6-1-2008

Towards regenerative development: A methodology for university campuses to become more sustainable, with a focus on the University of South Florida

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Towards Regenerative Development: A Methodology for University Campuses to Become More Sustainable, With a Focus on the University of South Florida

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science
Department of Environmental Science and Policy
College of Arts and Sciences
University of South Florida

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Date of Approval:
April 4, 2008

Keywords: restorative, LEED, green building, college operations, facilities planning

ACKNOWLEDGEMENTS

Whales may seem a curious first recipient of acknowledgements, particularly in a thesis centered on sustainable development. However, the journey to reach this goal began with my graduate studies in cetacean ecology over 12 years ago. My experiences with these ponderous creatures provided me the background necessary to deal with university bureaucracies.

As for the humans who assisted and supported me in this project, they are numerous. Tavey McDaniel Capps, the Sustainability Coordinator at Duke University provided valuable insights and information on both her school's efforts and the realities of implementing sustainable development plans at a university. Dr. Richard Flamm of the Florida Wildlife Research Institute provided valuable feedback and suggestions on ways to improve the survey submitted to USF leadership. Dr. Sharon Hanna-West of USF's College of Business Administration lent her support and shared the data collated by her class about some of the sustainable policies and practices at USF. Others who generously shared their time and information about sustainability at USF include Nainan Desai, Barbara Donerly, and Jennifer Isenbeck, as well as those campus leaders who chose to respond to the sustainability survey created for this study. I sincerely thank them all for their time and interest in this research. Further, I would like to thank my employers at VHB, Inc. for their flexibility in scheduling and support for the study.

Special thanks go to my family and friends for their encouragement through all phases of my graduate school career. Matt and Sue Nigro, my in-laws, have been generous in their time and support over these years, particularly when it comes to a certain 90-year old house. My siblings, Cam Rinard, Rob McDonald and Steve McDonald, have certainly wondered about their older brother, the permanent student and whether he would ever complete his Master's. Thanks to their support and participation as guinea pigs for the survey, the finish is near. My parents, Dick and Jan McDonald, also helped iron out the kinks in the survey, but their contributions are innumerable. Without their love, encouragement and understanding, I could have easily quit. And of course, immeasurable gratitude goes to my wife Sara, who has lived the trials and tribulations of this process with me, giving the love, support, wisdom of experience, and occasional mental kick in the rear to complete this journey.

Finally, I owe much to my committee members. Dean Charles Hight of the School of Architecture was not able to serve over the entire period, but his insights during the proposal process were valued. Holly Schoenherr brought a valuable perspective from the administration of USF, helping these ideas become more amenable to the administration. Dr. Donald Duke kept this study on track as an academic exercise through his careful readings and made this a better presentation; his commitment to me even after leaving USF is genuinely appreciated. Dr. Elizabeth Strom shepherded me throughout the process, lending a critical eye to the paper and keeping me focused and positive when progress would slow. Finally, Yann Weymouth was the first to enthusiastically support the idea of creating a sustainable development study for USF, and has championed this

effort since its inception. Though none of the members specializes in sustainable development, the various disciplines each member brought to the committee reflect the interdisciplinary, holistic nature of regenerative design and made the final thesis.

DEDICATION

To my father, who taught me love and respect for the environment, as well as the stubbornness to always finish what I start.

To my mother, whose eternal optimism constantly amazes me and leads me to believe there will always be solutions to any problem.

And of course to Sara, my Penelope in this Odyssey, whose love, support, and occasional exasperation inspired me to complete this journey.

"When we try to pick out anything by itself, we find it hitched to everything else in the universe." – ***John Muir***

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Richard K. McDonald, III

ABSTRACT

The administrations of several universities have developed strategies to reduce the negative environmental effects created by their institutions. Because no single, comprehensive methodology to guide institutions to sustainability exists, these strategies range widely in scope. As well, the definition of "sustainability" differs for these various institutions, resulting in strategies ranging from small-scale recycling programs to major initiatives to incorporate green building and revamping curricula. This study attempts to create the first comprehensive methodology to guide university campuses and processes to become ***regenerative.*** Regenerative systems "produce more resources than needed, provide resources for other projects, and enhance [the] environment" (Bernheim 2003), and are synonymous with the "triple top line" of sustainability presented by Braungart and McDonough (2002).

Sustainability plans of other universities were reviewed to determine what strategies have been successful for these institutions. These data were synthesized to create the comprehensive methodology. The methodology is incremental to allow time for institutions to adjust their financial plans and facilities management practices. Subsequently, the University of South Florida's Tampa campus (USF) served as a case

study. Buildings and other infrastructure were reviewed, as were the curricula, buying practices, food service, and other university processes. Finally, a survey was presented to the primary decision-makers for USF to identify obstacles to implementation of the sustainability methodology. Recommendations for overcoming these obstacles were then be devised, incorporating solutions developed at other institutions as well as novel ideas.

INTRODUCTION

The idea of "green," or sustainable, development is one that could generate important benefits to both natural and human environments at initial financial costs that are often minimal. Sustainable design and construction present alternatives to the traditional construction practices that have led to the environmental impacts of buildings. Green building concepts are "design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants" (USGBC 2005a). The 1987 Brundtland Commission defined sustainability as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs" (Mendler et al. 2006).

Various levels of green development have been defined, ranging from "light" green to "living" or "restorative" projects. "Light" green projects move little beyond conventional construction and design methodology and technology. Living buildings "are designed to produce sufficient resources… for their own use without polluting the environment. Restorative projects produce more resources than needed for their own use and are able to provide resources for other projects" (Bernheim 2003). Restorative, or ***regenerative***, building projects can help establish the foundation for a wholly sustainable community.

This thesis has two primary goals. First, it develops a comprehensive set of focus areas that can be viewed as both a *method of assessing* sustainability efforts, and as a *set of*

goals to be achieved by builders and planners seeking to develop truly regenerative built environments. Secondly, it applies this assessment tool to *university campuses*.

Because they encompass hundreds of buildings and influence thousands of people, universities provide a logical venue in which to study sustainable practices, and to propose a strategy to achieve regenerative building and planning goals. By retrofitting existing structures and planning new buildings to include green elements, energy and water consumption can be greatly reduced, leading to cost reductions for these institutions. Other measures, particularly those aimed at building interiors, can increase the productivity, performance, and health of students, faculty and staff, thus saving more money in healthcare costs and improving the standing of a university. Including sustainability concepts in the overall curriculum can reach thousands of students, thus moving the concepts beyond the esoteric. Finally, universities typically employ academic professionals with expertise in arenas that further enhance and improve sustainability efforts for campuses. University campuses also make ideal research sites for other reasons. Universities retain a high degree of credibility in the US; their adoption of regenerative practices will model "best practices" to other institutions and to the millions of students who live and study on their campuses each year.

Due to the potential economic, social and environmental benefits, several universities have weighed plans to incorporate sustainable elements into present and future building projects. Many of these have as of yet only conducted assessments of their infrastructures to determine their present environmental impacts, their measures of

sustainability, and what these may be in the future. This has allowed these institutions to begin adjusting their campus planning to consider sustainable strategies. Others have proceeded to construct individual green buildings. Finally, a few schools have made commitments to achieving certain standards developed by the U.S. Green Building Council (USGBC) for each new building constructed on their respective campuses. The USGBC is generally recognized as the preeminent organization for green building in the U.S.

However, no single tool for assessing the sustainable elements of a campus has been chosen by those universities that have conducted assessments. This thesis, therefore, proposes a comprehensive assessment model based on the various instruments currently used by universities and private companies. The LEED (Leadership in Energy and Environmental Design) green building rating system developed by the USGBC is used in several of these assessments as the benchmark for sustainable design; LEED is widely accepted as the current best practice for green building. Most if not all of these assessments, however, have been based on the LEED guidelines for new construction and major renovations (LEED-NC) and directed toward new buildings. One portion of the LEED program that has not been specifically incorporated into some of these assessments or strategies is LEED-EB, the rating system for existing buildings. As institutions focus on future construction, improvements to the extant physical structures have often been overlooked; however, some schools are beginning to address this area.

Similarly, no methodology to guide campuses to become sustainable after completion of a sustainability assessment has gained widespread acceptance. The USGBC itself has developed a guide for campuses, but this is based on the LEED-NC criteria and focuses on the certification process for multiple buildings; it does not evaluate the sustainability of the operations of the campus as a whole. Finally, and of most consequence to this study, no strategy to guide campuses to become regenerative has been attempted. The tenets of regenerative development offer solutions to the mounting environmental problems created or exacerbated by the built environment.

Though it is the ninth largest university in the United States (by enrollment) and the third largest in Florida, the University of South Florida (USF) has done little to reduce its ecological footprint. The main campus in Tampa campus covers over 1,500 acres, and building footprints alone encompass approximately 10% of the site. According to USF Facilities Planning and Construction, 28 new structures have been proposed for construction over the next decade (USF 2006a). The physical size and enrollment numbers of the school could make the potential environmental improvements and economic gains accrue quickly. Therefore, a study to create a plan for regenerative development that could be implemented at USF or any other university, particularly schools that have no sustainability plan, was conducted.

The primary objective of this study is to create the first comprehensive methodology to guide universities and similar institutions to become regenerative places. The Tampa campus of USF serves as the test site for and applying and evaluating the methodology.

The initial step within this study is to review the practices of a sample of universities that have begun to implement strategies to become more sustainable. Using these as well as principles of regenerative design and the criteria within the LEED rating systems, this research creates a strategy to lead campuses to become regenerative (the Regenerative Strategy). The study then reviews the sustainable elements of the current USF campus. Next, the research applies the Regenerative Strategy to USF to demonstrate its application. Apart from the Sustainable Endowments Institute review of USF in its College Sustainability Report Card, this effort is the only comprehensive assessment of the sustainability of USF. Further, this also the first effort to guide USF to sustainability. Finally, the thesis examines obstacles to implementation of green strategies and potential solutions to overcome these obstacles.

LITERATURE REVIEW

Sustainability Defined

Sustainability is a somewhat nebulous concept; oftentimes, it is user-defined. Numerous attempts to define the term have been made, and many papers have been written to address this complex issue (e.g., Brown et al. 1987; Shearman 1990; Frazier 1997; Parris and Kates 2003). A commonly used definition of sustainability was provided in the 1987 report of the Brundtland Commission, a group convened by the United Nations to respond to international environmental issues. According to the Commission, "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission 1987). Hes (2005) notes that this definition is problematic as it views development strictly from a human perspective. However, development is a human activity and its effects must be put into a human context for meaningful discussion to occur. Moreover, the Brundtland definition does not preclude any protections for other species; in fact, it can be argued that the "ability of future [human] generations to meet their own needs" would likely be compromised if other species are harmed.

The Brundtland Commission's definition is acceptable as a broad-based characterization of sustainability, but others have created their own, more specific definitions of the concept. Another regularly used set of criteria to define sustainable practice is known as the "triple bottom line," presented by Elkington (1997). Along with the traditional bottom line of economic growth, Elkington proposed that modern business and

development should meet goals for environmental protection and social equity. The University Leaders for a Sustainable Future (ULSF) combine both the Brundtland definition and the triple bottom line, labeling sustainable activities as those which are "ecologically sound, socially just and economically viable, and… will continue to be so for future generations" (ULSF 2007a).

The triple bottom line "has begun to define both long-term strategy and everyday practice for leading manufacturing corporations all over the world" (McDonough and Braungart 2002). As Hes (2005) indicates, however, Elkington's view equally values all three categories. An alternative view is that the environment is the most important of the three, as it contains both society and the economy (Gibson et al. 2005). In turn, society is more important than the economic factors, for without society the economy would not exist (Hes 2005; Gibson et al. 2005).

William McDonough, one of the foremost architects in the world, and his chemist colleague Michael Braungart take the idea of the triple bottom line to another level. They see the triple bottom line as a useful starting point, but one that merely extends the lives of conventional industrial and business practices (McDonough and Braungart 2002). They state that most strategies for sustainability merely meet minimal conditions for survival, focusing on "end-of-pipe" results instead of true innovation (McDonough and Braungart 2002). Instead, they propose a new paradigm, the triple ***top*** line, also referred to as "sustaining" development. The goal of triple top line strategies is to create a new design standard that focuses on the intentions of the project and then plans for positive

outcomes that meet the three factors; i.e., products are designed to enhance the environment and human cultures while simultaneously generating economic value (McDonough and Braungart 2002). These products would include buildings and building materials.

Green Building and Sustainability Strategies

Rethinking building construction and design is important from an environmental perspective due to the major impacts buildings have on the natural environment. Roodman and Lenssen (1995) point out that 55% of the wood harvested for non-fuel uses is for building construction and that buildings use 40% of the world's materials and energy. Similar studies reveal that in the United States building construction and operation are responsible for 30% of total waste output (60% of non-industrial waste), 12% of potable water consumption, and 65% of electricity use (USEPA 2004; USGBC 2007). Buildings also account for approximately 50% of the total chlorofluorocarbons (CFCs) produced and 33% of the CO_2 emitted (Roodman and Lenssen 1995). Studies on Canadian buildings reflect similar environmental effects (Lucuik et al. 2005). And as Lucuik et al. (2005) note, these figures do not include the energy and pollutants associated with transportation and production of the building materials. The quality of indoor environments also has tremendous impacts on building occupants. Both the USEPA (Mendler et al. 2006) and the Roodman and Lenssen (1995) paper reveal that 30-33% of all buildings have "sick building syndrome," a condition in which building occupants are exposed to stale, mold-laden, or chemically toxic air.

Due to the scope and breadth of the impacts of buildings on the environment, "green building" has become a major component within many sustainability strategies. The expressions "sustainable development," "smart building," and "green building" are often used interchangeably in the literature; this paper will refer to both "green building" and "sustainable development" synonymously. As with "sustainability," however, clearly defining green building is a challenge. The United States Green Building Council (USGBC) states that their goal for green buildings is "to significantly reduce or eliminate the negative impact of buildings on the environment and on the building occupants" (USGBC 2005a). The California Integrated Waste Management Board (2007) defines a green building as "a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner."

Complicating the concept of green building is the fact that various practitioners are involved and all have their individual ideas of what constitutes "green." Projects run from "light" green to restorative or regenerative, and any of these may be labeled as green development. "Light" green refers to projects that institute minimal environmentally beneficial technology, or can even be used as a substitute for greenwashing. Many have chosen not to attempt a definition, citing instead several characteristics of green building and noting that the concept is imprecise and fluid. For example, in their 2005 presentation on Canadian green buildings, Lucuik et al. list 25 "common green building traits" within five categories. The number of these traits found in a building, and therefore its "greenness," is dependent on "specific site, fiscal and operational parameters" (Lucuik et al. 2005).

Regenerative buildings or projects are those that produce more resources than needed for their own use and are capable of providing resources both for other projects and to enhance the natural environment (Bernheim 2003). The "sustaining" design of McDonough and Braungart can be considered synonymous with regenerative design. Regenerative design is "place-based:" that is, it uses the existing natural infrastructure and conditions in the design instead of molding the site to fit the needs of the development (Haggard 2002). Tenets of any regenerative design project include elimination of waste, use of recycled and salvaged materials, on-site food production, maximization of passive solar strategies, treatment and reuse of all wastewater on-site, and production of all power through renewable energy. In January 2008, development of what may be the first regenerative city in the world was announced. Masdar City in Abu Dhabi, UAE is planned to be the first zero-carbon, zero-waste, car-free city in the world (Masdar Initiative 2008). Equity and fair trade, use of sustainable materials in construction, organic food, sustainable water supplies, and preservation of habitats and rare species are other goals of this design (Masdar Initiative 2008).

Benefits of Green Building

Some believe the concepts of green building and sustainability are oxymoronic or myths. Frazier (1997) notes that the modern paradigm of human societies is focused on fiscal and physical growth, and that sustainable development in its current guise actually refers to "maintaining the process of growth." Until this worldview is altered, especially to the point that wealthy nations are willing to relinquish some economic power and comfort to enhance poorer nations (i.e., restrain growth), strategies for sustainability including green

building will remain merely "fashionable" and provide no real benefits (Frazier 1997). Frazier continues, labeling the concept of sustainable development only an aspiration that, until clearly defined and measurable, cannot be applied effectively to scientific or technical activities. Some green building programs are trying to do just that, however.

Green building presents many environmental, social and economic benefits with few drawbacks. Increased costs are often cited by critics of green building as a primary impediment to its implementation. Research shows these strategies to be cost effective, however, particularly in the long term. One study of 33 green buildings in California revealed that for an average 2% cost premium over conventional structures, these green buildings would save ten times that amount over the life of the building (Kats et al. 2003). Further, Matthiessen and Morris (2004, cited in Lucuik et al. 2005) compared 45 green buildings to 93 conventional structures and determined no statistical difference in the costs of construction. Importantly, they find "many projects can achieve sustainable design within their initial budget, or with a very small supplemental funding" (Matthiessen and Morris 2004, in Lucuik et al. 2005). Other studies have indicated that 60-85% of a building's total costs are in operations and maintenance; construction costs are only approximately 10% (National Academies 1999). Financial incentives are also being offered for green buildings in the forms of subsidies and tax credits, and permits in some municipalities and counties are fast-tracked for green construction projects (Gottfried 2003).

Further, many green design elements have been shown to improve occupant health and productivity, which can decrease medical costs and increase profitability. Lucuik et al. (2005) note that some insurance companies offer lower premiums for buildings that incorporate green strategies because occupants of the improved health of occupants of these buildings. Because payroll costs are much higher than building operation and maintenance costs, any increase in worker productivity will concomitantly improve profitability; Lucuik et al. (2005) determine that a 1% increase in productivity translates to an improvement of $2.00/square foot annually. Similar productivity gains have been observed in academic settings. An examination of student performance conducted by the Heschong Mahone Group revealed that students in classrooms with daylighting performed at levels up to 20% higher than students who were taught in classrooms with minimal or no daylighting (Mendler et al. 2006).

Green Building Organizations

As the popularity of green building has increased, several sustainable building organizations have arisen. These groups include the Ecological Building Network, the Healthy Building Network, and the New Buildings Institute. Most of these organizations are attempting to change the philosophy driving the way structures are designed and built so that the impacts to the environment and future generations will be minimal. Of the proponents of green building that have emerged, the United States Green Building Council (USGBC) is perhaps the most established and respected. The USGBC was founded in 1993, and its membership is a consortium of architects, engineers, landscape architects, developers, academics, government representatives, and manufacturers.

Moreover, the USGBC has created and instituted a comprehensive, consensus-based green building evaluation process, the LEED (Leadership in Energy and Environmental Design) building certification program.

Some sustainable building associations, however, have been created by developers and construction material manufacturers that use traditional design and techniques, integrating few green features. These companies give "the appearance of being green without providing substantive environmental benefit" (Cockram 2006). This strategy, known as "greenwashing," lets a project using practices that are less environmentally sound reap the financial rewards of the burgeoning demand for green buildings. The Green Building Initiative (GBI) is the best-known example of these organizations. GBI was founded in 2004 and has been primarily funded by plastics and timber industry trade groups as well as the home-building industry (Walsh 2006). GBI has developed the "Green Globes" standards, which are primarily watered-down LEED criteria (Rainforest Action Network 2005). However, with GBI membership including representatives of several Home Builder Associations, chemical companies (e.g., DOW Chemical), and the wood industry (e.g., Georgia-Pacific), Green Globes is gaining prominence and credibility nationwide (Walsh 2006).

LEED Benefits and Criticisms

The primary advantage of the LEED rating system over others is that it "offers a reference standard that is well-established and well-supported by the design industry" (University of California at Berkeley 2002). LEED was developed via the consensus of a

group of architects, engineers, homebuilders, ecologists, and other members of the USGBC. The first LEED certification criteria were released in 1998, and LEED for New Construction and Major Renovation projects is currently in its fourth iteration (version 2.2). The diverse make-up of the USGBC has helped the criteria remain stringent and reduce greenwashing. LEED creates specific environmentally responsible criteria for buildings and developments to achieve certification and therefore a higher degree of sustainability. The USGBC, recognizing that not all developments can be categorized together, has developed LEED criteria for a variety of projects: New Construction and Major Renovations (NC), Existing Buildings (EB), Commercial Interiors (CI), etc. Each system rewards early incorporation of green elements into a project and values holistic design of buildings.

LEED, however, is not without its flaws. As Lewis (2006) points out, the consensus-based approach used in developing LEED standards has led to several compromises with manufacturers "whose products it [the USGBC] should have banned." For example, he details a controversy in which the USGBC decided not to award credit for eliminating the use of polyvinyl chloride (PVC) in buildings despite the environmentally untenable process required to manufacture it (Lewis 2006). This decision was reached "after intense lobbying from the vinyl industry" (Lewis 2006).

Further shortcomings and difficulties with LEED are described by two green builders, one of whom is a LEED-Accredited Professional. Auden Schendler and Randy Udall (2005) believe that LEED's certification process is overly complex, expensive and time-

consuming, thus discouraging many builders from putting it into practice. Costs to prepare and submit the required paperwork can often take away funding for other green elements that could otherwise be incorporated into the building's design (Schendler and Udall 2005). Also, design professionals and developers can "point monger:" instead of creating a structure more sensitive to the environment, the goal of the design and building group becomes focused on earning credits regardless of whether they actually add environmental benefits (Schendler and Udall 2005). As a result, a building can achieve LEED certification though not be very green. The authors cite a project in Boulder, Colorado in which a recreation center received an Alternative Transportation credit for installing an electric vehicle recharging station. However, at the time of the writing, only six electric vehicles in the city could be charged at the site, and the charging station was being used less than once annually (Schendler and Udall 2005).

Critics also claim that LEED overlooks climatic and other differences among regions, and that the point system renders some of the criteria "meaningless" (Lewis 2006). Udall and Schendler (2005) point to the fact that one of their projects received a credit for reducing the heat island effect via a reflective roof even though the project site was far removed from urban areas, nestled high in the Rocky Mountains. Still others, such as Bill Walsh of the Healthy Buildings Network, note that LEED is not entirely science-based and can therefore create conflicts with environmental policy goals (Lewis 2006).

Despite these criticisms, LEED is better for this research than other methods that have been created. LEED remains the benchmark for green building in the United States, and

even the critics see many positives in the system. Schendler and Udall (2005) point out that even with the flaws they have noted, LEED has created momentum for, publicity about, and a broader general knowledge of green building. LEED is a proven system that has been implemented in hundreds of buildings nationwide, allowing it to be refined and improved (Bowen 2005). Others observe that LEED is but one method to evaluate the environmental aspects of building design, and like all tools must be wielded appropriately (Lewis 2006). And, its rigorous standards and widespread acceptance have helped expand the marketplace for green building as well as curb greenwashing (Bowen 2005; Lewis 2006).

Finally, the USGBC is listening to the criticisms levied at LEED. The rating system for new construction (LEED-NC), released in late 2006, is presently in its fourth iteration, and the fifth is already under development. According to Bowen (2005), the USGBC is incorporating input from experienced LEED professionals in efforts to improve and streamline the certification process. Furthermore, other LEED rating systems are being created or revised to address building types beyond the commercial and industrial structures on which LEED typically focuses (Bowen 2005).

LEED-NC Criteria

Because the Regenerative Strategy utilizes LEED extensively, a review of both LEED for New Construction and Major Renovations (LEED-NC) and LEED for Existing Buildings (LEED-EB) is warranted. The overview of LEED-NC is summarized from the USGBC's LEED-NC: Green Building Rating System For New Construction & Major Renovations

Version 2.2 (USGBC 2005b; USGBC 2005c). Within LEED-NC 2.2, levels of certification are based on a point/credit system that is applied to the design and expected performance of the building (USGBC 2005b). The levels range from basic Certified to Platinum. Seven (7) prerequisites within the design and construction process must be met for any project to attain LEED certification. Credits are acquired by addressing specific goals within five categories: Sustainable Sites (14 possible points), Water Efficiency (5 possible), Materials and Resources (13 possible), Energy and Atmosphere (17 possible), and Indoor Environmental Quality (15 possible). Up to five additional points may be earned through innovation within the design process, for a potential total of 69 credits. The basic certification can be achieved by gaining 26 points, LEED-Silver requires 33, LEED-Gold level requires 39, and a minimum of 52 points is necessary for recognition as a LEED-Platinum building. After construction is complete, a package detailing the scores and verifying all calculations and models supporting the application is compiled and presented to the USGBC for review and, if successful, eventual LEED certification. The USGBC is available for consultation through the entire certification process.

All LEED rating systems have prerequisites that are mandatory for a project to be considered for certification. Within LEED-NC, the seven prerequisites are: to control erosion and prevent sedimentation of water bodies; to institute a commissioning plan to ensure proper function of building operations; to design the building to meet minimum energy efficiency standards (established by local code or the American Society of Heating, Refigeration and Air Conditioning Engineers [ASHRAE]); to eliminate the use of ozone-depleting chloro-fluorocarbons (CFCs) from HVAC&R equipment (heating,

ventilation, air-conditioning and refrigeration); to provide basic recycling for the entire building; to meet minimum indoor air quality (IAQ) standards (also established by ASHRAE); and to prevent exposure of non-smokers to environmental tobacco smoke. Many of these requirements are contained within or surpassed by existing building codes, making these prerequisites easy to attain.

