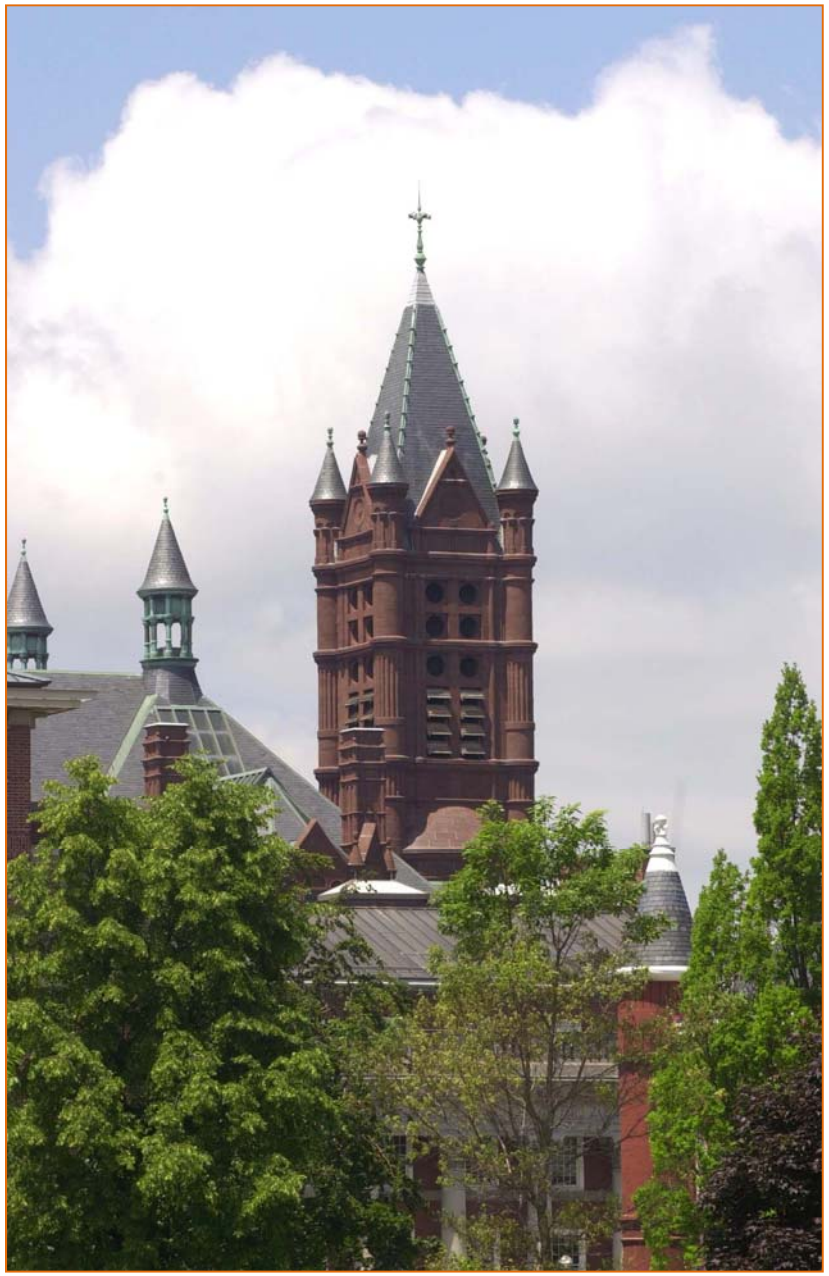
Syracuse University's Climate Action Plan – 2009

Achieving Climate Leadership on a Sustainable Campus



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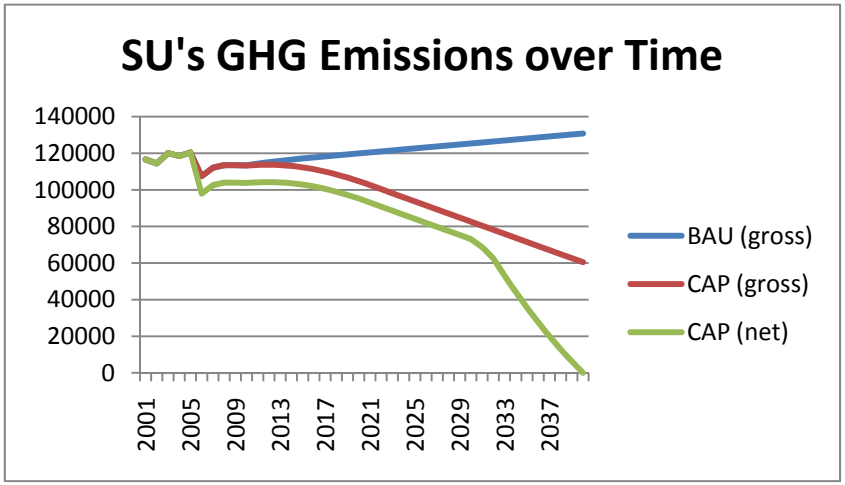
1. Executive summary

Syracuse University has developed this Climate Action Plan (CAP) to inform its efforts to **completely eliminate its net emissions of greenhouse gases (GHGs) by December 31, 2040**. Actual ("gross") emissions will be reduced by at least 65,000 metric tons as the result of a series of projects focusing on energy conservation, energy efficiency, creation of energy from renewable sources and changes in the behavior of students, faculty, and staff. Remaining emissions will be offset by the University, which will fund GHG reduction efforts beyond its campus, primarily in Central New York; these efforts will offset all remaining gross emissions, thus leading the University to a level of zero net emissions, often referred to as "climate neutrality" (see graph to right). SU has designed the CAP to demonstrate that carbon neutrality (zero net emission of GHGs) can be achieved in a fiscally responsible manner while actively enhancing the University's fulfillment of its educational mission and development of climate leaders.



SU's Climate Action Plan is technologically conservative in that it presumes only technologies and products already available in the marketplace. Since new energy-efficient technologies are certain to emerge over the coming decades, the plan also positions the University both to take advantage of these new technologies and to actively participate in their development. The CAP is responsive to SU's intent to increase its engagement with the community and the world; it recognizes and allows for future growth of the University in both square footage and student enrollment. Finally, the CAP is managerially responsible in that it accounts not only for the initial costs of implementation, but also for the ongoing costs of maintaining new infrastructure and eventually replacing or upgrading it.

The Climate Action Plan was prepared in response to the requirements of the American College and University Presidents Climate Commitment (PCC), which Chancellor Nancy Cantor signed February 23, 2007. Under terms of the PCC, signatories commit to eliminating net GHG emissions, take initial steps toward climate neutrality, inventory their annual emissions of GHGs (both initially and periodically), and develop and execute a plan for becoming climate neutral. In September of 2008, SU published its initial Greenhouse Gas Inventory, its first-ever accounting of its emissions of the six gases recognized in the Kyoto Protocol as contributing to global climate change. The GHG Inventory covered seven fiscal years (2001 – 2007); SU's average annual net emission level over this period (equivalent to 115,648 metric tons of carbon dioxide) was used as a baseline for developing the CAP.

Projecting into the future from this baseline using a set of **"business as usual"** (BAU) assumptions, the developers of the CAP estimated that SU's GHG emissions would grow to 119,928 metric tons by 2020 (a 4 percent increase), 125,368 metric tons (an increase of 8 percent) in 2030, and **130,809 metric tons (a 13 percent increase) by 2040.** These projections assume that, due to recent advances in design and construction techniques, new building space added in the future – including those buildings currently under construction – will require only 70 percent as much energy per square foot as that required by SU's current inventory of buildings.

By contrast, the Climate Action Plan establishes a series of continually decreasing GHG emissions targets into the future, culminating in the complete elimination of net emissions by 2040. The CAP charts a course by which SU can reduce its actual and net GHG emissions in a financially responsible manner, as indicated in this table.

Calendar Year	Business as usual GHG emissions	Actual (gross) GHG emissions	Reductions due to Renewable Energy Certificates and Offsets	Net GHG emissions
2015	117,208	112,381	(9,488)	102,893
2020	119,928	106,742	(9,488)	95,269
2025	122,648	93,686	(9,488)	84,198
2030	125,368	82,615	(9,488)	73,127
2035	128,089	71,543	(35,771)	35,772
2040	130,809	60,472	(60,472)	0

GHG emissions in metric tons

Syracuse University will attain carbon neutrality by implementing an action plan consisting of five overlapping components, the first two of which are already in process. More detailed component descriptions are included in Section 2. The five major components of the Climate Action Plan are:

- Analysis/Behavior/Communication/Demonstration/Engagement (ABCDE)
- Energy Conservation through Existing Technologies
- Energy Efficiency through Emerging Technologies
- Supply-Side Enhancements

- Offsets of Remaining Emissions

To help maintain community attention on the CAP, each component will include one or more **flagship projects**, selected and designed for maximum public interest and scholarly research potential while consistently demonstrating the University's commitment to fiscal responsibility. For the first component, the initial flagship project is construction and implementation of the Green Data Center.

To assure adherence to the Climate Action Plan, Syracuse University is moving to create a **Climate Operations Center** – a comprehensive integrated data repository and reporting source that will allow SU to constantly monitor its GHG emission levels, its energy utilization, and the performance of its infrastructure and facilities operations. In addition to assuring the University's compliance with the CAP and with its institutional commitments, the Climate Operations Center will provide real educational opportunities for students and other community members, and a storehouse of empirical data for future research into efficient energy use and building operations.

Data from the Climate Operations Center will feed into periodic reviews and updates of the CAP, which are scheduled to occur at five-year intervals. After each review, an updated CAP will be published to detail and respond to empirical results achieved, recognize opportunities to leverage technological advances, re-estimate the amount by which actual emissions can be reduced, and recommend shifts in priorities or schedules as appropriate. Thus, the current CAP is merely the first edition of a document that will evolve and grow at least until climate neutrality is achieved; future editions will likely project a greater ability to reduce actual emissions and, as a result, a diminished need to rely on offsets.

SU's Climate Action Plan is fully funded. Ongoing studies and construction (initiated before CAP publication but part of the University's efforts to reduce GHG emissions) are included in near-term capital project budgets, and a funding stream has been approved explicitly allowing for CAP-initiated projects to begin in fiscal year 2011. Increasing levels of annual funding are provided through fiscal year 2022, from which date CAP funding will remain level (in 2011 dollars). Based on conservative estimates of future energy costs and of energy savings achievable with current technologies, the savings generated by CAP-initiated projects should fully offset annual program costs starting in fiscal year 2023, with positive program-to-date cash flow being achieved from fiscal year 2030 forward. This positive cash flow is estimated to be an order of magnitude greater than will be required to pay for GHG offsets during the out-years of the CAP, even under technologically conservative assumptions. Thus, by implementing the CAP, Syracuse University will increase its ability to perform its educational and service missions into the future.

