned	2	17500.0	2078.2	24570.0	14641.4	40.0	8.4	12%	2025
24	Perform feasibility study for Biomass System & Back Pressure Steam Turbine at Boiler Plant	Boiler Plant	Planned	1	25.0	N/A	N/A		N/A	N/A	N/A	2010
25	Engineering Service Agreements to evaluate installation of steam back pressure turbine & CHP/Trigen systems	Campus	Planned	1	50.0	N/A	N/A	N/A	N/A	N/A	N/A	2010
26	Re-activate thermal storage system at St. Augustine Center	St. Augustine Center	Planned	1	5.0	3.3		N/A	20.0	1.5	67%	2010
27	Replace 150 ton chiller w/ high efficiency	Bartley Hall	Planned	3	150.0	5.5		81.5	30.0	27.4	4%	2032
28	Raplace 300 ton air cooled w/ water cooled chiller	Pavilion	Planned	3	360.0	29.2		434.5	30.0	12.3	8%	2023
29	Replace (2) 150 ton screw chillers w/ high efficiency systems	Connelly Center	Planned	3	360.0	14.6		217.3	30.0	24.7	4%	2015
30	Replace 150 ton chiller w/ high efficiency	Kennedy Hall	Planned	2	180.0	14.6		217.3	30.0	12.3	8%	2011
31	Replace (2) 150 ton reciprocating chillers w/ high efficiency systems	Tolentine Hall	Planned	2	360.0	14.6		217.3	30.0	24.7	4%	2011
32	Replace (2) 125 ton reciprocating chillers w/ high efficiency systems	Stanford Hall	Planned	2	300.0	12.2		181.0	30.0	24.7	4%	2018
SUBTOTAL:					35808.2	4131.6	37375.7	41480.6		8.7	12%	

Villanova University
Climate Action Plan
Energy Capital Investment Plan

	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR

IV. DISTRIBUTION

1	Install steam pressure reducing valves and perform steam pressure reduction test	Boiler Plant	Planned	1	50.0	25.0	300.9		25.0	2.0	50%	2010
2	Re-commissioning of BAS sequences for chilled water pumps and air handling units (pump VFDs hunting and chillers on with OAT = 45 F)	Driscoll Hall	Planned	1	15.0	5.0		74.5	25.0	3.0	33%	2010
3	Convert RTU 1-3 from constant to variable volume with addition of VFD control.	Davis Center	Planned	1	21.6	5.4		81.0	20.0	4.0	25%	2015
4	Replacement of gym AHUs nearing end of life cycle - consider installation of AHUs with energy recovery wheels and CO2 sensors for demand control ventilation	Pavilion	Planned	1	175.0	N/A	N/A		25.0	N/A	N/A	
5	Re-evaluation/re-commissioning of CW loop - control sequencing and OA lockout for P-3.	Pavilion	Planned	1	10.0	3.6		54.0	20.0	2.8	36%	2011
6	Re-evaluate HW pumps - VFD at full speed at site visit on moderately hot day.	Bartley Hall	Planned	1	5.0	1.4		20.3	20.0	3.7	27%	2010
7	Convert CW and HW pumps to variable flow through addition of VFDs.	Dougherty Hall	Planned	1	53.9	8.7		130.2	20.0	6.2	16%	2016
8	Convert all chilled water pumps to variable flow through addition of VFDs.	Connelly Center	Planned	1	35.6	6.2		91.8	20.0	5.8	17%	2016
9	Recommendation for installation of VFDs on remaining air handling units that are still constant volume (5 total).	Connelly Center	Planned	1	35.9	14.9		221.7	20.0	2.4	41%	2013
10	Convert dual temperature pumps from constant to variable volume with addition of VFDs.	Kennedy Hall	Planned	1	13.0	3.6		53.6	20.0	3.6	28%	2016
11	Add VFD control to ClimateChanger make-up air unit supply fan.	St. Augustine Center	Planned	1	9.0	2.6		39.4	20.0	3.4	29%	2015
12	Convert supply fans for 'New Falvey' air handling units from constant volume to variable volume with installation of VFDs	Falvey Library	Planned	2	24.0	2.8		41.7	20.0	8.6	12%	2020
13	Convert CW pumps for 'New Falvey' from constant to variable flow with installation of VFDs	Falvey Library	Planned	2	13.0	1.8		27.5	20.0	7.0	14%	2020
14	Install pressure sensors and VFDs on condensor water pumps for cooling tower.	Mendel Hall	Planned	1	35.0	11.1		165.2	20.0	3.2	32%	2015
15	Replace variable inlet vanes with VFDs on exhaust fans (reduce fan speed 10-20% before opening bypass dampers)	Mendel Hall	Planned	1	57.2	15.9		236.5	20.0	3.6	28%	2015
16	Install VFDs on HW pumps - run year round for heat and reheats in summer.	Mendel Hall	Planned	1	49.7	14.4		214.5	20.0	3.5	29%	2015
17	Recommend installation of VFD control for CW pumps.	White Hall	Planned	1	15.8	3.7		55.1	20.0	4.3	23%	2015
18	Recommendation for installation of VFD control on chilled water pumps.	St. Thomas Church	Planned	2	10.6	1.8		27.5	20.0	5.7	18%	2020

	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR
19	Install two-way valves and VFD control for dual temperature pumps in West Campus mechanical rooms	West Campus Apartments	Planned	2	118.0	18.5		275.4	20.0	6.4	16%	2020
20	Complete insulation repairs in mechanical room piping and insulation wraps on PRVs for all West Campus (1994) dormitories.	West Campus Apartments	Planned	2	20.0	1.6	19.3		10.0	12.5	8%	2020
21	Install CW bridge tender to control CW return to St. Mary's cooling plant.	West Campus Apartments/St. Mary's Plant	Planned	2	40.0	5.2		77.8	15.0	7.7	13%	2020
22	Install VFD's on AHU supply fans to be controled by supply duct pressure.	CEER	Planned	1	19.0	5.1		75.7	20.0	3.7	27%	2015
23	Install VFD's on CW/HW pumps to provide variable flow to secondary loop.	CEER	Planned	1	28.4	6.1		90.4	20.0	4.7	21%	2015
24	Increase size of condenser water piping to eliminate need of running (2) chiller systems during cooling season.	Conference Center	Planned	2	10.0	1.8		27.2	20.0	5.5	18%	2020
SUBTOTAL:					864.7	166.3	320.1	2081.1		5.2	19%	

Villanova University
Climate Action Plan
Energy Capital Investment Plan

	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR

V. END USE

1	Lighting Retrofit - throughout campus replace 32W-T8 bulbs with energy efficient 28W-T8 bulbs.	Campus	Planned	1	100.0	12.96		193.1	15.0	7.7	13%	2013
2	Change all exit signs to LED.	Campus	Planned	2	90.0	8.8		130.8	15.0	10.3	10%	2020
3	Re-commissioning of dimming control for lighting in stairwell/atrium area.	Driscoll Hall	Planned	2	1.0	0.11		1.6	10.0	9.4	11%	2020
4	Tie occupancy sensor in classroom and office spaces into control system - program VAV damper to close when space is unoccupied to save SF energy.	Driscoll Hall	Planned	2	40.0	7.1		106.4	15.0	5.6	18%	2020
5	Install occupancy sensors for lighting control in auditorium area.	Driscoll Hall	Planned	2	1.3	0.3		4.6	10.0	4.1	24%	2020
6	Reduce minimums below 50% for VAV setpoints and increase overall outside air percentage being brought in by RTUs.	Driscoll Hall	Planned	1	10.0	3.3		48.6	15.0	3.1	33%	2014
7	Install occupancy sensors for lighting control in all offices, group exercise, locker rooms, and restrooms.	Davis Center	Planned	1	1.3	0.6		8.6	15.0	2.2	46%	2019
8	Install T5HO 4-lamp Dimmable High Bay Fluorescent fixture in women's practice gym and T8 6-lamp Dimmable High Bay Fluorescent fixture in men's practice gym - both with occupancy sensor control (Lutron).	Davis Center	Planned	1	38.0	13.0		193.5	20.0	2.9	34%	2019
9	Install CO2 sensors and demand control ventilation for RTUs serving gyms and fitness areas	Davis Center	Planned	1	7.5	3.0	36.1		15.0	2.5	40%	2011
10	Replace metal halide lighting in Nevin Field House with T5HO 4-lamp Dimmable High Bay Fluorescent fixtures with daylight harvesting and occupancy sensors.	Field House	Planned	2	19.9	3.2		47.5	20.0	6.2	16%	2019
11	Replace metal halide lighting in Field House Pool with T8 6-lamp Dimmable High Bay Fluorescent fixture and occupancy sensors.	Field House	Planned	2	17.3	2.8		41.1	20.0	6.3	16%	2019
12	Replace metal halide lighting in Butler Annex with T8 6-lamp Dimmable High Bay Fluorescent fixture (Lutron) with occupancy sensors.	Butler Annex	Planned	2	13.9	2.2		32.5	20.0	6.4	16%	2019
13	Potential for automatic pool cover to reduce heating loss and evaporation of pool water.	Field House	Planned	2	40.0	10.0	120.4		10.0	4.0	25%	2019
14	Remove incandescent downlighting in classrooms -replace with CFL-PL or LED. Implement switching control of downlighting.	Bartley Hall	Planned	2	5.0	1.0		14.9	10.0	5.0	20%	2019
15	Recommendation for installation of occupancy sensors in old classrooms.	Bartley Hall	Planned	2	27.8	4.5		66.8	10.0	6.2	16%	2019
16	Staged lighting in atrium area at nighttime with occupancy sensors or schedule.	Bartley Hall	Planned	2	2.0	0.5		7.5	10.0	4.0	25%	2019