The *Sustainable Sites* category addresses a wide range of issues including selecting appropriate sites for development (e.g., avoiding wetlands, floodplains, habitat for endangered species), creating higher development densities, redeveloping sites (particularly brownfields), encouraging alternative forms of transportation, protecting natural habitats and open spaces, improving stormwater treatment, and reducing both light pollution and the heat-island effect. *Water Efficiency* credits are gained through measured decreases in potable water use, installation of drought tolerant landscaping, and reductions in wastewater delivered to conventional sewage systems.

The greatest number of credits is available within the *Energy and Atmosphere* category. Optimization of Energy Performance has up to ten credits available, based on a percentage of energy use reduction compared to baseline. A 35% reduction in a renovated building, or a 42% reduction in a new building (based on energy-use modeling), will result in the full ten points; less energy reduction results in fewer awarded credits. Other credits can be gained through the use of on-site renewable energy sources, use of "green power" (non-fossil fuel-based power) from an outside supplier, and/or improved management of power systems. *Materials and Resources* provide

opportunities to earn several credits. Reusing building shells and interiors instead of total demolition and re-build, recycling or reusing construction waste, utilizing construction materials with renewable or recycled content, employing wood products certified by the Forest Stewardship Council (FSC), and incorporating materials that are regionally produced are all methods to acquire credits within this category.

Indoor Environmental Quality is the fifth category. Incorporation of materials in the building that do not emit Volatile Organic Compounds (VOCs) or other harmful gases can lead to four possible credits. Other points come from improving ventilation, creating a management plan for indoor air quality both pre-construction and pre-occupancy, allowing individual control of thermal and light controls, and creating daylighting and views for as many building occupants as possible. Finally, new techniques or strategies not included in the above LEED categories may be presented to receive credits for the *Innovation and Design Process* category. And, a point is given within this category if a LEED-accredited professional is on the design and submittal team.

LEED-EB Criteria

LEED-EB has not been updated as recently as LEED-NC, so the following summary is from the 2005 USGBC LEED-EB Green Building Rating System (USGBC 2005d). LEED-EB has similar categories, but differs from LEED-NC in several ways. Primarily, LEED-EB credits are based on *performance* standards; LEED-NC focuses instead on *design* standards. The USGBC states that LEED-EB "maximizes operational efficiency while minimizing environmental impacts" (USGBC 2005). LEED-EB also requires

periodic re-certification (minimally every five years), ensuring that building performance remains efficient and continues to have reduced adverse environmental affects. Further, the re-certification process allows the building rating to be upgraded should operational or structural improvements be made over time, an impossibility in the LEED-NC process.

Because it is performance based, most of the credits available within LEED-EB require historic data on building operations for comparison to present and future data on the use of resources by the building and its occupants. As in LEED-NC, four certification levels exist, but more points are required (and available). Out of 85 total credits available, only 32 (less than 40%) are required for a structure to attain a Certified rating, while 64 are necessary for Platinum. Concomitant with the greater number of credits are a higher number of Prerequisites. These 13 mandatory requirements for any building attempting to attain a LEED-EB rating include many of the same prerequisites as LEED-NC: erosion and sedimentation control, building commissioning, minimum energy performance, ozone protection, recycling, and environmental tobacco smoke control. The other prerequisites address the building's age (cannot be less than two years at the time of application), minimal water efficiency, pollutants in discharge waters, reduction of toxic material sources (i.e., mercury in light bulbs), removal of PCBs (polychlorinated biphenyls) and asbestos, and maintaining ventilation from outside air and exhaust fan systems.

Within LEED-EB, the *Sustainable Sites* category attends to a range of issues similar in size and scope to the same category in LEED-NC. Incorporating environmentally

sensitive building exterior management, creating higher development densities (such as infill), encouraging alternative forms of transportation, protecting natural habitats and open spaces, improving stormwater treatment, and reducing both light pollution and the heat-island effect are all addressed. *Water Efficiency* credits are again acquired through reductions in potable water use, installation of xeric landscaping, and decreases in wastewater delivered to conventional sewage systems.

The *Energy and Atmosphere* category again provides the greatest opportunity for acquiring credits, and Optimization of Energy Performance offers up to ten potential points. On-site renewable energy sources and/or use of "green power" from an outside supplier also provide credits. Credits related to the performance of the building are abundant in the LEED-EB version of Energy and Atmosphere. Continuing education for building operations and maintenance staff, as well as long-term maintenance and monitoring of building systems contribute credits. Adding continuous metering programs for various building systems that use energy and water, measuring emission reductions, and documenting the costs and benefits of the sustainable building program are other potential performance-related points.

Materials and Resources also provide several possible credits within LEED-EB. Diversion of construction waste from landfills, utilization of construction materials with renewable or recycled content, use of FSC wood products, and incorporation of regionally produced building materials are all methods similar to those in LEED-NC to acquire credits within this category. Overlap with LEED-NC's *Indoor Environmental*

Quality is seen here as well, as two credits set minimum standards for the use of indoor materials with low or no VOCs and other chemicals. Incorporating sustainable cleaning products, expanding basic recycling to include hazardous or toxic materials (e.g., batteries), and using further reduced-mercury light bulbs are other opportunities for credits.

Finally, the *Indoor Environmental Quality* category within LEED-EB has several credits that differ from the same category within LEED-NC. For example, documentation of the affects on productivity by sustainable building strategies, in the forms of absenteeism and worker output will garner two credits. Establishment of a green cleaning program to govern pest management, janitorial chemicals, entryways, cleaning appliances, worker training and much more, can lead to six potential credits. Credit possibilities similar to those available in the new construction system include increasing and improving ventilation, managing indoor air quality both pre-construction and pre-occupancy, installing controls for individual occupants for temperature and light regulation, reducing indoor pollutants through the use of particle filters and isolation of chemical sources, and creating daylighting and views for building occupants.

Any novel strategies or achievement of environmental benefits beyond the LEED-EB system may be presented to the USGBC in an attempt to receive credits for the *Innovation in Upgrades, Operations, and Maintenance* category. Again, a point is given if a LEED-accredited professional is on the design and submittal team.

Sustainability and University Campuses

Green building and design, including constructing to LEED standards, is a tactic that universities can use to reduce their environmental impacts. Further, by incorporating these techniques and serving as an example, universities may influence their students, employees and surrounding communities to reduce their own impacts.

Individual university campuses are typically physically expansive and provide services to hundreds or thousands of people. Including two-year colleges, as of 2004 there were 4,388 institutions of higher learning in the United States, with a total enrollment of 17,568,606 students (Carnegie Foundation 2007). Beyond students, universities involve many faculty, staff, and alumni. The vast numbers of people that must be managed by universities and the accompanying infrastructure necessary to support university activities have exacerbated several of the environmental problems society faces. The physical campus must grow to accommodate the concomitant growth of the student and faculty body, thus often destroying natural habitat and using natural resources for buildings. And total U.S. enrollment is expected to increase 13-18% between 2004 and 2015 (Institute for Education Sciences 2006).

A concomitant increase in energy and water use typically occurs as enrollment rises. Between 1990 and 2000 at the University of Michigan, energy consumption grew 11% while the student population grew only 9% (Kadwell 2002). Facilities must expand as well - new housing, classrooms, laboratories, roads, parking, and other infrastructure must be built for the growing university population. This leads to more pollutants from

automobile use, as well as further destruction of habitat and consumption of natural resources from construction.

However, due to their physical sizes and abilities to reach large numbers of people, universities also offer opportunities for green building and other sustainability strategies to create tremendous positive effects in a relatively short time period. By implementing green design and development on a campus, the environmental impacts of thousands can be reduced through the construction and operation of mere scores of buildings. Incorporating ideas of sustainability into the everyday lives of students and faculty get these same thousands of people accustomed to these strategies, and in turn they may incorporate these into their lives outside of the university. Adding sustainability into curricula is another method of disseminating this information (Van Weenen 2000). Finally, university faculties often contain experts in areas that may provide contributions to any sustainability plan for their respective campuses (Uhl and Anderson 2001; Van Weenen 2000).

University leaders worldwide have been considering the impacts of their institutions on the environment for decades. In 1990, the Talloires Declaration was created and signed by 19 administrators representing universities from around the world to commit to environmental sustainability in higher education (University Leaders for a Sustainable Future [ULSF] 2007b). The Talloires Declaration is a ten-point action plan for incorporating sustainability strategies and environmental education in all facets of university responsibilities, including teaching, research, operations and outreach (ULSF

2007b). More than 300 university leaders from over 40 nations have endorsed the Declaration since the initial signing (ULSF 2007b).

Several groups dedicated to reducing or eliminating the environmental impacts of university campuses have arisen, including the ULSF, the Association for the Advancement of Sustainability in Higher Education (AASHE), and the Sustainable Development on Campus group within the International Institute for Sustainable Development. These have developed repositories for information on sustainability in universities. However, no single comprehensive methodology for achieving a green campus that can be applied to a broad spectrum of campuses has been proposed by any of these organizations. Further, despite several efforts, recent studies indicate that few institutes of higher education have yet to address the issue of sustainability in a broad-based, meaningful way (Glasser 2002, cited in CSAP 2007); the best strategies have been campus-specific. The USGBC has established LEED guidelines for campuses, but these principles are merely modified concepts of the LEED-NC (New Construction) criteria, altered to incorporate multiple rather than individual buildings (USGBC 2005e).

Universities and colleges worldwide are at various stages of incorporating green building strategies into their campus plans. Some have begun to implement isolated green efforts, such as instituting recycling programs, encouraging and improving bicycle transit, making real-time energy and water use information available, and phasing in the use of high efficiency light bulbs. Other higher education campuses have discussed implementation or have incorporated green building into their facilities and site planning.

Schools that have done so include the University of Oregon, the University of California at Merced, the University of Florida, and the University of Central Florida. Each contains buildings that are LEED-NC certified, and each has made commitments to construct all future buildings to meet minimum LEED-NC certification standards or higher. The programs planned or implemented at the first three schools exemplify some of the more advanced green campus strategies found in universities in the United States, while UCF is beginning its program. Brief summaries of each program are as follows:

The University of Oregon first published its Sustainable Development Plan in October 2000. Its campus plan states that "all construction projects shall adhere to the university's Sustainable Development Plan" (University of Oregon 2005). The Sustainable Development Plan is divided into seven categories addressing buildings, transportation, landscaping, energy use, and water resources. Sustainable design is to be included early in discussions of any new project and all new buildings must achieve minimal certification within LEED-NC. Energy efficiency and stormwater run-off are prioritized for all new building projects. The Sustainable Development Plan offers several suggested approaches and examples for administrators and staff to follow. Benchmarks to assess the changes on the campus due to the Sustainable Development Plan must be measured every five years. An initial evaluation was conducted in 2002 by an outside firm (Good Company, Inc.) as part of the process.

As a new campus within the University of California (UC) system, the University of California at Merced (UC Merced) was able to incorporate green development strategies

from the onset of planning the campus. Its first chancellor instituted a policy that all the buildings on the campus would meet LEED-NC Silver standards, a policy that is more stringent than that of the UC system. Of the approximately 7,000 acres that comprise the campus, only 910 are to be used for infrastructure – the remainder will serve as a wildlife preserve (Yoders 2005). These green building requirements make up a large portion of the Environmental Stewardship Program that guides many of the development and operational decisions of the school (UC Merced 2007a). Other areas governed by the ESP are purchasing, food, transportation, and curriculum/research (UC Merced 2007a). The campus is also being developed in phases, a strategy that facilitates the construction of higher performance buildings and allows time for reassessment and plan modifications, should they become necessary. UC Merced opened to 1,000 students in 2005, but is to expand to accommodate 25,000 by 2030 (Yoders 2005).

The University of Florida has developed one of the most comprehensive and complex sustainability programs on any U.S. campus. Like the University of Oregon, all new buildings must meet the minimum criteria to achieve LEED-NC certification. The administration has created an Office of Sustainability whose goal is to make the University of Florida "a model of sustainability, integrating the goals of ecological restoration, economic development, and social equity;" in other words, to meet Elkington's triple bottom line (UF Office of Sustainability 2007a). This office sets forth guidelines to direct operations and development on the campus, and goes well beyond the built environment. Further, the University of Florida has a stated goal of becoming a "carbon-neutral" campus by 2030 (Stannard 2003). This means that campus operations

and related activities will eliminate or offset the release of carbon dioxide, methane, nitrous oxide and other greenhouse gases (Stannard 2003).

A final example of a campus that has incorporated green building into its new construction is the University of Central Florida in Orlando. UCF requires that all new buildings meet LEED-NC Silver standards, and has established 19 credits that must be met within these standards (UCF 2007a). The Center for Energy and Sustainability is a unit within the Physical Plant of the university that promotes energy efficiency and green building practices within UCF's operations (UCF 2007b). Other resources for sustainable strategies include the Florida Solar Energy Center and the Stormwater Management Academy. The Academy built a green roof on the Student Union, the first green roof on any university building in Florida, and plans exist for several more (Binette 2005).

UCF is a rival of the University of South Florida in Tampa (USF) in many ways. The two schools are separated by less than 100 miles, draw from the same applicant pool, and are similar in size (>40,000 students) and location (the suburbs of large cities in central Florida). However, the campus planning for UCF has far surpassed that of USF when it comes to sustainable practices, especially green building.

Sustainable Elements at the University of South Florida

This research evaluates one campus in detail as a case study to determine how the Regenerative Strategy might be applied. That university and campus, the University of South Florida (USF) is described in this section.

USF contributes to environmental problems via many factors. The total enrollment in 2006 was 44,038 making it the 9th largest university in the nation based on student population (USF 2006b). 37,645 students are enrolled on the Tampa campus alone, on which this paper will concentrate. Due to this high enrollment and the projected 24% increase by 2014-15 noted in the Campus Master Plan Update (USF 2005), several new buildings are planned. Construction of more than 20 new buildings is slated to occur by 2015 (USF Facilities 2006a). USF is also a commuter school, with approximately 98% of its students driving to campus (New North Transportation Alliance 2007). However, many characteristics of USF make this campus a strong candidate to incorporate a comprehensive green strategy. The large student body and several planned new buildings offer opportunities to influence the built environment on the campus very quickly.

USF has a few sustainable design and construction concepts within its 2005 Campus Master Plan (USF 2006c), including protection of greenways and open spaces, use of native plant species in landscaping, and improvement of energy efficiency in buildings through the use of conventional technology. These nods to green design, as well as specific references to the LEED program are encouraging and indicate that support for these concepts exists at USF. No requirements to achieve any certification level are contained in the Master Plan, however. Most of the language indicates that incorporating

sustainable design elements is voluntary and/or predicated on University finances. For example, the Master Plan (USF 2006c) states: "USF embraces the concepts of sustainable building and site design. The University also recognizes that the techniques, technology and costs of sustainable design are continuously evolving and improving. Therefore, it is the intention of the University to build the most sustainable, efficient, and healthy buildings ***practical and financially feasible at the time of their construction***" (emphasis added).

Student and public support for USF becoming a sustainable campus has also grown. One of the most prominent construction projects on the campus is the renovation and expansion of the Marshall Center, which serves as the student union and bookstore. In February 2006, an article in the student newspaper of USF quoted students who were pushing the USF administration to require the new Marshall Center to achieve LEED certification (Carroll 2006). Alumni are also supportive. Charles J. Kibert, who serves as Director of the Powell Center for Construction & Environment, is a professor in the Rinker School of Building Construction at the University of Florida, and earned his doctorate in mechanical engineering from USF in 1982 (Tampa Bay Vigil 2006). Kibert, who is also on the Board of Directors for the Florida Gulf Coast chapter of the USGBC and was instrumental in getting the University of Florida to adopt LEED certification for their buildings, has lobbied USF President Judy Genshaft to implement LEED standards (Tampa Bay Vigil 2006).

USF also has many on-campus experts and resources that could contribute valuable insight and assistance in developing a green campus. The Center for Urban

Transportation Research (CUTR), is a research group within the USF College of Engineering that develops innovative, practical solutions to transportation issues, and "serves as an important resource for policymakers, transportation professionals, the education system, and the public" (CUTR 2007a). Experts in alternative fuels, bicycle/pedestrian paths, greenways and rail, and many others conduct studies at CUTR (CUTR 2007a). Also within the College of Engineering is the Clean Energy Research Center (CERC), which evaluates environmentally friendlier energy sources like hydrogen, fuel cells, solar energy, and biomass (CERC 2007a). Within the School of Architecture and Community Design is the Florida Center for Community Design and Research (FCCDR), a research group founded to focus on urban and regional problems related to natural and built environments, and "to assist the citizens of Florida in the creation of more livable and sustainable communities" (FCCDR 2003). Other potential campus resources include students and faculty within the Geography Department, the Environmental Science and Policy program, the School of Public Health, and the College of Business Administration.

Another possible resource is one of the newest programs at USF, the Patel Center for Global Solutions. Founded in 2005 and already internationally known, the goal of the Patel Center is to "promote sustainable, healthy communities in a globalizing world" (Patel Center 2006). Interestingly, the Patel Center's characterization of a sustainable, healthy community mirrors that of the triple bottom line: the natural, economic, and social environments interact to influence communities worldwide (Patel Center 2006).

Plans for the new Patel Center building include references to green technologies, including solar power and wastewater reclamation, but LEED is not referenced.

Summary

With the potential environmental and economic benefits, the size and continued growth of college campuses in the United States, and the support of students, alumni, and community members, creating a sustainable development plan is an important consideration for any university administration. A comprehensive, broad-based methodology for sustainable development will facilitate the creation and implementation of these strategies. Utilizing best building practices such as LEED will begin to move these institutions to higher levels of sustainability and to modify the current paradigm of unchecked growth and consumption of resources. Many universities have taken their sustainability plans beyond buildings: curricula, food resources, purchasing and other business practices, habitat restoration, etc. And though no campus has done so, it is technologically feasible to become fully sustainable (regenerative). As the worldview continues to shift, campuses can move beyond LEED requirements, changing into the regenerative, sustaining places envisioned by McDonough and Braumgart. USF, because it has no extant sustainable development plan, provides an opportunity to serve as a case study for creation of a methodology to take a campus from conventional to regenerative.

METHODS

Creating the Regenerative Strategy

The primary objective of this research was to create a comprehensive methodology (Regenerative Strategy) to guide any university or similar institution to the regenerative, or sustaining, development ideal set forth by McDonough and Braumgart. To create the Strategy, the thesis carefully reviewed plans for sustainability developed at other institutions, determining common themes to be included in any sustainable development methodology. A literature review also revealed novel ideas that might also be incorporated into a broad-based methodology.

The sustainability strategies in place at eight (8) universities were selected for review. The schools chosen were the University of Florida (UF), the University of Oregon (UO), Duke University (Duke), Harvard University (Harvard), Pennsylvania State University (Penn State), the University of British Columbia (UBC), the University of California at Merced (UC Merced), and the University of Central Florida (UCF). These choices provided a mixture of institutions of varying sizes, funding sources (public vs. private), and various geographic and climatic locations. Seven of the eight have been recognized as being on the forefront of campus sustainability efforts. Duke, Harvard, Penn State, UBC, and the University of California (of which UC Merced is a member) all were named as "Campus Sustainability Leaders" by the Sustainable Endowments Institute (SEI) in 2006. In 2007, the SEI added UO and UF to that list. UBC also received an Association for the Advancement of Sustainability in Higher Education (AASHE)

Campus Sustainability Leadership Awards. The Sierra Club named Harvard, UC, Duke, and Penn State to its Top Ten "green" campuses in November 2007. UCF, the eighth school, was selected because it shares many similar characteristics with USF, including enrollment, age, climate, and location, and provided an interesting comparison.

After the reviewing the strategies at these campuses, the Regenerative Strategy for colleges and universities was created. This Strategy was synthesized from the best elements of the selected campus plans, LEED-NC and EB criteria and guidelines, and from the strategies used to construct existing and proposed regenerative buildings and developments. The Strategy, developed after review of the eight subject campuses, incorporated twelve (12) Areas of Focus to assess and guide schools on the path to becoming regenerative. The review included assessment tools created at individual universities, specifically, those produced by UO, Penn State, and UBC. These tools, as well as those developed by the Sustainable Endowments Institute and Good Company, Inc., a private consulting firm specializing in sustainability, all contain sustainability indicators, which are synonymous with Areas of Focus. The Areas of Focus developed and used as the basis for the Regenerative Strategy were: administration, academia, buildings, energy supply, greenhouse gas emissions, water, landscape and native habitat, materials management (waste and recycling), transportation, food resources, procurement, and endowment investment. These Areas encompass virtually every aspect of campus planning and operations.

Neither the Penn State (Penn State Green Destiny Council 2000) nor the UO (Mital et al. 2007) assessments used Purchasing as an indicator, and the Penn State study also declined to include Endowment Investment. The SEI assessment focused primarily on Endowment Investment. Though organized in a different manner than this research, UBC assessed indicators equivalent to all 12 included in this strategy (UBC 2007a). Finally, Good Company incorporated many similar indicators in its campus assessments, but considered some, including renewable energy purchase and endowment investment, as supplementary indicators (Good Company, Inc. 2002). Good Company considered these supplemental because: a.) there was a "low level of consensus" as to the suitability of the indicator; b.) it was difficult to "define technologies or strategies" for solutions; or c.) it was difficult to create benchmarks, "especially for the long-term" (Good Company, Inc. 2002). Like the indicators for UO, the Areas of Focus in this study were selected because they were deemed the most relevant to campus environmental sustainability (Mital et al. 2007). Further, synergies among these Areas were noted and encouraged, for regenerative design requires holistic, interdisciplinary approaches.

Preliminary Assessment of USF

Once the Regenerative Strategy was created, a preliminary assessment of the sustainability efforts at USF was performed. Interviews with administration and staff members, as well as review of the 2005 Campus Master Plan and other USF information (written and electronic) were incorporated into the evaluation. After this was completed, the Regenerative Strategy was applied to the current USF campus to demonstrate and

evaluate the methodology; it also determined where USF lies on the road to regenerative development and the next steps the school should take to improve its sustainability.

Determining Obstacles to Implementation

Finally, this study attempted to determine what obstacles might be in place to impede the implementation of any and all of the proposed strategies for regenerative development at USF. Using the Survey Monkey on-line analysis tool, a survey of campus leaders was performed to help identify these obstacles and their potential solutions. The USF Institutional Research Board approved the survey protocol (IRB #106295). Strategies to overcome these obstacles were reviewed and assessed, including successful strategies from other universities.

RESULTS AND DISCUSSION

This section is divided into three chapters. Chapter 1 reviews the plans for sustainable development that eight universities have instituted and develops a strategy developed for campuses to achieve regenerative status, hereafter referred to as the Regenerative Strategy. In Chapter 2, the results of a preliminary assessment of the sustainability of USF and a subsequent application of the Regenerative Strategy using USF as a case study are reviewed and discussed. Particular focus is placed on how the Regenerative Strategy might be implemented at USF. Finally, in Chapter 3 the results of the on-line survey and literature review used to determine potential obstacles to implementing the Regenerative Strategy at USF are presented and discussed, including methods to overcome these obstacles.

Chapter 1: The Regenerative Strategy

The strategy to move campuses to regenerative design and development created in this chapter is based in part on the various LEED criteria, the sustainability strategies developed and implemented at eight universities, and the processes to create individual regenerative buildings. The strategy contains 12 Areas of Focus similar to and derived from sustainability indicators developed during assessments of specific universities. The Areas of Focus are: administration, curriculum and research, buildings, energy efficiency, greenhouse gas (GHG) emissions, water use, landscape, food resources, procurement, endowment investment, transportation, and recycling/waste management. Within each Area of Focus, a review of its importance to the sustainability plan is conducted, followed

by a summary of how each of the eight subject universities has addressed sustainability within that Area. The implementation of the Regenerative Strategy is broken into phases based on a proposed chronology for each Area of Focus. A 30-year time frame for incorporating regenerative design and development at college campuses was chosen as the goal because it allows schools time enough to acquire the funding and expertise necessary to implement the technologies, as well as to overcome the institutional inertia present at all universities. However, the time frame is aggressive enough to acknowledge the warnings of many climate scientists. The 2007 United Nations Intergovernmental Panel on Climate Change Report (Metz et al. 2007) determined that GHG emissions must decline by 2015 and be halved by 2050 to limit the potential damage from global climate change. Much of the technology to build regenerative campuses already exists and has been incorporated into buildings at schools such as Oberlin and California State Polytechnic University, Pomona, so this Regenerative Strategy is realistic.

The Areas of Focus were chosen both to simplify the presentation and to guide administrations to specific areas of sustainability; synergies and overlaps among these Areas will be evident and strategies to foster these synergies should be encouraged. Because each campus is unique and regenerative design by definition both incorporates and responds to its locale, the strategy offers general direction and multiple options to achieve certain objectives; it will be at the discretion of campus leadership and designers to determine what specific methods best fit their respective schools. Also note that any segment or any phase may be bypassed should a university wish to move more rapidly toward a regenerative campus, or if the goals have already been achieved.