Time, cost and GHG reduction effects under the CAP are estimated based on a set of potential campus enhancement projects, each considered fully feasible using current technology. While the list of projects will certainly evolve through the engagement of the campus

community, basing estimates on potential project costs and energy savings is key to achieving a high level of confidence that CAP targets and timelines are realistically achievable. The potential projects that were considered for purposes of estimation include:

- Green computing across the campus
- Demonstration projects for solar and wind generated electricity
- Improving controls and lighting fixtures
- Increasing heat recovery in existing facilities
- Optimizing energy usage at athletic and recreational facilities
- Improving water conservation across campus
- Expanding use of videoconferencing to decrease air and local travel
- Managing campus solid waste
- Improving local transportation options
- Increasing the use of alternative-fuel vehicles
- Enhancing SU's energy management systems
- Expanding the use of ground-source heat pumps (geothermal heating) for heating and cooling
- Converting the central steam plant fuel source to biomass

Projected energy efficiency of newly constructed buildings on campus was estimated based on national averages for LEED-certified buildings. The 30 percent savings projected is consistent with expectations for buildings currently under construction, including the Center of Excellence in Environmental and Energy Systems, the Green Data Center, the Carmelo Anthony Basketball Center and Ernie Davis Hall.

While guidelines and mechanisms for initiating and prioritizing projects under the Climate Action Plan are largely in place, specific project proposals are still being developed and evaluated. Various governance bodies are working with academic schools and colleges within the University to identify and formulate early initiatives that are most likely to produce positive results. In addition, demonstration and "showcase" projects that are being constructed will help determine the specific applicability of leading-edge technologies within the challenging climate typical of Central New York. By these means, Syracuse University expects to build awareness of – and demand for – CAP-related projects and resources, thereby maximizing the University's opportunity to achieve its goal of carbon neutrality by 2040.

Syracuse University will encourage increasing levels of sustainability-related research on campus, in part by establishing a Sustainable Initiative Fund. Funding will be available, on a competitive basis, for research and demonstration projects to be conducted by students, faculty

members, or teams including both. Specific guidelines and procedures for applying to the fund will be distributed to students and faculty members during the spring 2010 semester, with initial funding becoming available in the fall of 2010.

In addition to encouraging sustainability-related research, awareness of the Sustainable Initiative Fund will also **increase engagement of the campus community** in issues of sustainability and actions to achieve it. SU faculty, students and staff are already engaged with a number of organizations around Central New York with an eye toward creating regional initiatives for climate action; initial efforts are under way to coordinate these measures and enhance communications among community members, both on and off campus.

Effective implementation of such a wide-ranging set of plans requires an **appropriate and effective governance structure.** SU's Climate Action Plan is both a product of, and an effort to leverage, the activities of five existing organizations:

- The Syracuse University Sustainability Committee, charged with creating policies and guidelines for the sustainable operation of campus buildings, as well as process, protocols and funding proposals for LEED certification of major new construction efforts
- The PCC (Presidents Climate Commitment) Steering Committee, which oversees all sustainability efforts at the University
- The PCC-CAP Committee, charged with engaging the campus community in the ongoing development and enhancement of the Climate Action Plan
- The PCC-Sustainability in the Curriculum Task Force, which is responsible for making climate neutrality and sustainability a part of the educational experience of all SU students, under terms of the PCC
- The Sustainability Division (located in the Department of Energy and Computing Management), which provides dedicated leadership and support to sustainability efforts at SU and within the community

While the existing governance structure is sure to evolve, these and their successor organizations will take active roles in moving Syracuse University toward climate neutrality. In a process designed to actively involve a wide range of campus community members, the PCC Steering Committee will focus work with each individual school and college on campus to create and empower teams incorporating students, faculty and staff who will identify, prioritize, initiate and oversee local project implementations. CAP-initiated projects will be managed through the University's existing project management mechanisms. A subcommittee of the PCC Committee will continually ensure campus awareness of and engagement with the University's progress, thereby facilitating the development of broad-based climate leadership as SU works to create a sustainable campus.


2. CAP target dates and actions

Syracuse University has established net GHG emissions targets that define a realistic trajectory toward zero net emissions:

Year ending	Gross GHG emissions (MTCO2e)	Net GHG emissions (MTCO2e)
12/31/2015	112,381	102,893
12/31/2020	106,742	95,269
12/31/2025	93,686	84,198
12/31/2030	82,615	73,127
12/31/2035	71,543	35,772
12/31/2040	60,472	0

GHG emissions Targets

The University will attain carbon neutrality by implementing an action plan consisting of five overlapping components, the first two of which are already being implemented. Components are defined by nature of activity rather than chronological sequence, although lower-numbered components tend to predominate in early years while higher-numbered components account for the majority of out-year activities. This five-component plan was developed to leverage SU's historic strengths, deal with its unique challenges, assure fiscally responsible management throughout the process and realistically minimize actual emissions of greenhouse gases (GHGs) while credibly and rigorously offsetting emissions that cannot physically be eliminated.

The five major components of the Climate Action Plan, as currently envisioned, are:

1. Analysis/Behavior/Communication/Demonstration/Engagement (ABCDE). The activities in this component, some already under way, include projects internal to Syracuse University as well as some undertaken in partnership with SUNY-College of Environmental Science and Forestry, the Syracuse Center of Excellence in Environmental and Energy Systems, and civic organizations in Syracuse and Onondaga County. The overriding objective of projects in this component is to increase awareness among our students of:
    - The University's commitment to achieving carbon neutrality
    - The University's determination to reach that state
    - The University's willingness to adapt its practices and infrastructure in the effort
    - The University's Its informed and judicious consideration of new and emerging technologies with apparent potential to reduce the ecological impact of campus operations

- Its emphasis on empirical demonstration of real-world results as a key element in responsible decision-making

SU intends to involve groups of students majoring in appropriate disciplines in a wide range of audit, study and **analysis** projects aimed at quantifying and selecting technology enhancement and retrofit projects across campus. Students are already engaged in a series of behavioral audits and analyses and will be involved in engineering studies and analyses in the near future.

A number of efforts to facilitate and promote **behavioral** change are ongoing, under a number of formal and informal auspices. These include:

- Color-coding (by material category) of recycling containers on campus
- Conducting the "Saving Juice in the 'Cuse" residence hall energy conservation competition
- Placing water conservation stickers in residence hall bathrooms
- Mounting recyclable materials posters in dining hall kitchens
- Promoting free or reduced-fare bus commuting via web service and on-campus posters

Similar emphasis will be focused on Syracuse University's leading-edge Green Data Center, currently under construction on South Campus. Since the actual data center building is intentionally located toward one edge of the campus area, student awareness of technologies incorporated and results achieved will depend more on explicitly communicated information than on happenstantial awareness. But given the nature of modern data centers and students' conception of them as spaces as much "virtual" as physical, electronic **communication** of information about this project can be highly effective for non-technical audiences. The Green Data Center has been designated a "flagship" project, creating further opportunities for media attention and increased awareness within the campus community.

Demonstration projects implemented as part of this component will be designed, to the extent practical, in a way that maximizes their visibility to students on a day-to-day basis. Demonstration projects will inherently raise students' awareness of the University's sustainability efforts. To further increase awareness, informational displays at the project location, in high-traffic campus locations, and on the University's web site will provide detailed and up-to-the-minute information on project objectives, technologies and results. To this effect, efforts will be made to cluster technology demonstration projects around SU's two main student centers – Schine Student Center on the University's Main Campus and Goldstein Student Center on South Campus. The two student centers will, over time, evolve into SU's sustainability showcases, concentrating a wide range of established, emerging and speculative sustainability technologies into specific high-traffic locations.

GREEN DATA CENTER

The Syracuse University Green Data Center, currently under construction on South Campus, will serve as a model of efficiency for energy-intensive computer facilities and a laboratory for related research. The 12,000-square-foot, $12.4 million building is expected to use 50 percent less energy than a typical data center through a combination of cutting-edge technologies. A partnership between the University and IBM Corporation, the center has also received funding from the New York State Energy Research and Development Authority (NYSERDA).

The first university data center in New York State to be powered by on-site generation, the Green Data Center will not only seek LEED certification, but will be capable of operating completely off-grid. IBM plans to showcase the facility to help clients design new data centers or improve their current operations. Meanwhile, the L.C. Smith College of Engineering will manage and analyze the center's performance, as well as research and develop new analysis and modeling tools for data center efficiency.

Energy Efficiency Features:

- **On-site electrical tri-generation system.** Natural gas-fueled microturbines and absorption chillers will generate all electricity, heating, and cooling. Any excess that cannot be used inside the center itself will help heat and cool an adjacent building.
- **Dynamic server virtualization.** A dynamic virtualization approach will be used to turn off racks of servers when not needed. This approach substantially reduces both the amount of electricity used to power the servers and the amount of energy required to cool them.
- **Direct current (DC) power.** The center is designed to use DC power wherever possible, reducing the need to expend energy converting to alternating current (AC).
- **Thermal transfer cabinets.** Water-cooled cabinets around individual racks of computer server equipment will eliminate the need to cool an entire large room. Instead, each rack is cooled individually, with cooling dynamically matched to its current needs.

The higher level of student awareness of these and other practical steps toward advancing sustainability knowledge and practice across campus will, in all likelihood, increase student **engagement** in, and social energy generated by, the sorts of campus-wide sustainability events in which SU has been involved for years. While, in the past, a number of teach-ins, speakers, and other informational events have been organized largely by University faculty and staff, current plans call for the University's Sustainability Learning Community (a self-selected group of students with a year-long commitment) to take on significant organizational responsibility. The combination of greater general awareness in the campus community and more student-focused design and implementation will, it is hoped, make future sustainability events even more successful than previous ones have been.

The ABCDE component of the CAP is already being implemented and is expected to continue indefinitely. The intent of this component is cultural change, and the time required to accomplish that will be long. Periodic reviews, associated with each of the Climate Action Plan five-year milestones, will examine the extent to which demonstration and educational efforts need to continue. Over time, the nature of these efforts will likely change, but some continuing effort will most probably be necessary.

2. Energy Conservation through Existing Technologies. The second component of the Climate Action Plan consists of projects intended to reduce campus energy consumption within the immediate term. These projects are characterized by dependence on existing technologies. Project objectives include replacement of older, obsolescing infrastructure with more modern, more efficient alternatives and/or facilitation of individual and institutional change to use installed technologies as efficiently and effectively as possible.