Villanova University
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17	Pipe steam from flash tank to low pressure side of PRV for use in wintertime.	Bartley Hall	Planned	2	5.0	0.5	6.0		10.0	10.0	10%	2020
18	Daylight harvesting opportunity in University Shop - addition of photocells with dimming control for exterior lighting fixtures	Kennedy Hall	Planned	3	7.5	0.4		5.7	10.0	19.6	5%	2025
19	Replace electric VAVs (approximately ten units) with heating water VAVs.	St. Augustine Center	Planned	2	30.0	5.7	-47.2	143.9	15.0	5.2	19%	2020
20	Install occupancy sensor control for 2nd floor stack area with stage lighting and timeclock integration.	Falvey Library	Planned	1	13.3	3.5		52.0	10.0	3.8	26%	2015
21	Tie control of 'Old Falvey' AHU into control system.	Falvey Library	Planned	2	25.0	5.0		74.5	20.0	5.0	20%	2018
22	Installation of CO2 sensors and demand control ventilation for library AHUs serving large stack areas.	Falvey Library	Planned	1	40.0	40.0	481.4		20.0	1.0	100%	2011
23	Re-balancing/re-commissioning of building - lab exhausts causing huge negative pressure in lab space.	Mendel Hall	Planned	1	100.0	25.0	300.9		20.0	4.0	25%	2014
24	Install VFDs to cooling tower fans.	Mendel Hall	Planned	1	45.8	8.9		132.6	20.0	5.1	19%	2019
25	In place of running two small Carrier chillers in winter, install plate and frame heat exchanger and use cooling tower to cool down chilled water system (est 100-150 ton load)	Mendel Hall	Planned	1	300.0	35.4		528.0	20.0	8.5	12%	2013
26	Install zone prescense sensors/occupancy sensors for Mendel labs to reduce air exchange to 4 ACH during unoccupied times.	Mendel Hall	Planned	1	400.0	90.0	714.9	442.6	15.0	4.4	23%	2013
27	Recommend supply air temperature reset control for McQuay AHU based on outside air enthalpy.	White Hall	Planned	1	5.0	5.0	60.2		15.0	1.0	100%	2013
28	Installation of CO2 sensors and demand control ventilation to reduce OA intake when church is not at full capacity and add system to BAS.	St. Thomas Church	Planned	1	50.0	10.0	120.4		15.0	5.0	20%	2014
29	Daylight harvesting opportunity in main dining area.	Donohue Hall	Planned	2	15.0	1.8		26.6	15.0	8.4	12%	2025
30	Install DDC thermostats in all apartments with automated controls for holiday curtailment.	West Campus Apartments	Planned	2	100.0	19.3	231.7		15.0	5.2	19%	2020
31	Re-commissioning of CEER Building (VAVs and exhaust)	CEER	Planned	2	50.0	10.0	120.4		10.0	5.0	20%	2020
32	Integration of automated controls system for conference center - allow for scheduling and holiday curtailment.	Conference Center	Planned	1	TBD	TBD	TBD		TBD	TBD	TBD	
33	Evaluate operation / programming for AC-5 (Dining Room). AHU running at 59.2 HZ during low load day.	Conference Center	Planned	1	5.0	1.2		18.0	15.0	4.1	24%	2012
34	Change electric reheats to hot water reheat system.	White Hall	Planned	2	75.0	14.3	-118.1	359.8	15.0	5.2	19%	2020
35	Install card access control system for hotel rooms and conference rooms that disable power and put HVAC system to standby mode when key is not activated.	Conference Center	Planned	2	TBD	TBD	TBD		TBD	TBD	TBD	

Villanova University
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36	Improve equipment scheduling across campus. Many buildings are not currently scheduled or have extended hours of operation. Test occupancy schedules to ensure systems are controlling properly during shutdown sequence.	Campus	Planned	1	100.0	612.0	1516.1	7241.7	10.0	0.2	612%	2010
37	Building Automation System Upgrades to improve system control and energy use	Campus	Planned	1	500.0	100.0		1490.1	15.0	5.0	20%	2012
38	Building Automation System Upgrades to improve system control and energy use	Campus	Planned	2	500.0	87.5		1303.8	15.0	5.7	18%	2015
39	Building Automation System Upgrades to improve system control and energy use	Campus	Planned	3	500.0	75.0		1117.6	15.0	6.7	15%	2018
40	Installation of CO2 sensors and demand control ventilation for AHUs.	Connelly Center	Planned	1	35.0	23.0	276.8		15.0	1.5	66%	2011
41	Program supply air reset control for (3) AHUs to reduce reheat load and overcooling of spaces during partial occupancy. Use return air RH setpoint as safety to prevent humidity level from raising above 60% RH.	Driscoll Hall	Planned	1	10.0	5.0	60.2		15.0	2.0	50%	2012
42	Program supply air static pressure reset control for VAV RTUs to reduce static pressure setpoints during low load conditions to save energy.	Driscoll Hall	Planned	1	10.0	3.5		52.2	16.0	2.9	35%	2012
43	Install VFDs on cooling tower fans	Bartley Hall	Planned	2	22.9	4.4		66.3	20.0	5.1	19%	2019
44	Review BAS control sequences and setpoints for systems to improve energy efficiency & operation. AHU-2 & AHU-4 outdoor air enthalpy economizer lockouts are set at 896 Btu and 2992 Btu respectively. These units are operating with 100% OA at all times.	Bartley Hall	Planned	1	15.0	25.0		372.5	16.0	0.6	167%	2010
45	Retrofit city water cooled condenser to air cooled to save water	Stanford	Planned	1	10.0	3.5	N/A	N/A	15.0	2.9	35%	2011
SUBTOTAL:					3384.2	1288.2	3880.1	14325.2		2.6	38%	

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Energy Capital Investment Plan

	ENERGY SUB-SYSTEM	BUILDING	STATUS	PRIORITY	ESTIMATED COST ($000)	ANNUAL SAVINGS ($000)	FOSSIL FUEL Emissions Impact (1000 X LBS CO_2)	ELECTRICAL Emissions Impact (1000 X LBS CO_2)	PROBABLE LIFE CYCLE	PAYBACK PERIOD	ROI %	IMPLEM YR
VI. COMMUNITY INVOLVEMENT												
1	Develop Holiday Curtailment Program - get aggressive during periods of low occupancy on campus (Christmas, Thanksgiving, Spring Break, etc)	Campus	Planned	1	50.0	203.9	2453.9		20.0	0.2	408%	2011
2	Provide training for BAS for HVAC Staff	Campus	Planned	1	5.0	N/A	N/A		N/A	N/A	N/A	
3	Develop heating and cooling temperature policy for the campus (ie. 68-70 F heating setpoint, 74-76 F cooling setpoint)	Campus	Planned	1	20.0	81.2	TBD		N/A	N/A	N/A	2011
4	Develop energy competitions between dormitories and/or students	Campus	Planned	1	N/A	N/A	N/A		N/A	N/A	N/A	
5	Implement energy projects in conjunction with support from Villanova Commitment to Sustainability Committee	Campus	Planned	1	N/A	N/A	N/A		N/A	N/A	N/A	
SUBTOTAL:					75.0	285.1	2453.9	0.0		0.3	380%	

ENERGY CAPITAL INVESTMENT PLAN TOTAL:					41212.1	6423.4	44029.9	57886.9	20.0	6.4	16%	

Appendix C Campus Master Plan

VILLANOVA UNIVERSITY
CAMPUS MASTER PLAN
Executive Summary

Venturi, Scott Brown and Associates, Inc.

October 21, 2008

I. INTRODUCTION AND EXECUTIVE SUMMARY

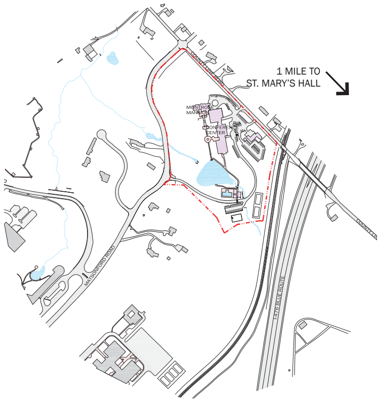
"From the day I was selected to serve in this role, people have been asking me to share my vision for the university. It is not complicated. I want Villanova to be Villanova. I don't want us to be anyone else. We know what we do well and we must strive to do it better…"

-- from Father Peter Donohue's Inauguration Speech

"I have initiated the development of a campus master plan to evaluate many aspects of our campus and assess current and future needs for space. The campus master plan will be a roadmap for future construction, renewal, and maintenance."

-- from Father Peter Donohue's message to the University, April 2007

VSBA has been invited to be the planners for this roadmap. Our mandate is to develop a plan rooted in a deep understanding of the institution's history and mission, its opportunities and constraints, and goals and objectives for its future -- one that can help Villanova become more *positively* and *cohesively* what it is. Here we present an overall planning framework – one that can result in a coherent set of landscapes and buildings, provide opportunities for future growth, and retain the capacity for individual places of great beauty.



CONFERENCE CENTER

0 400' 1000'