AREA OF FOCUS 1: ADMINISTRATION

Student and/or faculty grassroots efforts initiated sustainability movements on many campuses. For example, sustainability strategies at the University of Oregon began with a recycling program and a bicycling plan that originated with student volunteers in the 1970s (University of Oregon 2007a). However, no sustainability plan will be successful without the support of the university administration (Kibert 2007). This is reflected in the schools that were analyzed for this study, as all eight have received commitments from previous and current university administration.

At Duke University, the administration has taken several steps to support sustainability efforts for the campus. In 2004, Duke hired its first Sustainability Coordinator, who reports to the Executive Vice President. Six other staff members are dedicated to sustainability issues within various departments at Duke. Duke adopted a Campus Environmental Policy in 2005, signed by the University President and other administration officials (Capps 2007a). Duke has also hired a Green Purchasing Coordinator, adopted several purchasing policies, instituted a LEED policy for campus building construction, and has signed the American College and University Presidents Climate Commitment (Capps 2007a). Several committees have been formed to report to senior administration officials about sustainability efforts and needs, including the Environmental Management Advisory committee, the Committee on Facilities and the Environment, and the Duke Transit Advisory committee (Capps 2007b). The administration has also supported the creation of the Green Grant Fund through the

Office of Sustainability. This $50,000 yearly grant funds student, staff and faculty initiatives to increase sustainability at Duke.

The President of the University of Central Florida (UCF) has taken several steps to bring sustainability to the forefront at that school. In 2006 UCF's administration made a commitment to adopt LEED-NC Silver standards for all campus construction. Soon thereafter, in early 2007, the President signed the ACUP Climate Commitment and was named a member of the ACUP Leadership Circle (Binette 2007). Further, UCF has created and the administration endorsed an Environmental Policy. The policy encourages education of students, faculty and the community in environmental issues, research in sustainability issues, and minimization of UCF's impacts on the environment (UCF Environmental Management 2007a).

The Environmental Management Department works to fulfill the goals of the Environmental Policy and the Environmental Management Plan for the campus. The Department is led by an Environmental Coordinator, whose primary responsibilities include reviewing environmental legal requirements that apply to UCF, presenting ideas to update and improve the conservation portion of the campus Master Plan, maintaining data on environmental performance at UCF, determining proper disposal methods for all university-generated waste, and overseeing environmental training of staff (UCF Environmental Management 2007b).

Beyond the Environmental Management Department, five diverse departments have collaborated to create the Sustainability Alliance to focus on increasing the environmental sustainability of campus operations (Young 2007). The five departments are the Physical Plant, the Center for Energy and Sustainability, Campus Landscape and Natural Resources, the UCF Arboretum, and the UCF Department for Environmental Health and Safety (Young 2007). The intent of this group is to improve upon and eventually replace the Environmental Management Department (Young 2007).

In 2001, the President and the Faculty Senate of Pennsylvania State University (Penn State) unanimously approved the Green Destiny Ecological Mission for the University, a document that provides an overview of sustainability goals and strategies to achieve them. This was a follow-up to the Green Destiny Council's Penn State Indicators Report, a comprehensive review of the sustainability of Penn State's policies and practices.

Environmental stewardship is also a Key Initiative in the Penn State Finance and Business strategic plan; this Initiative states a goal of "moving toward environmentally sustainable behavior" (Penn State Finance and Business Office 2002). Team members of this Initiative are working to incorporate sustainability into all operations and practices across the campus (SEI 2007).

As noted above, sustainability at the University of Oregon (UO) began with a student initiated recycling program and other grassroots efforts. In 1989, the university administration realized that there was a need for a more formalized group to advise the school about environmental issues, so the Environmental Issues Committee (EIC) was

developed and became established in 1991 through the president's office (UO) 2007a). "The EIC meets monthly and acts as visionary body for university sustainability issues" (UO 2007a).

In 1997, UO produced its Comprehensive Environmental Policy Statement. This policy was created "to identify general goals and strategies for a commitment to environmental responsibility" including environmental education, purchasing policies, efficient use of resources, minimization of waste, and implementation of environmentally responsible campus design (Livelybrooks et al. 2005). In 2000, the University developed a Sustainable Development Plan for the long-term development of its campus, and later authorized a private company (Good Company, Inc.) to assess the status of the University's efforts at sustainability; the assessment was completed in 2002. A Sustainability Coordinator was hired in 2004, though as a part-time employee; other employees that are partially responsible for sustainability efforts are the Environmental Resource and Recycling Manager (50%) and the Utilities Analyst (60%) (Mital et. al 2007). More recently, the President of UO signed the ACUP Climate Commitment in April 2007 (Mital et al. 2007). However, though recommended by the EIC (Mital et al. 2007), the university had not signed the Talloires Declaration as of November 2007.

The administration at Harvard has made several commitments to create a more sustainable campus. In 2004, Harvard enacted a statement of Sustainability Principles to guide campus development and practices. Further, the university has given support to the Harvard Green Campus Initiative (HGCI). The HGCI is a service organization that

works on various sustainability efforts across the campus including procurement, alternative energy, education and outreach, recycling, and building upgrades, design and construction. The group markets and sells these services to departments and schools within Harvard that are interested in saving money and diminishing the environmental impacts of their practices (HGCI 2006). Should these units not have funds to pay for these services, HGCI has established the Green Campus Loan Fund to provide up-front capital for projects. In turn, the Fund is repaid from the savings garnered through the savings in operating costs achieved after implementation of the project (HGCI 2006). The Green Campus Loan Fund has received tremendous support from Harvard's President, who stated, "the best investment in the University is not the endowment but the Green Loan Fund" (HGCI 2007a). As support has risen, so has the size of the Fund; it began in 2001 with $3 million, and has grown to $12 million due to its successes and subsequent administration backing.

The University of British Columbia (UBC) began its formal efforts in sustainability when its leadership signed the Talloires Declaration and the Halifax Declaration in 1991. The Halifax Declaration came out of a conference of university leaders from Canada, Brazil, Indonesia and other nations regarding the roles of universities in the environment and development (IISD 1996). In 1997, UBC became the first Canadian university to execute a sustainability policy, and the following year created its Sustainability Office (UBC 2007b). The mission of the Sustainability Office is to develop an environmentally responsible campus that is simultaneously economically sound and promotes the values of the campus community (UBC 2007b). As of 2007, the Sustainability Office is solely

funded by savings created from the energy reduction programs that have been implemented on the campus through various sustainability initiatives (UBC 2007b).

Overseeing the Sustainability Office is the Director for Sustainable Development, who in turn reports to the Associate Vice President for Land and Building Services. The Director is responsible for coordinating sustainable development activities across the campus and is the primary contact with the community regarding sustainability efforts at UBC (UBC 2007b). A Sustainability Advisory Committee comprised of students, faculty and staff counsel the Director on many of these issues (UBC 2007b).

Finally, UBC Policy requires all university departments and operations units to create action plans for making their practices more sustainable. Each plan is reviewed and approved by the Vice President overseeing the department or unit. Unit heads area responsible for implementation of the plan and communication with unit members regarding plan goals and practices. Plans are reviewed, and if necessary revised by the unit every two years to account for changes in technology or funding (UBC Board of Governors 2005).

The administration of the University of Florida (UF) has a long history of commitment to sustainability. In 1994, UF became a signatory to the Talloires Declaration, and less than three years later a grassroots campus environmental stewardship group, Greening UF, was initiated by a coalition of students, faculty and staff (UF Office of Sustainability 2007a). In 2000, an Office of Sustainability was established by the College of Design,

Construction and Planning to promote sustainability projects on campus. The following year UF adopted LEED-NC criteria for all new construction and major renovation projects. Later in 2001, at the behest of the Faculty Senate, the administration established the Sustainability Task Force to review UF's policies and practices, and in turn recommend ideas to increase the sustainability of the UF campus (UF Office of Sustainability 2007b). The Task Force published its findings and recommendations in a 2002 report that was endorsed by the Faculty Senate.

In 2004, a Student Senate resolution called for a university Office of Sustainability, and the President and Faculty Senate instituted an ad hoc Sustainability Committee. The following year UF established the university Office of Sustainability, elevating it from its previous position within a single College, and the Office hired its first director in 2006. The mission of the Office of Sustainability is "to make the University of Florida – in its operations, education, research, and outreach – a model of sustainability, integrating the goals of ecological restoration, economic development, and social equity" (UF Office of Sustainability 2007b). Later in 2006, the ad hoc Sustainability Committee was made a permanent committee of the Faculty Senate. In 2007, the UF President was the first to sign the ACUP Climate Commitment (UF Office of Sustainability 2007b).

As a new university, the University of California at Merced (UC Merced) has many advantages over older, established universities that have existing structures and bureaucracies that must be renovated or revamped to incorporate policies to increase the sustainability of their practices. This extends to the university leadership. The UC

Merced administration, operating from the Brundtland Commission's definition of sustainability, committed early in the planning process to include green technology and practices in their new university. In January 2002, the Chancellor stated that the UC Merced should "set the standards for sustainable use of energy and other scarce resources and to be a model of development in the great San Joaquin Valley" (UC Merced 2007b). The Environmental Stewardship Program at UC Merced is the group primarily responsible for developing specific goals and policies to achieve the sustainability ambitions of the school.

As a member of the University of California system, UC Merced must adhere to the practices and policies put in place by the University of California. The University of California has made commitments to reduce the University's effects on the environment. For example, it has created and instituted policies for green building design, clean energy standards, and sustainable transportation practices. Other policies focus on building renovations, climate protection, sustainable purchasing and recycling and waste management. Further, the office of the Senior Vice President for Business and Finance has developed guidelines for implementation of these policies (UC Merced 2007c). The University of California has indicated that it will institute future campus policies for "green" cleaning, "green" landscaping, and climate neutrality (UC Merced 2007c). The president of the University of California system has also signed the ACUP Climate Commitment.

Though the chancellor of UC-Merced has not signed the ACUP Climate Commitment,

the UC Merced administration has created the Chancellor's Advisory Committee on Sustainability to "promote environmental stewardship and development that is based on ecological principals at the University of California, Merced" (UC Merced 2007d). The Committee advises the Chancellor on sustainability goals, policies, and practices centering on several key points including strategies to achieve the required LEED-NC and EB criteria for campus buildings and ideas to integrate sustainability throughout campus programs and planning (UC Merced 2007d).

Table 1: Summary of Administrative Efforts in Sustainability at Eight Subject Universities

	Duke	UCF	Penn State	UO
Public Commitment	ACUP; Campus Environmental Policy	ACUP; Environmental Policy	Embraced Green Destiny Indicators Report	ACUP; Comprehensive Env. Policy Statement
Creation of an Office of Sustainability	Yes - 2004	No	No	Yes – 2004
Construction and Operations budgets linked/ other funding solutions	Green Grant Fund	None	Hire energy management companies	None
Student/Faculty input	Yes – several committees	Sustainability Alliance	Green Destiny Council	Environmental Issues Committee

	Harvard	UBC	UF	UCM
Public Commitment	Statement of Sustainability Principles	Talloires Declaration, Halifax Declaration	Talloires Declaration, ACUP	UC system signed ACUP; public statements and documents
Creation of an Office of Sustainability	Yes – HGCI in 2000	Yes - 1998	Yes – 2000 (departmental), 2005 (university wide)	Environmental Stewardship Program
Construction and Operations budgets linked/ other funding solutions	Green Campus Loan Fund	Hire energy management companies	None	New school – funding in budget
Student/Faculty input	HGCI	Depts. assist with sustainability plans	Faculty and Student Senate committees	Advisory committee

Administration Goals:

Because it is evident that administrative support is vital for sustainability to be implemented at a university, the strategy begins with the school administration as the first

Area of Focus. The goals for this Area are that the administration embraces the need for sustainable development such that the concepts become institutionalized within the university; and that the university develops the financial and personnel resources necessary to adopt the strategies to achieve a regenerative campus within 30 years.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

In the first phase, much is asked of the administration of the institution. A commitment from the administration to creating a more sustainable, and ultimately regenerative, campus is the first step. To do so, the administration will make public commitments to this goal so that they may be held accountable to achieving these goals. First, the university will create and distribute an environmental/sustainability policy statement to serve as the basis for its environmental strategy. Within this statement will be a commitment to transform the current campus into a regenerative campus within a 30-year time frame.

Next, the university President (or other chief executive) will sign both the Talloires Declaration and the American College and University Presidents (ACUP) Climate Commitment. Released in 1990, the Talloires Declaration is "a ten-point action plan for incorporating sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities. It has been signed by over 350 university presidents and chancellors in over 40 countries" (ULSF 2001). The ACUP Climate Commitment is a more recent document, developed in 2006, which 422 university and

college presidents had signed as of late October 2007. Like the Talloires Declaration, the Commitment contains steps to move campuses toward becoming more sustainable, but concentrates primarily on waste and energy use reduction as well as incorporating sustainability issues into university curricula (ACUPCC 2007).

Further, the university administration will immediately create and fund an Office of Sustainability for the campus. The Office should at a minimum consist of a director and support staff. The primary duty of the Office will be to serve as a clearinghouse for information on university sustainability resources and efforts. Assessing campus sustainability needs, assisting in periodic reviews of sustainability strategies, and prioritizing projects for campus sustainability will be other duties of the Office. The Office will also conduct outreach efforts about the benefits of sustainability and strategies to overcome obstacles to achieving it; educating other departments and administration officials is vital to successfully developing a sustainable campus.

According to the Sustainability Coordinator at Duke, to be most effective the Director of the Sustainability Office must report to a high level administrator; suggested placement of the Office of Sustainability is within the Office of the Vice President of Operations or its equivalent (Capps 2007c). Without this level of influence, it will be much more difficult to institute the philosophy of sustainability necessary to transform the campus (M'Gonigle and Starke 2006). Note that as administrations change, it may become necessary to educate new officials about sustainability so that the university commitment achieved in Phase I does not waver.

Budgetary constraints are an oft-cited reason for institutions rejecting the construction of green buildings and other sustainable infrastructure. Though this will be discussed further in Chapter 3, a possible solution to this problem lies in the arrangement that most universities have with their facilities budgets. In many university systems, the budget for building construction is separate from the building operations budget. Because of this division, no financial incentive exists for the construction team to incorporate green technologies, particularly when the construction team has several other directives such as maximizing space available for classrooms, offices or labs, aesthetic considerations, deadlines, etc. Therefore, adjusting the budgetary system to link the construction and operations budgets so that the potential long-term cost-savings of green technology, as well as the short-term cost increases (if any) are equitably shared among university departments is another task with which the administration will be tasked. Alternatively, the administration could establish a loan program similar to Harvard's Green Campus Loan Fund such that the loan is repaid via the savings gained by implementing green technology.

Once established, the Office of Sustainability will conduct an assessment of the sustainability of current campus infrastructure and practices within the first year to lay the groundwork for the rest of the Phases and Areas of Focus. For campus infrastructure, LEED-EB will be the assessment tool for all campus buildings greater than 2 years old, and LEED-NC for all younger as well as proposed buildings. Further, the LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects will be incorporated into the assessment, as this guide provides direction in how best to apply

LEED-NC criteria to campuses. Particular focus of this LEED Campus Guide is on shared transportation, water, and waste management resources. Beyond buildings, the campus assessment will review policies and practices involving food resources, curriculum and research, procurement, investments, transportation, and greenhouse gas (GHG) emissions. Finally, the report will offer recommendations as to what projects the university should pursue in the ensuing five years to increase sustainability.

Phase II: Within the first 5 years of plan implementation: During the second year of implementation, the Office of Sustainability will work with various university departments to begin instituting the recommendations established during the Phase I assessment. The Office of Sustainability will serve as the lead for the administration on all sustainability issues, and the Sustainability Coordinator (head of the Office of Sustainability) will directly advise the Vice President of Operations. An option is to elevate the Sustainability Coordinator position to the level of a Vice President to infuse sustainability issues into the decisions of the cabinet and Board of Trustees. Office of Sustainability members will be included on other major university decision-making bodies as well. The Harvard Campus Sustainability Coordinator position is a model to follow, as it is autonomous in nature and can therefore facilitate projects across the entire university, but is also accountable to academic and operations needs (M'Gonigle and Starke 2006). Much like the University of Florida, the Office will conduct annual sustainability assessments of the entire campus and release an annual report of its findings to guide campus development toward becoming more regenerative.

After these programs have been established, the Office will create a regenerative development plan specific to its university using the goals elaborated within this strategy as a guideline. Finally, a fund to provide the financing necessary to build the regenerative campus will be established, funded in part by the savings generated by the construction and retrofit of greener campus buildings.

Similar to the Departmental Sustainability Coordinator program at UBC (see below), each academic, operational and administrative department will establish a sustainability officer to champion sustainability issues within his/her respective department. In turn, the officer will report to the Office of Sustainability about progress annually, thus assuming some of the assessment roles.

Phase III: On-going after Phase II:

The Office of Sustainability will continue to be a clearinghouse for information on sustainability efforts at the campus and will press for more sustainable practices and regenerative solutions. The Office will constantly monitor new technology and strategies to stay up to date on practices that ensure that the university was utilizing the best practices available to become more sustainable and accelerate the implementation of regenerative development. Further, the Office will increase outreach and fundraising to promote regenerative design for the campus, educate potential donors and campus users on regenerative development, and replenish the fund established to create the regenerative campus. Funds will be disbursed from the account such that money will be given to regenerative projects on the campus to account for any construction cost

increases over standard construction costs; again, operational cost savings will be diverted to replenish the fund until the loan is repaid in full. Finally, once the university has achieved regenerative status, the Office of Sustainability will continue to search for ways to improve the campus and surrounding community environment and social.

AREA OF FOCUS 2: ACADEMIA

With the ability to reach millions of students, as well as millions more faculty, staff and alumni, universities can influence and educate a significant portion of the population about sustainability. Institutions can accomplish this by serving as examples via building and operating practices, and through outreach programs into the community. One of the most direct, influential and important ways to influence and educate is to address sustainability within the curricula taught on the campus. By expanding the numbers of courses available that educate students about sustainability, as well as incorporating sustainability into core courses, these lessons can begin to permeate the student culture.

Another area to be addressed within sustainable academia is the type of research that is conducted and funded at the university. Many schools have research groups that directly or indirectly study issues of sustainability. As these programs grow, more students and faculty become involved and the issues become more prominent within and beyond the university. Financial and other institutional support for student groups that focus on these issues is also important, particularly if these groups are growing (Mital et al. 2007). Any successful strategy to institute sustainable, and eventually regenerative, development at a university must include "greening" curricula, research and outreach to the community.

The effort to move toward sustainable development policies in society as well as at universities has to begin with education. Most people are unaware of their individual impacts on the environment and have little knowledge of environmental issues in general. As an example, Penn State surveyed 150 graduating seniors to determine their "ecological literacy," and determined that "63% were unable to name one federal or state law that protects the environment… 72% had no idea that they were living within the Susquehanna River Basin; and 40% were unable to name even two tree types on campus" (Penn State Green Destiny Council 2000). This lack of knowledge is one symptom of how society has forgotten its relationship with the planet, and only a sea change in how humans view and subsequently interact with the natural environment will bring about a sustaining relationship between humanity and the earth. "Members of sustainable communities have the capacity to see themselves as part of, rather than separate from, the environment in which they dwell (e.g., they understand where their water comes from and where their waste goes)" (Penn State Green Destiny Council 2000).

All eight of the universities reviewed for this study have created courses and supported research focused on sustainability issues, and each has given financial and institutional backing to student organizations advocating the same. For example, twenty-two of the 46 academic departments at the University of Oregon offer courses related to environmental and sustainability issues (Mital et al. 2007). Further, Oregon has seven research institutions that focus on sustainability: the Oregon Institute of Marine Biology, the Institute for a Sustainable Environment, the Solar Energy Center, the Center for Ecology and Evolutionary Biology, the Oregon Institute of Marine Biology, the Center

for Housing Innovation, the Oregon Transportation Research and Education Consortium, and the Sustainable Supply Chain Management Center (Mital et al. 2007). There exist many smaller sustainability research programs such as the Green Chemistry Program and the Environmental Change Research Group (Mital et al. 2007).

Students are also involved with sustainability issues via several student groups, including eight that have formed over the past decade (Mital et al. 2007). Student organizations include the Sustainable Business Group and the Center for the Advancement of Sustainable Living (Mital et al. 2007). Oregon sponsors 11 community outreach programs about sustainability, including the Community Planning Workshop and the Environmental Leadership Program (Mital et al. 2007). Through its Continuing Education Center, Oregon has also established a continuing education program for working professionals called the Sustainability Leadership Program.

The newly opened (2005) UC Merced has three academic schools, each with sustainability-related courses throughout. A multidisciplinary graduate studies program in Environmental Systems has been established with the Schools of Engineering and Natural Sciences, and several researchers are working on climate change issues. One research group is the Sierra Nevada Research Institute, which takes an interdisciplinary approach to environmental issues. Their research focuses on seven primary subject areas: population growth and development, water and watersheds, air quality, fire ecology, biodiversity, climate change, and resource management and policy (UC Merced 2007e).

Finally, students at this new university have already established two student groups to address sustainability issues.

Harvard offers 370 courses in environmental and sustainability related issues. Further, many other sustainability courses are available via cross-registration agreements with the Massachusetts Institute of Technology and Tufts University. Several research groups focused on sustainability are also found at Harvard, including the Clean Energy Project, Sustainability Science Program at Harvard's Center for International Development, and the Science, Environment and Development (SED) Group. The Harvard University Center for the Environment promotes interdisciplinary strategies to address global environmental problems and supports the development of environmental research and instruction throughout Harvard. Several student groups work with this research group and across Harvard, including the Harvard Environmental Law Society, the Harvard Business School Business & Environment Club, and the Harvard College Environmental Action Committee.

The Harvard Green Campus Initiative has initiated numerous education and outreach programs as well. In partnership with the Harvard Extension Service, HGCI presents courses in sustainable practices and green building. HGCI hosts the Best Practices Exchange to facilitate discussion and education in the Harvard community about environmentally sustainable campus practices (HGCI 2007b). The Graduate Green Living Program, another HGCI initiative, promotes sustainable living in graduate student residences on campus. Graduate student volunteers educate fellow residents on energy

and water conservation and recycling (HGCI 2007c). A similar program exists for undergraduate residences.

UF offers more than 100 courses on sustainability issues within ten academic programs. Further, 23 research centers on campus address sustainability, including the Land Use and Environmental Change Institute, the Center for Health and the Built Environment, the Florida Institute for Sustainable Energy, the Water Institute, and the Powell Center for Construction and the Environment. The Provost has funded a Fellowship in Sustainability to lead to the creation of a "dedicated course of study in sustainability" (UF Office of Sustainability 2007c).

Several students work as interns within the Office of Sustainability and have helped create the Gator Green Guide to educate their fellow students about sustainability at Florida. Many student groups have originated to address these issues as well, including Gators for a Sustainable Campus, the Bioenergy and Sustainable Technology Society, and the American Solar Energy Society. Gators for a Sustainable Campus (GSC) has led an initiative for a Renewable Energy Student Fee (Green Fee) to purchase green power and fund renewable energy projects on the campus (GSC 2007). GSC also conducts outreach to local middle and high schools as well as to students on-campus. Finally, students can be involved in the administration as members of the University's Sustainability Committee and the Student Government Environmental Affairs Cabinet (UF Office of Sustainability 2007c).

Penn State offers 517 courses on environment, energy and other sustainability issues. The Center for Sustainability at Penn State, a research, education and outreach organization, promotes these courses and many of their upper level staff serve as instructors for some of these classes. Other campus research units addressing sustainability issues include the Penn State Institutes of Energy and the Environment, the Social Science Research Institute, the Undergraduate Biodiesel Research Group, and the Rock Ethics Institute, which focuses in part on global climate change. Beyond these research and curriculum opportunities, students may also be involved in sustainability issues through campus-supported student organizations such as Eco-Action, the Penn State Green Destiny Council, the Solar Decathlon team, and the Sustainable Agriculture Club.

Thirteen of the 37 academic departments at UCF were found to have courses involving sustainability issues. Several research units on campus focus on these as well, including the Florida Solar Energy Center, the Stormwater Management Academy, and the Center for Energy and Sustainability. These research units, as well as the UCF Physical Plant, offer outreach to students, employees and the general public via webpages that offer strategies for energy and water conservation.

The General Education Program (GEP), the core curriculum program at UCF, centers on a Unifying Theme of global climate change. The students, indicating their commitment to learning about and acting on environmental issues, chose this Theme. "The GEP Unifying Theme encourages UCF undergraduate students to engage in interdisciplinary,

academic discourse about global climate change, potential solutions, and opportunities for direct student action" (UCF General Education Program 2007). Also, the GEP Unifying Theme website serves as a clearinghouse for faculty research and resources for use in this effort.