   A number of the projects in this component have already been started or have been initiated and are making their way through the University's normal process for approving and prioritizing capital improvement projects. Among the capital projects already initiated are:

   - Window replacement and repair of leaks
   - HVAC system improvements
   - Enhancement of steam and chilled water lines
   - Boiler replacement and domestic hot water upgrade
   - Art gallery temperature and humidity control upgrade

   Future projects to be implemented will be selected from a dynamic list of possibilities. The initial iteration of this list consists of the projects used to establish baseline expectations and to calibrate estimations of greenhouse gas reduction and project costs (see Appendix C). However, as will be described below, it is SU's expectation and objective that new projects be added to the list (potentially eliminating or mooting earlier ones) in collaboration with campus members as community engagement increases.

This second component of the Climate Action Plan is, in part, an amplification and expansion of SU's normal periodic infrastructure maintenance and enhancement activity. As such, while explicit labeling of these undertakings as "CAP-related" may disappear at some time in the future, the activities themselves are likely to continue indefinitely.

3. Energy Efficiency through Emerging Technologies. Over the 30-year span of SU's Climate Action Plan, new and more energy-efficient building technologies will certainly emerge. As these technologies become viable, projects to retrofit them into the University's built environment will be evaluated and implemented.

   However, Syracuse University expects to be more than a passive consumer of emerging building energy technologies. Building energy and the built environment are areas of particular research focus on campus. As a result, the University expects to play an active role in the development of these technologies and – working with our strategic partners – to demonstrate and initially quantify the energy and environmental benefits available.

   Specific technology or project descriptions, of course, are not yet known. However, the research centers that we expect to generate these technologies and projects are already in place, including the:

   - Building Energy and Environmental Systems Laboratory
   - NY STAR Center for Environmental Quality Systems
   - US DOE Industrial Assessment Center
   - Air Barrier Association of America Test Facility
   - Syracuse Center of Excellence in Environmental and Energy Systems

   SU will monitor research coming out of these and other centers, and will identify specific projects that have high potential for GHG reduction, starting no later than the 2015 CAP milestone and progress review.

4. Supply-side Enhancements. Conservation and efficiency both reduce the demand for energy, and Syracuse University intends to make major investments in both. However, GHG emissions can also be reduced by shifting to energy that is generated by clean or renewable means. Projects included in this component of the CAP will focus on generating energy cleanly, responsibly, and either on or near campus.

   The first component of the Climate Action Plan will include pilot or demonstration projects of renewable energy generation, including at least one wind turbine and one small solar photovoltaic array. These installations will be more for educational purposes than for

reducing campus emissions, but are as an important first step toward supply-side energy management. As truly renewable generation technologies mature and become more price-competitive, SU expects to incorporate an appropriate subset into its campus buildings, both new construction and retrofits.

Indeed, SU's flagship Green Data Center project already includes installation of natural gas-fired micro-generators as part of a leading-edge combined heat and power system – the building is designed to produce more energy than it requires for its own (traditionally energy-intensive) uses.

5. Offsets of Remaining Emissions. When all reasonable conservation and efficiency improvements have been made and all practical steps have been taken to provide the campus with clean renewable energy, it's almost certain that some level of GHG emission will still occur on campus. The initial version of the plan estimates that these emissions will approach 80,000 metric tons per year, but SU's goal and expectation is to reduce the level far below that number. The objective of the CAP is to reduce actual emissions as much as possible, but what will be possible in 2040 simply cannot be known in 2009.

   Offsetting GHG emissions is SU's least preferred option. Offsets neither produce energy nor reduce energy use, so no cost savings are generated. Commercially marketed offsets typically expire and must be repurchased, leaving the University with no lasting value for its dollar.

   Still, the University is committed to achieving zero net GHG emissions, so whatever level of GHGs is still occurring on campus as the plan nears its end will be offset. Offsetting GHG emissions is a subject of some controversy, but we fully expect that by the time SU invests significantly in offsets, an effective consensus will have been attained. At present, the preferred option is for the University to invest in projects that will have local impact and support the educational mission of the University.

One outstanding opportunity to decrease GHG emissions is provided by SU's existing steam station, which already incorporates combined heat and power capabilities. SU currently purchases its steam from an independent developer who is responsible for operating the plant. Due to recent changes in the electricity market, the University may again take over direct operating responsibility. Since the main boilers in the plant were originally designed to burn solid fuel (coal), conversion to fueling with solid biomass would appear to be straightforward. No specific planning is feasible under current circumstances, but the situation appears to offer potential for significant supply-side emissions reduction.

Ideally, this activity will:

- Create measurable reductions in actual GHG emissions
- Allow SU to assure additionality by selecting improvement projects that would not have occurred without the school's involvement
- Allow the University to monitor long-term building performance to measure GHG reduction over a period of years
- Provide hands-on learning experiences to students involved in measuring, analyzing, and possibly even construction activities
- Enhance Syracuse's reputation as a "green city"
- Strengthen SU's ties to the community

As a result of Climate Action Plan efforts, Syracuse University will undertake to reduce its net emissions of GHGs in accordance with a schedule specifically intended to attain carbon neutrality by December 31, 2040. Actual emissions will be measured and monitored, initially through periodic greenhouse gas inventories (similar to the one used to establish SU's emissions baseline) and later through the operation of the University's Climate Operations Center (see Section 5).

Implementing such a wide variety of projects across a large campus in a complex institutional environment necessarily presents problems of project prioritization. SU has determined to focus its infrastructure improvement efforts at each stage of the CAP on facilities serving a small number (initially, one) of the University's component schools and colleges. By concentrating our efforts on a defined subset of campus – largely serving a defined subset of students – we hope to create clear and convincing messages in relatively short time-frames (ideally, four years or less). By actively involving students in many levels of the projects that affect their home colleges, we hope to embed those messages in our graduates for years to come.

The Presidents Climate Commitment Committee is in the process of designing a process by which schools and colleges may apply to enhance their facilities by means of CAP projects. An initial candidate – SU's College of Visual and Performing Arts – has already come forward and been approved.

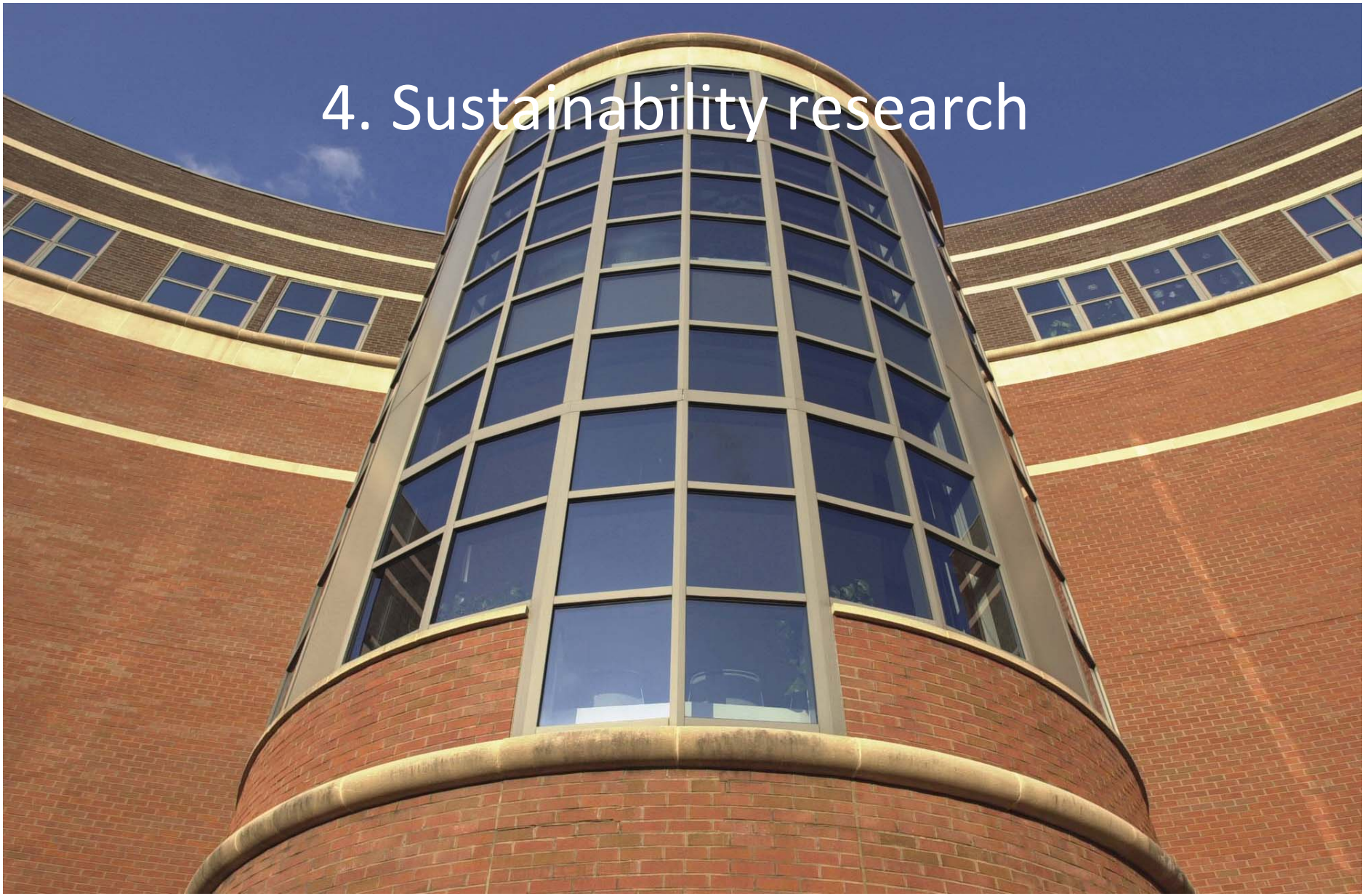
Given that different schools and colleges inhabit buildings of varying ages, designs and construction techniques, an appropriate and beneficial set of projects will be selected and prioritized on a case-by-case basis. This individualized selection and prioritization takes notice not only of differing architectures, but also of differing uses, schedules, educational requirements and expectations.

3. Sustainability education

In order to assure that exposure to sustainability issues becomes part of each graduate's experience, Syracuse University has undertaken a coordinated effort at curriculum enhancement. In the fall of 2008, Vice Chancellor and Provost Eric Spina created the Sustainability in the Curriculum Task Force, consisting of faculty, administrators and students representing each of SU's schools and colleges. "The faculty, deans, and many other leaders at the University feel that we, as an institution of higher learning, must ensure that our students – whether they're going to run a manufacturing plant, whether they're going to write policy, whether they're going to communicate through the media – know something about sustainability," Spina was quoted as saying in the Spring 2009 issue of Syracuse University Magazine. A team of the task force is currently reviewing selected models of sustainability education, evaluating the current state of educational opportunities at SU, conferring with faculty at the University's constituent schools and colleges, examining opportunities for consolidation of various initiatives, and preparing possible revisions to existing curricula and introduction of new academic programs.