KEY

APPROXIMATE VU BOUNDARY LINES

VU FACILITIES

PEDESTRIAN PATHWAYS

ROADWAYS & PARKING LOTS

NON-VU FACILITIES

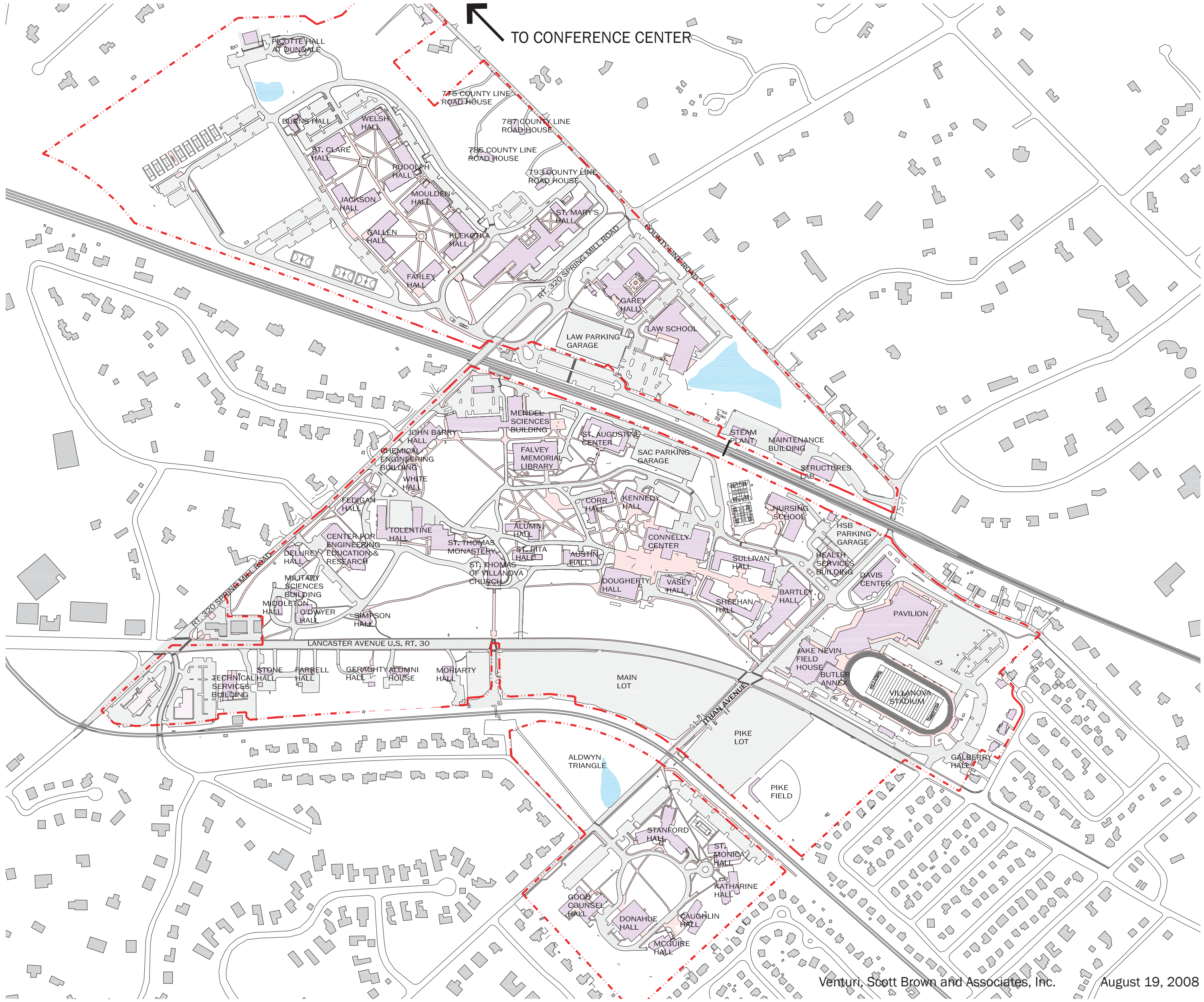
VU FACILITIES LEASED BY OTHERS

KEY PLAN

Villanova University Campus Planning

Base Map Source:
Information Source: Property Lines
July 2008 AEC Property Map

0 200' 500' 1000'



A. PURPOSE OF THE PLAN

Now, as the University is in the process of completing major construction projects – including a building for the School of Law and the recently-opened Davis Center for Athletics and Fitness and the College of Nursing's Driscoll Hall– Villanova has chosen to survey a broader picture, to gauge the impact these projects may have on each other and on the campus as a whole and to plan purposefully and strategically for future phases of development. The plan should allow all aspects of the physical campus to work together in support of the University's mission; the campus, like the University, should be more than the sum of its parts. Its recommendations should:

- Nurture a ***beautiful, amenable and sustainable campus*** that supports the ***Augustinian ideal of living and studying amongst friends*** in an atmosphere of hospitality and scholarship.

- Provide facilities, landscapes and physical linkages that support Villanova as a ***residential, co-educational and multi-cultural institution with a world-wide perspective***.

- Plan for academic and cultural facilities – including a performing arts center – that ***support student engagement*** in curricular and co-curricular activities.

- Increase physical opportunities for ***interdisciplinary activities and scholarship***, especially inter-college.

- Plan for ***student residential facilities*** that support ***Villanovan ideals of community***, while meeting the University's commitment to housing underclassmen and its desire to house seniors.

- ***Consider the needs of all members of the University community*** – undergraduate, post-baccalaureate and continuing education students; faculty and staff; Augustinians; the Township and neighbors; visitors and others.

- Plan facilities and landscapes that help ***attract and retain students, faculty and staff*** of the highest caliber.

- Make the campus more ***pedestrian-friendly, accessible to people of all ages and abilities, and welcoming to visitors***. For example, make entrance to the campus more welcoming, easier to find, and more distinctly Villanovan.

- Meet University needs for ***access, parking and service***.

- Identify opportunities to ***move the campus toward the University's commitment to carbon neutrality***.

- Carefully consider and create functional adjacencies that facilitate ***efficiency, collaboration and a greater sense of community***.

- Provide ***guidelines and strategies*** for meeting the physical requirements of the ***University's evolving Strategic Plan.***

- ***Honor the University's heritage while supporting the needs of the present-day Villanova and its aspirations for the future***.

Because the physical campus is a vital operating engine of the University and part of its identity, heritage and meaning, campus planning should be considered in conjunction with the highest level of University academic, operational and financial planning. This final recommendations report should become a valuable tool for shaping future decisions on programming and policy, as well as on rehabilitating existing buildings and adding logical increments of new building at Villanova University.

As the University moves forward and as Radnor Township becomes more fully engaged in the discussion, this plan for the campus can provide a basis for the continuing debate on physical directions for Villanova University.

B. PLANNING APPROACH AND PROCESS

We have approached the campus planning process as a series of interrelated tasks whose goal is to propose strategies and a vision for the long term future and to obtain consensus among the University's constituent groups. Our process has been an iterative one, surveying the campus at varying scales and levels of detail.

Over the course of the plan, we have worked with University committees of faculty, staff and students to evolve the recommendations presented in this document. We have reviewed our interim findings on a regular basis with the President's Advisory Council; with the Pedestrian Encounter, Academic Mission, Student Experience and Administrative Services committees; and with the Teaching and Research Space subcommittee. Meetings with an appointed committee of Board of Trustee members were conducted quarterly, along with an interim update to the full Board. We also consulted with ad hoc groups throughout the campus; and conducted initial conversations with Radnor Township officials.

C. SOME KEY NEEDS

There are needs for more – and more functional, amenable and accessible – space throughout Villanova's campus. Those defined by the University as high priorities include:

- ***Academic space***, including a new Performing Arts Center, classrooms and faculty offices -- particularly in Arts and Sciences -- and an updated library.
- ***Student residences.*** These are needed to meet the University's commitment to underclassmen, and potentially offer seniors the opportunity to live on campus.
- ***Student social space***, including activity space, central campus dining, and recreational athletics.
- ***Administrative space***, particularly related to Campus Ministry and student services.
- ***System-wide needs***, including the need to improve accessibility (throughout campus, and especially to buildings used by the public), life safety, building condition and campus infrastructure.

Also, there is a strong desire for a more ***beautiful, sustainable campus,*** with a ***more beautiful and visible entrance***.

D. RECOMMENDED STRATEGIES

- Meet the University's needs for space while preserving its iconic green spaces, including the Lawn.

- Create combinations of uses, within precincts and within buildings, that support Villanova as an integrated community.

- Preserve a vibrant mix of uses at the campus core, and consider more mixed use for campus satellites.

- Mediate between the need to add new facilities and the need to maintain and support those the University already has.

- Pursue development through a combination of strategies including new building and renovation within the campus core; further development of campus satellites; and, possibly, development along the routes between satellites and the core.

- To meet the University's need for space, develop its properties on the south side of Lancaster Avenue -- including its large expanse of surface parking -- as an integral, positive component of Villanova's identity and image. A vibrant townscape here would complement the University's wide lawn on the north side of the Avenue. (See Section III.F for zoning considerations.)

- Preserve and rejuvenate the University's historic buildings and spaces, including Alumni, Corr, St. Rita and Austin.

- Reclaim, rejuvenate and, where practical, return to communal use historic interior spaces such as St. Rita Chapel, the Old Falvey Reference Room, and the University's first library in Austin Hall.

- Create a more pedestrian-friendly campus core, while meeting campus needs for maintenance, service, universal access for people with disabilities and emergency vehicles.

- Minimize land that must be allocated to parking by building structured parking and densifying existing parking structures. Locate parking near tracks wherever possible, and build structured parking as high as allowed – without creating public or campus eyesores.

- Help meet the objectives of the broader community by improving traffic conditions, providing more holistic stormwater management measures, and reducing the number of students living in off-campus neighborhoods.

- Take advantage of opportunities presented by the availability of St. Mary Hall and Garey Hall to benefit the entire campus.

- Improve accessibility and life safety throughout campus. The importance of this cannot be overstated.

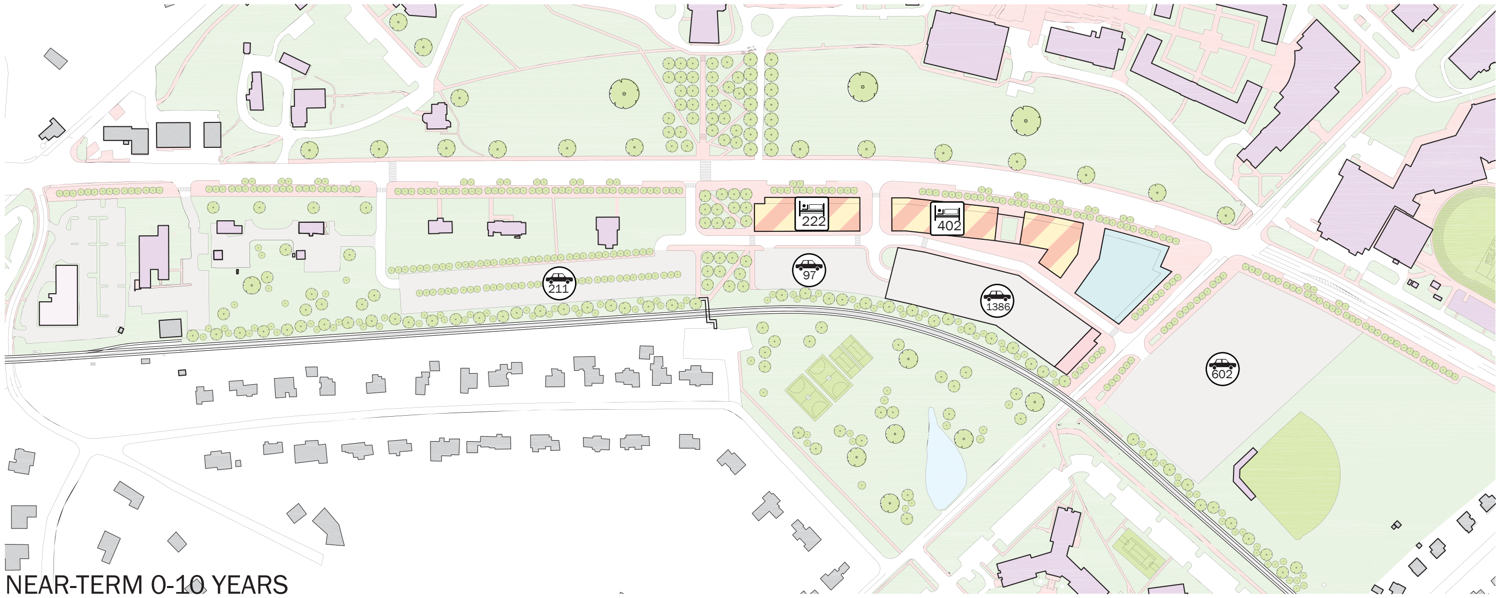
- Maintain some building sites near the center of campus for future development.