Student groups focusing on sustainability issues include Engineers Without Borders, the ASHRAE group, and the Society of Environmental Engineers. Eco-Advocates, a student environmental organization, has been active in promoting sustainable practices at UCF. One initiative backed by Eco-Advocates has been a measure to include a "Green Fee" within student fees to fund sustainable technology and practices for UCF (Young 2007b). All money from this assessment would be placed in a fund overseen by a Green Fee subcommittee under the Sustainability Alliance and would be comprised primarily by students (Young 2007b). Finally, the UCF Student Government Association has established an environmental and sustainability coordinator position.

Duke's Environmental Policy Statement makes a commitment to environmental research and education, stating its goal to "use [its] institutional capability to constructively affect environmental policy throughout the world. [They] are committed to supporting interdisciplinary environmental scholarship and research, disseminating information about environmental research and policy, increasing faculty and student awareness of environmental issues, and enhancing environmental educational offerings" (Duke University 2007a).

Although an exact number was not available, Duke offers hundreds of courses in sustainability issues. In particular, the Nicholas School for the Environment and Earth Sciences offers courses, research and outreach programs in many aspects of sustainability. Students have become further involved by creating several organizations on campus including the Students for Sustainable Living, the Duke Environmental Alliance, the Duke University Greening Initiative, and the Duke Bike Advocates.

To educate the community about Duke's efforts and direct students and employees who might wish to be involved, a website was created by the Office of Sustainability to serve as a clearinghouse for the many sustainability initiatives throughout the campus (Capps 2007b). The Office also writes a bimonthly electronic newsletter, educates students via the Sustainability Internship Program, and offers workshops to faculty, staff and students (Capps 2007b). Community outreach is done via a lecture series, the publication of the Duke Environmental Magazine, and projects such as the "Share the Light" program in which students delivered energy-saving light bulbs to the local Department of Social Services for free distribution (Capps 2007b). The Duke Environmental Leadership Program offers continuing education for environmental professionals and others wishing to learn more about environmental policy and management. Finally, Duke uses the physical campus to educate the community and visitors; the university has developed a sustainability map focusing on the sustainable projects and buildings located across the campus (Capps 2007b).

UBC offers over 300 undergraduate and graduate courses that address sustainability

issues. Further, more than 150 faculty members are conducting research into areas such as social policies and green building. Research groups on the campus include the Global Sustainability Solutions Exchange, the Institute for Resources, Environment and Sustainability, and the Center for Human Settlements. Two UBC researchers developed the Ecological Footprint concept and published a book detailing their ideas; several governments and companies throughout the world have embraced this concept (UBC 2007c).

UBC has developed and/or encouraged the development of programs and organizations for students to increase their knowledge of sustainability issues and to assist the campus in its environmental initiatives. First, the Sustainability Office has created a Sustainability Pledge for students to sign on-line, accompanied by information on UBC's efforts and what they as students might do to become more effective environmental stewards. Students may also act as Sustainability Ambassadors to educate fellow students, may serve as Residence Sustainability Coordinators to lead initiatives in student housing, or may enroll with the Sustainable Leaders mentoring program coordinated between UBC and local professionals working on sustainability matters (UBC 2007d). Other student groups include the Bike Co-op, the Food CO-op, the Student Environmental Centre, and the Environmental Law Club (UBC 2007d).

Faculty and staff are involved in sustainability initiatives at UBC beyond the classroom as well. Within each of UBC's 300 academic and operational departments are Sustainability Coordinators who educate fellow workers about sustainability issues and

about alternatives available to reduce the environmental impacts of their activities. Primary areas of focus are energy use, waste production and transportation. Estimates are that the Sustainability Coordinator program saves UBC approximately $75,000 annually (UBC 2007e).

Finally, UBC as created an academic program to assemble interested faculty, staff and students to work on projects that focus on sustainability issues. The Social, Ecological, Economic Development Studies program (SEEDS) was created in 2001, has involved more than 1,000 participants, and has saved UBC hundreds of thousands of dollars through implementation of ideas that have originated in this program (UBC 2007f). SEEDS projects include exploring a sustainable food system for UBC, finding alternatives to pesticides, and determining stormwater treatment options.

Table 2: Overview of Academic Efforts in Sustainability at Eight Subject Universities

	Duke	UCF	Penn State	UO
Courses	Hundreds of sustainability courses	13 of 37 departments with sustainability courses	517 courses on environment and energy	22 of 46 departments with sustainability courses
Research	Several, including the Nicholas School of the Environment and the Duke Center for Environmental Solutions	Several, including the Florida Solar Energy Center and the Stormwater Management Academy	Several, including the Center for Sustainability and the Penn State Institutes of Energy and the Environment	20 research units focusing on environmental sustainability
Environmental Literacy Mandate	No	No	In development	No
Student groups	Several	Several	Several	16 student groups focus on sustainability

	Harvard	UBC	UF	UCM
Courses	370 courses; cross-offerings w/Tufts and MIT	Over 300 courses	109 courses	All 3 academic schools have sustainability courses
Research	Several, including the Sustainability Science Program at Harvard's Center for International Development	Several, including the Institute for Resources, the Environment and Sustainability and the Design Centre for Sustainability	23 centers, institutes and outreach programs	Sierra Nevada Research Institute
Environmental Literacy Mandate	No	No	No	No
Student groups	Several	Several	Several	2 groups

Academia Goals:

All students will attain environmental literacy as a requirement for graduation, learning alternatives to the current, non-sustainable paradigm that permeates Western society.

Students will understand how their personal choices influence the environment and learn about accessible, viable alternatives to the conventional.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

Within the first year of adopting the strategy, as part of the campus sustainability assessment, Office of Sustainability will compile a list of all courses directly or indirectly addressing sustainability issues. In the assessment, the Office will also review graduation prerequisites for each academic major to evaluate which schools require students to possess knowledge of sustainability issues, and will list all research units and their research concentrations to evaluate the level of research being conducted into sustainability. Finally, the assessment will determine the student groups on campus that advocate for and/or focus on sustainability, as well as the university funding for these groups.

Phase II: Within three (3) years of plan implementation:

To improve the sustainability knowledge base in modern university students, the university will offer sustainability-related courses to all students in the university. Each academic department will teach at least one course on sustainability issues. Alternatively, if enough institutions are in proximity to one another, an exchange program for sustainability courses similar to the one instituted by Tufts, MIT and Harvard could be established. Simultaneously, research into creating sustainable solutions for environmental, economic and social problems will be encouraged through funding and

faculty-hiring processes. Research programs in these areas will receive priority for laboratory space. University funding to student groups that advocate for sustainability issues will increase. Students will participate with the Office of Sustainability on advisory panels for campus sustainability plans, much like the UF Sustainability Committee. Interested students will receive the opportunity to intern with the Office of Sustainability to work on specific sustainability initiatives, much like interns at UF and Duke. The administration, via the Office of Sustainability, will also work with student groups that wish to implement their own sustainability projects for the campus and community. Loans from the office that are repaid from the cost savings accrued by the project, much like the proposed loan program for the university at large discussed above, would give these groups the financial backing to implement their ideas.

Phase III: Within five (5) years of plan implementation:

After sustainability courses are in place, the university will implement a policy that each matriculating senior must pass at least one course in sustainability issues. Departments will continue to prioritize funding and laboratory and office space for research units that focus on studies involving sustainability issues. Also, administrative support for student sustainability initiatives and student participation will expand.

Phase IV: Within 10 years:

To achieve the goal of environmentally literate graduates, each major will have sustainability integrated into its curriculum. Minimally, one core course within a major will concentrate on the relationship between the major subject and how it may influence

or be influenced by environmental, social and economic sustainability. As technology and funding improve, sustainability can be woven into the curricula of all academic majors. Students will receive instruction into how their chosen careers may impact the environment and will be exposed to the more sustainable options available within their fields. As an example, the University of Florida's School of Building Construction offers a course entitled "International Sustainable Development" that focuses on the environmental impacts of construction worldwide. Further, all graduating seniors will be required to pass a course offered university-wide that focuses on general sustainability. This course would be designed to offer students an alternative view to the unsustainable practices that are the current norm in Western society. The basic elements of regenerative design and development will be included in this course as well. The goal of the course will be to educate students as to how their personal choices influence the environment and explore accessible, viable alternatives to conventional practices.

The mandate that all students attain environmental literacy as a requirement for graduation may appear to be unrelated to certain majors, e.g. music, dance, foreign language, etc. However, these students all have effects on the planet through their personal behaviors, and teaching them the potential consequences of their actions is as important as teaching those in disciplines more directly related to sustainability. In fact, it may be more important, as many in the more-related disciplines probably already have some degree of environmental literacy. As examples of schools attempting to implement sustainability into seemingly unrelated disciplines, Penn State's Green Destiny Council (2000) relates that the "World Resources Institute is working with over 100 business

schools to integrate ecological literacy into business curricula (www.wri.org/wri/meb/); and the Consortium for Environmental Education in Medicine is working with medical schools to elucidate the relationship between human health and environmental health (www.ceem.org)."

Phase V: Within 30 years:

As the built environment of the campus becomes regenerative, courses will be updated so that all students and faculty have a working knowledge of the processes that make the campus regenerative. Courses taught in regenerative buildings will incorporate the features of the buildings into class material. Education on the regenerative nature of residence halls, cafeterias and other common spaces will be included in freshman and faculty orientation. With this knowledge of regenerative development, students and faculty will be better equipped to lead their communities toward this type of development as well.

AREA OF FOCUS 3: BUILDINGS

As noted in the Literature Review, buildings account for considerable global resource consumption. Construction, operation and maintenance of buildings consume 40% of total raw materials and energy, 16% of water, and 25% of harvested wood (Orr 2004). Buildings account for approximately 30% of total waste output (60% of non-industrial waste), 50% of the total chlorofluorocarbons (CFCs) produced, 40% of SO_2 and NO_x pollution, and 33% of the CO_2 emitted (Orr 2004; Roodman and Lenssen 1995). And indoor environmental quality has tremendous impacts on human health, as the USEPA

reports that approximately 30% of all buildings have "sick building syndrome" (Mendler et al. 2006).

Universities have thousands of new buildings planned for construction (Orr 2004). How colleges and universities construct these new buildings and renovate their existing ones will have environmental impacts through energy and water use, water quality, human health, raw material consumption, GHG emissions, and waste creation. Though many of these topics will be discussed individually – waste management, GHGs, energy and water – all will be addressed in this section through the new and renovated building criteria proposed for college campuses. And, because these areas do not function individually, many opportunities to coordinate design and operations among several departments will arise.

Several universities, after recognizing the reduced environmental impacts as well as the long-term economic benefits, have begun to implement green design and construction practices on their campuses. For example, UF has incorporated green building to show "its commitment to save and protect the environment and provide its occupants health and comfort" (UF Facilities Planning and Construction 2007a). Of these, many have instituted requirements that new buildings achieve LEED certification or meet LEED criteria without undergoing the full certification process; one has developed its own criteria to complement LEED. However, none of these has begun regenerative development.

In 2001, UF adopted LEED-NC standards for all new construction and renovation projects, and in 2006 enhanced this to require LEED-Silver criteria. As of November 2007, UF has 17 LEED-NC certified buildings, including two LEED-NC Gold structures, and several other projects have begun the LEED certification process (UF Office of Sustainability 2007e). To address existing buildings, UF has selected 35 structures to be evaluated through its LEED-EB pilot program (UF Office of Sustainability 2007e).

The UF Physical Plant contains an Office of Energy Conservation to monitor and decrease the consumption of energy on the campus. Evaluations of existing buildings and energy schedules are being conducted. Future projects of this office include installation of automated building utility meters and higher efficiency building energy controls (UF Office of Sustainability 2007f). Students have also made a commitment to more sustainable energy by voting for a fee increase to pay for renewable energy projects at UF. Finally, a demonstration green roof project has been constructed on one campus building. Progress Energy, the electricity provider for the university, has assisted in building a cogeneration plant at the school and has funded a professorship. Progress Energy is also evaluating the feasibility of implementing solar photovoltaic projects.

At UF, all wastewater produced on campus is sent to a 3 million gallon per day Water Reclamation Facility for treatment, and then a portion is piped to the irrigation system (UF Office of Sustainability 2007g). Other effluent water not used for irrigation is diverted to Progress Energy's campus cogeneration plant (UF Physical Plant 2007a). Other water

saving measures in place at the UF include cisterns to collect rainwater and installation of low flow fixtures in new buildings.

The 2005 University of Oregon Campus Plan mandates that all new building design and operations adhere to the 2000 Sustainable Development Plan. The Sustainable Development Plan requires that all construction meet LEED standards, but does not mandate certification due to the added expense (Mital et al. 2007). Later, a requirement that LEED scorecards be used to self-assess buildings was developed (Mital et al. 2007). In 2004, the requirement was increased to mandate LEED-NC (Version 2.0) Silver criteria, but again, certification was not required; renovation projects are required to achieve only basic certification standards (Mital et al. 2007). These requirements are based on an Oregon law requiring self-assessment of construction projects by all state agencies; the law further mandates the creation of a maintenance plan that incorporates sustainable methods as well (Mital et al 2007).

Other criteria new buildings must meet are those set forth in the State Energy Efficiency Design (SEED) program created Oregon Dept. of Energy. In its current form, SEED requires that state agency projects constructed after June 2001 exceed building code energy conservation requirements by 20%, and that existing buildings must be retrofit to exceed these requirements by 10% (Mital et al. 2007). However, no mechanism exists within the university to ensure compliance with these conditions, and no centralized staff is in place to oversee project qualifications, manage the LEED and SEED processes, or ensure compliance with LEED/SEED criteria (Mital et al. 2007). As of May 2007, UO

had constructed four buildings that met LEED-NC 2.0 Certified or higher standards, and has proposed three more. One of the completed buildings has achieved LEED-NC Silver certification, but only one building meets the SEED requirements (Mital et al. 2007).

In fiscal year 2005-06, through the use of solar panels and the purchase of wind power, 4% of UO's total electricity came from on-site renewable resources, constituting 1.3% of the total energy used on-site (Mital et al. 2007). The Central Power Station is a cogeneration facility that produces up to 30% of the university's electricity as a by-product of the creation of steam (UO Facilities Services 2007). More renewable energy projects will be implemented at UO, as the students voted to increase their annual fees to purchase renewable energy credits for the student union (Mital et al. 2007). And though no formal policy exists, UO has converted over 80% of its fluorescent lighting from T12 lamps to the considerably more efficient T8 lamps (Mital et al. 2007).

UO has also begun several pilot programs for water conservation and reduction of stormwater runoff. A rainwater catchment system (cistern) was installed on the Outdoor Program building, and the water is used to clean the equipment and vehicles used by the program (Mital et al. 2007). Two living roofs have been installed on campus buildings, but one failed. The infrastructure remains for the failed roof, and "valuable learning opportunities" were provided for future projects (Mital et al. 2007).

Duke has become a university leader in constructing new buildings to LEED-NC standards. As of December 2007, 17 buildings on the campus had attained a LEED-NC

Certified rating or higher. Duke has also established University Design Guidelines, which state that energy conservation, and efficiency of mechanical and electrical systems and equipment is of prime importance (Capps 2007b).

A major initiative at Duke is the redevelopment of the Central Campus, a 200-acre project that involves integration of sustainability initiatives into all aspects of this area of campus. Among the goals are to preserve green spaces and create a more walkable campus. (Capps 2007b). All new buildings as well as those undergoing renovation in the Central Campus are being targeted for LEED-NC Silver, at minimum (Duke 2007b). Yet another green building project is the "Smart Home" pilot program in which the College of Engineering has partnered with Home Depot, Inc. to construct a green home that serves as a living experiment as well as a home to a select number of Duke students every year. This project is aiming to achieve LEED-NC Gold certification.

Duke has made substantial efforts in improving the energy efficiency of and reducing the energy consumption by its campus. Within the Facilities Management Department (FMD), Duke has created an Energy Manager position. This manager is responsible for developing and implementing all energy programs, but especially energy efficiency and self-generation projects. The manager is also the primary technical advisor to Duke regarding energy supply and delivery issues. Further, the FMD is in the process of creating a long-term energy management strategy to help guide campus development. The Energy Management Team within FMD conducted an energy audit and performed simple retrofits and technical upgrades in campus buildings starting in 1995. Between

Fiscal Year 1997-98 and 1999-2000, these efforts saved the university over $2.8 million in water and energy costs (Friedman 2000).

Duke has also mandated that all purchases for qualifying products will be ENERGY STAR certified; for those products not governed by ENERGY STAR, energy efficient products will be sought (Capps 2007b). ENERGY STAR is a joint program of the US Environmental Protection Agency and the US Department of Energy to promote energy efficient products and practices (ENERGY STAR 2007). In 2006, ENERGY STAR helped Americans save $14 billion in utility bills and prevented the release of greenhouse gas emissions equivalent to those produced by approximately 25 million cars (ENERGY STAR 2007).

Duke has established a goal of reducing water consumption by 30% of fiscal year 2006-07. As LEED certified buildings are constructed on campus, more water-saving fixtures are being installed. For example, one building has a 70,000-gallon cistern to collect rainwater for irrigation; a second had 50 waterless urinals and low-flow toilets that save approximately 2 million gallons per year (Baxter 2007).

UBC opened its first green building in 1996. The C. K. Choi Building for the Institute of Asian Research included reused and recycled materials, natural ventilation, and composting toilets, and won several awards for its environmentally friendly design. Several other green buildings, including structures achieving LEED-NC basic certification and higher, have been constructed or are in the planning stages at UBC. To

complement LEED, UBC developed its own green building assessment standard to ensure that all new residential construction on campus lands would be more sustainable. The UBC Residential Environmental Assessment Program (REAP) was introduced in 2006. Though based on LEED, REAP is unique in that it "is a single system that can be applied to both low and high rise buildings" (UBC 2007h). Like LEED, REAP has mandatory and optional requirements as well as various levels of certification. Regardless, developers of residential projects on UBC lands must apply REAP criteria to their developments and are encouraged to go beyond Base Compliance (UBC 2007h).

University Town is a sustainable community being developed by UBC. When all phases are complete, University Town will include five neighborhoods throughout the campus containing residential and retail facilities with accompanying recreational and natural areas (UBC 2007i). The developments will be constructed following REAP criteria, and are expected to increase the population living on campus to approximately 18,000 residents by 2021 (UBC 2006a). A minimum of half of the new residents will be affiliated with the university as employees or students in an effort to move this commuter campus to a more sustainable one (UBC 2006a).

Existing buildings are also part of the UBC plan. UBC entered into a public-private partnership with the provincial government of British Columbia to create and fund the $120 million UBC Renew program (UBC Public Affairs 2005). The Renew program is an effort to upgrade older buildings on campus before they deteriorate, and in turn save materials and money that would have been used for new construction (UBC 2007j). The

plan calls for the useful lives of these older buildings to be extended by 40 years or more, and when completed almost 1 million square feet of buildings will be upgraded (UBC 2007j). As of April 2007, ten buildings were undergoing the process. Estimates are that these would have cost $209 million to build new compared to the renovation costs of $120 million, thus saving UBC $89 million (UBC Public Affairs 2007). Looked at another way, when compared to the cost of constructing new buildings, the UBC Renew program generates savings such that every third campus building would be free (UBC Public Affairs 2007).

Due to the efforts of the Sustainability Office, in 2003 UBC implemented the largest university energy and water retrofit program in Canada, ***Ecotrek*** (UBC 2006b). This three year, $35 million project involved the renovation of the infrastructure of almost 300 buildings to install new energy and water saving technologies (UBC 2006b). Since its completion in mid-2006, the program has saved $3.8 million in energy costs, and projected annual utility savings are $2.6 million (UBC 2006b). Further, ***Ecotrek*** has already met and exceeded the benchmark 20% reduction in energy use established at the outset of the project (UBC 2006b).

Specific actions taken to save energy in the ***Ecotrek*** program include the following:

- retrofitting lighting systems in 120 buildings with energy efficient fixtures and other components;
- replacement of road and path lighting with efficient fixtures;
- expansion of the Building Management System, an automated monitor and control system, to include 90% of campus buildings;
- sealing door and window leaks in 200 buildings;
- installation of solar panels on a new engineering building;
- and scheduling periodic training for staff on the new technologies and energy

efficient operation of buildings (UBC 2006b).

Ecotrek was funded via Energy Performance Contracting, an arrangement wherein the energy cost savings are used to repay the costs of the infrastructure improvements. The Energy Performance Contract is administered through an Energy Management Services Agreement between the university and a private energy management firm (MCW 2002). The university contracts the firm to design, install and fund the new technology, and the EMSA is worded such that the payments to the firm are contingent on the performance of the system upgrades – the firm guarantees the energy savings and will reimburse any shortfall (MCW 2002).

Water conservation is also addressed in the comprehensive ***Ecotrek*** program. The target for water use reduction was 30%, a figure that was achieved by the end of the program in 2006. In the first year and a half after the project was completed, UBC saved approximately $1.5 million in water utility costs. To accomplish these savings, over 3,000 low-flow plumbing fixtures were installed and more than three miles of steam system condensate pipe was repaired.

Harvard has constructed several green buildings on its campus. Eight of these buildings are LEED-NC or LEED-CI certified, 21 more have been registered to begin the certification process, and three others are in planning. One of these, the home of University Operating Services, achieved LEED-NC Platinum, and Harvard has committed to certify all buildings at LEED-NC Gold for the new Allston campus. (SEI 2007).

Like UBC, Harvard has also established its own green building guidelines. All projects that cost in excess of $5 million must acquire LEED-NC Silver ratings, and Harvard mandates that some of these LEED credits be achieved as prerequisites; the required credits are for energy efficiency, water consumption, utility metering, and indoor environmental quality (HGCI 2007d). Further, these projects must undergo periodic building commissioning over the life of the structure (HGCI 2007d). Though LEED certification is not required of projects below $5 million, Harvard has created LEED-based guidelines for these as well. For existing buildings, a pilot program to determine the feasibility of acquiring LEED-EB for two buildings is underway.

Solar photovoltaic panels have been installed at four locations across the campus to provide supplemental electrical power to Harvard buildings. Harvard also utilizes geothermal systems for six buildings, with plans to install similar equipment in two more. These geothermal systems have proven to be more efficient than fossil fuel-based heating and cooling at Harvard (HGCI 2007e).

Harvard has strived to reduce potable water consumption on its campus. Low-flow toilets and shower heads have been installed in many buildings; replacing conventional toilets in 12 residential halls led to an annual savings of over 4.1 million gallons of water and $43,000 (HGCI 2007f). Other initiatives include replacing washing machines at residence halls with more efficient models and altering chemical and biological laboratory protocols (HGCI 2007f). Finally, green roofs have been installed on four buildings to reduce and treat stormwater.

University of California policy mandates that all new construction at each campus achieve LEED Silver Certification or the equivalent (UC Merced 2007b). At UC Merced, the LEED Silver rating is the minimum acquired, with three LEED –NC Gold and one Silver in the application stages. In order to meet these goals, all new construction contracts contain LEED Silver requirements and specific building performance goals (UC Merced 2007b.). UC Merced has created campus-wide site development and infrastructure credits to be applied to every new construction project as part of a USGBC Pilot Program for college campuses (UC Merced 2007b). Further strategies to achieve the remaining necessary credits are developed on a project-specific basis (UC Merced 2007b).

UC Merced has committed to incorporating a "high degree of energy efficiency" into the design of all its buildings as well as major renovation projects that will occur as this new campus ages (UC Merced 2007f). UC Merced has established building energy performance targets that "ensure that new buildings are significantly more efficient than required by code or compared to other university buildings in California" (UC Merced 2007f). The targets are for new buildings on campus to use 30% less energy than required by Title 24, the California law that set energy efficiency benchmarks for structures (UC Merced 2007f). As well, the new buildings must meet energy budgets that are 50% of the University of California / California State University energy performance benchmarks (UC Merced 2007f). However, these requirements are being phased in; interim targets are 80% of the UC/CSU standards, then 65% through the first 1.2 million

gross square feet of buildings (UC Merced 2007f). Architectural shading, high efficiency building mechanical systems and high-performance window glazing are but some of the technologies used to achieve these targets.

Another strategy involves budgeting for peak demands for chilled water, electricity, and natural gas. Within UC Merced's Central Plan is a Thermal Energy Storage Tank. Energy is used to chill water during off-peak night hours, which is then stored and later distributed to cool buildings during the day (UC Merced 2007f).

Further, UC Merced is a Pilot Partner of Laboratories for the 21st Century (Labs21), a program developed and supported by the U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy (DOE), and the International Institute for Sustainable Laboratories (I2SL) (UC Merced 2007f). Labs21 is a program to increase efficiency of energy, water and other systems in laboratory buildings. Because laboratories use three- to five-times the energy that a typical building uses, and because several laboratory facilities will be located on the campus, the incorporation of the Labs21 protocols is extremely important to UC Merced's energy efficiency strategy (UC Merced 2007f). Finally, UC Merced has installed an energy management and control system that is operated from a central location. The system monitors at both the whole-building and individual system levels, allowing for quicker identification and repair of problems (UC Merced 2007f).