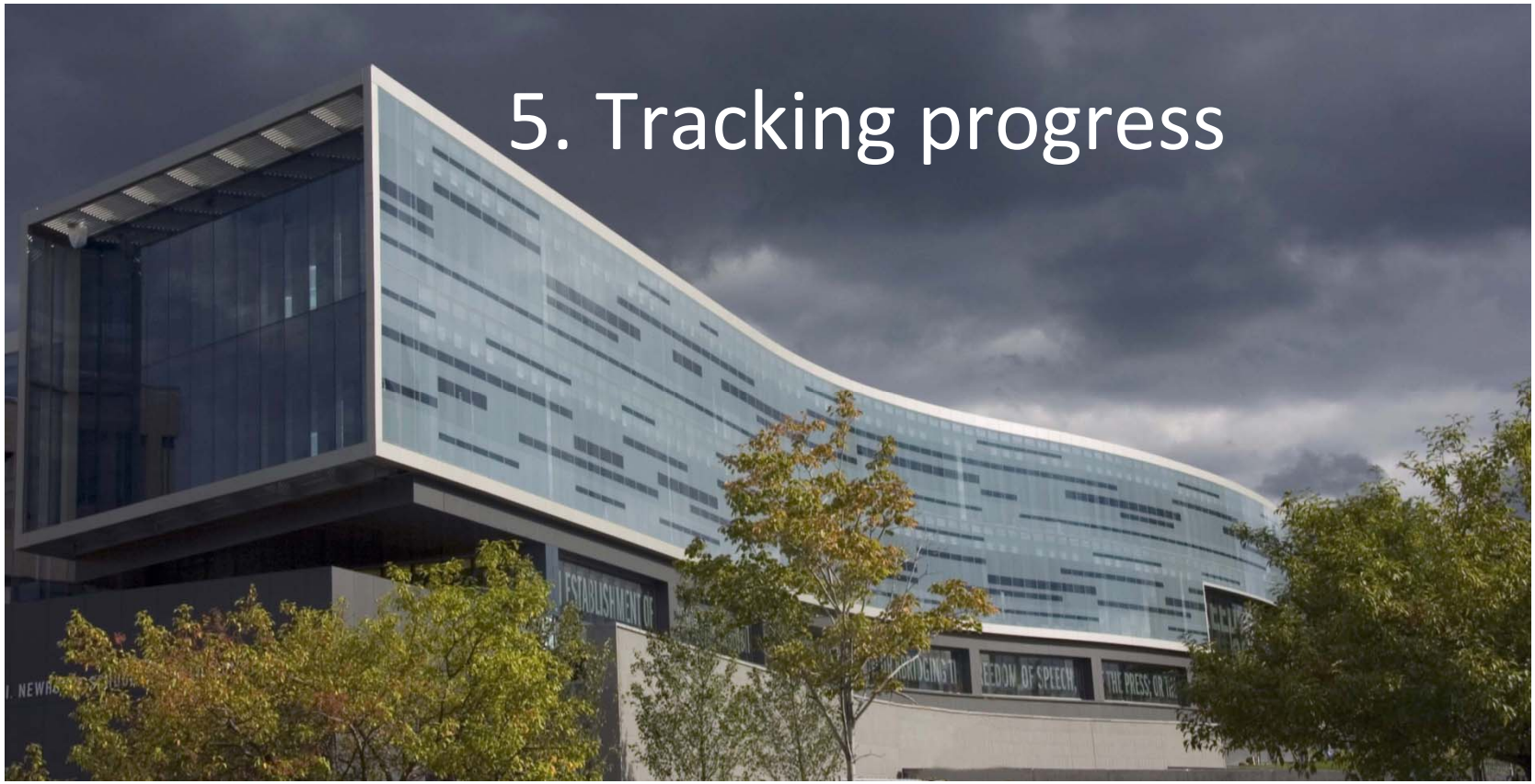
The University already has a large catalog of courses and extracurricular activities available to educate students about the scientific, social, economic and political causes and effects of global climate change; the ethical implications of action or inaction; and the possibilities for solutions that informed creative thinking can supply. From this catalog of more than 150 courses, students are encouraged to engage on both a scholarly and practical level. They can learn about the interdependent biological, chemical and physical systems of the changing climate or the ways in which cultures try to adapt to altered environments. They can help build experimental renewable energy plants or craft campaigns to help local communities adapt sustainable practices. Courses being offered vary from "Green Technology and Sustainability," an environmental engineering class; to "Climate Change: Science, Perception and Public Policy," a public policy course; to a new "Sustainability Science Communications" program that brings together science and journalism students in order to teach them how to help the public better understand complex sustainability issues. A second team of the Sustainability in the Curriculum Task Force is currently surveying the campus community to identify and categorize offerings and assure awareness of existing campus sustainability resources.

4. Sustainability research



Syracuse University has a broad-based portfolio of research programs that address energy sources, conversion and utilization, and the effects of energy production on the environment. One research thrust is the development and application of new technologies to improve energy generation and efficiency. To enable this research and with support from New York State, the University established the Syracuse Center of Excellence in Environmental and Energy Systems (Syracuse CoE). The unique Syracuse CoE experimental building is highly instrumented to monitor and assess energy and water use, indoor environmental quality and outdoor air quality. The Syracuse CoE building is also a living laboratory that includes state-of-the-art facilities and space for collaboration between faculty and industrial partners to develop innovations to reduce energy demand and impacts. A second research thrust is investigation of the effects of global change on soil, water quantity and quality, ecosystem function and biodiversity. A recent highlight of this effects research is an effort to downscale results from Ocean-Atmosphere Global Circulation Models to a local-scale watershed model to assess the future effects of climate change on the quantity, distribution and quality of water in high-elevation watersheds across the U.S. High-elevation areas are critical to the water supply of the U.S.

Information regarding SU's involvement in current research projects at the Syracuse CoE, through other research centers and partnerships and by means of a newly established Sustainable Initiatives Fund, is included as Appendix D.


5. Tracking progress

On the simplest possible level, Syracuse University will assure that campus GHG emissions decrease at least at the rate projected in this Climate Action Plan by conducting annual GHG inventories and comparing the results to the trajectory presented in Section 2. However, SU has decided to take a proactive stance with regard to institutional energy consumption and emissions. For Scope 1 (direct) and Scope 2 (purchased utilities) emissions, the University will move toward real-time monitoring of energy consumption, continuous auditing of building and other facility performance, and incidental (end-project and post-project) review of results of projects intended to mitigate GHG emissions.

Syracuse University's baseline GHG inventory was conducted on an *ad hoc* basis, combining trial-and-error data collection exercises, a minimum of computer automation (word processing, spreadsheets and presentation software), and a significant level of manual calculation and estimation. While this was entirely appropriate for a local-first-of-its-kind exercise, it is neither an efficient nor a truly effective means of addressing a regular reporting requirement. Since signing the PCC, the University has become a voluntary reporter of GHG emissions to The Climate Registry. As a result, an annual GHG inventory conducted using an approved and auditable methodology is now required; the sort of *ad hoc* methodological compromises made during the preparation of the initial PCC GHG inventory are no longer acceptable.

However, a need to perform robust GHG emissions accounting is, in effect, an opportunity to measure and manage energy consumption more tightly and proactively. Syracuse University has determined to seize this energy management opportunity, thereby assuring that not only the emissions targets but also the financial projections contained in the CAP will be met. SU's new Climate Operations Center will provide the mechanism by which this proactive measurement and management (at least for Scope 1 and Scope 2 emissions) will be achieved. Additionally, the center will create a base of historical data, providing a repository of energy information available for educational and awareness use across the campus.

The Climate Operations Center will build upon the capabilities already embodied in the University's leading-edge Energy Operations Center. This facility – staffed 24 hours per day, 365 days per year – is responsible for monitoring, troubleshooting, and programming SU's Andover Continuum building automation system, which oversees thousands of pieces of equipment and hundreds of thousands of constantly changing data variables to control heating, cooling, ventilation, lighting and building access across campus. Personnel working alongside Energy Operations Center staff are additionally responsible for energy procurement, energy accounting, and the University's participation in energy-related grant and low-interest loan programs.

In addition to data that originates within the Andover Continuum system, Energy Operations staff also access data from the University's Facilities Administration & Maintenance Information System (building square footage and floor plans), a Square D Power Measurement campus metering system, weather information from the National Weather Service and energy cost information from the University's energy accounting system. Already in 2009, Syracuse University has integrated information from most of these sources within the Andover Continuum system. As a result, SU has a system in place that is capable of producing complete, accurate, and up-to-date Scope 1 and Scope 2 GHG emissions reports in support of both PCC and The Climate Registry reporting requirements.

Enhancing the existing Energy Operations Center to create a Climate Operations Center will require creating

- A repository of information describing energy usage by form and location, chronologically correlated with equipment status and operational readings
- Algorithms to periodically compare actual energy usage to CAP-determined usage targets and flag out-of-tolerance variance conditions
- Filtering and reporting logic that will monitor building performance and continually assure performance that matches current building design specifications
- Real-time information feeds from central monitoring facilities to on-campus kiosks, SU's sustainability web site and community information services

Management of Scope 3 (indirect) emissions will not be addressed by the Climate Operations Center, as the University has no direct role in – and so no direct data regarding – the creation of Scope 3 emissions. Under terms of the PCC, signatories are encouraged to include Scope 3 emissions from both local commuting and university-paid air travel in their GHG totals. SU intends to decrease the levels of these emissions by expanding the use of videoconferencing and improving local transportation options. (See Appendix C.) Related to the videoconferencing thrust, SU has initiated a project that will make more complete and accurate air travel data available.

- A high-volume climate and campus operations data warehouse that will retain key energy, emissions and environmental information for years of campus operations, creating a valuable data store for scholarly and industry analysis as well as an overarching perspective to facilitate the University's own climate and energy planning, analysis and management

For every energy conservation, energy efficiency or supply-side project initiated as a result of this Climate Action Plan, Syracuse University is determined to assure that project design goals are met or exceeded. For example, if a building enhancement project is justified (in part or in whole) on the premise that energy consumption for heating and cooling will be decreased by 20 percent, SU is committed to determining by actual measurement and analysis that this level of performance is achieved and sustained over time.

To support Syracuse University's objective of creating a useful empirical base of building operation and energy use time-series data, the Climate Operations Center will also require an information integration and presentation tool capable of creating a simple, yet comprehensive, perspective for data selection and filtering by academic researchers, operational analysts and interested students. Syracuse University is currently reviewing commercially available product and service offerings, in search of such an integration and presentation tool that incorporates:

- A secure web site to view data from all campus information management control systems (regardless of manufacturer or location)
- A flexible design to allow storage and standardization of data from any energy management control systems or input system without loss of information
- Scalability to accommodate the addition of future systems on campus
- Real-time automated data collection and processing
- The capability that data from any time period can be selected, graphed and exported to spreadsheets for further analysis
- Alarms if project or campus operating data veers outside pre-established parameters.