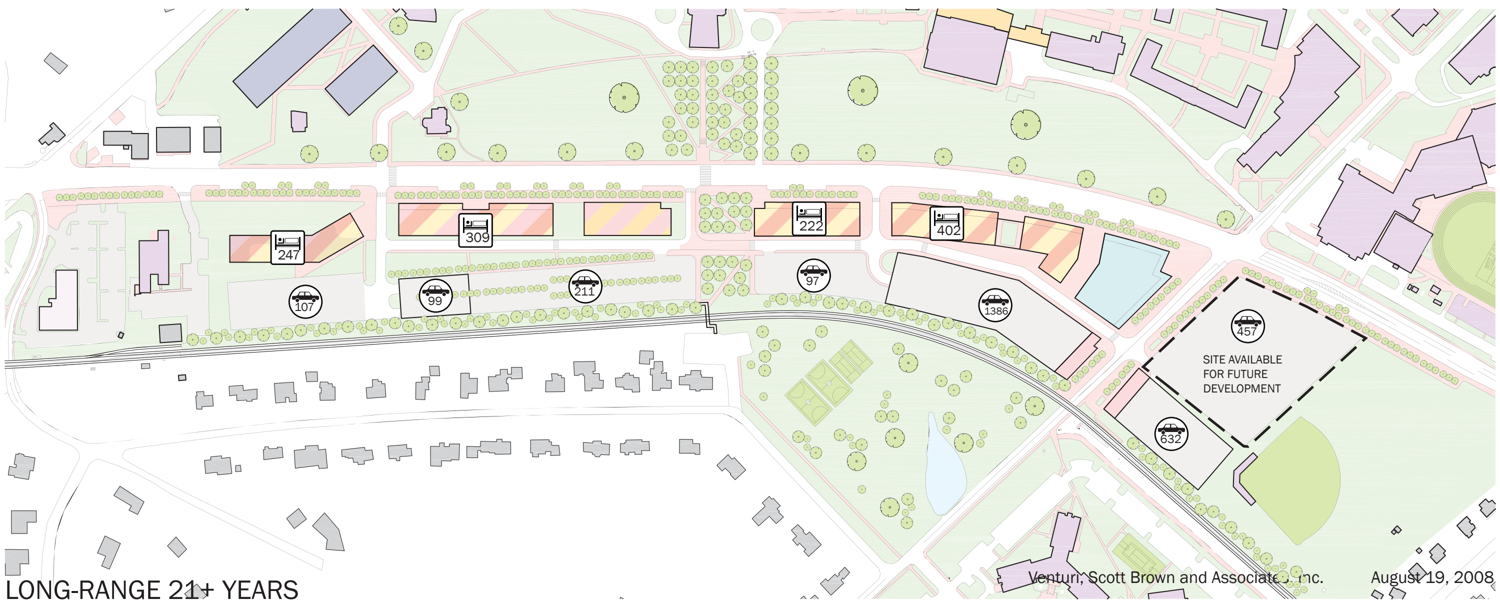
E. KEY COMPONENTS OF THE PLAN

• ***The "hamlet of Villanova."*** The University's ability to meet its needs for space depends in large part on its ability to develop its properties along the south side of Lancaster Avenue; this would require significant amendments and exceptions to current zoning. Ideally, a pedestrian-friendly townscape would be created along the south side of Lancaster Avenue, with retail or University "public" uses at the ground floor and student residences – and perhaps some offices -- above. Structured (and some surface) parking would be provided along the Route 100 tracks; improved grade-level pedestrian crossings would connect to South Campus and the campus core. Functions that engage the broader community – such as a performing arts building, University Shop, and perhaps Alumni and Admissions – would be located along the Avenue, providing a welcoming face to the community. Public Safety could be located here as well, perhaps within or adjacent to a parking structure.


cafe
S. STIMSON 5.08

Hamlet of Villanova: Mixed-Use Development





KEY

- 257 PARKING STALLS
- 96 UNDERGRADUATE STUDENT BEDS
- RESIDENTIAL USE
- ADMINISTRATIVE SERVICE USE
- STUDENT SERVICE USE
- STUDENT LIFE USE
- ACADEMIC USE
- PARKING USE
- EXISTING VU FACILITIES
- VU FACILITIES LEASED BY OTHERS
- NON-VU FACILITIES
- PEDESTRIAN PATHWAY
- CAMPUS GREEN
- OUTDOOR ATHLETIC SPACE

POTENTIAL DEVELOPMENT
SOUTH OF LANCASTER AVENUE

Villanova University Campus Planning

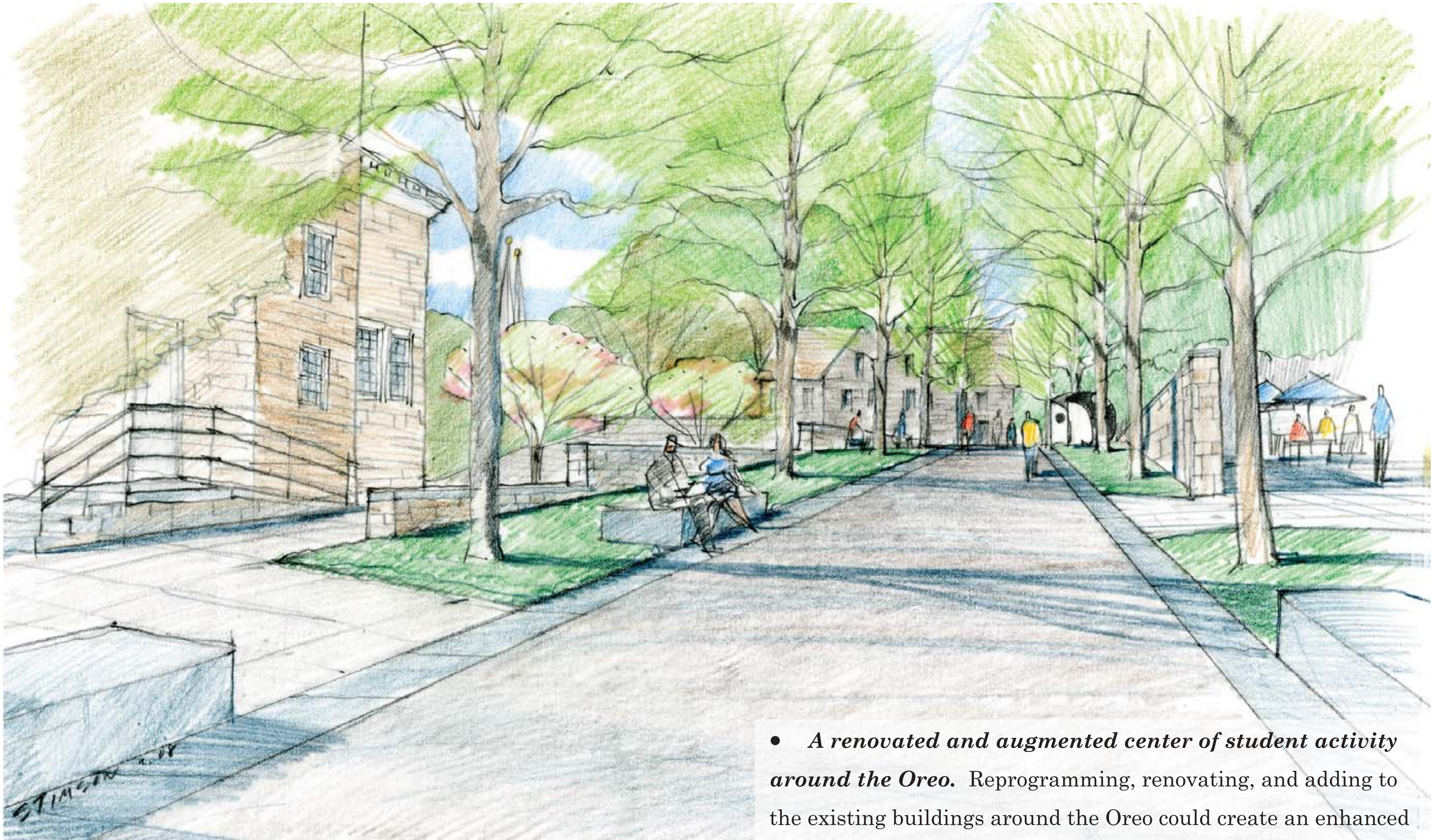
Base Map Source:
Information Source:

0 100' 200' 300' 600'