Water use in all buildings at UC Merced is at least 20% below state-mandated goals, with

some buildings achieving 30% reductions (UC Merced 2007g). Installation of low-flow fixtures and waterless urinals has assisted in creating these reductions. Further decreases in potable water consumption are expected to arise from rainwater capture technology (cisterns), gray water recycling, and installation of updated sewage treatment equipment (UC Merced 2007g).

Penn State has developed and periodically updates a green building policy based on LEED-NC criteria. The most current revision was in August 2007, and is based on LEED-NC v.2.2. LEED certification is required for all new buildings and major renovations, and the policy gives guidance to architects and engineers as to which credits within LEED will be given priority in design and construction (Penn State Physical Plant 2007b). Finally, a Continuous Commissioning Program has also been implemented at Penn State since 1998 to optimize building operating systems, resulting in improved indoor air quality and reduced utilities costs in existing buildings on campus, with a typical payback period of two-four years (Penn State Physical Plant 2007c).

Penn State has implemented several programs to optimize energy use in campus buildings. Beyond the Continuous Commissioning Program, Penn State has also implemented a Guaranteed Energy Savings Program per the guidelines of the State of Pennsylvania. Among many others, some of the Energy Conservation Measures employed via this program include installation of solar PV panels (on two buildings), replacement of T-12 with T-8 fluorescents, building metering, and periodic system tune-ups (Penn State Physical Plant 2007d). To perform these projects, much like UBC, Penn

State contracts energy service companies to design, employ and warranty self-funded energy-savings projects. If a project fails to meet the designed savings, the energy service company must reimburse the university for the difference between the guaranteed and the realized savings (Penn State Physical Plant 2007e). Other Energy Conservation Measures at Penn State include the installation of occupancy sensors for lighting in bathrooms and reducing temperatures in some buildings during winter break (Penn State Physical Plant 2007d).

Penn State owns and operates its wastewater treatment facility, and after treatment all 2.6 million gallons per day are used to irrigate farm crops on or near campus (Fennessey 2007). To reduce water consumption and waste, the university has completed plumbing retrofits for several residence halls, including the installation of low-flow showerheads. Replacing all washing machines in residence hall laundry facilities with ENERGY STAR models saves approximately 14 million gallons annually (Zitomer and Neil 2004). The new building construction guidelines at Penn State, based on LEED criteria, require a 20% reduction in water use from baseline, and a 30% reduction is encouraged (Penn State Physical Plant 2007b). Finally, Penn State mandates as part of its green building policy that a minimum of 75% of construction waste be diverted from landfills (Penn State Physical Plant 2007b).

At UCF, all new buildings and major renovations to buildings are required to meet LEED-NC Silver standards. Construction began in August 2007 on the first LEED structure at UCF, the new Physical Science building. To increase the efficiency of existing buildings, the Center for Energy and Sustainability created an in-house Building

Commissioning Team for the purpose of identifying and implementing resource-saving practices and technology (UCF Sustainability and Energy Management 2007). The first three buildings have entered the commissioning process, while all other buildings have been placed into a four-year recommissioning cycle. The first two buildings to complete the process have displayed approximately 20-28% reductions in electricity use and 14% reductions in chilled water use; the third remains in the bidding phase (UCF Sustainability and Energy Management 2007a).

UCF's Center for Energy and Sustainability plans to install a solar water heater in a 500-person residence tower as a pilot program (UCF Sustainability and Energy Management 2007b). If successful, solar water heating systems will be placed on three other residence structures and in future construction (UCF Sustainability and Energy Management 2007b). Further energy savings will be achieved when lighting systems in the library and physical plant facilities are retrofit. Currently, T-12 fluorescent lighting is used but will be replaced with high efficiency T-8 fluorescents. When completed, the return on investment (ROI) for this project is expected to be slightly more than one year (UCF Sustainability and Energy Management 2007c). Finally, to reduce water consumption, the new campus master plan at UCF mandates the use of low-flow fixtures in all new buildings (UCF Board of Trustees 2004).

Table 3: Summary of Green Building Efforts at Eight Subject Universities

	Duke	UCF	Penn State	UO
LEED-NC requirement	No formal policy; 17 certified buildings; Silver for Central Campus	Silver	Basic – school guidelines on specific credits	Silver – certification **not** required
Existing building retrofits	Retrofit and upgrade program in 1995	In-house building commissioning team – started retrofit of 4 buildings	Continuous commissioning program; Replace T-12 with T-8 fluorescents	Replace T-12 with T-8 fluorescents
Building energy efficiency	ENERGY STAR appliances; Campus Energy Manager	Solar water heaters planned for 4 residence halls	Pilot solar panel project; occupancy sensors	Exceed code by 20%; solar and wind on-site
Building water efficiency	GOAL: reduce use by 30%; Cisterns, waterless urinals, low-flow fixtures	Low-flow fixtures	Water reclamation facility – used for irrigation; Low-flow fixtures and infrastructure repair	Pilot green roof and cistern programs
Recycling/ salvage of construction waste	---	---	Minimum of 75% of construction waste be diverted	---

	Harvard	UBC	UF	UCM
LEED-NC requirement	Several LEED buildings >$5 million – Silver <$5 million, school guidelines on specific credits	No policy; several LEED bldgs. on-campus; REAP system for residential projects	Silver	Silver; also, part of USGBC Pilot Program for College Campuses
Existing building retrofits	Feasibility study for LEED-EB at 2 buildings	UBC Renew; ***Ecotrek*** – 300 buildings	35 structures to be evaluated through LEED-EB pilot program	None – opened in 2005
Building energy efficiency	Photovoltaic cells on 4 buildings; geothermal at 6	***Ecotrek*** – reduced energy use by over 20%; Pilot solar panel project	Office of Energy Conservation; Cogeneration Plant; Student fee for renewable energy	All must use 30% less than CA. mandate; Thermal Energy Storage Tank
Building water efficiency	Low-flow fixtures, high-efficiency washing machines, 4 green roofs	***Ecotre***k – reduced water use by 30%; Low-flow fixtures and infrastructure repair	Reclamation facility – waste water re-used; Cisterns; Low-flow fixtures	20% below CA. mandates; low-flow and waterless fixtures; gray water reuse and cisterns planned
Recycling/ salvage of construction waste	---	---	No known policy, but has been conducted on some projects	

Buildings Goals:

All buildings on campus will be regenerative, either through renovation or new construction. Though this goal may appear daunting, a few regenerative projects have already been constructed on college campuses. The Lyle Center for Regenerative Studies at California State Polytechnic University at Pomona and the Lewis Center for Environmental Studies at Oberlin College are two well-known examples.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

The administration will create a policy that all new buildings and major renovation projects will apply for and achieve LEED-NC Silver certification beginning one year after the campus strategy is initiated. During the campus-wide sustainability assessment conducted by the Office of Sustainability in this Phase, an evaluation of the sustainability of current campus infrastructure and operations will be performed. All campus buildings greater than 2 years in age will be reviewed using LEED-EB criteria. This assessment will help determine which buildings are the most inefficient and unsustainable, ultimately leading to a priority list of buildings to retrofit or replace. Depending on the extent of renovation necessary, the bottom 25% of existing buildings in terms of efficiency will be updated to achieve LEED-NC Silver or LEED-EB Silver. Further, much as UBC did in its ***Ecotrek*** project, the responsible operations groups will replace all light fixtures in all existing buildings with high efficiency versions; inspect all doors and windows, and repair any leaks or damage; and inspect and repair all water lines and fixtures as well.

LEED-NC will be used to evaluate all younger buildings and proposed buildings, and costs to upgrade these to meet LEED-NC Silver criteria will be determined. If any recently completed structures might meet the criteria or do so with minimal effort, the university will make application for certification with the USBGC. Further, the Office of Sustainability will incorporate the LEED-NC Application Guide for Multiple Buildings and On-Campus Building Projects into the assessment, as this guide provides direction on how best to coordinate efforts across the campus to satisfy LEED credits for several individual building projects. Credits that could be shared among projects are found primarily in transportation, water efficiency (irrigation), and waste management.

Phase II: Within the first five (5) years of plan implementation:

Implementation of the LEED-NC and –EB Silver goals stated in Phase I will occur in Phase II. Though LEED-NC Silver buildings are at best minimally sustainable, conducting these efforts will introduce the concepts of LEED and green building to the campus community at large, display the environmental and economic benefits of the concepts, and give the administration and staff tasked with sustainable development valuable experience in coordinating green building design and construction; in short, they will "learn by doing." The designs will concentrate on achieving as many credits as possible in the categories that provide energy and water savings as well as those that promote the health of building occupants. Focusing on these areas will likely display the greatest return on investment via reduced operating costs, increased employee and student productivity, and improved health of building occupants. The operations cost

savings will be set aside within the campus budget for further sustainable construction projects.

Several credits within LEED –NC categories Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Water Efficiency generate significant environmental benefits and long-term cost savings, either through reduced utility bills or increased worker productivity and health. Similar credits exist within LEED-EB and will be applied to existing buildings; the 25% least efficient existing buildings, based on the Phase I assessment, will be renovated to achieve LEED-NC Silver or LEED-EB Silver. However, this strategy will focus on LEED-NC criteria for simplicity.

To make buildings more energy efficient, and in turn meet five credits within Energy and Atmosphere, new buildings will be constructed to achieve a 25% improvement in energy performance. This will be achieved with climate-appropriate and energy-efficient materials, including glazing; the structures will be sited to maximize daylighting and passive climate control; and the most efficient appliances and fixtures available will be installed in the buildings. Room occupancy sensors and compact fluorescent or LED light bulbs are other simple technologies that can be incorporated immediately to improve energy efficiency. Therefore, regardless of the power system used for the buildings, reduced financial outlay will be necessary for energy. Costs from energy suppliers will diminish, or if the decision to use on-site alternative energy is made, smaller systems (e.g., fewer solar panels) will suffice. To maintain the efficiencies designed into the

buildings, each will be metered to compare actual energy consumption to the design; this will also meet the Measurement and Verification credit within LEED-NC.

The goal for Water Efficiency in Phase II is to attain a 20% reduction in water use compared to baseline, and in doing so acquire one LEED-NC Water Use Reduction credit. Incorporating technologies such as low-flow fixtures and waterless urinals will help to achieve this standard. Indoor Environmental Quality credits produce high return on investment through protecting the health of building occupants. Fewer illnesses, and therefore potentially lower insurance costs, will result, as will higher worker productivity and student performance. For example, Fisk (2002) notes that the estimated productivity reduction in U.S. offices due to sick building syndrome in employees was 2%, resulting in an annual loss of $60 billion. If symptoms of sick building syndrome are decreased 20% to 50%, annual savings could achieve $10 billion to $30 billion (Fisk 2002). Therefore, easily incorporated products such as interior furnishings, carpets, adhesives and finishes that contain low or no VOCs (4 credits) and individual controls for lights and thermal comfort (2 credits) will be maximized. To avoid contamination of the HVAC system and therefore the entire building during the construction process, a Construction Indoor Air Quality (IAQ) Management Plan will be required for all new projects. Any IAQ plan for campus buildings must meet the LEED criteria for both during construction and before occupation; this will also result in qualifying for 2 more LEED credits.

The source and content of building materials and how construction waste is handled can also contribute to both LEED credits and reducing environmental impacts of

construction. Diversion from landfills of a minimum of 50% of construction waste will be mandated for all new construction (1 point). This can be accomplished by recycling waste materials, using at least 5% (by cost) of otherwise waste products in the new building (brick, flooring, etc.) for another point, and ensuring that 50% of the wood used in the building is Forest Stewardship Council (FSC) certified for a third point. Incorporating materials with recycled content "such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost) of the total value of the materials in the project" is easily attainable, will reduce resource consumption, and will garner another LEED credit (USGBC 2005c). Finally, to reduce the embodied energy used in transporting building materials, a minimum of 10% of materials (by cost) extracted and produced regionally (within 500 miles) will be required of all new building projects (1 point).

The above tactics minimally provide 19 of the 33 LEED-NC credits required to achieve Silver. The remaining points will be garnered from "low-hanging fruit" –credits that are attained with minimal cost or effort. Examples of these are: surveying building occupants about the thermal comfort of the new building (1 point.); eliminating light pollution via fixture orientation and automated night shut-off of non-emergency lights (in conjunction with exterior light regulations, can achieve 1 point); and installing bicycle racks and showers at new buildings (1 point). Inclusion of a LEED-AP on the design team also gains the project a credit. However, those credits that best fit each project will ultimately be chosen.

Finally, in this stage the planning for a regenerative campus will begin. Establishing the infrastructure layout, plantings, etc. early in the process allows for budgets to be determined and funds to be raised, and minimizes disruptions to campus life. Vital to the overall Regenerative Strategy is that the campus augments the sustainability achieved in early phases until the regenerative level is met. New structures must allot space for future alternatives in their designs. Solar collectors, wind turbines, or other alternative energy sources, as well as green roof infrastructure and sites for cisterns and wastewater treatment wetlands are but a few examples of possible technology that could be implemented for buildings to meet higher LEED certification. Easily accessible and removable interior infrastructure such as wiring and plumbing, will be favored in designs to allow upgrades to occur with nominal disruption to the building and minimal waste produced.

Phase III: Within 10 years of plan implementation:

To continue improving the sustainability of the campus and moving toward regenerative levels, all new buildings will achieve LEED-NC Gold. The lowest 25% of existing buildings not upgraded during Phase II will be enhanced to achieve LEED-NC or -EB Gold standards. Further, to ensure that existing buildings operate at maximum efficiency and to build on their successes, the 25% that were upgraded in Phase II will be reassessed per LEED-EB requirements every five years to maintain their certifications; within Phase III these will also be improved to Gold levels. Finally, all LEED-NC Silver buildings constructed during Phase II will undergo LEED-EB analysis within five years of construction. Each of these will be upgraded to attain LEED-EB Gold as well.

Again, the designs will focus on acquiring as many credits as possible in the categories of energy and water conservation and indoor environmental quality to maximize the return on investment, incorporating many of the same criteria that were used in Phase II and expanding to include more sustainable technology. And again the operations cost savings will be placed into the budget for further sustainable construction projects.

To improve building energy efficiency, and in turn meet eight credits within Energy and Atmosphere, new construction will be mandated to achieve a 35% improvement in energy performance. To improve the insulation of the building roof, one option is to incorporate a green, or vegetated, roof. Green roofs not only provide extra insulation, they also treat and reduce stormwater, and could be used to grow food for campus needs (see the Food Resources section). Beyond the requirements in Phase II, a modest amount of energy (2.5% of the structure's needs) will be produced on-site by renewable energy sources; possible sources are solar photovoltaic, geothermal, biomass and others. Meeting this goal will attain another LEED credit for the building project.

The goal for Water Efficiency in Phase III is to attain a 30% reduction in water use compared to baseline, and therefore to gain two LEED-NC Water Use Reduction credits. Installation of composting toilets will further reduce water consumption to meet this goal, but larger gains in water conservation will arise from using alternative sources of water for non-drinking purposes. Though this component will be discussed in more detail in the Water section, it is mentioned here due to the infrastructure that will be necessary to install. "Gray water," the waste water from sinks, showers, laundry and dishwashing, can

be captured and reused for irrigation and toilet flushing. Cisterns to capture rainwater could be used for a similar purpose. Finally, treating wastewater on site to tertiary standards is an alternative acceptable under LEED criteria, so long as the water is allowed to infiltrate or be used on the site. The approach most suited for the campus will be implemented, as climate and space requirements will affect these decisions.

On top of the requirements in Phase II, Indoor Environmental Quality credits required of new buildings will include designs to provide daylighting for 75% and views for 90% of regularly occupied areas (2 credits), to increase outdoor air ventilation for spaces (1 point), and to reduce pollutants from chemicals stored in the building or particulate pollutants that may enter via exterior doorways (1 point). Monitoring of outdoor air delivery via CO_2 monitoring equipment and airflow measuring will also be included to protect occupants (1 point).

Both sourcing of building material and construction waste disposal will also become more stringent. Mandate that for all new construction a minimum of 75% of construction waste be diverted from landfills (1 point beyond Phase II). Incorporating at least 10% (by cost) of otherwise waste products in the new building (brick, flooring, etc.) will assist in that goal and garner a credit beyond that achieved in Phase II. Also, the use of materials with recycled content will increase to at least 20% (based on cost) of the total value of the materials in the project; this will further reduce resource consumption and attain another LEED credit. Further, a requirement that a minimum of 20% of materials (by cost) in the building be extracted and produced regionally (1 credit beyond Phase II)

will be instituted, as well as one that mandates no less than 2.5% (by cost) of building materials be from rapidly renewable resources such as bamboo, linoleum, or wheatboard (1 point).

When a campus building is to be razed, one option to minimize the waste from demolition, as well as attain more LEED points, is to contract a building deconstruction company. Demolition has significant environmental and economic costs. "According to the EPA there are over 136 million tons of building related construction debris generated annually (Steward et al. 2004). Within this total, 125 million tons (80%) are taken from demolition and renovation sites, while 11 million tons (8%) originate from new construction projects (Steward et. al 2004). These quantities account for at least one quarter of the total landfilled waste in the U.S. (Hilmoe et al. 2001)" (Endicott et al. 2005). Further, planned deconstruction can provide economic benefits to the university through tax incentives, grants, and reduced tipping fees.

Combined with the 19 credits acquired in Phase II, the above provide 33 credits toward the 39 necessary to achieve LEED-NC Gold. The "low-hanging fruit" credits are not included in these numbers. Again, those credits that best fit each project and each campus will be sought.

To continue the steps toward the regenerative campus, land will be set aside for the necessary infrastructure, and no development of this land will occur. Further, the university will invite participation from leaders in regenerative design to participate in

charrettes with university leaders and representatives of campus community groups, including students, to create plans for the regenerative buildings.

As one of the basic tenets of regenerative design is to "design to place," formulaic design is not appropriate and canned solutions are not offered in this strategy. Instead, by working with the environment of each building, the design team will determine the appropriate architecture and technologies to meet the objectives of regenerative design for that particular structure. The design will maximize synergies within the building as well as with other campus buildings and infrastructure, as this is another hallmark of regenerative design.

Phase IV: Within 25 years:

As technology and experience with LEED construction improve at the campus, the goal for all new and existing buildings is to achieve LEED Platinum ratings. Building designs will attain a minimum of 42% improvement in energy efficiency over baseline, which will qualify for all 10 LEED credits in Optimize Energy Performance. Further, on-site renewable energy sources will account for a minimum of 12.5% of each new building's energy use to achieve the three credits available.

The university will also finalize plans for the first regenerative buildings to be constructed in Phase IV. At the end of this phase, bids will go out for design and construction of regenerative buildings. The plans will address the characteristics mentioned in Phase III.

Regenerative buildings maximize the use of passive solar strategies to minimize the need for energy-intensive lighting and climate control. By designing to the site, prevailing winds, solar angles, and landscape elements can be important elements in reducing energy needs for buildings. As Haggard (2002) notes, "every aspect of the design attempts to reduce or eliminate the need for mechanical or electrical energy, while taking advantage of solar and biological energy. Run off water supports deciduous trees that provide shade in summer and solar access in winter."

Further, regenerative buildings incorporate technology to generate the energy to meet their own needs. Again, the specific site of the building will dictate which particular energy sources are used. Wind turbines, solar photovoltaic panels, solar concentrators, geothermal, tidal generators and biogas generation via anaerobic digesters are all potential options, as are combinations of these technologies. And, these represent the best regenerative technologies available currently – future energy generation may grow from sources in their infancy today, including nuclear fusion and "crowd farms." This latter concept is being developed at MIT "to harness the power generated by the simple act of walking….The Crowd Farm would harness that energy through a responsive flooring system made up of blocks that depress slightly under the force of human steps, absorbing vibrations of movement that would otherwise be wasted" (MIT 2007).

Similarly, regenerative buildings treat and reuse 100% of their wastewater and source as much drinking water as possible. Again, because regenerative design is not formulaic, design teams will determine which strategies for water supply and wastewater

management are most appropriate for the site and create the most synergies with other building systems. Water supply options include placing cisterns on the site to collect rainwater, or water desalination (reverse osmosis) facilities for coastal campuses. Condensation collection from dehumidifying machines has also proven to produce high quality drinking water, and at least one manufacturer is working with the USGBC to qualify for LEED credits (Gargaro 2005). Dehumidification also aids in improving occupant comfort, particularly in tropical and subtropical climes.

However, a large portion of the potable water in buildings is used for non-potable duties, including toilet flushing and irrigation. By using recycled water for these functions, the amount of necessary potable water will drop considerably. To be deemed regenerative, a building must recycle all its water for use in irrigation and waste removal. A few companies have developed wetland systems, or "living machines," to mimic the natural processes that treat wastewater. The Lewis Center for Environmental Studies at Oberlin contains a living machine system that has successfully treated all wastewater and re-circulated it for irrigation and toilet flushing since the building was completed in 2000, saving hundreds of gallons of potable water daily (Oberlin College 2007). Should potable water resources become even more limited in the future, these natural systems could be used to treat the building wastewater to drinking water standards (a process known as "toilet to tap"). The difficulty in implementing this is not in creating the technology, as it is currently available and used in several locations, including Singapore; the psychological battle to get campus users beyond the "ugh" factor and accept that

wastewater can be treated to become cleaner than typical tap water has proven to be the more arduous task (Dingfelder 2004).

Recycled, reused, and/or salvaged construction materials will be chosen for the buildings. These will also be recyclable or reusable, or be capable of breaking down into useable nutrients for the natural environment. As McDonough and Braungart note, one of the basic principles of regenerative design that mimics nature is that "waste equals food;" waste does not exist in nature and therefore is eliminated in regenerative design (MBDC 2007). Moreover, buildings will also be designed for longevity. In the U.S. the average life span of a building is approximately 35 years (Birkeland 2002). Replacing buildings at that rate consumes tremendous energy and resources. A typical complaint is that buildings outlive their design or functionality within the 35-year time frame (or less), leading for a desire to change (Birkeland 2002). However, some university buildings have lasted for centuries, including New College at Oxford University, which was founded in 1379. To save resources and reduce environmental impacts, modern university design and construction should strive to emulate these examples through timeless, smart design and the use of highly durable materials.

To protect human health and improve the indoor environment, all materials will be non-toxic. This mandate will govern all textiles, finishes, flooring, etc. Further, fresh air delivery will be maximized via operable windows and vents, and incorporating passive airflow design such as the stack effect.

Phase V: Within 30 years:

All new buildings constructed on the campus after this time will be regenerative, incorporating the design elements discussed in Phases III and IV as appropriate to the locations of the buildings. Existing buildings will be upgraded to be regenerative as well, beginning with the least efficient buildings on the campus.

AREA OF FOCUS 4: ENERGY SUPPLY

The world continues to depend on fossil fuels as its energy source. In 2005, petroleum (crude oil and natural gas plant liquids) was the world's primary energy source, accounting for 36.8% of world primary energy production (EIA 2007). Coal ranked second, accounting for 26.6%, and natural gas third (22.9%), so that those sources contributing most to global climate change emissions combined to account for 86.3% of the world's primary energy production (EIA 2007). Sources that are produce few if any GHG emissions, including hydroelectric, nuclear, and renewable (geothermal, solar, wind, and wood and waste) electric power generation ranked fourth, fifth, and sixth, accounting for 6.3%, 6.0%, and 0.9%, respectively (EIA 2007). To reduce GHG emissions and the consequences of global climate change, as well as the environmental damage wrought during the extraction and production of fossil fuels, the energy paradigm must change such that renewable sources provide the majority of the energy produced globally.

Universities can assist by mandating that their energy supply companies provide more renewable and alternative energy. Though renewable energy contributed less than one

percent of the global primary energy production in 2005, energy from renewable fuels increased at an average annual rate of 7.9% between 1995-2005 (EIA 2007). As demand rises for these energy supplies and as they become more readily available, universities will have more opportunities to purchase renewable energy; many have begun buying it already.

UBC purchases Green Power certificates to address the energy needs of two buildings and is investigating an expansion of this program (UBC 2007k). Penn State has signed contracts to increase the share of green power to service the campus; the university has been purchasing renewable power since 2001, and in 2006 contracted to have 20% of its electricity provided by wind, biomass, and hydroelectric sources. All sources are certified through the Green-e Standard for Renewable Energy Products, the certifying system favored by the USGBC for LEED criteria (Penn State Physical Plant 2007f).

Harvard has established a goal to become the largest university purchaser of renewable energy in the US (HGCI 2007g). Efforts to meet this goal have entailed purchasing Renewable Energy Credits. Harvard's Renewable Energy Fund purchases the Renewable Energy Credits (RECs) from a local wind energy facility; the university receives no power from the wind turbines, but the RECs are an attempt to equate a monetary value to a fixed amount of environmental benefits gained from wind power (HGCI 2007h). In the 2006 Fiscal Year, RECs accounted for 7.36% of Harvard's total electrical use, up from 1.86% in 2004 (HGCI 2007i). Duke is the fifth-largest university purchaser of green

power in the United States, and is currently creating a long-term energy management plan for the campus (Capps 2007b).