By this integration of process-control and information technologies, including automated representations of the ever-decreasing GHG emission targets established by this Climate Action Plan, Syracuse University intends to position itself fully to assure institutional compliance with terms of the PCC.


6. Financial implications and projections

It is clearly impossible to make accurate detailed predictions regarding the financial costs or attractiveness of GHG mitigation projects 10 or 20 years into the future. Indeed, the overall governance structure of the Climate Action Plan is designed specifically to avoid the need for such predictions. Rather, the CAP is premised on, and gains its assurances of economic feasibility from, an assortment of general long-term trends that are likely to continue more or less unabated, combined with a variety of uncertain but likely events that – if and when they occur – will amplify those trends.

Major long-term trends that are expected to continue into the future include rising conventional energy prices (especially fossil fuel prices) and gradually decreasing capital costs for clean renewable energy technology. Likely – although unknowable – events include the development and commercialization of new energy efficiency and generation technologies and the imposition of some form of cost for emission of GHGs (be it a national or global cap-and-trade system, a "carbon tax", the effects on utility rates of the existing Regional Greenhouse Gas Initiative, or anything else).

Combining these various factors, a general pattern emerges by which energy conservation (infrastructure upgrade and behavioral modification) projects are financially attractive in the immediate term, energy efficiency projects (major demand-side technology shift, such as all-electric vehicles or passively heated buildings) become attractive in some middle term, and supply-side projects range from middle-term (*e.g.*, biomass conversion of the existing steam station) to longer-term (*e.g.,* wind power or solar photovoltaic) attractiveness.

In order to assure SU's ability to take advantage of attractive project opportunities as they develop, the University has established a stable long-term funding stream. Beginning in fiscal year 2011 and extending at least until climate neutrality is achieved, SU will provide CAP-designated capital funds. Funding levels will accelerate annually during the period from 2011 until 2022 and then remain constant (adjusting for inflation) for the duration of the program. The level of funding committed is designed and intended to achieve SU's GHG reduction targets.

<u>Conventional energy prices will continue to rise</u>

One of the key determinants of economic feasibility for any energy conservation, efficiency or substitution (supply-side) project is the price of energy itself. While SU's Climate Action Plan is projected to continue through fiscal year 2040, reputable energy price predictions are available only through 2030; predictions vary as to the extent of likely price increase over even this shorter period. Still, there is no reason that energy price trends over the next two decades should somehow reverse at the end of that period, and, while specific predictions vary, all reputable predictions share an expectation of significant price rises for conventional energy into the future.

Two respected institutions charged with publishing predictions of future energy pricing are the Energy Information Administration of the US Department of Energy (EIA) and the Comptroller of Public Accounts for the State of Texas. (Texas generates significant tax revenue from its

production of fossil fuels, so energy pricing has significant state revenue and policy implications.) The following table includes data selected from recent publications of the two offices, reflecting predictions of pricing for forms of energy that make up the bulk of SU's consumption.

Information Source	Energy Category	Current (2009/2010) Price (units vary)	2030 Price	% increase
Energy Information Administration (US DOE)	Fuel oil	16.97	36.16	113%
	Natural gas	9.19	15.97	74%
	Electricity	24.23	38.13	57%
Texas Comptroller of Public Accounts	Crude Oil	41.62	128.60	209%
	Natural gas	5.29	11.63	120%

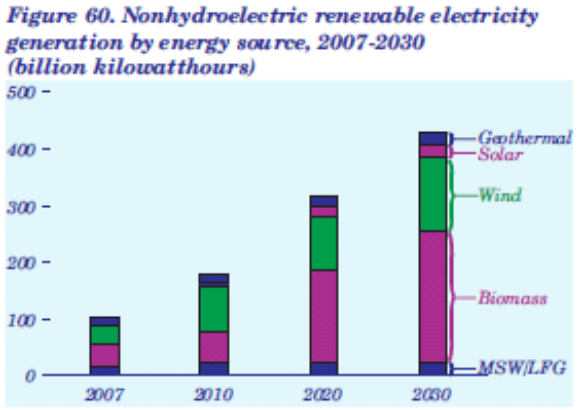
Future Energy Pricing

Sources: http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2009).pdf
http://www.window.state.tx.us/taxinfo/proptax/cong09/

Based on these and similar projections, it seems safe to assume that energy costs over the next 20 years, even at a constant purchase volume, will increase on the order of 50-100 percent. Linear extrapolation, then, yields a likely increase by 2040 of 75-150 percent. And even these projections may be too conservative, as demand for natural gas may well expand out of proportion to global economic growth due to developed countries' desire to decrease GHG emissions and other pollutants worldwide. (Note that SU's steam station is currently fueled entirely with natural gas.)

Capital costs for renewable energy generation will continue to fall

Over the same two decades, capital costs for renewable generation of electricity are projected to fall. The Energy Information Administration projects that renewable generating capacity will more than double between 2010 and 2030, as shown:



Source: http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2009).pdf

As renewable energy capacity is expanded and the enabling technologies mature, capital costs will decrease by EIA estimates:

Projected Reduction in Capital Costs (2006$/kW) from 2010 to 2030 (%)

Biomass	Hydro	Landfill Gas	Wind	Solar PV	Solar Thermal
(19%)	(11%)	(6%)	(12%)	(25%)	(28%)

Data source: http://www.eia.doe.gov/oiaf/aeo/pdf/0383(2009).pdf

Energy conservation projects are already economically attractive

Working with its strategic partners, Syracuse University has sampled its inventory of existing buildings and identified major categories of energy conservation projects that present attractive payback potential. Looked at in terms of potential GHG reduction (and extrapolated to the campus as a whole), these include:

Categories of Opportunities for Reduction of GHGs through Energy Conservation

Category of Emissions Reductions Opportunities	Examples	GHG Reductions Potential (MTCO2e)	
Demand-side reductions through technology	Energy efficient lighting, more efficient boilers, steam pipe insulation, energy management system recommissioning	Electric:	10,727
		Natural Gas:	1,564
		Steam:	6,174
		Chilled Water:	404
Demand-side reductions through behavior change	Videoconferencing, increased parking rates and/or carpooling incentives (to discourage single car commuting)	Electric:	2,239
		Natural Gas:	192
		Steam:	485
		Chilled Water:	202

From a financial perspective, near-term projects to address these opportunities are financially attractive, offering simple payback periods of no more than seven years:

Projected Financial Parameters for Energy Conservation Projects

Types of Emissions Reduction Projects	Annual Cost Savings					Approx. Simple Payback w/o Incentives
	Electric	Natural Gas	Steam	Chilled Water	Total	
Demand-side technology	$2,706,548	$339,732	$2,529,029	$444,549	$6,019,857	7.0 years

Types of Emissions Reduction Projects	Annual Cost Savings					Approx. Simple Payback w/o Incentives
	Electric	Natural Gas	Steam	Chilled Water	Total	
Demand-side behavior	$565,000	$41,667	$198,689	$222,274	$1,027,630	5.5 years

Category of Emissions Reductions Opportunities	**Examples**	**GHG Reductions Potential (MTCO2e)**	
Supply-side management	Biomass/Cogen Central Plant, Solar energy systems, wind energy systems, biofuel energy systems, fuel switching for current generation assets	Electric:	8,324
		Natural Gas:	0
		Steam:	24,248
		Chilled Water:	2,022

Type of Emissions Reduction Projects	Annual Cost Savings					Approx. Simple Payback w/o Incentives
	Electric	Natural Gas	Steam	Chilled Water	Total	
Supply-side management	$1,065,524	$0	$1,149,750	$0	$2,215,274	14.8 years

Supply-side projects will become economically attractive

As the capital costs of supply-side technologies come down and market prices of current conventional forms of energy rise, the economics of supply-side projects will likely improve. As a result, supply-side projects are anticipated for implementation only some years into the process of the CAP. Addressing conservation projects with shorter payback periods in the near term and other forms of projects as cost/benefit ratios improve will enable the University to attain maximum GHG emission reduction while responsibly investing its financial resources.

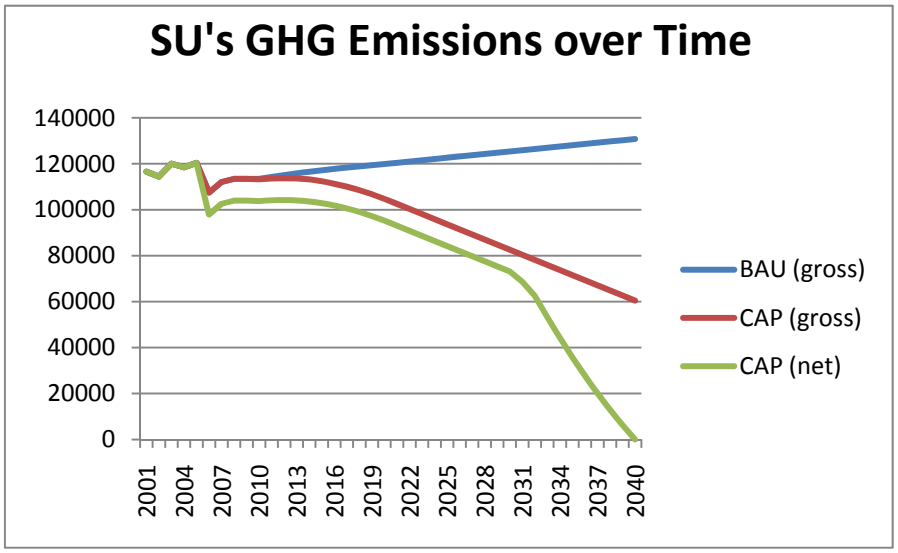
Funding will achieve SU's GHG reduction targets

Syracuse University has committed to providing sustained funding in support of its Climate Action Plan for the period necessary to achieve carbon neutrality. Based on current project cost estimates and potential for GHG emissions reduction, this funding stream will allow implementation of projects achieving the following levels of GHG reduction:

Total Metric Tons of CO2 Eliminated by Type of Project

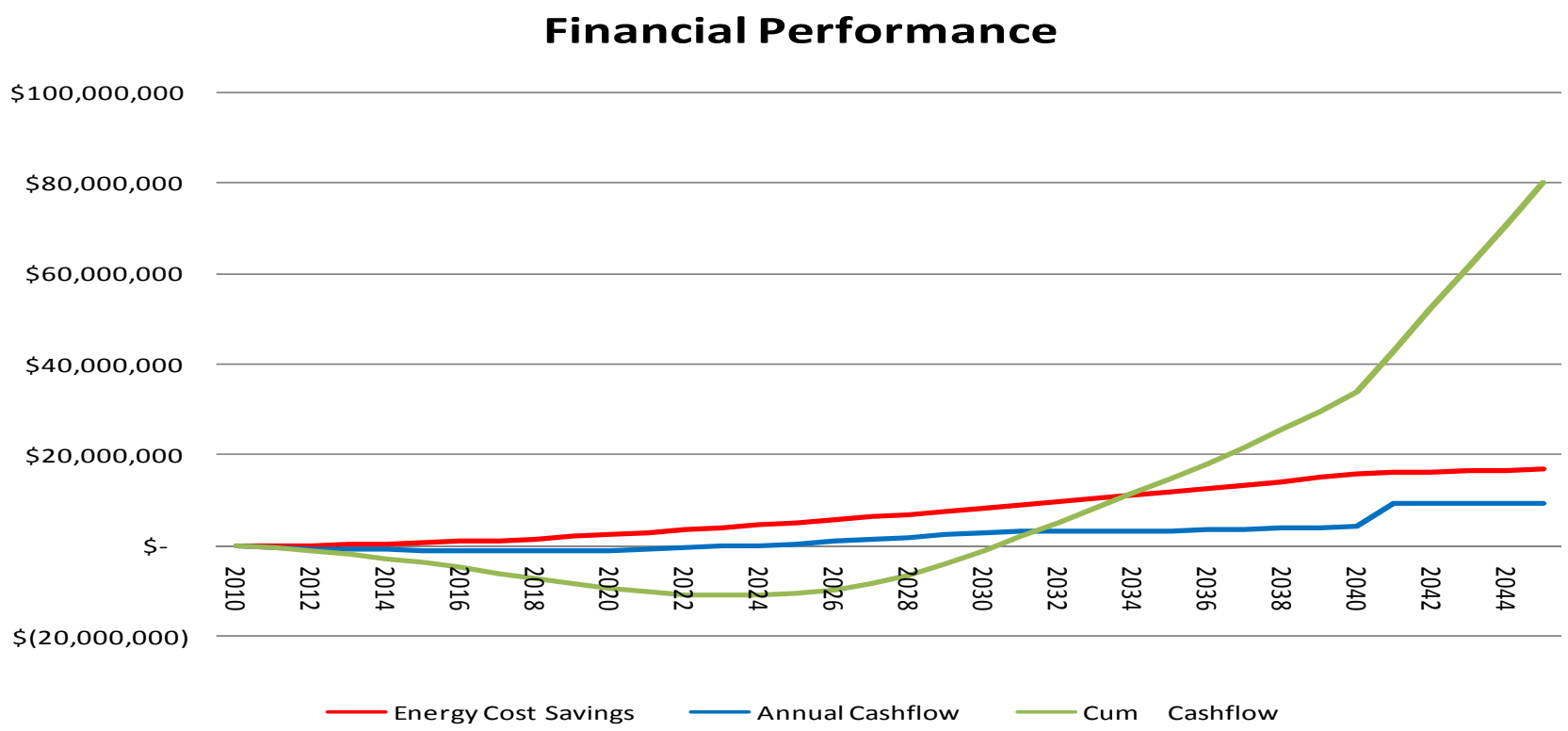
Project Category	% GHGs Reduced	Facilities Projects	Non-Facilities Projects	Total
Demand - Technology	18%	18,870	1,370	20,239
Demand - Behavior	9%	3,118	7,720	10,839
Supply-side	31%	34,595	1,128	35,723
RECs / Offsets	42%	16,176	32,670	48,847
Totals	**100.00%**	**72,759**	**42,888**	**115,648**

Thus, even presuming that no capital cost reductions occur and that no project payback periods are reduced, the Climate Action Plan positions the University to achieve a trajectory toward carbon neutrality as indicated.



The Climate Action Plan more than pays for itself

And based upon the same set of current-technology assumptions, the cumulative savings will compound, as each year SU will decrease the amount of energy it purchases. Savings start small but compound at a high rate (on the order of 10-15 percent, on average). As a result, the annual savings realized by purchasing less energy will exceed the annual expense of implementing CAP projects around fiscal year 2023. Subsequently, around fiscal year 2030, the sum total of savings to date will match or exceed the sum total of program expenditures to date. From that point forward, since savings increase every year while program expenditures (adjusted for inflation) remain constant, the Climate Action Plan and the projects resulting from it will make a net positive contribution to Syracuse University's financial well-being.


Financial Performance
$100,000,000
$80,000,000
$60,000,000
$40,000,000
$20,000,000
$-
$(20,000,000)
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
Energy Cost Savings
Annual Cashflow
Cum Cashflow

7. Implementation and integration

Syracuse University's Climate Action Plan is designed as an integrated whole. The plan achieves a workable balance among GHG reduction through conservation and efficiency projects (both infrastructure projects and behavioral efforts); generation of clean, renewable energy from a variety of sources; research to advance the state of a number of sustainability-related technologies and practices; a long-term funding stream designed to support both on-campus GHG mitigation and – as required – the eventual purchase or other funding of GHG offsets; and education, awareness and intentional involvement to keep members of the campus community engaged in the University's sustainability initiatives.

The issue of community engagement – particularly student engagement – was a key consideration throughout the development of the CAP. As a signatory to the PCC, Syracuse University is committed to eliminating its net emissions of greenhouse gases, and therefore its measurable contribution to global climate disruption. On a more significant level, however, our attainment of a climate neutral campus is the least important aspect of our efforts. The modest contribution a thousand-acre campus can make to climate change mitigation pales in comparison to the impacts our graduates will have, collectively and over the coming decades, as they take their places in an increasingly global society.

Thus, SU's Climate Action Plan is designed not just to create a climate neutral and sustainable campus, but also to actively promote climate leadership on the campus, which in itself promotes sustainability.

8. Acknowledgements

Chancellor Nancy Cantor has provided the leadership and courage to make visionary commitments on behalf of Syracuse University.

SU's sustainability efforts have been sponsored and supported by Louis Marcoccia (Executive Vice President and Chief Financial Officer) and Eric Spina (Vice Chancellor and Provost).

SU's Division of Sustainability drives our innovative climate neutrality and sustainability efforts: Steve Lloyd, Ann-Catherine Browne, Melissa Cadwell and Rick Martin.

Many individuals dedicated their time to developing this plan and the platform for SU's sustainability investments. Members of three President's Climate Commitment (PCC) committees contributed significant oversight and guidance:

Steering Committee	Climate Action Plan Committee		Sustainability in the Curriculum Task Force		
Mitchel Wallerstein, *Chair*	Steven Brechin, *Co-Chair*	Esther Gray	Gerry Greenberg, *Co-chair*	Charles Driscoll	Sarah Pralle
Eric Beattie	Rebecca Reed Kantrowitz, *Co-Chair*	Jack Matson	Timothy Stenson, *Co-chair*	Norm Faiola	Richard Smardon
Doug Daley (ESF)	George Athanas	Sara Miller	Elet Callahan	Susana del Granado	Laura Steinberg
Charles Driscoll	Frederick Carranti	Kevin Noble	Sharon Dotger	Esther Gray	Donald Torrance
Esther Gray	Ross Diliegro	Nathan Prior	David Driesen	R. David Lankes	Elizabeth Wallace
Tim Sweet	Corey Goyeneche	Tim Sweet		Sarah McCoubrey	Tim Wilke
Donald Torrance		Donald Torrance		Michael Pelken	
		Scott Webster			

Photos are courtesy of SU's Photo and Imaging Center.

Finally, several outside organizations have contributed to SU's sustainability efforts. NYSERDA – the New York Energy Research and Development Authority – continues to provide visionary leadership in energy efficiency, making New York a leader in sustainability.

O'Brien & Gere assisted with the engineering and scientific analyses integral to the development of this plan.

Constellation Energy helped develop the analyses and recommendations in this report.

9. Appendices

Appendix A – GHG Inventory

Syracuse University's GHG inventory undertook to estimate the volume of SU's emissions of six specific greenhouse gases; emissions of methane, sulfur hexafluoride, nitrous oxide, perfluorocarbons and hydrofluorocarbons were converted and expressed as volumes of carbon dioxide, based on factors expressing each gas's relative forcing of greenhouse effect. The time period addressed in the inventory was fiscal years 2001 – 2007; an average of these years serves as the baseline period against which SU's efforts to reduce greenhouse gas emissions will be measured.

The scope of the inventory was limited to SU's operations in Onondaga County plus commuting behavior of students and employees based at Onondaga County locations, air travel paid directly by University-owned "travel and entertainment" credit cards, and air travel necessitated by SU's various study abroad programs. Activities responsible for generating greenhouse gases within each of these categories could be estimated comprehensively and with acceptable accuracy. This scope incorporated the activities commonly addressed in other campus GHG inventories. It allows useful comparison between SU's emission levels and those at other universities, both in total and on a per-student or per-square-foot basis. It addresses the major sources of emissions identified by universities that have done GHG inventories in the past, and set the stage for implementing the University's Climate Action Plan.

SU's GHG inventory was conducted in accordance with the Greenhouse Gas Protocol published by the World Resources Institute and the World Business Council for Sustainable Development. Our efforts were facilitated by our use of the Clean Air-Cool Planet Campus Carbon Calculator (v. 5.0), a tool explicitly recommended in the implementation guidelines accompanying the PCC. The major sources of GHG emissions at SU were identified as:

- Purchased electricity
- Purchased steam and chilled water
- Student and employee commuting
- Air travel

The four major sources account for some 93 percent of all identified emissions.

Further information regarding the conduct and results of Syracuse University's GHG inventory is available online at http://greenuniversecity.syr.edu.

Appendix B – BAU emissions projections

In order to determine the amount by which Syracuse University's GHG emissions have been reduced, it is necessary to estimate what they would have been had the CAP not been implemented. This estimate of emissions under a "business as usual" (BAU) scenario is computed by adjusting baseline emissions (for the fiscal years 2001-2007) for anticipated growth, both in student enrollment and in square feet of built space. As the University grows, its GHG emissions will naturally increase, all other things being unchanged.

Calculating BAU emissions, then, requires estimating SU's future growth – which, in turn, requires making certain assumptions. As with other aspects of the CAP, SU has erred on the side of caution. In this case, caution equates to estimating growth that may be greater – again, both in enrollment and in built space – than will actually occur.

University growth over time is determined by a wide range of factors, including population statistics, labor market demands, national and global economic conditions, institutional finances, the school's academic offerings and reputation and – in future – the capacity and perceived desirability of competitors overseas. As a rule, campus plans – both at SU and at other institutions – have been more influenced by current conditions during the planning period than has proven warranted. That is, plans developed when growth was strong tended to be overly optimistic, while plans created during periods of more modest growth (or even shrinkage) tended to underestimate future demand.