VILLANOVA THEATRE

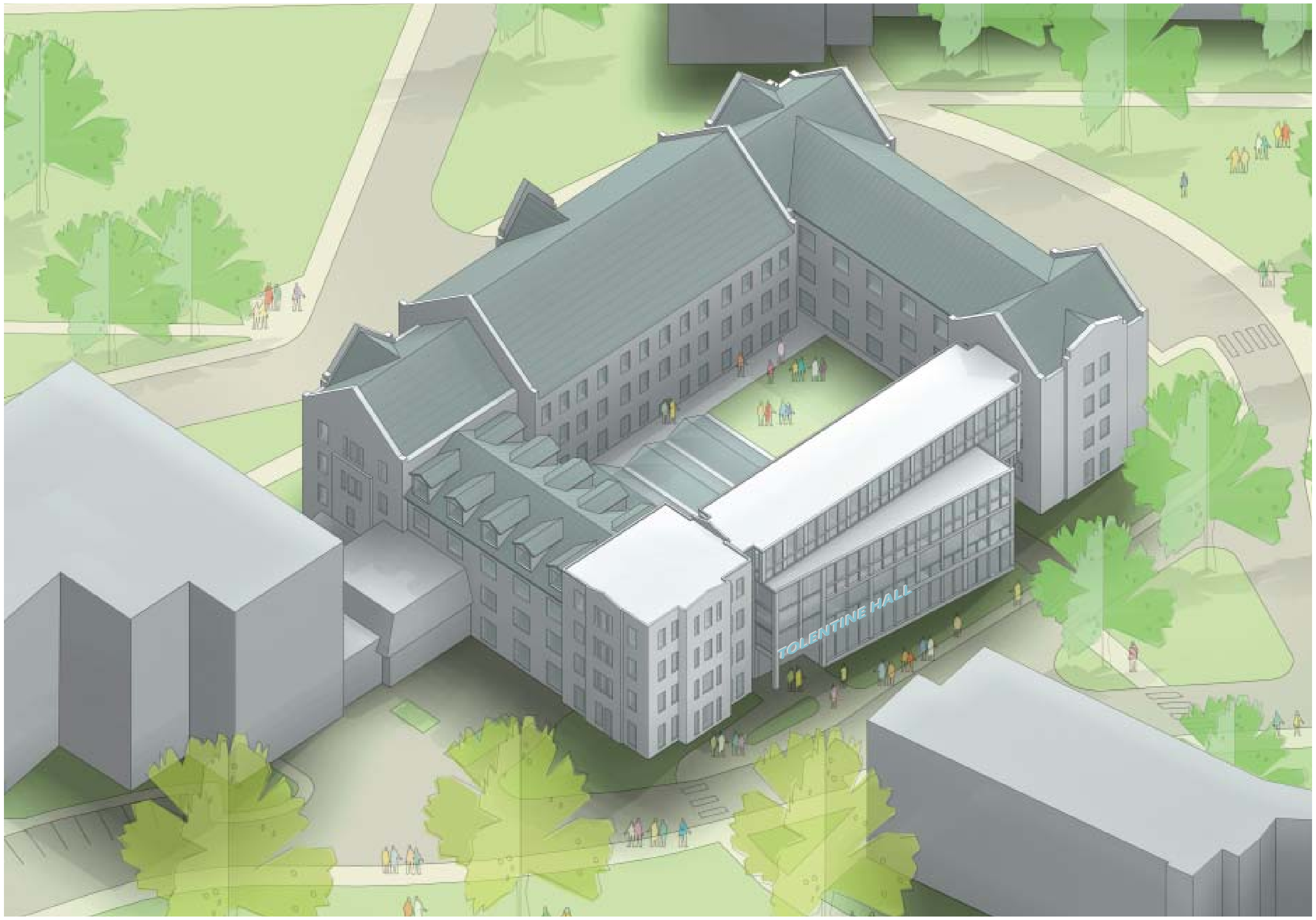
Core Campus Improvements: Mendel Field

- ***A pedestrian-centered campus core.*** Keeping most vehicles near the perimeter of the campus core would help create a more sustainable, pedestrian-friendly campus, while allowing access for service, emergency and other essential vehicles. Existing University parking structures along the R-5 tracks would be replaced or enlarged to replenish spaces lost at the campus core. Eliminating constant conflicts between pedestrians and vehicles would allow a more cohesive, beautiful and functional campus landscape.



- ***A renovated and augmented center of student activity around the Oreo.*** Reprogramming, renovating, and adding to the existing buildings around the Oreo could create an enhanced center for student life. Student-oriented uses could initially include space in the Connelly Center and Dougherty Hall (or its replacement), and could be augmented by space in Vasey and by the historic library in Austin, once other space is available for existing uses in these areas. A sloped, tree-lined path would replace the existing concrete steps and ramps between these buildings, creating a more amenable and beautiful sense of place.

- ***A re-imagined and renewed heart of campus.*** The area around the Grotto – including Falvey, Old Falvey, Alumni, Austin and Corr, with paths extending to Mendel and the St. Augustine Center – could become a center of activity with a stronger *sense of place*, with large shade trees and green lawn, and a more lively mix of uses. Maintaining student residences in this area – in tandem with other uses – would ensure 24-hour activity at the center of campus.



- ***Renewed key academic buildings, including Tolentine and the Library.*** Renovating and rejuvenating the campus' historic buildings could help meet new mandates for use while celebrating Villanova's history.

-- *Tolentine* could be completely renovated and renewed. With wide, generous hallways and high ceilings, this building could be Villanova's premier academic building. Through strategic additions to the building, significant space could be added. New entrances would face a renewed Mendel Field – an enlarged, oval lawn.

-- The *Falvey Memorial Library* and Old Falvey complex, could be re-imagined to create a community commons – an innovative, collaborative, multidisciplinary academic library facility tied into the social and academic life of the University.

- ***Campus-wide improvements*** to improve accessibility, life safety, building condition and campus infrastructure.

Draft Recommendations: Near-Term 0-10 Years

KEY

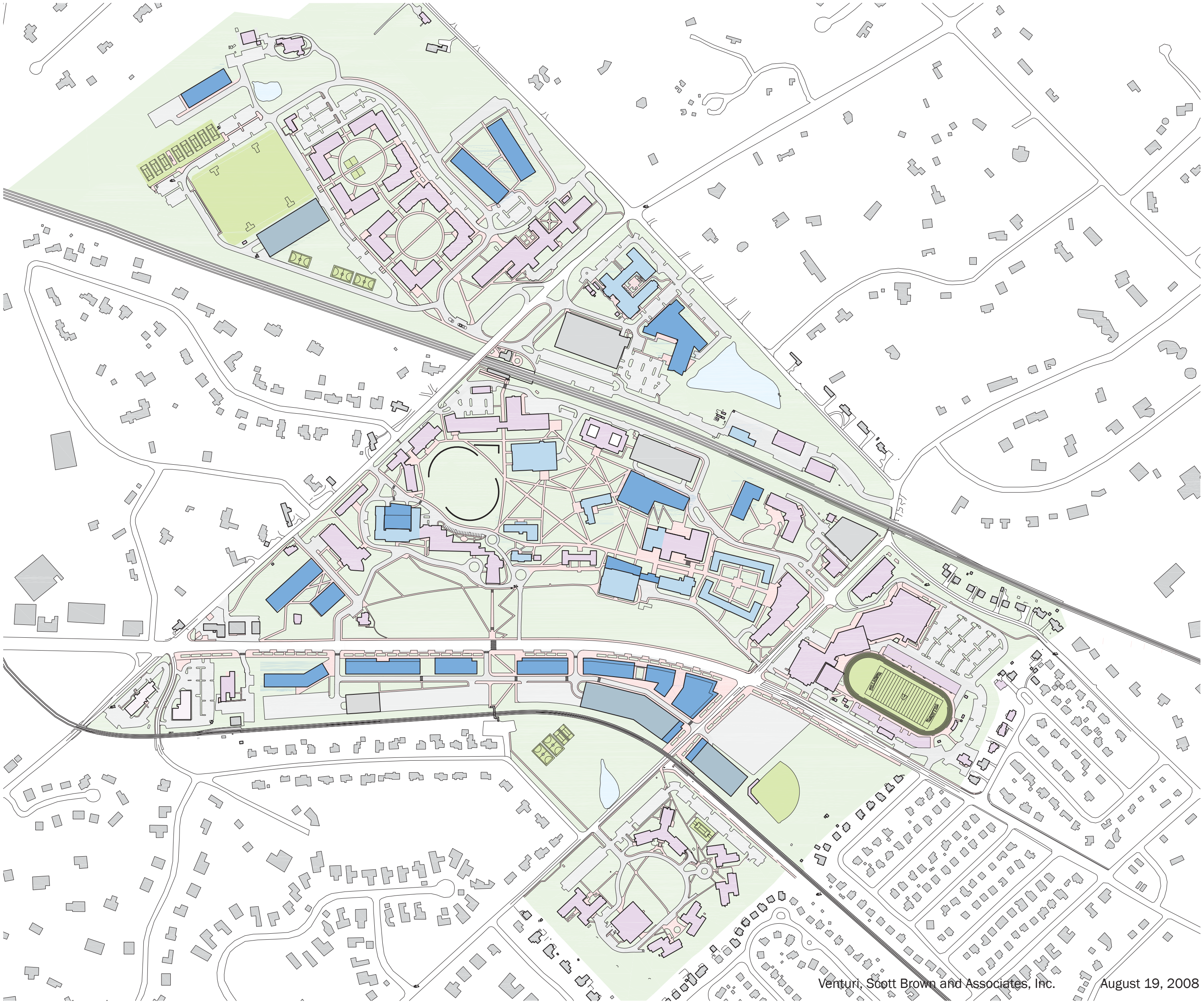
- VU FACILITIES + SUPPORT
- VU ATHLETIC FIELD
- VU CAMPUS GREEN
- VU PEDESTRIAN PATHWAY
- VU ROADWAYS & PARKING LOTS
- VU PARKING STRUCTURE
- NON-VU FACILITIES
- VU-FACILITES LEASED BY OTHERS

NEAR-TERM
0 - 10 YEARS
ONE POSSIBLE SCENARIO

Villanova University Campus Planning

Base Map Source:
Information Source:

0 200' 500' 1000'



KEY

- VU FACILITIES + SUPPORT
- VU ATHLETIC FIELD
- VU CAMPUS GREEN
- VU PEDESTRIAN PATHWAY
- VU ROADWAYS & PARKING LOTS
- VU PARKING STRUCTURE
- NON-VU FACILITIES
- VU-FACILITES LEASED BY OTHERS

LONG-RANGE
21+ YEARS
ONE POSSIBLE SCENARIO

Villanova University Campus Planning

Base Map Source:
Information Source:

0 200' 500' 1000'

Concept Perspective looking West

F. NEXT STEPS

The plan has engaged the campus community in a self-assessment of the University's priorities and vision for its physical campus. The recommendations in this report are rooted in this perspective, but also in a shared understanding that input from the broader community is needed as well. Our October presentation to the Trustees marks the end of our study. In many ways, however, the University's work is just beginning. Villanova's ability to develop its campus responsibly and well depends on building trust and support in the Radnor Township community.

The plan outlined in this document will help meet the University's needs for physical space, preserve its most memorable buildings and landscapes, and enhance the beauty and utility of the campus. The plan weaves the University's past, present and future into a more integrated system of landscape and buildings – one that is explicitly and joyfully *Villanovan*.