The electrical power provider for the University of Florida, Progress Energy, is "the leader in energy efficiency in the State of Florida and one of the top leaders in the U.S." (UF Office of Sustainability 2007f). Progress Energy has entered into a contract to purchase energy from the two largest biomass power plants in the country (UF Office of Sustainability 2007f). UC Merced has committed to using renewable energy sources, and Oregon's governor has stated a goal to have all state agencies, including universities, powered by 100% renewable electricity by 2010 (Mital et al. 2007).

Energy Supply Goals:

All new campus buildings will be constructed to be off the power grid, and older buildings retrofit to the same. Any energy provided to the campus for buildings not retrofit to 100% on-site renewable power after the 30-year goal will be renewable. The USGBC uses the Center for Resource Solutions definitions for renewable, or green, energy within their Green-e products certification. Renewable energy (aside from transportation) includes geothermal, solar, wind, biomass, biodiesel and fuel cells. Low-impact hydroelectric generators may also be considered renewable (USGBC 2003). Electrical providers have begun using these sources, albeit in small amounts, to generate electricity. In areas where no green power is generated, Renewable Energy Credits (RECs) may be purchased as offsets (as Harvard does), which is an acceptable option under LEED criteria as well. "As the green power market matures and impacts on the environment and human health

are factored into power costs, green power products are expected to be less expensive" and increasingly available to a wider geographical range of consumers (USGBC 2003).

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

To begin implementing the use of renewable energy from off-site sources, during the initial campus sustainability assessment the Office of Sustainability will determine what energy sources supply the campus. If renewable power is unavailable from the current energy supplier, the university will express its interest in purchasing power generated by renewable sources to its supplier to encourage the supplier to provide renewable energy. The university will also research the costs to purchase RECs to offset fossil fuel-based campus energy use.

Phase II: Within the first five (5) years of plan implementation:

To fulfill one of the obligations within the ACUP Climate Commitment signed by the administration in Phase I, the university will require a minimum of 15% of the electricity for the campus be provided by renewable sources through contracts with the energy supplier or via the purchase of RECs. If the campus has its own power-generating facility instead of an outside supplier, the same criteria will be applied to it. The use of the renewable energy is preferable, for as the Harvard Green Campus Initiative (HGCI 2007h) notes "the use of RECs as carbon offsets is somewhat contentious, and the most conservative offsetting scheme would offset electricity with true carbon offsets, not RECs."

Phase III: Within 10 years of plan implementation:

Similar to Phase II, but expand to require that a minimum of 20% of the electricity for the campus be provided by renewable sources through contracts with the energy supplier, via the purchase of RECs, or a combination of the two. Increasing the requirements incrementally will allow the energy producers to "catch up" to the market and gradually replace their fossil fuel technology with renewable sources.

Phase IV: Within 25 years:

To help meet the LEED Platinum criteria such that Phase IV in Buildings is accomplished, the university will require a minimum of 35% of the electricity for the campus be provided by renewable sources through contracts with the energy supplier. The LEED credit for Green Power requires 35% of the power be supplied through these sources for each building in a campus situation, so providing this for the entire campus will ensure that all new building projects attain this point. Also, as the buildings on campus are built to be more energy efficient through the incremental institution of higher LEED goals, overall campus energy use will decrease, concomitantly decreasing the amount of green power necessary to meet the 35% goal.

Phase V: Within 30 years:

At this point, all new campus buildings will be constructed to be regenerative and therefore off the power grid. However, existing buildings will still be powered via external energy suppliers until they are retrofit to achieve the regenerative goals stated in Phase V of the Buildings Area of Focus. Therefore, the university will mandate that all

energy from external providers necessary to power the campus during this transition period be renewable.

AREA OF FOCUS 5: GREENHOUSE GAS EMISSIONS

Global climate change, which the majority of the scientific community attributes to an increase in greenhouse gas (GHG) emissions and a simultaneous increase in deforestation, is one of the most serious environmental problems the world currently faces. Scientists predict many environmental and human health perturbations will occur as the climate changes, including a rise in ocean levels, more powerful tropical weather systems, increased ranges of diseases, species loss in temperate and other higher latitude climates, and reduction in crop yields (USEPA 2008).

Combustion of fossil fuels for heating, cooling, transportation, and other electrical and mechanical functions is the leading producer of carbon dioxide (CO_2), the primary pollutant for global climate change via its contributions to the so-called "greenhouse effect" (USGBC 2003). Methane (CH_4) and nitrous oxide (N_2O) are the two other major GHGs (USEPA 2008). The USEPA (2008) notes that over 50% of the energy-related emissions come from sources such as power plants, while transportation is responsible for approximately one-third. Reducing these emissions through switching to more efficient buildings and vehicles, relying more on renewable energy sources, and creating carbon sinks through re-vegetation and habitat restoration efforts are the primary strategies to combat climate change proffered by the USEPA (2008).

Several universities have begun to incorporate many of the ideas to address GHG emissions. In 2007, UF's President became the first to sign the ACUP Climate Commitment. To meet the requirements set forth in that document, UF has pledged to become a carbon-neutral campus by 2020 (UF Office of Sustainability 2007f). UF is taking the first steps to achieve this goal by performing an audit of the carbon emissions of the campus. Further, UF is working with the International Carbon Bank and Exchange to develop a strategy to meet the 2020 deadline (UF Office of Sustainability 2007f).

UCF conducted a GHG (carbon dioxide) emissions study to quantify a baseline of the GHGs produced by campus operations. In 2006, the primary source of GHG emissions was electrical power used for lighting and climate control in campus buildings (88.5%); transportation accounted for only 6% (UCF Sustainability and Energy Management. 2007d). However, the transportation segment did not include commutes for students, faculty and staff. An annual GHG emissions study will be conducted to determine UCF's progress toward reducing its emissions. The energy efficiency measures implemented on the campus are expected to assist in this goal.

In 2004, Penn State researchers developed a greenhouse gas emissions inventory and projected GHG emissions from the campus out to the year 2012. The project was conducted in part to aid the university in mitigating and reducing its GHG production. Energy to supply building electricity and climate control accounted for almost 90% of GHG emissions at Penn State (Steuer 2004). In 2006 the University President offered public support for reducing GHGs and stated that the plan for the campus would result in

"double digit" reductions by 2012, and made a commitment to a 17% decrease in these emissions (SEI 2007; Spanier 2006). The purchase of more renewable energy, the installation of alternative energy sources, and the comprehensive energy efficiency and building commissioning programs combine to reduce the GHG emissions for which Penn State is responsible.

Oregon has performed a comprehensive audit to estimate its GHG emissions (CO_2 equivalent) from heating and cooling, lighting, commuter travel and other university travel excluding air (Mital et al. 2007). Oregon has been able to determine the sources of the emissions to track the areas producing the most GHGs. From this breakdown, it was found that the majority of emissions come from boilers to heat the campus, and the university subsequently allocated funds to replace these with more efficient units (Mital et al. 2007).

The electricity supplier for the University of Oregon has committed to producing carbon-neutral energy, an action that in 2004 resulted in 22% of the energy used at the Oregon campus produced from carbon neutral methods (Mital et al. 2007). Further, in 2005 students elected to raise their fees in order to purchase renewable energy credits for the Student Union building (Mital et al. 2007). The administration has supported GHG reductions by signing the ACUP Climate Commitment, pledging to reduce GHGs by 80% by 2050 (Mital et al. 2007). And, the Governor of Oregon has committed, though not in any binding fashion, to have all state agencies use 100% renewable electricity by 2010 (Mital et al. 2007).

Though no benchmark for reduction was established, implementation of the ***ecotrek*** program at UBC, as discussed in the Energy and Buildings sections, has resulted in a 15% reduction in GHG emissions. Further, modifications to the Central Steam Plant resulted in a 15% decrease in nitrogen oxide emissions. The updated Sustainability Strategy has set higher benchmarks: to cut CO_2 emissions by 25% and nitrogen oxide emissions from the steam plant by 80%. As of November 29, 2007, UBC estimates that it has reduced GHG emissions by 62,000 tons via its sustainability initiatives since 1999 (UBC 2007l).

Though the administration has made no concrete commitment to reducing GHG emissions from the Harvard campus, the university has conducted an annual inventory of GHGs since 2001. Data back to 1990 were made available and have been analyzed as well. As of October 2007, emissions had risen by over 65% since 1990, and by 1.2% since 2005 (HGCI 2007j).

Duke has performed a greenhouse gas emissions inventory and has developed a study to determine the feasibility of various options to reduce or eliminate these emissions (Capps 2007b). The inventory reveals a 31% increase of GHG emissions between 1990 and 2003 for which Duke was responsible (Hummel and Huang 2004). However, the increases slowed with the implementation of the energy management program that retrofit several buildings on campus with energy and water saving features (Hummel and Huang 2004).

The University of California administration has signed the ACUP Climate Commitment, but the UC Merced Chancellor has not. Regardless, UC Merced has made climate neutrality a goal to be achieved via utilization of renewable energy and purchasing or creating carbon offsets. As part of the UC policies, each campus registers with the California Climate Action Registry to measure and report on GHG emissions annually (UC Merced 2007f). Further, UC policy mandates that all campuses decrease GHG emissions to 2000 levels by 2014, and to 1990 levels by 2020 (UC Merced 2007f). However, other benchmarks will be necessary for UC Merced as it is a new campus with no 1990 or 2000 GHG data (UC Merced 2007f). Finally, UC Merced purchasing policies encourage local and regionally produced goods to minimize transportation emissions.

Table 4: Summary of GHG Reduction and Renewable Energy Supply at Eight Subject Universities

	Duke	UCF	Penn State	UO
Purchase of renewable energy	Yes	None	20% of electricity from renewable sources	State gov't. goal to have all agencies powered by 100% renewable energy by 2010
Carbon emission reduction commitment	None	ACUP Climate Commitment signatory	17% reduction by 2012	ACUP Climate Commitment signatory; electricity supplier also committing to become carbon neutral
GHG inventory	Yes	Yes – will be annual	Yes	Yes

	Harvard	UBC	UF	UCM
Purchase of renewable energy	Yes: goal is to be largest purchaser of renewable energy in US; has bought RECs to equal over 7% of use	Purchases Green Power certificates	Purchases biomass power	"Commited" to using renewables
Carbon emission reduction commitment	None	Goal: reduce carbon emissions by 25%	ACUP Climate Commitment signatory; goal of carbon neutrality by 2020	UC is an ACUP Climate Commitment signatory; UC-Merced goal is carbon neutrality
GHG inventory	Yes	Unknown	Yes	No

GHG Goals:

This Area of Focus, unlike the others, is not divided into phases. All requirements set forth by the ACUP Climate Commitment, signed in Phase I must be followed. The initial campus sustainability assessment will include a GHG inventory to establish a baseline from which to track GHG reductions. As per the guidelines of the ACUP Climate

Commitment, emissions from all sources including electricity, heating, cooling, and air travel and other transportation will be quantified. If data are available, the assessment will inventory the GHG emissions created during the harvest, manufacture, and delivery of campus goods. Again, per the ACUP document, the university will develop a plan of action to become climate neutral within two years of signing the Commitment. Potential methods to reduce GHG emissions include increasing the energy efficiency of campus buildings and vehicles, switching to renewable energy sources, purchasing local and sustainably produced materials and goods, participating in or funding carbon sequestration projects, and purchasing carbon off-sets. Use of renewable energy is the most effective option; UF notes that if all its energy came from renewable sources, the campus GHG profile would decrease by 80% (UF Office of Sustainability 2004). Sequestration of carbon emissions through installation of plants (typically trees) is a less expensive option, and only the sequestration option actually removes carbon from the atmosphere (UF Office of Sustainability 2004). It is likely that a combination of these strategies will be employed to achieve carbon neutrality for the campus.

The Office of Sustainability will include GHG inventories in the annual campus sustainability assessments to track the progress towards the final goal of achieving climate neutrality. The ACUP guidelines require a target date for climate neutrality, which within this strategy will correspond to the beginning of Phase V (30 years after implementation of the regenerative strategy).

AREA OF FOCUS 6: WATER

Water shortages affect many areas of the US, and with several aquifers already at low levels and recharge rates unable to keep pace with US consumption, these shortages are expected to widen. For example, the Ogallala Aquifer in the central US is depleted at a rate 14 times faster than it can be recharged through natural processes, and between 1991 and 2002 it decreased an average of three feet annually (Barlow and Clarke 2002). Numerous other North American aquifers reveal similar overuse patterns, including the Floridan aquifer system in the southeastern US. In some areas the water table has dropped so far that saltwater from the Atlantic has intruded and contaminated the freshwater drinking supply (Barlow and Clarke 2002).

Several factors have led to these water shortages. Though population growth and increased personal water use for sanitation have increased, households and cities only account for about 10% of overall water consumption; industrial processes consume 20-25% of global freshwater resources (Barlow and Clarke 2002). The majority of available freshwater is used for irrigating agricultural crops, particularly large factory farms (Barlow and Clarke 2002).

Aquatic pollution also reduces the amount of freshwater available for consumption. Habitat destruction has eliminated millions of acres of wetlands and riparian forests, which serve as pollutant filters and reduce flood risks (Barlow and Clarke 2002). Both groundwater and surface water sources have seen increases in pollution from chemical, sediment, and sewage runoff as well as groundwater leachate from industry, agriculture

and transportation (Barlow and Clarke 2002). Global climate change and the predicted concomitant droughts in many areas are expected to exacerbate the water shortages as well (Barlow and Clarke 2002).

As with energy and GHGs, the environmental impacts of campus water use go well beyond buildings. To reduce these impacts, universities can participate in efforts to safeguard the drinking water supplies for the campus and surrounding community, protect native aquatic habitat from water-borne pollution, and reduce the amount of potable water used for non-potable needs such as irrigation of the campus landscape. Several campuses have already instituted stormwater and wastewater initiatives that complement the strategies employed for water conservation within buildings.

Penn State's campus design has preserved natural hydrologic areas for stormwater runoff; the campus has four primary drainage basins, each of which is managed differently due to varying topography and geology (Fennessey 2007). Further, 500 acres of Water Resources Preservation Areas have been identified and slated for protection to safeguard the water resources of the university (Fennessey 2007). These efforts have allowed Penn State to maintain a water supply to the campus that requires no filtration to meet both Pennsylvania and U.S. drinking water standards (Fennessey 2007).

The UBC Landscape Plan addresses water conservation and stormwater, encouraging the maximization of permeable surfaces, creation of bioswales, and installation of automatic irrigation systems. An Integrated Stormwater Management Review is being conducted

and is scheduled for completion in 2009 (UBC Campus and Community Planning 2007a). Currently, UBC operates a stormwater monitoring program to determine changes in the stormwater discharged from the campus (UBC Campus and Community Planning 2007a). Finally, UBC created "Sustainability Street," a water-savings project that is the "world's first closed-loop system integrating stormwater management, wastewater treatment, and ground source heat pumps. It will not only demonstrate the latest in sustainable 'street' design, it will also teach and inspire the world to build with the lightest of ecological footprints" (UBC. 2006a).

At the University of Oregon, water consumption was reduced by 13% from 2001 – 2006 due in large part to the installation of a more efficient irrigation system (Mital et al. 2007). The Facilities Services Department is in the process of phasing in the installation of an automated watering system for landscape irrigation that is based on local weather information; it can also detect leaks and eliminate flow to damaged areas (Mital et al. 2007). This system has been shown to decrease water use 30-70% (Mital et al. 2007).

To reduce the pollutant loads entering local water bodies, Oregon has installed six bioswales to filter out stormwater runoff, and the campus abides by the Oregon Department of Environmental Quality "Best Management Practices for Stormwater Discharges" (Mital et al. 2007). Oregon has also commited to preserve and expand open space on campus, in order to increase the permeable surface available for stormwater to percolate. This commitment succeeded in increasing the permeable surfaces from 39.5% of the gross acreage of the campus to 49% between 2001 and 2006 (Mital et al. 2007).

Automation of the irrigation system for the Harvard Business School grounds reduced usage by almost 4.8 million gallons per year; similar results were achieved using rain meters in irrigation systems at Harvard Yard (HGCI 2007k). To address stormwater issues, Harvard's Environmental Health and Safety group developed best practices for stormwater treatment. These practices include increasing vegetated areas and reducing the area of impervious surfaces to allow more percolation through soils; specific best management practices have been established for various project types.

The primary water-saving measure at UCF is the automated Maxicom irrigation system that adjusts every sprinkler based on weather conditions and forecasts. Employment of the Maxicom system saved almost 2 million gallons of water per month in 2004 versus 2003 (Laing 2004). Plans are also being created to irrigate the landscape with reclaimed water and water taken from stormwater ponds. Finally, xeriscaping for new building construction and common areas is required in the new campus Master Plan (UCF Board of Trustees 2004).

Duke has established a goal of reducing water consumption by 30% of fiscal year 2006-07. To achieve this goal, Duke has already begun installing drought-tolerant landscape plants and decreasing the time for irrigation of athletic fields (Capps 2007b). Stormwater is also being managed with more environmentally friendly technology. A study to model stormwater flow on the Duke campus was conducted by Duke researchers and led to the design and construction of an 8-acre wetland and retention pond to attenuate run-off from 1600 acres of Duke and the city of Durham (Duke University 2007c). Working in

conjunction with this is the Duke Stream and Wetland Assessment Management Park (SWAMP), a stream/lake system that was designed and restored to help protect the region's water supply and improve the health of downstream river systems (Capps 2007b). SWAMP controls stormwater run-off from the campus and 1200 surrounding acres (Capps 2007b).

Over 90% of the Florida campus is irrigated with reclaimed water, and irrigation is kept to a minimum through xeriscaping (UF Office of Sustainability 2007g). The Superintendent of Landscaping and Groundskeeping estimates that 80% of new landscaping projects are xeriscaped, with more than half of those utilizing a majority of native species (UF Physical Plant 2007b). To improve water quality on the campus, the UF Clean Water Campaign educates students and employees about water quality, monitors water quality, and has successfully advocated for the use of Best Management Practices in stormwater pollution controls including bioswales, wetland retention areas, porous pavement, and forested buffer zones (UF Clean Water Campaign 2006).

The first Phase of the UC Merced development constitutes 100 acres. Within this Phase the landscape has been designed to use 50% less water than projected through installation of California native and other drought tolerant plants, and limiting the use of turfgrass in the landscape to only high use and recreational field areas. Tree planting has been concentrated adjacent to these limited turf areas to minimize evapotranspiration in the summer (UC Merced 2007g). The computerized irrigation system is centrally controlled and monitored; it incorporates field moisture sensors, drip irrigation and specialized

watering tubes for trees (UC Merced 2007g). This irrigation system was designed to be fed by reclaimed water sources when they become available to the campus (UC Merced 2007g).

Table 5: Summary of Water Supply Preservation and Conservation at Eight Subject Universities

	Duke	UCF	Penn State	UO
Xeriscape	Yes	Yes – new buildings	No?	No
Automated irrigation system	No	Yes	No	Yes
Use of reclaimed water	No	Planned	Yes – from campus wastewater treatment facility	No
Stormwater management	Created wetland; restored lake and stream system	No specific strategies	Preserve natural hydrologic areas for run-off	BMPs: bioswales, protect and expand open space

	Harvard	UBC	UF	UCM
Xeriscape	No	No	Yes	Yes
Automated irrigation system	Yes – in limited locations	Yes	No	Yes
Use of reclaimed water	No	No	Yes – from campus wastewater treatment facility	Planned
Stormwater management	Developed own BMPs for stormwater treatment; increase vegetated surfaces and reduce impervious areas	Maximize permeable areas; installation of bioswales; comprehensive stormwater review	BMPs: installation of bioswales and porous pavements	BMPs: bioswales, protect and expand open space

Water Goals:

In conjunction with the improvements in water use technology in campus buildings discussed earlier, the university will use no potable water for non-potable functions. The campus design and development will capture and treat all stormwater; this resource will also be made available for non-potable needs, particularly irrigation. The capture, treatment and reuse of wastewater are also important to achieve this goal, and are discussed in the Buildings Area of Focus.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

During the campus assessment, the Office of Sustainability will determine the sources of water for the campus as well as how the campus uses water, both potable and non-potable. Further, the assessment will evaluate the amount of potable water used for non-potable functions and compare to the overall campus water budget. The campus assessment will also include a comparison of the percentage of water-intensive landscape vegetation, including turfgrasses, with xeriscaped areas. For stormwater, the assessment will determine the percentage and quality of stormwater captured, treated and released from the campus as well as any opportunities to use reclaimed water from the municipality or from campus supplies such as stormwater ponds.

Phase II: Within the first five (5) years of plan implementation:

The university will develop a plan to phase out water-intensive landscaping from the campus grounds in favor of xeriscaping as well as capture, treat and reuse enough

stormwater to address campus irrigation and other non-potable needs. To further reduce the needs for irrigation water, it will investigate the option of installing a "smart" irrigation system like the systems in place at UCF, Oregon and Harvard. If available, the irrigation system will be connected to the local municipal reclaimed water supply.

To reduce runoff and increase ground infiltration of stormwater, the university will establish a plan to replace impervious surfaces (parking lots, sidewalks, roads, etc.) with permeable materials. These materials can be quite effective; researchers at North Carolina State University tested several permeable parking lots in eastern North Carolina and determined that over several years, annual runoff volume decreased by at least 60% (Hunt and Szpir 2006). Other potential solutions to decrease runoff and improve the quality of any runoff are installation of green roofs and/or cisterns, construction of bioswales, detention and retention ponds, and development of man-made wetlands to mimic natural wetland functions. All of these, as well as other emerging stormwater technologies will be considered as the plan is developed.

While the plans are being developed, the campus will begin with a goal that overall water use for irrigation decrease by 25% of the baseline determined in Phase I. To accomplish this, the university will replace conventional irrigation controls with an automated irrigation system that responds to plant type, soil moisture and weather, as UCF and other schools have done. These systems have been shown to decrease water use by 30-70% (Mital et al. 2007). Further, the university will require xeriscaping for all new construction projects to meet the LEED criteria for the two Water Efficient Landscaping

credits. Also, native or drought tolerant grasses will replace designated areas of nonnative turfgrasses. The amount to be replaced in this Phase will be based on existing irrigation rates for these areas. Native, drought tolerant grasses are readily available and some new turfgrasses have been developed that thrive when irrigated with brackish or salty water (Environmental Turf 2007).

Campus-wide stormwater runoff reduction of 25% will also occur by the end of Phase II. This will assist new building projects in meeting another LEED requirement (Stormwater Design – Quantity Control) in Phase III. To decrease runoff, impervious sidewalks will be replaced with permeable materials, including porous pavement or open-cell pavers. The amount to be replaced will be based on the square footage of impervious area versus total area. For individual buildings, building designers will create the smallest building footprint possible in the design phase of each building. Underground parking designed into the building can greatly reduce the amount of stormwater run-off from a building project and should be studied for each new construction project if parking is necessary.

Phase III: Within 10 years of plan implementation:

The university will increase the goal for campus irrigation reduction to 50%. Efforts will include continuing to replace areas of nonnative turfgrasses with native or drought tolerant grasses and to install xeriscape at all new construction projects. Further, existing water-intensive landscaping will be replaced with native and drought-tolerant species so that existing buildings might claim one of the Water Efficient Landscaping credits as well.

At the end of Phase III, the campus will achieve a stormwater runoff reduction of 50%. Replacement of remaining impervious sidewalk will continue; replacement of existing impervious parking and road surfaces with permeable materials will begin, and any new parking, sidewalk or roads will be constructed using these same pervious materials. Coincident with Building Phase III, the design team will assess the feasibility of green roofs for each new building project and if appropriate, include them in the design. Green roofs retain well over 50% of annual precipitation, and also diminish peak flows and volumes of rainfall (Hunt and Szpir 2006). Vegetated roofs can also provide campus-grown produce for cafeterias, and/or recreate habitat for local fauna. If green roofs are not feasible, cisterns are another option. Cistern rainwater catchments systems can capture and reuse 30 – 70 % of stormwater (Hunt and Szpir 2006).

Phase IV: Within 25 years:

Native or drought tolerant grasses will be planted in place of any remaining areas of nonnative turfgrasses. Xeriscaping at all new construction projects will also continue, in order to meet the LEED criteria for both Water Efficient Landscaping credits.

The university will replace any remaining impervious sidewalk and continue rebuilding impervious parking and road surfaces with permeable materials. The second LEED-NC Stormwater Design credit (Quality Control) states that each building must "Implement a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats the stormwater runoff from 90% of the average annual rainfall using acceptable best management practices (BMPs). BMPs used to treat runoff must be

capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing monitoring reports" (USGBC 2005c). As such, stormwater systems for all new buildings will meet this standard. Along with the rain catchment systems, green roofs and pervious surfaces, potential techniques such as vegetated swales, constructed wetlands and others mentioned above (see Phase II) will be incorporated into the design to promote infiltration and in turn decrease pollutant loads (USGBC 2005c). If possible, campus plans will cluster buildings such that the appropriate stormwater technologies (e.g., detention ponds or constructed wetlands) can be shared by several structures.