SU's most recently published master plan is the Campus Plan published in September of 2003.[1] Its third and fourth chapters describe the history of planning at the University and demonstrate the pattern just described. Accordingly, the authors of the plan made a concerted effort not to make the same mistakes. Writing during the effects of what has been called the "echo boom" (the national surge in population growth occurring some 25 years after the post-WWII "baby boom") and the highest post-secondary enrollments in national history, they foresaw the end of that enrollment bubble and projected only moderate institutional growth over the long term.

Events since 2003 raise the strong possibility that even those intentionally moderate projections, however, may be too high. Reflecting a trend over the last half-century, the Campus Plan presumes a continuing increase in square feet of built space per student enrolled. This national pattern – driven by the need to attract top-quality students in an increasingly competitive enrollment environment – may well reverse itself; the higher education sector as a whole has determined to reduce its environmental impact, and this cannot be achieved by constantly building more square feet of enclosed space. Many schools – Syracuse University very possibly among them – may decide to compete for students by offering not *more* space but *better* (including more environmentally responsible) space.

[1] Available online at <http://cpdc.syr.edu/CPDC/uploads/CampusPlan.pdf>.

Still, the Climate Action Plan is based on assumptions of future institutional growth consistent with those reflected in the Campus Plan of 2003. In that plan, the University estimated that the capacity for new building space on the Main Campus was 3,420,000 gross square feet (GSF). Adding this capacity to the built space present in 2003 (7,293,000 GSF) suggests that the University's Main Campus built space has the potential to reach 10,713,000 GSF. In preparing the CAP, a constant growth rate equating to 76,543 GSF per year was assumed. This rate of growth is similar to the actual increases in campus GSF experienced during the baseline period , and yields the total of 10,713,000 GSF (from the 2003 plan) by mid-century.[2]

For growth in SU's student enrollment, no long-term institutional projection is publicly available; any projection must be based solely on historical data. University enrollment growth has varied widely over the years. During the baseline period (fiscal years 2001-2007), enrollment grew at a rate of approximately 239 ± 84 full-time equivalent (FTE) students per year. However, as noted earlier, this growth occurred in part due to a temporary demographic phenomenon (the "echo boom") that has already peaked. Additionally, SU is already one of the largest private universities in the United States and may well be approaching a practical limit on single-campus enrollment. Thus, for purposes of BAU projections, FTE enrollments are projected to increase by 100 students per year through 2014 and remain constant thereafter.

Each estimate of future growth has been used to project future emissions that are likely to increase as a result. That is, the estimate for growth in gross square feet has been used to compute increased BAU emissions from stationary combustion (primarily, fuel oil and natural gas used to heat smaller buildings on campus), purchased electricity, purchased steam and chilled water. The estimate for student enrollment growth (acting as a proxy for growth in the campus community as a whole) has been used to compute increased BAU emissions from mobile combustion (operation of vehicles on campus, predominantly campus shuttle bus service), commuting of students and employees, and air travel).

For each source of emissions, emission intensity (emissions per GSF or per FTE) was presumed to be constant, with the sole exception being that emissions per marginal (new or additional) GSF were estimated at 70 percent of the average for existing built space. The 30 percent reduction is no mere hypothesis or aspiration but is premised on three facts.

1. SU has established a policy by which all new construction will be built to LEED-certified standards.
2. The experience of other colleges and universities that have constructed LEED-certified buildings and achieved roughly a 30 percent level of energy reduction.
3. The specific results (modeled and measured) in terms of reduced energy demands from SU's current cohort of buildings designed to achieve LEED-certified (or better) performance.

[2] SU's actual growth during fiscal years 2001-2007 was 73,000 GSF per year, plus or minus 39,000.

Emissions intensities per GSF or per FTE were calculated based on data from the GHG Inventory, which covered fiscal year 2001 through fiscal year 2007. Intensity factors were calculated as follows.

Emission Intensity	Mean	95% Confidence Interval on Mean*
Purchased Electricity (metric tons CO_2E per Thousand GSF)	5.50	5.45 - 5.55
Purchased Steam and Chilled Water (metric tons CO_2E per Thousand GSF)	3.83	3.66 - 4.01
Stationary Combustion (metric tons CO_2E per Thousand GSF)	0.84	0.81 - 0.88
Mobile Combustion (metric tons CO_2E per FTE)	0.14	0.13 - 0.15
Commuting (metric tons CO_2E per FTE)	1.20	1.12 - 1.28
Air Travel (metric tons CO_2E per FTE)	1.21	1.18 - 1.25

* - based on t-statistic for normally distributed data

Using mean intensity factors, "business as usual" emissions through fiscal year 2040 are projected as follows.

Fiscal Year	*Student Population (FTE)*	*Building Space (thousand GSF)*	*GHG Emissions ($MTCO_2e$)*	*GHG Emissions Growth*
2001-2007 (avg.)	16,862	7,425	115,684	baseline
2020 (proj.)	18,277	8,541	119,928	4%
2030 (proj.)	18,277	9,267	125,368	8%
2040 (proj.)	18,277	9,993	130,809	13%

Appendix C – Project Summaries

The potential projects that were considered for purposes of estimation are as follows:

Component 1 – Analysis/Behavior/Communication/Demonstration/Education

Green Computing Across the Campus

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
6.4	$2,900,000	$5,000,000	$790,000	2,442

The Syracuse University Green Data Center, currently under construction on South Campus, will serve as a model of efficiency for energy-intensive computer facilities and a laboratory for related research. The 12,000-square-foot, $12.4 million building is expected to use 50 percent less energy than a typical data center through a combination of cutting-edge technologies. It is a partnership between the University and IBM Corporation. The center has also received funding from the New York State Energy Research and Development Authority (NYSERDA).

Cutting-edge energy efficiency features include:

- On-site tri-generation (electricity, heating and cooling)
- Dynamic server virtualization
- Direct current (DC) power system
- Thermal transfer cabinets


Syracuse University Green Data Center

Consistent with the resulting increase in data center energy efficiency, SU will undertake a multi-year implementation of energy-efficient desktop and peripheral computing infrastructure, *e.g.,* replacing current-generation PCs with “thin client” workstations where appropriate, consolidating work-area printers without reducing employee efficiency, and installing “smart” power controllers to reduce unnecessary electrical load.

Demonstration projects for solar and wind generated electricity

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
13.6	($175,000)	$2,000,000	$146,600	580

Given increasing opportunities through the introduction of stimulus dollars and aggressive tax incentives, SU is very interested in exploring the possibility of demonstrating these technologies on campus.

SU will evaluate solar PV options for their demonstration/educational benefits as well as for potential to become a major supplier of campus electricity. The first area to be evaluated will be South Campus, due to the abundance of purchased electricity in use.

The demonstration of an on-site wind generation system will be one of the first renewable initiatives undertaken, in an effort to develop cost-effective high visibility educational renewable energy production on campus. The Skytop area has been selected due to its elevation relative to the surrounding landscape.

Both of these technologies will have the benefits of lowering SU's energy costs and emissions. However, the contribution to students' educational experience and exposure to new ideas will be the major benefit to the campus community.

Component 2 -Energy Conservation through Existing Technologies

Improved controls and lighting fixtures

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
5.3	$2,650,000	$5,525,000	$1,050,000	4152

Lighting technology and controls have made dramatic cost effective improvements since the campus's last upgrade. This project will focus on campus interior lighting with emphasis on energy efficiency, new and emerging technologies, color rendering, new layouts and usage based technologies and daylight/dimming controls. The benefits of this will be work space improvement and energy savings.

Pedestrian, roadway and building exterior lighting is a mix of various types of luminaries. These fixtures will be improved in energy efficiency, on and off scheduling, and light distribution. There is a concern with light pollution; a number of existing luminaries are not Dark Sky Compliant. In order to qualify for certain points in the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design Programs (LEED), light pollution reduction must be addressed. Still, safety will always be the overriding factor in fixture selection and light dispersion.

Increase heat recovery in existing facilities

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
9.1	$130,000	$1,900,000	$209,000	977

Heat can be recovered on a university campus from many sources, including clothes dryers, ventilation air, cooking hoods, cooling equipment, and boiler exhaust. This heat (in many cases low-grade) can be used to preheat air, water or glycol for many space heating, domestic hot water and process applications. Many buildings at SU currently employ heat recovery systems in the form of heat pipes, glycol systems, heat wheels, etc. These systems become particularly cost-effective in buildings with high ventilation rates, where heating is typically the most costly. Once infrastructure is in place, this is a free heat source.

Optimize energy and operations at athletic and recreational facilities

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
7.6	$400,000	$1,425,000	$188,000	743

Syracuse University's athletic and recreational facilities are utilized on extended schedules and have unique lighting and environmental requirements. For purposes of estimation, Tennity Ice Pavilion was used as a proxy for all such facilities. Ice rinks typically consume a tremendous amount of energy, and major technological and efficiency improvements have occurred since Tennity was constructed in 2000. A few of the opportunities to reduce energy and emissions come in the form of a low-emissivity envelope, high-efficiency compressors, humidity controls, continuous commissioning and seasonal scheduling.

Improve water conservation across campus

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
11.63	($157,000)	$950,000	$82,000	344

The price of water in Central New York is low, so water conservation is less attractive financially than other energy opportunities. However, water conservation remains a focus at the University. An audit should be conducted in all facilities to ensure that proper hot water settings are in place, low-flow fixtures are installed where feasible and a water conservation education and awareness plan is rolled out to the University community. All new construction will emphasize innovative water use management. The potential to utilize gray and rain water capture systems will be investigated. Water and sewer bills will be reduced as these strategies are put into place.

Expand use of videoconferencing to decrease air and local travel

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
1.9	$3,900,000	$950,000	$500,000	4094

Air travel is a major contributor to the SU campus GHG footprint. Technology has advanced so that videoconferencing could be an alternative to some forms of travel. Flights and cross-campus travel could be reduced utilizing this technology. Many options are becoming available for webinars, online courses and video meetings with digital records and document sharing, all to be explored for additional and intrinsic value. This initiative has the potential to significantly lower the campus carbon footprint and travel expenses. Additionally, air travel expenses and miles flown are some of the most difficult carbon-emitting activities to track for purposes of GHG accounting. Presently SU does not have a central travel agent, billing system or management system to accurately account for all travel. A combination

accounting/software solution should be investigated. If an attractive approach is identified, this could become the flagship project for Component 2.