Appendix D Renewable Energy Analysis

Villanova University Photovoltaic Opportunity Assessment

Location	Total Building Area (SF)	Est. No. of Floors	Est. Roof Area (SF)	Solar Roof Area (%)	Solar Roof Coverage (SF)	Est. System Size (kW DC)	Est. System Cost ($'s 2009)	Est. Annual Production** (kWh/yr)
Existing Condition								
Connelly Hall*	-	-	-	-	-	39	$280,529	37,985
Law School Carport*	-	-	-	-	-	256	$1,844,196	249,337
SAC Carport*	-	-	-	-	-	268	$1,925,318	261,024
Dougherty Hall	N/A	N/A	N/A	N/A	6,200	83	$537,333	51,149
Garey Hall	N/A	N/A	N/A	N/A	5,000	67	$433,333	41,169
Structural Eng. Lab	N/A	N/A	N/A	N/A	3,200	43	$298,667	26,198
Maintenance Bldg.	N/A	N/A	N/A	N/A	2,700	36	$252,000	22,456
Katherine Hall	N/A	N/A	N/A	N/A	4,000	53	$373,333	33,684
Caughlin Hall	N/A	N/A	N/A	N/A	4,000	53	$373,333	33,684
McGuire Hall	N/A	N/A	N/A	N/A	4,000	53	$373,333	33,684
Falvey Library	N/A	N/A	N/A	N/A	8,500	113	$708,333	*140,972*
						1,064	*$7,399,710*	*931,343*
Near-Term 2010-2014 Campus Growth Condition								
Structured Parking P-2	274,850	5	54,970	100%	54,970	366	$2,748,500	456,599
Performing Arts P-3	76,250	2	38,125	30%	11,438	153	$953,125	190,873

* System size, cost, and estimated annual production based upon schematic design by Alteris Renewables

** Production estimates based upon PVWATTS v.2

Villanova University Photovoltaic Opportunity Assessment

Location	Total Building Area (SF)	Est. No. of Floors	Est. Roof Area (SF)	Solar Roof Area (%)	Solar Roof Coverage (SF)	Est. System Size (kW DC)	Est. System Cost ($'s 2009)	Est. Annual Production** (kWh/yr)
Near-Term 2010-2014 Campus Growth Condition (continued)								
Tolentine Hall P-5	46,300	4	11,575	75%	8,681	116	$752,375	144,714
Surface Parking P-7	65,900	1	65,900	25%	16,475	110	$823,750	274,548
Mixed Use P-9	147,400	3	49,133	50%	24,567	328	$1,965,333	409,192
Mixed Use P-10	105,900	3	35,300	40%	14,120	188	$1,176,667	234,537
						1,260	$8,419,750	1,710,463
Mid-Term 2015-2024 Campus Growth Condition								
Kennedy Hall P-20	166,000	3	55,333	80%	44,267	590	$3,246,222	736,047
New Res. Hall P-22	221,100	4	55,275	50%	27,638	369	$2,211,000	460,341
New Res. Hall P-23	221,100	4	55,275	50%	27,638	369	$2,211,000	460,341
						1,327	$7,668,222	1,656,729
Long-Term 2025-2030 Campus Growth Condition								
Academic Bldg. P-26	96,000	4	24,000	80%	19,200	256	$1,600,000	319,370
Athletic Develop. P-27	233,280	2	116,640	80%	93,312	1,244	$6,531,840	1,551,937
SOL Develop. P-28	911,700	3	303,900	50%	151,950	2,026	$10,130,000	2,527,512
W. Campus Develop. P-29	165,850	2	82,925	80%	66,340	885	$4,643,800	1,104,071

* System size, cost, and estimated annual production based upon schematic design by Alteris Renewables

** Production estimates based upon PVWATTS v.2

Villanova University Photovoltaic Opportunity Assessment

Location	Total Building Area (SF)	Est. No. of Floors	Est. Roof Area (SF)	Solar Roof Area (%)	Solar Roof Coverage (SF)	Est. System Size (kW DC)	Est. System Cost ($'s 2009)	Est. Annual Production** (kWh/yr)
Long-Term 2025-2030 Campus Growth Condition (continued)								
Academic Develop. P-30	168,600	2	84,300	80%	67,440	899	$4,720,800	1,121,537
						5,310	$27,626,440	6,624,427

* System size, cost, and estimated annual production based upon schematic design by Alteris Renewables

** Production estimates based upon PVWATTS v.2

Solar Opportunity Assessment Summary

Phase	System Size (kW DC)	Cost ($'s 2009)	Annual Production (kWh)
Existing Condition	1,064	$ 7,399,710	931,343
Near-Term 2010-2014 Campus Growth Condition	1,260	$ 8,419,750	1,710,463
Mid-Term 2015-2024 Campus Growth Condition	1,327	$ 7,668,222	1,656,729
Long-Term 2025-2030 Campus Growth Condition	5,310	$ 27,626,440	6,624,427
TOTAL	**8,961**	**$ 51,114,122**	**10,922,962**

* System size, cost, and estimated annual production based upon schematic design by Alteris Renewables
** Production estimates based upon PVWATTS v.2

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solar
thermal
wind

Solar Projects: Financial Comparisons

VILLANOVA UNIVERSITY

June 12th 2009

Jodi Gold jgold@alterisinc.com

523 Danbury Road | Wilton, CT 06897 | t: 203.210.7710 | f: 203.210.7709 | www.alterisinc.com

Comparative Financial Analysis Utility Rate $.085kWh

System Overview	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
1st Year Production	40,314	264,622	277,026
% of Customers Usage	N/A	N/A	N/A
System Cost	$280,529	$1,844,196	$1,925,318
State Rebate (no tax applied)	$87,750	$576,000	$603,000
1st Year Investment*	$191,569	$1,260,257	$1,314,007
Assumptions			
Federal Tax Rate	0%	0%	0%
State Tax rate	0%	0%	0%
1st Year Utility Rate	**$0.0850**	**$0.0850**	**$0.0850**
25 Year Avg. Utility	$0.1603	$0.1603	$0.1603
Utility Rate Riser	**5%**	**5%**	**5%**
System Life	25 Years	25 Years	25 Years
Investment and Operating Costs			
Investment Cost/kWh	$0.202	$0.202	$0.201
Estimated Operating Cost/kWh	$0.029	$0.015	$0.015
Total PV Cost/kWh	$0.231	$0.217	$0.216
Lifetime Savings and Payback			
Simple Payback (Yrs.)	>25 years	>25 years	>25 years
Internal Rate of Return	N/A	-3%	-2%
Net Present Value @ 7 %	($131,886)	$(826,628.90)	$(859,395.58)
Total Avoided kW hours (lifetime)	949,635	6,233,423	6,525,611
Savings per kWh	$(0.071)	$(0.057)	$(0.056)
Total Avoided Utility Costs	$152,192	$998,990.48	$1,045,817.57
% Savings over Utility Grid	-44%	-35%	-35%

Environmental Benefits 25 Year The system is the equivalent to…	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
CO2 Avoidance (Metric Tons)	682	4,476	4,685
# Trees Planted	17,483	114,758	120,138
# Passenger vehicles off the road /yr	5.3	34.8	36.4
Powering # of Homes per yr	3.4	22.1	23.2

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Comparative Financial Analysis $.11kWh Utility Rate

System Overview	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
1st Year Production	40,314	264,622	277,026
% of Customers Usage	N/A	N/A	N/A
System Cost	$280,529	$1,844,196	$1,925,318
State Rebate (no tax applied)	$87,750	$576,000	$603,000
1st Year Investment*	$191,569	$1,260,257	$1,314,007
Assumptions			
Federal Tax Rate	0%	0%	0%
State Tax rate	0%	0%	0%
1st Year Utility Rate	**$0.1100**	**$0.1100**	**$0.1100**
25 Year Avg. Utility	$0.2074	$0.2074	$0.2074
Utility Rate Riser	**5%**	**5%**	**5%**
System Life	25 Years	25 Years	25 Years
Investment and Operating Costs			
Investment Cost/kWh	$0.202	$0.202	$0.201
Estimated Operating Cost/kWh	$0.029	$0.015	$0.015
Total PV Cost/kWh	$0.231	$0.217	$0.216
Lifetime Savings and Payback			
Simple Payback (Yrs.)	>25 years	>25 years	>25 years
Internal Rate of Return	-1%	-1%	-1%
Net Present Value @ 7 %	($113,942)	$(708,844.97)	$(736,090.60)
Total Avoided kW hours (lifetime)	949,635	6,233,423	6,525,611
Savings per kWh	$(0.024)	$(0.010)	$(0.009)
Total Avoided Utility Costs	$196,954	$1,292,811.20	$1,353,410.97
% Savings over Utility Grid	-11%	-5%	-4%

Environmental Benefits 25 Year The system is the equivalent to…	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
CO_2 Avoidance (Metric Tons)	682	4,476	4,685
# Trees Planted	17,483	114,758	120,138
# Passenger vehicles off the road /yr	5.3	34.8	36.4
Powering # of Homes per yr	3.4	22.1	23.2

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Comparative Financial Analysis $.13kWh Utility Rate

System Overview	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
1st Year Production	40,314	264,622	277,026
% of Customers Usage	N/A	N/A	N/A
System Cost	$280,529	$1,844,196	$1,925,318
State Rebate (no tax applied)	$87,750	$576,000	$603,000
1st Year Investment*	$191,569	$1,260,257	$1,314,007
Assumptions			
Federal Tax Rate	0%	0%	0%
State Tax rate	0%	0%	0%
1st Year Utility Rate	**$0.1300**	**$0.1300**	**$0.1300**
25 Year Avg. Utility	$0.2451	$0.2451	$0.2451
Utility Rate Riser	**5%**	**5%**	**5%**
System Life	25 Years	25 Years	25 Years
Assumptions			
Investment Cost/kWh	$0.202	$0.202	$0.201
Estimated Operating Cost/kWh	$0.029	$0.015	$0.015
Total PV Cost/kWh	$0.231	$0.217	$0.216
Lifetime Savings and Payback			
Simple Payback (Yrs.)	24.78	23.60	23.52
Internal Rate of Return	N/A	1%	1%
Net Present Value @ 7 %	($99,587)	$(614,617.83)	$(637,446.61)
Total Avoided kW hours (lifetime)	949,635	6,233,423	6,525,611
Savings per kWh	$0.014	$0.028	$0.029
Total Avoided Utility Costs	$232,764	$1,527,867.79	$1,599,485.69
% Savings over Utility Grid	6%	11%	12%

Environmental Benefits 25 Year The system is the equivalent to…	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
CO2 Avoidance (Metric Tons)	682	4,476	4,685
# Trees Planted	17,483	114,758	120,138
# Passenger vehicles off the road /yr	5.3	34.8	36.4
Powering # of Homes per yr	3.4	22.1	23.2

Comparative Financial Analysis $.15kWh Utility Rate

System Overview	Connelly 39kW	Law School Carport 256kW	SAC Carport 268kW
1st Year Production	40,314	264,622	277,026
% of Customers Usage	N/A	N/A	N/A
System Cost	$280,529	$1,844,196	$1,925,318
State Rebate (no tax applied)	$87,750	$576,000	$603,000
1st Year Investment*	$191,569	$1,260,257	$1,314,007
Assumptions			
Federal Tax Rate	0%	0%	0%
State Tax rate	0%	0%	0%
1st Year Utility Rate	**$0.1500**	**$0.1500**	**$0.1500**
25 Year Avg. Utility	$0.2828	$0.2828	$0.2828
Utility Rate Riser	**5%**	**5%**	**5%**
System Life	25 Years	25 Years	25 Years
Investment and Operating Costs			
Investment Cost/kWh	$0.202	$0.202	$0.201
Estimated Operating Cost/kWh	$0.029	$0.015	$0.015
Total PV Cost/kWh	$0.231	$0.217	$0.216
Lifetime Savings and Payback			
Simple Payback (Yrs.)	22.42	21.47	21.39
Internal Rate of Return	1%	2%	2%
Net Present Value @ 7 %	($85,232)	($520,391)	$(538,802.63)
Total Avoided kW hours (lifetime)	949,635	6,233,423	6,525,611
Savings per kWh	$0.052	$0.066	$0.067
Total Avoided Utility Costs	$268,574	$1,762,924	$1,845,560.41
% Savings over Utility Grid	18%	23%	24%

*This is the investment amount after all rebates, tax credits, depreciation and REC's have been factored in.