Phase V: Within 30 years:

Potable water will no longer be used for non-potable functions. To achieve this, campus infrastructure will capture and treat all stormwater from the campus using the methods detailed above; if needed, stormwater will be available for non-potable needs, particularly irrigation. Further, all campus landscaping will incorporate only native and/or drought tolerant species. Aside from athletic fields and formal common areas, irrigation will no longer be necessary and the university will remove the lines. Finally, any remaining paved surfaces, as well as all future paved areas, will be constructed with permeable materials.

AREA OF FOCUS 7: LANDSCAPE AND NATIVE HABITAT

Land development and other human activities have destroyed millions of acres of natural habitats. This habitat loss has led to a multitude of environmental ills including

decreased biodiversity, degraded air and water quality, and increases to GHG concentrations in the atmosphere as carbon sinks disappear. Universities have contributed to this destruction by clearing land for buildings and replacing existing native habitat with formal landscaping and lawns over the hundreds or thousands of acres a typical campus covers. The extensive areas of turfgrasses found on most campuses require frequent irrigation with valuable water resources.

Exacerbating the environmental problems of university development are the choices universities make when maintaining their campus landscaping. Pesticides, herbicides and fertilizers often contain toxic chemicals that run off in stormwater and contribute to water pollution. Further, to maintain these formal lawns, campus landscape personnel apply large amounts of pesticides and herbicides and conduct mechanically intensive maintenance (mowing). Mowing and trimming grasses contribute greatly to GHG emissions and smog. According to an EPA study, lawn and garden equipment accounted for as much as 5% of all man-made hydrocarbons emissions prior to 1997 (USEPA 1998). Use of non-native ornamental vegetation often requires similar levels of irrigation, supplemental feeding, and maintenance.

Though it encourages expansion and retention of native habitats, this strategy recognizes that the university has several obligations to a variety of campus users. University communities need turf areas for recreational purposes. More formal commons areas and quadrangles, typically near campus centers, are hallmarks of colleges and offer places for students to socialize. However, the university also has responsibilities to teach

environmental issues and serve as an example to the community of how to live in accord with the planet. The choices of plants for campus grounds, the protection and creation of habitat on its lands, and the methods of maintaining its landscape in part reflect the values of a university, and several have taken the first steps to create more sustainable landscapes.

As noted in the Water section, UC Merced has incorporated native and drought tolerant species into the first phase of its new campus. Turfgrass areas have been minimized, and tree plantings along these areas will create shading and limit evapotranspiration.

UC Merced is located within the 7,030-acre Virginia Smith Trust Lands, northeast of the city of Merced. Though the first phase of development is only 100 acres, the campus is planned to cover 2,000 acres at build-out (UC Merced 2007h). Eventually, 910 acres of the 2,000 will be within a designated "academic life area" and 340 more will be placed in a land reserve for future use (UC Merced 2007h). The final 750 acres will become a protected Campus Natural Reserve for research and instruction in native California ecosystems (UC Merced 2007h). During the planning process for the campus, a conservation strategy was created to address concerns raised by the U.S. Fish and Wildlife Service regarding federally listed plant and animal species found on the site. The conservation strategy provides guidance for developing and incorporating conservation efforts focusing on these affected species and sensitive habitats.

Penn State has conducted a tree survey of its campus, cataloging all tree species as well

as “Heritage Trees” that provide special historic or aesthetic value to the campus (Penn State Physical Plant 2007g). The Arboretum at Penn State was completed in November of 2007; part of this project involved restoration of woodlands on part of the campus via exotic species removal and installation of native flora (Steiner 2007). Integrated Pest Management plans are in place for the Arboretum and the rest of the campus (Steiner 2007).

UBC has conducted a vegetation survey for the entire campus to inventory all plant species. This survey revealed that 17.2% of the campus consists of “natural” vegetation (UBC Campus and Community Planning 2007b). The UBC landscape plan directs that all “materials in the landscape, from paving to plants, will be considered in relation to their source, production, cost, installation, maintenance, replacement, and disposal” (UBC Land and Building Services 2001).

Though the interior of the campus is urbanized, with planned green spaces and ornamental plantings, the edges abut the Pacific Ocean and Pacific Spirit Regional Park, a 1,885-acre forest serving as a buffer between UBC and Vancouver (UBC Land and Building Services 2001). The Park contains miles of hiking and cycling trails and access to the Pacific, as well as ecological reserve areas that are not available to the general public (Metro Vancouver 2007). Several courses are taught in the Park’s forests, and ecological research is conducted within the Park as well.

A tree inventory was conducted for the University of Oregon campus, and revealed that 14% of trees on campus are native to the area (Mital et al. 2007). The Sustainable Development Plan for the university recommends protection of wildlife habitat, forests, wetlands and watersheds as much as possible and creation of wildlife and plant corridors (Livelybrooks et al. 2005). Oregon has made a commitment to preserve and expand open space on campus, which would result in expanding the amount of permeable surface to allow stormwater to percolate. As noted in the Water section, between 2001 and 2006, permeable surfaces increased from 39.5% of the gross acreage of the campus to 49% (Mital et al. 2007).

The Facilities Department has begun implementing a plan to expand bird habitat on the campus by installing native trees and shrubs, leaving dead trees on site to create nesting habitat, and mounting birdhouses in strategic areas (UO Exterior Team 2002). When trees must be felled to make way for campus development, wood is often milled from these trees (UO Sustainability Database 2007). Finally, an integrated pest management plan has been practiced since 1994. "Strong efforts are made to control pests by means other than chemical pesticides" at the university (Mital et al. 2007).

Protecting native habitat and using environmentally sound land management are the two overarching goals for UF lands. To achieve these, the university is implementing strategies such as limiting the use of pesticides, herbicides and inorganic fertilizers, installing more indigenous plant species in the campus landscape, and planning for a denser, more centrally focused campus to conserve existing natural habitats on

university property (UF Office of Sustainability 2007h). Further, Florida has created 31 Conservation Areas on the campus which are governed by a Conservation Area Land Management (CALM) plan to protect and enhance these designated areas (UF Facilities Planning and Construction 2007b; UF Facilities Planning and Construction 2004). These lands also include the University of Florida Natural Area Teaching Laboratory for field instruction in ecology and biodiversity. The Conservation Areas and CALM plans led to Florida being named an Audubon International Cooperative Sanctuary. Audubon's program promotes ecologically friendly land management and resource conservation via a certification program (UF Office of Sustainability 2007h). Florida is the first university in the nation to work with Audubon within the guidelines of the Cooperative Sanctuary Program to establish campus-wide environmental planning, and is part of a pilot study within the Sanctuary Program to establish standards specifically for college campuses (UF Facilities Planning and Construction 2007b).

The Fourth Principle of the Duke Campus Master Plan states that "Duke is a university in the forest," and as such selected natural areas should be preserved or conserved; expansion of development should be limited as well (Capps 2007b; Duke University 2000). The Duke Forest surrounding and within the Duke campus covers 7050 acres, and contains a diversity of species (Capps 2007b). Research on forest ecosystems and the environment has taken place in the Duke Forest for decades. To protect this resource, 1220 acres of the Forest were placed in the Registry of Natural Heritage Areas in an agreement with the North Carolina Department of Environment and Natural Resources (Capps 2007b). This action protects this portion of the Forest from any development and

invasive research (Capps 2007b). A Duke Forest committee has been established to assist in planning for the future of the Forest.

The Master Plan places other areas in "conservation zones" for protection, where development is “discouraged or prohibited” (Duke University 2000). Assets to be conserved include forested areas, fragile ecological areas, riparian corridors, Duke Gardens and central open spaces. Other protection zones where development is limited include managed open spaces and historic quads, but with lesser degrees of protection (Duke University 2000). Finally, plants that will be installed on the campus are to be drought tolerant, and within conservation zones, they must be native to the region (Duke University 2000).

The UCF Master Plan (2004) recommends the installation of native landscaping materials where “appropriate” and limits the planting of exotic and/or invasive plant species. Existing invasive plants that are on the Florida Exotic Pest Plant Council’s “Most Invasive Species” list will be removed from the campus.

UCF’s campus contains existing natural preserves and protected wetlands; one wetland near the center of campus has a boardwalk and is a focal point of the campus. The Campus Arboretum contains representations of several native Florida habitats, and was active in promoting a campus tree survey. Prescribed burns, performed by the Arboretum staff, are conducted to help restore wildlife habitat throughout the campus. Due to these

efforts, the National Wildlife Federation awarded UCF a Campus Ecology Recognition for its prescribed burn policy in 2005 (Bartlett 2005).

Approximately 60% of the Harvard campus is open space despite its urban setting. Harvard has been in operation for over 350 years, and its landscape has evolved over that time to include lawns, formal gardens, and buffer spaces. One primary function of the landscape that developed over the years is to direct pedestrian traffic (Harvard Planning and Real Estate 2000). The evolution of the landscape continues, as xeriscaping has been used at some of Harvard's LEED certified buildings.

Table 6: Overview of Landscape Practices and Habitat Preservation at Eight Subject Universities

	Duke	UCF	Penn State	UO
Required use of native species in landscape	Yes	Yes	No	No
Survey of existing vegetation	No	Trees	Trees	Trees
Protection plans for existing habitat	Yes – Duke Forest, conservation zones	Yes – prescribed burns, exotics removal	Yes – Arboretum lands	Yes – create corridors and habitat as well
Integrated Pest Management Plan for Landscape	No	No	Yes	Yes

	Harvard	UBC	UF	UCM
Required use of native species in landscape	Yes	No	Yes	Yes; also minimizing turf-grass installation
Survey of existing vegetation	No	Yes	Prior to development	No
Protection plans for existing habitat	For off-campus forest	Yes – Pacific Spirit Regional Park	Yes – 31 conservation areas; Audubon Int'l. Cooperative Sanctuary	Yes – 750 acre reserve
Integrated Pest Management Plan for Landscape	Yes	Yes	Yes	No

Landscape Goals:

Restore or create native habitats on a minimum of 50% of remaining campus open space (excluding building footprints, as per LEED). Eliminate the use of toxic fertilizers, herbicides and pesticides in the landscape. Eradicate all nuisance and invasive plant species.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

As part of the overall campus sustainability assessment, the Office of Sustainability will conduct a review of all existing ecological resources including wetlands, forests, mature trees, listed (threatened or endangered) species, and wildlife corridors within which the campus may lie. The assessment will also identify locations of all nuisance and invasive plant species. Further, the university will perform a study to learn what habitats existed at the site prior to development of the campus; another will be conducted to determine which areas are suitable for restoration to pre-development conditions or for the creation of habitat native to the region. The evaluation will place particular focus on areas of turf that are not designated for recreation or are underutilized by the campus community. Finally, the pesticide, herbicide and fertilizer regimes for the campus will be assessed.

Phase II: Within the first five (5) years of plan implementation:

After the information has been gathered, the university will develop a plan to restore or create native habitats on a minimum of 50% of remaining campus open space, eliminate the use of toxic fertilizers, herbicides and pesticides in the landscape, and to eradicate all nuisance and invasive plant species. As the plan is being created, the school will institute a moratorium on development in the areas identified in Phase I as potential sites for restoration or creation of native habitat. Development will also be prohibited within the habitat of any listed species found on campus, as identified in the assessment in Phase I. The landscape design team will explore and incorporate opportunities to expand these habitats via restoration or creation of like habitat in adjacent lands. By coordinating with

the appropriate academic programs, some of the restoration projects may be used as a teaching and research opportunities.

Elements of the plan will include the following: begin working with the food/dining services, landscape, and waste management personnel on a composting plan to decrease campus waste production and to provide a replacement for chemical fertilizers used in the landscape. Food/dining services will begin composting pre-consumer food wastes by the end of Phase II, and coordinate with landscape maintenance group to introduce it as a replacement for chemical fertilizers; landscape wastes will be added to the compost process as well.

To reduce the application of chemical pesticides, the landscape maintenance group will institute an integrated pest management (IPM) plan by the end of Phase II . Integrated pest management (IPM) is a method of pest control that incorporates monitoring and record keeping to indicate when treatments are necessary (USEPA 1997). "Biological, cultural, physical, mechanical, educational, and chemical methods are used in site-specific combinations to solve the pest problem. Chemical controls are used only when needed, and in the least-toxic formulation that is effective against the pest" (USEPA 1997). Further, this group will investigate and develop a phase-in plan for organic herbicides to replace chemical herbicides, starting by the end of Phase II. Vinegar is an example of a non-toxic compound that will effectively kill undesirable vegetation but leave no pollutants in the soil (Pollock 2005). Finally, to protect remaining natural habitat, the university will mandate that all nuisance and invasive species will be removed from the campus. A maintenance plan to prevent invasive species from reestablishing populations within these natural areas will also be developed.

Phase III: Within 10 years of plan implementation:

The university will begin to implement the habitat plan so that 10% of the campus open space is restored or converted to native habitat, with particular focus on areas containing listed species. A minimum of 50% (by area) of the nuisance and exotic species will be removed from campus landscaping and these areas replanted with native and drought tolerant species. The exotic and nuisance plant maintenance efforts, as well as the IPM will continue, and the groundskeeping staff will monitor advances in pest-control and herbicide technology that may further minimize the use of chemical pesticides. To further reduce the application of chemical fertilizers, the composting program will expand to incorporate post-consumer food waste as well as paper products. Should excess compost be available, the landscape/groundskeeping group will offer it to local municipalities, gardening groups, local farms, and others to replace their chemical fertilizers.

Phase IV: Within 25 years:

Restoration and creation of natural habitats will continue such that 25% of the campus open space is restored or converted to native habitat by the end of Phase IV. The replacement of toxic chemical landscape maintenance products with benign, organic versions will also continue.

Phase V: Within 30 years:

The restoration and creation of habitat will continue until a minimum of 50% of the campus open space (measured when the Strategy is instituted) is restored or converted to

native habitat. No toxic fertilizers, pesticides or herbicides will be used on the campus. With the increased amount of native and adapted vegetation, the need for these products will be reduced, particularly as large swaths of turf are replaced with natural habitats.

AREA OF FOCUS 8: MATERIALS MANAGEMENT (WASTE & RECYCLING)

The primary solution for dealing with solid wastes in the United States is the development of landfills. However, landfills present several environmental problems including soil and groundwater pollution from leaching and GHG emissions due to the methane produced during the biological decomposition process (Lyle 1994). These environmental impacts, as well as increasing urban population densities, public health concerns, and less land available for landfills, impede the construction of new landfill facilities (Sener, Süzen, and Doyuran 2006).

Alternatives to disposal in landfills include direct reuse of products and recycling. Reuse is preferable, as it requires no energy; both processes help to eliminate the need for virgin natural resources to create a product and to reduce landfill requirements (Lyle 1994). Lyle (1994) notes that recycling one ton of paper products saves 17 trees from being processed and three cubic yards of landfill space. Aluminum recycling uses only 5% of the energy necessary to produce new aluminum (Lyle 1994).

With computers, cell phones and other electronic technology ubiquitous across college campuses, of particular concern to universities are "e-wastes." E-waste, or electronic waste, is the fastest-growing constituent of refuse, increasing at a rate five times that of

all other waste sources (Electronic Recyclers International 2007). E-waste includes obsolete or unwanted computers, cell phones, televisions, printers, and many more products. Due to the hazardous compounds used to create these products, though e-waste comprises only 2% of the total trash in landfills, it accounts for 70% of toxic landfill wastes (Slade 2007). Cleaning products and chemicals used in research and teaching also often contain toxins that may adversely affect custodial staff, building occupants, and the environment.

Many universities have created plans to address the growing concerns regarding the environmental problems generated by conventional waste disposal methods, i.e., landfills. The Physical Plant at UCF instituted a recycling program for conventional recyclables that is maintained by its Special Services Unit (UCF Physical Plant 2007). Surplus property from campus units is auctioned or offered for "cannibalization, " wherein desirable parts are removed and the remainder discarded (UCF Physical Plant 2007). Also, at the end of each academic year, unwanted clothing, furniture and appliances are collected during "Move Out Days" at campus dormitories to be donated to charity (Kotala 2007).

To reduce potential hazardous waste from mercury, UCF has implemented a thermometer exchange program. The ReChem program was initiated to accept and donate chemicals from courses and research in an effort to reduce chemical waste and costs (UCF Environmental Health and Safety 2006a). Finally, the Environmental Health and Safety Department has instituted chemical purchasing guidelines to reduce the numbers of

hazardous chemicals on the campus; if less toxic alternatives are available, these are recommended for purchase (UCF Environmental Health and Safety 2006b).

The University of Oregon has an extensive recycling program that deals with at least 24 materials; in 2005-6, 45% of campus waste was diverted from landfills, though this did not include construction waste and debris (Mital et al. 2007). The recycling efforts have won several awards, including a 2005 EPA University Partner of the Year Award. The Campus Recycling Program has located disposal bins for recyclables on every floor of every academic building and in most department offices and copy rooms; there are also 20 outdoor drop-off sites for glass, aluminum, paper, cardboard and plastics (Mital et al. 2007). Several other materials are picked up via special arrangement

UO has made other efforts to reduce waste from its campus. Styrofoam food containers were banned in 1989, as they cannot be recycled or composted (Mital et al. 2007). Campus Recycling established exchanges for surplus office supplies and furniture, and the Department of Environmental Health and Safety has created the "Computer Harvest" Program to pick up obsolete or broken computer equipment for deconstruction and recycling (Mital et al. 2007).

Hazardous wastes are being minimized through several efforts as well. First, the Reuse Chemical Facility accepts usable chemicals that are no longer needed and makes them available to faculty and researchers. Facilities Services at Oregon has increased the amount of "green" cleaning chemicals to 92% as of 2006 and reduced the numbers of

chemicals available for use by custodians (Mital et al. 2007). Cleaning supplies must be certified as Sustainable Earth products from Coastwide Labs in order to accepted for use on the campus (Mital et al. 2007). In the landscape, few pesticides has been reduced per the Integrated Pest Management Plan, and any fertilizers used are slow-release; phosphorous use has been reduced to decrease potential water pollution via run-off (Mital et al. 2007). Finally, Oregon created the Green Chemistry Program, an internationally recognized protocol that promotes the use of fewer toxic chemicals in classes to teach the same concepts and techniques found in traditional chemistry courses (Mital et al. 2007).

UF has instituted recycling and waste reduction initiatives that have successfully diverted approximately 40% of the campus waste from landfills (UF Office of Sustainability 2007d). Most of the waste generated and subsequently recycled comes from the deconstruction of buildings as well as the maintenance and management of campus grounds. Florida has established a goal to recycle 60% of its deconstruction materials; nearly 100% of the concrete from deconstruction activities is recycled currently (UF Office of Sustainability 2007d). Almost all landscape debris is also recovered and either mulched or composted.

Recycling of conventional office materials has been provided since 1989 (UF Physical Plant 2007c). Other recycling efforts include development of an electronics reuse/recycling policy, scrap metal recycling for used appliances and machinery, used pallet recovery, and reuse of sludge from the wastewater treatment facility as fertilizer (UF Physical Plant 2007c). UF University Housing promotes a move out program to

donate unwanted furniture and appliances to local charities (UF Office of Sustainability 2007d). Finally, the Division of Environmental Health and Safety oversees recycling of old paint, batteries, oils and fluorescent bulbs (UF Physical Plant 2007c).

UC Merced has implemented a recycling program for the campus, working in cooperation with the local county government. Standard recyclables (glass, plastic, paper, cardboard and metals) are accepted at stations in buildings across the campus. Small containers for batteries are located by these bins as well. Staff workstations are provided with individual recycling containers, while larger bins are located in common areas such as copier and break rooms (UC Merced 2007i). The Environmental Health and Safety Department handles disposal and recycling of batteries, e-waste and other hazardous materials (UC Merced 2007i). As a result of these initiatives, UC Merced successfully diverted 43% of the waste generated on the campus, excluding construction waste, from landfills during the 2006-07 academic year (UC Merced 2007j).

UBC has an aggressive strategy to reduce waste production on its campus. The Waste Management unit has established a goal of 55% per capita waste reduction by 2010 (UBC 2006c). To achieve this, several initiatives are under way, including numerous paper use reduction tools. Double-sided copying and printing is encouraged, and the administration is being lobbied to allow double sided printing for formal theses and dissertations (UBC 2007m).

Recycling is a major component of the waste reduction strategy as well. The UBC Landscape Plan (2001) integrates recycling bins into its designs to facilitate recycling of conventional materials (e.g., glass, paper, plastic, aluminum). Department offices are provided recycling containers at each desk for paper and cardboard. Special items like fluorescent bulbs and batteries are sent off-site to companies that recycle them, while furniture is collected for resale or reuse through the Surplus Equipment Recycling Facility (UBC Waste Management 2007). Special items recycling stations are also distributed across the campus for household batteries, plastic bags, and small e-waste products (UBC Waste Management 2007).

These and other initiatives have led to UBC recycling or composting 46% of its waste (UBC Waste Management 2004). And to "close the loop" of recycling, UBC has instituted a policy that minimum 30% post-consumer recycled content paper be purchased (UBC 2007m). Finally, to reduce chemical wastes, UBC began using certified green cleaning products in one building in 2005, then expanded the program to eight more buildings in 2006 (UBC 2006a).

In 1989, a group of students took on the task of recycling at Duke University, beginning with four pickup locations, seven collection items and one truck (Duke Facilities Management 2007). This program has grown into one of the leading university recycling programs in the nation, as Duke collects 18 different types of recyclables at hundreds of locations, diverting over 1250 tons of waste from landfills each year (Duke Facilities Management 2007). Many non-traditional materials are recycled as well, such as food compost, motor oil, pallets, coal ash and tires, thus reducing waste stream by an

additional 5,000 tons (Duke Facilities Management 2007). Duke has also begun a Rechargeable Battery and Cell Phone Recycling Program (Capps 2007b). Purchase of viable replacements for cleaning products and other chemicals is encouraged (Duke 2004).

Other examples of Duke's waste minimization and recycling include a computer exchange program that donates Duke computers for use in local public schools, and the Duke Surplus Program which collects surplus furniture and office equipment and other materials, then offers these items to other departments and to local non-profits at no charge (Duke Facilities Management 2007). During the "Move Out for Charity" program at the end of the academic year, unwanted furniture, clothes and appliances are collected from the dormitories to be given to charitable organizations (Capps 2007b).

Recycling began at Penn State in the 1970s as an informal effort established by concerned students; the formal campus-wide program did not begin until 1989. The current program is extensive, as recycling of standard office and residential products mark only the beginning of the effort. Computers, batteries, fluorescent bulbs, motor oil, cell phones and pallets are accepted for recycling or reuse at various locations at Penn State (Penn State Physical Plant 2007h). The recycling website established by the Office of the Physical Plant also directs campus users to off-campus locations where other materials, including Styrofoam packaging, are accepted for reuse. Penn State also has a surplus outlet that accepts items no longer wanted by university departments and sells them to students, employees and the general public. Combined, these initiatives led Penn State to recycle 48% of its total waste in 2006 (Penn State Physical Plant 2007h).

Like the other universities reviewed, Harvard has a campus-wide recycling program in place for conventional recyclables (paper, plastics, cardboard, and glass). Electronic waste including computers and batteries are recycled, and Harvard ensures that recycled computers are dismantled properly and not sent abroad to nations with less stringent waste disposal laws (Harvard University Operations Services 2007a). Surplus items that are in good condition are donated to charities and other groups. These initiatives led Harvard to an overall recycling rate of 45% in 2001 (HGCI 2007l). Chemical use is reduced via a campus-wide green cleaning program and an Integrated Pest Management plan for buildings and the landscape.

Table 7: Overview of Recycling and Waste Reduction Strategies at Eight Subject Universities

	Duke	UCF	Penn State	UO
Recycling of standard materials	Yes	Yes	Yes	Yes
Non-conventional and hazardous waste recycling	Yes	No	Yes	Yes
E-waste recycling	Yes	No	Yes	Yes - computers
Surplus exchange/ donation	Yes	Yes	Yes	Yes
Lab Chemical Reuse / Reduction	No	Yes	No	Yes – created Green Chemistry program
Green Cleaning Program	Yes	No	No	Yes – campus wide

	Harvard	UBC	UF	UCM
Recycling of standard materials	Yes	Yes	Yes	Yes
Non-conventional and hazardous waste recycling	Yes	Yes	Yes (EH&S)	Yes (EH&S)
E-waste recycling	Yes – ensures the products are recycled not shipped abroad for disposal	Yes – ensures the products are recycled not shipped abroad for disposal	Yes	Yes (EH&S)
Surplus exchange/ donation	Yes	Yes	Yes	No
Lab Chemical Reuse / Reduction	No	Yes	No	Yes – created Green Chemistry program
Green Cleaning Program	Yes – campus wide	Yes – pilot program	No	No

Materials Management Goals:

Divert 100% of waste from landfills, including food and construction waste. Eliminate toxic chemical cleaners. Minimize other chemicals in the classroom and research facilities.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

During the campus sustainability assessment, the Office of Sustainability will conduct an audit of waste products from operations and campus life, determining their sources and fates; food and construction wastes reviewed in other sections of this strategy will be included in the assessment. If not already in place, the university will immediately develop and implement a plan to recycle paper, cardboard, glass, plastic and common metals campus-wide in order to address the LEED Materials and Resources prerequisite for Storage & Collection of Recyclables.