Manage campus solid waste

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
1.8	$212,500	$50,000	$27,650	variable

Several sustainable initiatives are at very preliminary stages, including composting of organic materials from food preparation, starting an outdoor recycling program and recycling of materials from facility renovation projects. A campus waste audit should be conducted to measure and verify the types and amount of waste generated. From those results a comprehensive plan to address the disposal of the tons of waste generated would be produced. GHG reductions will vary, depending on the future market for recycled materials. Proposed efforts include:

- Investigating the feasibility of composting waste in all facilities. Use compost in lieu of chemical or petroleum-based fertilizers for grounds efforts.
- Exploring the practicality of an on-campus composting facility.
- Expanding recycling and composting through educational efforts.
- Standardizing waste collection containers to create an identifiable look across campus. Implement a color coding program for containers based on type of waste they collect.

Establish a campus re-use center to collect and distribute supplies and materials that are no longer needed by the campus community department. Student employees could manage and operate this endeavor, perhaps modeling it after the Purchasing Department's Excess Property Program.

Improve local transportation options

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
7.1	$1,035,000	$2,850,000	$400,000	4,500

Currently the University offers a free, convenient and environmentally friendly shuttle bus system in partnership with Centro, our local mass transit organization. Expanded and new efforts to consider are:

- Combining and computerizing the carpool and ride share programs. This would increase participation by making commuting faster, easier and more convenient. In addition, efforts should be undertaken to reach out to other community organizations and institutions to consolidate efforts and reduce single occupancy commuting.
- Analyzing the Zip Car program to determine its effectiveness and evaluate any need to expand.
- Working with Centro to increase the number of Park and Ride locations.
- Instituting a campus-wide “no idling” policy for all vehicles.
- Increasing the accuracy of fuel use records to assist in future greenhouse gas inventories.

Although the Syracuse climate is not conducive to year-round bike use, non-winter bike riding is a viable and increasingly popular transportation option. Initiatives like community bikes or bike-share, bike clubs, promotionalgiveaways, campus bike maps, emergency ride service, free or low-cost repairs, parts centers, covered bike racks and other anti-theft measures, widened paths and sidewalks, free convenient locker/shower facilities, safety courses, instruction, and bike commuter events are all likely to increase bike ridership and reduce the SU footprint while improving the fitness of our students, faculty and staff.

Component 3 - Energy Efficiency through Emerging Technologies

Enhance SU's energy management systems

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
4.2	$5,520,000	$4,275,000	$1,010,000	4,405

To provide active assurance that CAP goals will be met and to create a cutting-edge repository of empirical operations and emissions data, Syracuse University will undertake to evolve its current Energy Operations Center into a state-of-the-art Climate Operations Center that will:

- Capture, store and report detailed and consistent data regarding energy usage by form and location, chronologically correlated with equipment status and operational readings
- Join new and existing SU data sources as "feedstock" for generating statistical and management reports
- Measure and verify performance to the level necessary to satisfy the reporting requirements of the organizations to which SU is committed
- Provide for institutional reporting of progress toward commitments
- Automate custom documents for all organizational reporting requirements
- Operate as an intelligent continuous commissioning system that ensures implemented climate neutrality initiatives are always operating on "specification"
- Provide real-time energy consumption and GHG emission data to on-campus kiosks, SU's sustainability web site, and other information dissemination mechanisms to inform the SU community and create a sense of sustainability as a concrete – not just an abstract – objective
- Enable SU's operations and scholarly employees, working together, to achieve continuous improvement in energy measurement and verification methods and accuracy

Increase the use of alternative-fuel vehicles

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
11.4	($35,200)	$237,500	$21,000	603

One initiative is to explore the use of a biodiesel fuel blend in campus fleet vehicles. This fuel is created at SUNY-ESF from dining center waste fryer oil through a co-op administered by students from both institutions; SUNY-ESF has used this fuel blend on its campus for more than four years with no problems.

Currently there are several gas/electric hybrid vehicles in use by the Department of Public Safety and Physical Plant. Food Services utilizes emissions-free Gem Cars, battery-electric vehicles, and an electric golf cart for special events. SU looks to continue to expand its safe use of electric and hybrid vehicles. In addition, SU is involved with the Clean Cities Program, which hopes to expand the use of alternative fuel vehicles in the area.

Expand the use of ground-source heat pumps (geothermal heating) for heating and cooling

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
12.4	($812,000)	$3,800,000	$308,000	1,220

The best location for large-scale heat pump installation is the South Campus. Many student apartments are heated with electricity. Heat pumps would be three to five times more efficient than the current heating systems. However, South Campus is built on a drumlin with a mix of rock and glacial till, not ideal in terms of geology. The entire area should be studied and tested to determine the viability of a ground source heat pump system. A significant reduction in energy could be achievable.

Component 4 - Supply-Side Enhancements

Convert the central steam plant fuel source to biomass

Simple Payback (years)	Net Present Value	Project Cost	Annual Financial Savings	Annual GHG Reduction (MTCO2e)
14.9	($2,400,000)	$17,100,000	$1,150,000	30,827

In the future, the University may resume operating the boiler plants, currently managed by a third party. Under this scenario, all emissions from the central plant will convert from Scope 2 emissions to Scope 1 emissions. This would give SU the ability to significantly impact its GHG footprint by converting the central boiler plant(s) to biomass. Several higher education institutions of similar scale around the country have already made this conversion. SU will evaluate the potential to impact its footprint and the feasibility of operating such a facility in the City of Syracuse. The University steam system presents a good opportunity for a cogeneration plant, and the campus provides a very good host for an appropriately sized system.

Appendix D – Sustainability research

Substantial sustainability-related research occurs at Syracuse University through projects funded by the Syracuse Center of Excellence in Environmental and Energy Systems (SyracuseCoE). Additional concentrations of research take place in the context of other centers and collaborative groups. To further stimulate research, the University plans to create a Sustainable Initiative Fund, which will provide financial support for faculty and student research and demonstration projects beginning in fall 2010.

Projects Funded by the SyracuseCoE

Syracuse University founded and partners in the operation of the SyracuseCoE, a 200-member industry-university collaborative organization with roots in the L.C. Smith College of Engineering and Computer Science. SyracuseCoE encourages job creation and economic vibrancy in New York State by supporting research, development, and commercialization activities for new technology in its three focus areas of clean and renewable energy, indoor environmental quality, and water resources. SyracuseCoE awards grants for basic and applied research, product prototyping and testing, and commercialization efforts. Those grants have funded, and continue to fund, numerous research projects for members of the Syracuse University faculty. Active projects currently include:

- *Characterization of the Ambient Air Quality in Syracuse, NY, and Identification of its Origins.* This project measures pollution and other characteristics of the outdoor air in Syracuse, New York. It received a $600,000 grant from SyracuseCoE for the period of May 1, 2007- April 30, 2010. It is led by Clarkson University, in collaboration with Syracuse University, Cornell University, and the SUNY College of Environmental Science and Forestry (SUNY-ESF).

- *An Intelligent Urban Environmental System (i-UES) for Central New York Water Resource Management.* Syracuse University leads this study involving robots that monitor and automatically report water quality. The University is collaborating with the Upstate Freshwater Institute. The project received a $600,000 grant from SyracuseCoE for the period of May 1, 2007- April 30, 2010.

- *Open Web Services-Based Indoor Climate Control System, Phase III.* Syracuse University and CollabWorx Inc. are collaborating on a product prototyping/testing effort for technology developed to conserve energy in buildings while addressing indoor air quality and employee comfort. The project is funded by a SyracuseCoE grant of $144,998 for the period of May 1, 2009-April 30, 2010.

- *Analysis and Optimization of a Novel Regenerative Bio-Filter System for Enhanced VOC Removal from Indoor Environments.* This study at Syracuse University analyzes a system that uses interactions between plants and microbes to filter potentially harmful

volatile organic compounds (VOCs) from indoor air. SyracuseCoE has awarded a $100,000 grant for the period of June 2009-May 2010.

- *Reactive Oxygen Species in Particulate Matter: Formation, Elimination, and In Vitro Assessment of Relative Toxic Effects.* Researchers at Syracuse University are examining a specific type of airborne particle inside buildings to better understand if and how it causes respiratory health problems. SyracuseCoE has funded this project in the amount of $100,000 for the period of June 2009-May 2010.

Other Research Centers and Collaborations

In addition to projects funded by the SyracuseCoE, Syracuse University faculty and students are engaged in concentrations of sustainability-related research within the context of other centers and collaborative groups. These efforts span the disciplines and have not been exhaustively catalogued; however, a number of prominent activities originate in the L.C. Smith College of Engineering and Computer Science, the Maxwell School of Citizenship and Public Affairs, and the Whitman School of Management.

The L.C. Smith College established an endowed professorship in sustainable energy studies in 2009. In addition, the L.C. Smith College is home to the Center for Environmental Systems Engineering (CESE). CESE brings together faculty from the departments of Civil and Environmental Engineering and Chemical Engineering and Materials Science. Faculty members within CESE conduct research in environmental assessment and environmental technology.

The Maxwell School's interdisciplinary Center for Environmental Policy and Administration (CEPA) brings together faculty and graduate students from anthropology, economics, geography, political science, public administration, public affairs, and sociology to explore environmental issues from an integrated perspective. CEPA works closely with two other research centers at the Maxwell School, the Center for Technology and Information Policy and the Center for Policy Research. In addition, CEPA works with Syracuse University faculty in the sciences, law and engineering, as well as with faculty at SUNY-ESF. CEPA has ties to the SyracuseCoE, the EPA Region 2 Environmental Finance Center at Syracuse University, and the SU/SUNY-ESF Enspire initiative on interdisciplinary environmental research.

The Whitman School is home to the Sustainable Enterprise Partnership (SEP), which is responsible for the school's new graduate-level Certificate of Advanced Study in Sustainable Enterprise. SEP is a collaborative effort among faculty and researchers from the Whitman School, SUNY-ESF, and SyracuseCoE; it develops trans-disciplinary curricula and fosters research that addresses sustainability from a business perspective.

New Sustainable Initiative Fund

Beginning in fall 2010, the University plans to operate a Sustainable Initiative Fund as a mechanism for encouraging high-profile projects and engaging the campus in sustainability-related research. Established with a modest initial contribution from the University, the fund will provide financial support, on a competitive basis, to research and demonstration projects developed by faculty and students.

Specific guidelines and procedures for applying to the fund will be distributed to students and faculty during the spring 2010 semester. Teams and individuals will submit proposals to the Presidents Climate Commitment Climate Action Plan (PCC-CAP) Committee, which will review the submissions and award the funds, drawing students and research faculty into the process as appropriate.

The PCC-CAP Committee anticipates proposals for a wide variety of projects. These may include, but are not limited to:

- Composting systems
- Energy conservation measures
- Energy generation from exercise equipment
- Gray water systems
- Green roof demonstrations
- HVAC system enhancements
- Interior green spaces
- Natural landscape areas
- Rainwater capture systems
- Recycling program enhancements
- Sustainable soil practices
- Trash audits
- Water conservation measures
- Wind, solar, and other renewable energy demonstrations