Not for Construction

Campus Total: 563 kW DC (STC)
2,815 200W High-Efficiency Modules

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Montpelier, VT 05602 USA
802 223 7804

CLIENT
Villanova University
800 Lancaster Ave
Villanova, PA 19085

PROJECT
Campus Photovoltaic Prospects

ISSUE
5-22-09

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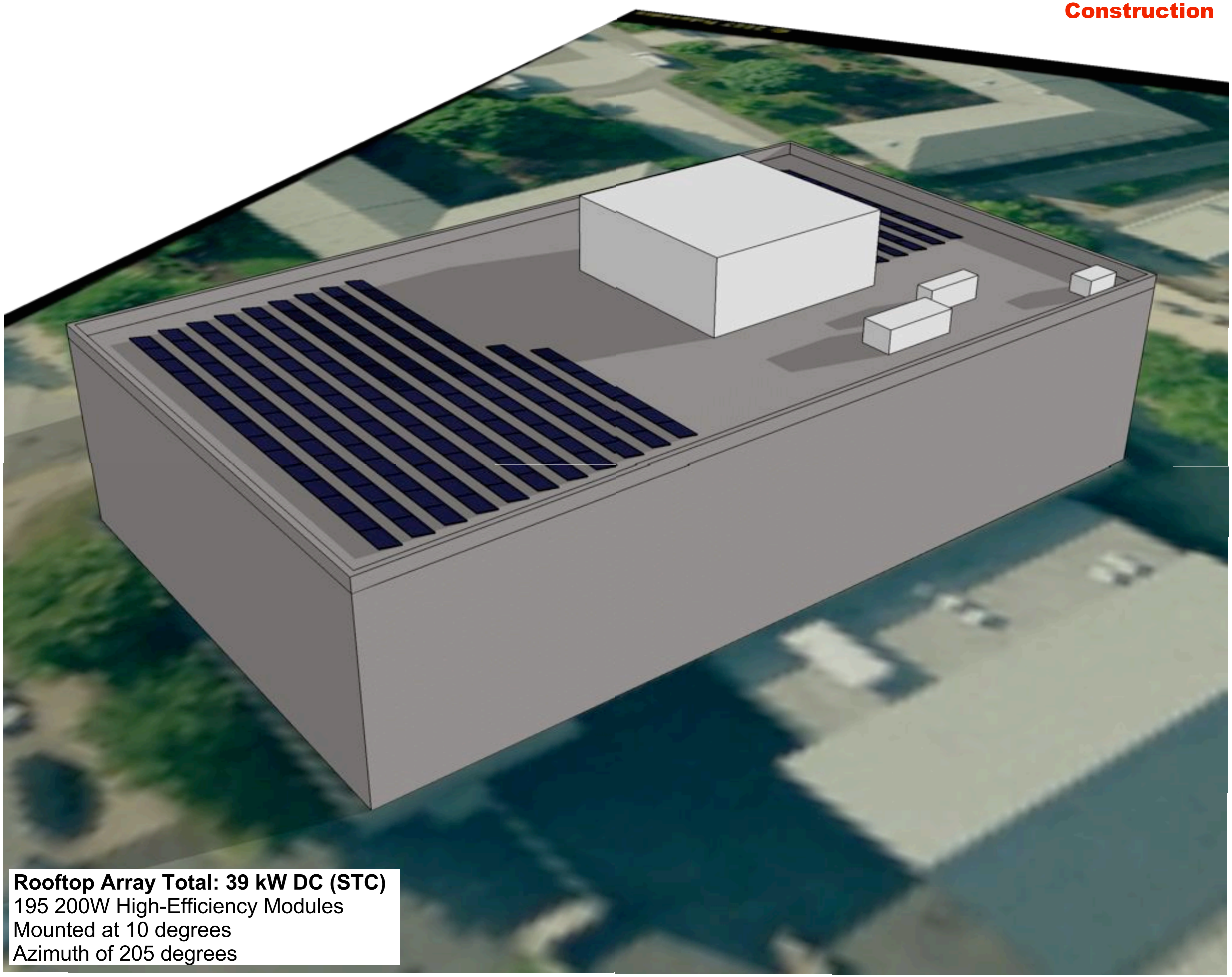
JR

Overview
with photo
N.T.S.

Not for Construction



Rooftop Array Total: 39 kW DC (STC)
195 200W High-Efficiency Modules
Mounted at 10 degrees
Azimuth of 205 degrees

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Connoly Hall
from North
N.T.S.

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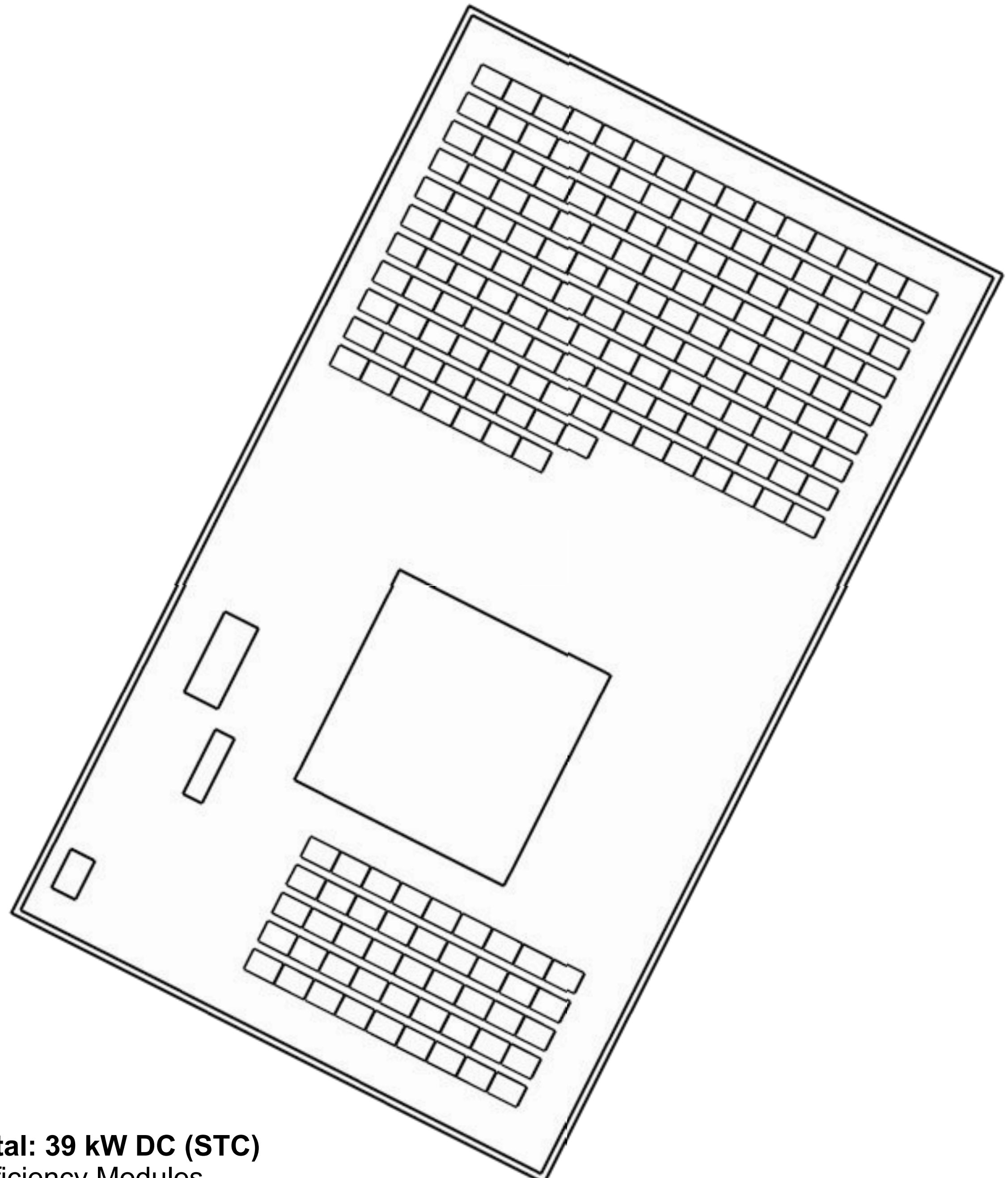

Rooftop Array Total: 39 kW DC (STC)
195 200W High-Efficiency Modules
Mounted at 10 degrees
Azimuth of 205 degrees

Connoly Hall
Plan View
1" = 25' (Printed 8 1/2 x 11)

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Law School Parking

Aerial from S

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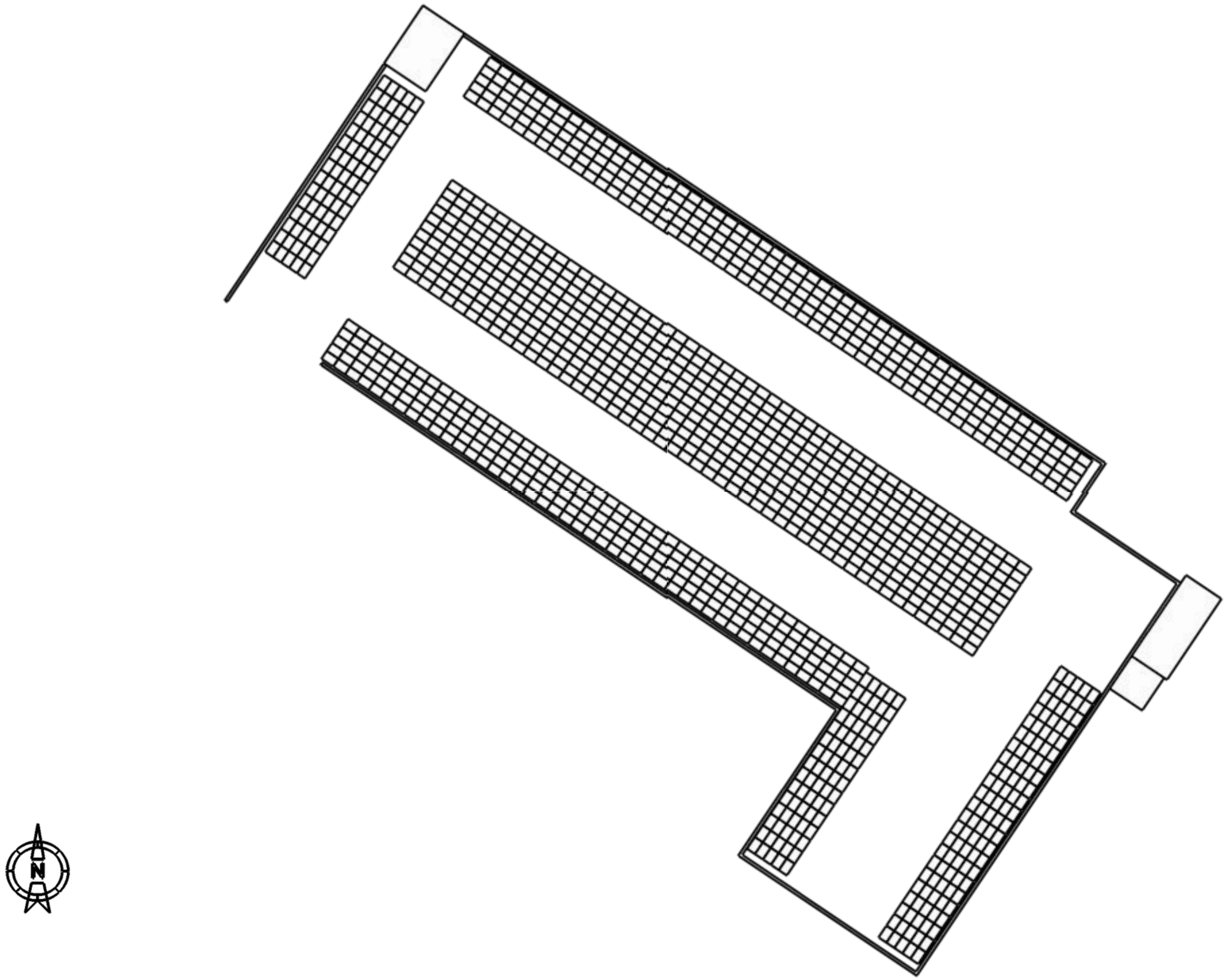

Carport Array Total: 256 kW DC (STC)
1,280 200W High-Efficiency Modules

Law School Parking
Plan View

1" = 50' (Printed 8 1/2 x 11)

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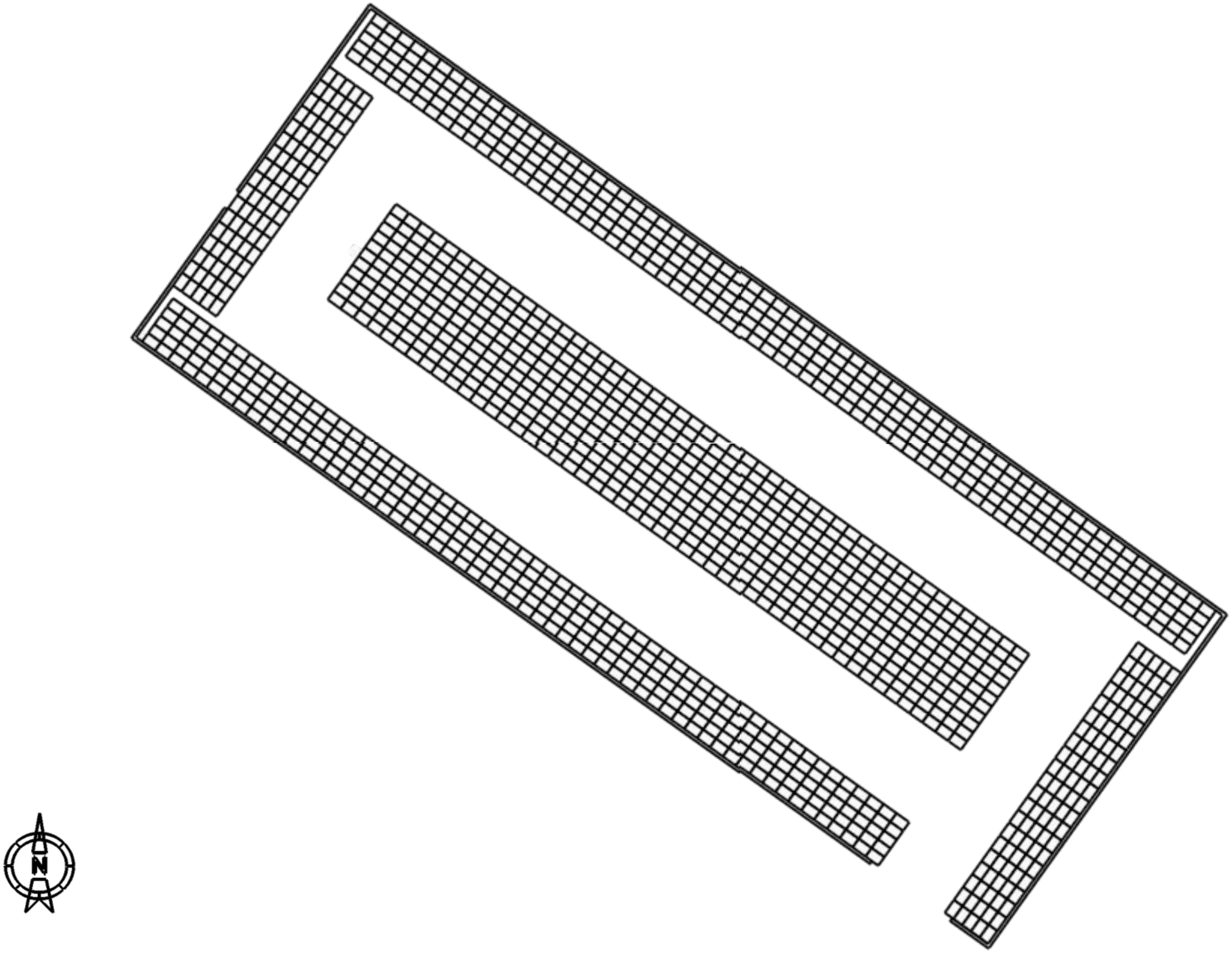
St. Augustine Center Parking
Aerial from S
N.T.S.

Not for Construction



Carport Array Total: 268 kW DC (STC)
1,340 200W High-Efficiency Modules

St. Augustine Center Parking
Plan View
1" = 50' (Printed 8 1/2 x 11)

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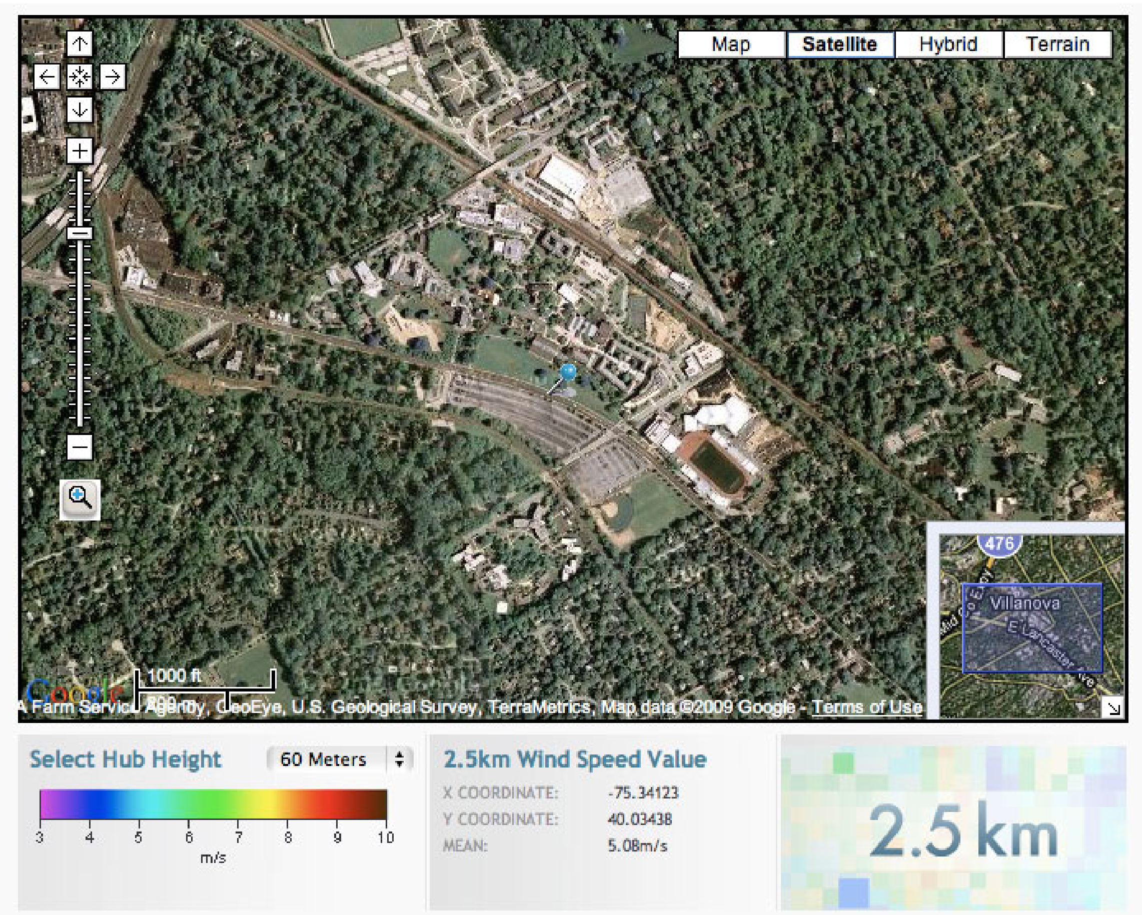
Wind Study

An initial evaluation of wind resources at the Villanova University campus suggests wind resources are marginal for a wind energy system. Mean wind speed for the campus is 5.08 m/s. Wind mapping was provided by AWS Truewind's windNAVIGATOR. A 2.5 km resolution was used for the purposes of this study.



Beyond the assessment of wind resources, the ability to find a suitable site is questionable as there do not appear to be sites that would allow for lay down in the event of catastrophic failure.