An important component of waste management is purchasing. Though this is discussed in more detail in the Procurement section, waste management teams and procurement teams will work closely to minimize and eventually eliminate the purchase of non-recyclable products. The university, through its purchasing group, will develop requirements that purchased products be longer lasting, composed of recycled materials (to generate a market for recyclable products), and recyclable or reusable. Education of students and employees about their purchases, waste minimization and recycling will be vital as well.

Phase II: Within the first five (5) years of plan implementation:

The university will establish a goal to eliminate 30% of total campus wastes by weight from landfills; this goal has been met and exceeded by several of the campuses reviewed above. To achieve this, the school will create a surplus equipment directory to offer these items to other departments. Unwanted goods will be donated to local schools or charities, and campus housing will designate two or three days per year when the university will collect unwanted items from campus residents and donate these to charities as well. Composting will begin at the end of this phase, and 50% of all construction waste will be diverted from landfills as well. To reduce paper waste, all printers will default to print double-sided. The Office of Sustainability will coordinate with procurement personnel to establish a policy to purchase paper products with recycled content.

Campus recycling will expand to include batteries and e-waste, as these are common products that contain hazardous and toxic compounds. Much like Harvard has done, the university will contract e-waste removal only with companies that ensure recycled electronic equipment is properly disassembled and not exported to countries with lax environmental laws. Recycling plans for compact fluorescent bulbs and fixtures will also be necessary, as these will be used more commonly.

"Green" cleaning products will begin replacing conventional chemical cleaners. Several manufacturers are producing these currently, and organizations such as Green Seal have established criteria to scientifically evaluate the environmental impacts and benefits of various products, including cleaners.

Phase III: Within 10 years of plan implementation:

The goal for diverting campus refuse from landfills will increase to 50% of total campus wastes by weight. The recycling, reuse and donation programs begun in Phases I and II will continue and expand; similar programs at the reviewed schools have shown in 40-48% reductions in wastes going to landfills. The recycling program will grow to include less common items including fleet maintenance supplies (tires, oils, etc.).

Using Oregon's Green Chemistry Program as a model, the university will replace the toxic chemicals in classes with less harmful or benign substances to teach the same concepts and techniques found in traditional chemistry courses. The phase-in of green cleaning products will also continue.

Phases IV and V:

The university will divert 75%, and eventually all campus wastes by weight from landfills. The relationship between procurement and waste management will be most critical in these latter phases, as reuse and recycling of conventional products has its limits. Purchasing materials that will break down and become nutrients for the environment or that can be returned to manufacturers at the ends of their useful lives to be disassembled and reintegrated into new products will be vital to achieving the goal of eliminating wastes to landfills. The procurement office will research products for these characteristics. At the beginning of Phase V, a ban will be placed on the purchase or sale of products, including packaging, on campus that cannot be recycled, composted or reused. Also, the custodial group will prohibit the use of cleaning products that contain

chemicals proven harmful to human health and the environment. Finally, the university will continuously update the Green Chemistry program to minimize the use of harmful chemicals in the laboratory and classroom.

AREA OF FOCUS 9: TRANSPORTATION

Automobiles became the primary source of transportation in the United States in the early 20th Century at the expense of other forms of transit (Dreier et al. 2004). Urban development patterns in the U.S. arose in large part because of American attitudes about cars, especially the belief that they "provide a degree of personal freedom and flexibility that public transit cannot" (Dreier et al. 2004). Federal policy, including the Interstate Highway and Defense Act (1956) promoted suburban development via the construction of highways ringing and radiating from major cities, funded with federal gas tax revenues (Dreier et al. 2004). As people and commerce moved away from central cities, existing mass transit became a much lower priority for funding, and new transit projects made little sense in car-dominated suburbia. Flight from central cities left those areas poorer, and mass transit became identified with poverty and crime and was stigmatized as a lower-class alternative by suburban dwellers. These policies and attitudes have led to the current situation in which most American have no choice but to use the automobile (Dreier et al. 2004).

Ironically, as Dreier et al. (2004) point out, the promise of freedom and flexibility held by the automobile often fades due to traffic jams. Collectively, Americans spend 8 billion hours per year in traffic, and this is increasing annually (Dreier et al. 2004). Automobile

use also inhibits the health of both humans and the environment. Transportation accounts for approximately 66% of U.S. petroleum consumption, 50% of which is used for personal vehicles (Toor and Havlick 2004). Vehicles contribute 26% of VOC, 32% of NO_x, and 60% of carbon monoxide (CO) pollution to the atmosphere, leading to various human health problems including lung and heart disease (Toor and Havlick 2004). Combustion engines powering personal vehicles also contribute significant amounts of GHG emissions.

Automobile traffic and parking problems plague most urban and suburban university campuses (Toor and Havlick 2004). The rise in the numbers of students with cars, a trend paralleling the U.S. as a whole, has increased not only traffic and parking difficulties, but also the negative environmental impacts to university communities (Toor and Havlick 2004). Therefore, as Toor and Havlick (2004) state, "Any university that is attempting to make the transition toward sustainability must confront the issue of transportation. The daily movement of people back and forth to campus in automobiles burning fossil fuels is one of the largest impacts a typical educational institution imposes on the life support systems of the planet."

Recognizing the magnitude of the environmental impacts for which transportation is responsible, many universities have taken steps to reduce these impacts. Duke's campus fleet contains 35 alternative fuel vehicles, including gas-electric hybrid, compressed natural gas, and electric vehicles (Capps 2007b). In 2004, the campus shuttle buses

began using biodiesel fuels as well. These shuttles move students within and between the Duke campuses.

Carpooling is encouraged via a parking permit fee reduction. Vanpools are similarly supported; reserved, free parking is offered to groups of seven or more commuters who live near one another and ride together. Duke works with the local transit authority, which provides the van and pays for fuel, insurance and maintenance; vanpool members in turn pay a low monthly fare based on the mileage (Duke University 2007d). Emergency Ride Home services are provided to assist those using these and other forms of alternate transportation.

Bicycling is also encouraged at Duke. Several buildings contain shower facilities, and the university is creating a campus map of bike racks and storage as well as showers (Duke University 2007d). Further, those who rely primarily on bicycles can acquire single-day parking permits for emergencies, inclement weather, or other times a car may be necessary (Duke University 2007d). Finally, Duke has established a "Duke Bikes" pilot program for loaning bicycles to campus users (Capps 2007b).

UCF has made several options for transportation other than personal automobiles available to students and employees. Bicycling is encouraged and the Environmental Management Committee has a Transportation Subcommittee to focus on developing more bicycle paths on campus and in the surrounding community. A free shuttle system serves off-campus student residential complexes within one mile of the campus, allowing

students to avoid driving; over 11,000 students use the shuttle daily (Merck 2007). The shuttle system also serves students traveling within the campus. UCF, like many other schools, has worked with the local transit agency to provide convenient routes and discounted rates for students to use the public bus system

UCF is also experimenting with alternative fuel vehicles in its campus fleet. The Center for Energy and Sustainability has modified a conventional gas-electric hybrid vehicle to become Florida's first plug-in hybrid (Dellert 2007). Further, in January 2007 UCF began testing different applications for biodiesel in fleet vehicles to determine which might be most suitable for this fuel; potentially, landscape maintenance equipment and the campus shuttles may run on this fuel (UCF Sustainability and Energy Management 2007e).

UF has promoted alternative transportation in a variety of ways. First, UF has collaborated with the local municipal government to offer free bus passes to all students, faculty and staff, and several of the buses have bicycle racks. The free bus passes were first distributed in 1998, a year in which less than a million riders used the system. By 2006, ridership had grown to 8.6 million, and Florida students comprise 75% of the riders (UF Office of Sustainability 2007i). To further facilitate cycling as a transportation option, UF has created bicycle lanes on major roads and has provided bike racks across the campus; more bikeways and other cycling infrastructure are planned. Also, the Student Government has established a free bicycle repair program on the campus. Carpooling is promoted and members are offered reduced parking permit fees and

preferred parking spaces. A program called UF Greenride that assists carpoolers in locating other potential carpool members has made great strides in eliminating the need for single occupancy vehicle travel to, from, and around campus (UF Office of Sustainability 2007i).

UF has partnered with Flexcar to offer a car-sharing program to campus users. Hybrid and other low-emissions vehicles are available for hourly or daily rental, and the company provides all insurance, maintenance and fuel costs (UF Office of Sustainability 2007i). The university fleet is also growing to be more sustainable, as more hybrids and flex-fuel vehicles are being purchased to replace aging conventional vehicles. UF has established E85 ethanol and biodiesel refueling stations for fleet vehicles and is conducting a pilot study on the use of biodiesel in its fleet trucks and landscape equipment (UF Office of Sustainability 2007f).

To reduce reliance on automobiles for student and employee transportation, Penn State provides several alternate transportation options. First, driving is discouraged through high parking permit fees ($145 - $325 per semester) and a limited number of parking spaces (Penn State Transportation Services 2007). To encourage bus ridership, an agreement with the local transit authority allows students to ride without paying fares on most routes, and all employees are eligible to purchase a reduced fee pass. The university has also worked with the local authority to create carpools and vanpools, with an accompanying guaranteed ride home program. On campus, a free shuttle service is available for students, employees and visitors. Alternatively, pedestrian access has been

improved via the campus master plan process, and by working with local municipal government to improve pedestrian crossings; future plans call for more roads to be closed on campus for increased pedestrian access (SEI 2007, Penn State Physical Plant 2007i).

Cycling is promoted through the construction of several paths in and around the campus community and more are planned; campus shuttles and regional buses have bicycle racks as well. Fleet Services provides vehicles for faculty and staff business trips, including hybrid SUVs. And, the Office of the Physical Plant is switching its fleet vehicles to alternative fuels.

UBC has established a goal to reduce the number of single occupant vehicle (SOV) trips by 30% of 1997 levels by 2010 (UBC Trek 2007). To achieve this goal, UBC promotes several transportation options. First, UBC encourages bicycle and pedestrian transportation via the planning process by incorporating links from development to sidewalks and bike paths (UBC Land and Building Services 2001). These links are further connected to bus routes that are on or near the campus. To facilitate use of buses and other public transit, UBC has also worked with local officials to create the U-Pass program that offers unlimited access to bus, ferry and light rail services throughout Vancouver. Though a monthly $22.00 fee is assessed as part of tuition and fees, students have voted in favor of referenda instituting this fee twice (UBC U-Pass 2007). These initiatives, along with high parking permit fees (beginning at $84.00 per month) discourage driving on campus (UBC Parking 2007a). Further, only 9,268 spaces (reduced from

14,000 in 1980) are available for over 43,000 students (UBC Parking 2007b). As more on-campus residences are created, such as University Town, fewer employees and students will need to commute to the school.

Primarily due to the implementation of the U-Pass program and the higher parking fees, transit ridership has increased 163% since 1997 (UBC Campus and Community Planning 2007c). And although enrollment unexpectedly jumped 22% in the early part of this decade, overall SOV trips have been reduced by 4.8% (UBC Campus and Community Planning 2007c). Other alternatives to SOV trips offered by UBC include carpooling and vanpooling, a car-sharing program, and an emergency ride home plan. A final effort to reduce the environmental impacts of campus transportation at UBC is the incorporation of biodiesel fuel to power the vehicles of the maintenance department fleet (UBC. 2006a.).

At the UO, 73% of students live off campus. Of these, 22% use buses, 15% bike, 22% walk, 6% carpool, and 4% get to and around campus using "other" means; only 31% drive alone (Mital et al. 2007). Faculty and staff show a more car-dominant pattern, with 60% of them driving alone and 7% carpooling (Mital et al. 2007). Ten percent of employees use the bus system, 13% bicycle, 6% walk, and 4% use "other" means (Mital et al. 2007).

To achieve the relatively low numbers of campus users driving alone to campus, UO has instituted several programs to facilitate and promote alternative transportation. Bicycling was enhanced as an option when the university spent over $400,000 to create a cycling infrastructure by 1996 (Mital et al. 2007). Over 4,000 bicycle parking spaces are available on campus, or approximately one for every six campus users (faculty, staff and students) (Mital et al. 2007). Alternative transportation is further encouraged by the extremely low ratio of automobile parking spaces to campus users; at one space per eight drivers, this is one of the lowest ratios of universities in the U.S. (Mital et al. 2007).

The university also provides incentives for carpooling and public transportation. By working with the local transit system, several park-and-ride locations have been established around Eugene, the home of the university, to reduce auto traffic to and from the campus (Mital et al. 2007). Since 1988 a portion of student fees have been used to provide free bus passes for the university population (Mital et al. 2007). Shuttle services to bus stops and a Guaranteed Ride Home service for faculty and staff who ride the bus to campus are also provided (Mital et al. 2007). Carpooling is encouraged through reduced rates for parking permits as well as preferential parking areas (Mital et al. 2007). Finally, the university's Facilities Services group has purchased an electric truck for its recycling program.

Harvard has established incentives for carpools and vanpools as ways to encourage employees to use alternative transportation. Carpool members are given a 50% parking permit discount for a two-person carpool, 75% for three or more (Harvard Commuter

Choice Program 2007). Members are also automatically enrolled in the Emergency Ride Home Program. Similar incentives are provided for vanpools.

A preferred parking program for low-emissions and fuel-efficient vehicles is in a preliminary stage at the Harvard Business School. If a permit holder drives a vehicle meeting EPA Smart Way Elite certification criteria, the permittee is eligible to park in preferred spaces similar to the carpool spaces (Harvard University Operations Services. 2007b). To discourage driving to campus, permit fees are extremely high, beginning at $880 annually for commuters and $1710 for campus residents.

Cycling is promoted as an option through a departmental bicycle purchase to acquire bikes for employees to use on campus. Several bicycle racks are located around the campus, and a non-profit, student-run group called Quad Bikes provides bicycle repair services and used bikes for sale on the campus. Beyond bicycles, a car-sharing program with ZipCar has been established, and a biodiesel-fueled shuttle system moves students and employees around the campus. Biodiesel has been used to power all diesel vehicles in Harvard's fleet since 2004.

Most of the UC Merced campus remains undeveloped, but transportation has been incorporated into the campus development plan. First, the plan includes provisions that the academic core area will be accessible within a ten-minute walk from any point on the main campus (UC Merced 2007k). A free campus transit service (shuttle) and bus service add accessibility to campus and links to local light rail as well. An extensive

system of bicycle paths is planned, and some have been built during the first phase of campus construction (UC Merced 2007k). Development of a bicycle-friendly community adjacent to campus is also being considered (UC Merced 2007k).

Table 8: Alternative Transportation Strategies at Eight Subject Universities

	Duke	UCF	Penn State	UO
Campus shuttle	Yes	Yes	Yes	Yes
Carpool incentives	Yes – parking fee reduction	No	No – promoted	Yes – reduced parking permit fee, preferential parking
Improved bike/pedestrian infrastructure	Yes	Planning	Yes	Yes
Reduced fee to use local transit	No	Yes	Yes	Yes
Car Sharing Program	No	No	No	No
High parking fees / reduced spaces	No	No	Yes – high fees	Yes – few spaces
Alternative fuel vehicles for fleet	Yes	Yes - pilot	Yes	Yes - pilot

	Harvard	UBC	UF	UCM
Campus shuttle	Yes	No – municipal buses serve most of campus	No – local bus line serves as shuttle	Yes
Carpool incentives	Yes – parking fee reduction	No	Yes – reduced parking permit fee, preferential parking	Yes – parking fee reduction
Improved bike/pedestrian infrastructure	Yes	Yes	Yes	Yes
Reduced fee to use local transit	No	Yes	Yes	No
Car Sharing Program	Yes	Yes	Yes	No
High parking fees / reduced spaces	Yes – high fees	Yes – high fees and few spaces	No	No
Alternative fuel vehicles for fleet	Yes	Yes	Yes	No

Transportation Goals:

Though the ultimate goal of any regenerative campus is to eliminate all transportation based on fossil fuels, this is unlikely in the 30-year time period discussed in this strategy. Aside from the technological challenges, the university cannot control all elements of the transportation options available to campus users and therefore cannot be expected to eliminate undesirable options alone. If these are to be eliminated, consumers, private business and government must be involved in demanding, implementing and using transportation based on alternative fuels. Therefore, this will remain a goal to reach beyond the 30-year time frame.

Instead, to decrease traffic and parking problems, this strategy calls for a reduction of SOV trips originating or ending at the university by 75%. Further, the entire university fleet, including support vehicles (shuttles, carts, landscape equipment, etc.) will be powered by alternative fuels that are not fossil fuel-based.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

The Office of Sustainability will conduct a comprehensive review of campus transportation elements. Included in the assessment will be a determination of the primary transportation used by members of the campus community, the number of daily SOV trips to and from campus, the frequency of use of alternative transportation (cycling, walking, mass transit, carpooling, etc.), the infrastructure of the campus for pedestrians and cyclists, and parking facilities. The assessment will also evaluate on-

campus and near-campus housing available for students, faculty and staff, as well as programs for alternative transportation instituted by surrounding municipalities.

Phase II: Within the first five (5) years of plan implementation:

In this phase, the university will develop a plan to meet the regenerative goals stated above and begin implementation by the end of Phase II. The University of Colorado created a hierarchy of priorities in its transportation plan; pedestrian travel ranked first, followed by bicycle, buses (and other transit), and automobiles (Toor and Havlick 2004). Any comprehensive transportation plan produced for the university will prioritize transportation options in a similar manner. Suggested tactics and a chronology for implementation follow:

In Phase II, the school will secure funding to begin or expand programs to be implemented in the transportation plan. The goal for Phase II is to reduce SOVs by 25% from the baseline level determined in the transportation audit conducted in Phase I. One program that leads to significant reductions in driving to campus is a university shuttle system that serves the campus and nearby off-campus housing. Other funding will be used to provide financial incentives to discourage students from driving and to improve pedestrian and bike infrastructure. Incentives not to drive could include offering tuition or fee reductions and receiving preference in course registration or dorm assignments. The campus will make pedestrian crosswalks more visible through signage and lighting; elevating them for visibility and to act as traffic calming devices is another option.

Potential sources of funding for these programs include increased parking permit fees and traffic violation fines. These have the added effect of decreasing the numbers of drivers to campus and therefore reducing the need to add parking. As Toor and Havlick (2004) report that the capital costs to build structured parking are $15-30,000 per net new space, this makes financial sense for the university.

The university will also create and improve bike lanes on campus property and coordinate with the local municipality to perform similar tasks on roads that serve the school. A bike loan program for the campus similar to the one found at Duke (above) will begin, and the university could work with cycling clubs to offer a bicycle repair and maintenance facility in the student union or other common area. To achieve a LEED credit, the school will install bicycle racks at all buildings and design shower and changing facilities in new buildings.

To further reduce both strains on parking and campus traffic, a policy that no freshmen may have cars on campus will be enacted. This has been implemented at schools including Tulane University, Purdue University, and University of California - Davis, and several others have restrictions on freshman automobiles on campus; the California-Davis policy resulted in 600 spaces being opened (Toor and Havlick 2004). To provide another incentive for alternate transportation, to reduce parking and traffic pressures, and to meet another LEED credit, the university will offer preferred parking for hybrids and alternative fuel vehicles, carpools and vanpools. Further, it will offer discounted parking permits for carpool members.

Increasing the numbers of students and employees living on and in close proximity to campus facilitates their use of alternative transportation, particularly walking, cycling and campus shuttles (Toor and Havlick 2004). Most students who reside on-campus do not use their cars daily; rather, they "store" them for weekend trips and occasional errands (Toor and Havlick 2004). The administration and university planners will develop plans to increase the numbers of dorms on campus. Further, by the beginning of Phase III, all first-year students will be required live on campus. These tactics will not only reduce the numbers of automobile trips originating or ending at the school, they will also build a stronger, more collegial atmosphere. Also, the university will coordinate with and encourage local developers and municipalities to build student-oriented housing and affiliated retail and recreation facilities near campus. By the end of Phase IV, the campus is foreseen as the center of the university community, and the needs of all residents will be met within a ¼ mile of the campus, per the recommendation of New Urbanist philosophy.

Coordination with the local transit agency to create a program to provide free or reduced fare access to public transit for students, faculty and staff has been successful at several schools including UF and UBC, and any comprehensive transportation plan will incorporate this idea. Construction of bus stops within ¼ mile of campus buildings will occur to meet the requirements within the LEED Public Transportation Access credit. A campus shuttle bus system may be used to connect to public bus stations for this credit as long as the stops for the campus system meet the ¼ mile location requirements as above. The program could be funded through student activity fees and savings generated by not

having to construct parking lots. If the local transit system includes light rail, the local transit coordination will include access to it as well. Further, if a rail stop is not located at or near the school, the university will lobby for one to be built. If light rail is not available in the area, the school will encourage its construction if the population base of the community outside of the university is large enough to support one.

Another program that can easily be implemented within Phase II is car-sharing. As noted above, many students, particularly those living on-campus, use their cars sporadically. Due to the high financial costs and the scarcity of land for parking facilities, a car-sharing program would likely be less expensive not only for drivers, but also for universities. Private companies provide vehicles on an hourly or daily basis to customers who pay a nominal membership fee and a fixed rate for the use of the car. The university has no financial obligation to the company; it merely markets the option to the campus community and provides parking spaces for these cars on campus (Zipcar 2008).

A key to any alternative transportation effort is how it is marketed to the end users. Toor and Havlick (2004) relate a study that observed a 6-14% reduction in automobile driving as a result of strong marketing to the campus community. Therefore, funding should be allotted for marketing campaigns to educate students and employees about transportation options, costs of driving, and benefits of alternatives. This information will be included in orientation materials submitted to both students and parents. Other successful ideas from other campuses involve on-campus fairs and contests, campus displays, and direct email to campus users (Toor and Havlick 2004).

Finally, as the university fleet vehicles reach the ends of their useful lives, the university motor pool will replace them with hybrids or alternative fuel vehicles. As alternative fuel technology improves and becomes more widely available, fossil fuel-powered vehicles will be phased out. This process will begin in Phase II; by Phase V the entire fleet will have turned over so that every fleet vehicle runs on alternate fuels. As well, the university fleet will be audited to determine if it can be reduced, and the use of alternative fuels for support vehicles (landscape equipment, carts, shuttles, etc.) will be investigated.

Phase III: Within 10 years of plan implementation:

The goal for SOV trip reduction will increase to 35% of the baseline in Phase I. To accomplish this, funding of the programs begun in Phase II will continue. Periodic evaluations to determine which of these provide the best results will occur; the most successful programs will be expanded. Further, the study will ascertain reasons other programs have proven unsuccessful and recommend either improving or eliminating them. The ban on car permits will expand to include sophomores, thus freeing more parking spaces and diminishing the number of SOV trips.

Planning will begin for the relocation of parking to campus edges; to conserve green space, the university will commit to build only structures, not surface lots, if new parking is necessary or existing spaces must be relocated. Directing parking to campus edges is expected to reduce conflicts between cars and pedestrians or cyclists. If appropriate, a loop road system, much like what has been created at University of North Carolina-Charlotte, will be integrated into campus plans. Loop roads create a pedestrian- and

cyclist-friendly core by focusing traffic at the campus perimeter; they also distribute traffic to multiple access routes, thus decreasing problems on roads outside the university (UNC Charlotte 2007). Further, future parking needs will be reassessed periodically; as SOV trips drop, the necessary numbers of parking spaces will decrease as well. The university will commit to freezing the number of parking spaces at Phase II levels; by providing no new parking for buildings, another LEED credit can be attained.

To help accomplish this commitment, the campus shuttle system will expand to serve more off-campus locations, particularly housing and retail hubs. Construction of dormitories will continue so that the mandate that first-year students live on campus can be met. Also, the university may seek proposals for designs for a "university village" much like University Town at UBC, provided campus space is available. If not, similar proposals will be sought for the conversion of existing residence halls or the redesign of planned ones to incorporate the characteristics of the village concept. Design features will include housing for faculty and staff as well as students, recreational and green spaces, and retail outlets.

The fleet vehicle replacement program in Phase II will expand and include a retrofit program for support vehicles to run on alternative fuels; biodiesel is the most available and most common choice at present. If retrofit is not possible, these vehicles will be replaced at the ends of their useful lives with similar equipment that operates on these fuels.

Phase IV: Within 25 years:

The goal for SOV trip reduction will increase further, to 50% of the baseline in Phase I. Again, the programs begun in Phase II will be fully funded and the periodic audits to determine which success of the programs will continue. Parking demands will also be reassessed as the parking relocation plan and loop road are implemented. As the reduction in SOV trips lowers demand, the university will commit to reduce the number of parking spaces; lots and structures may then be removed and replaced with green space or buildings, and fewer lots will require relocation.

Development of the university village or similar project will begin and construction of other residences will go on until on-campus housing needs are met. University support will continue for the creation of retail and recreational development by private entities adjacent to and near campus such that the needs of all residents will be met within a ¼ mile of the campus.

To further encourage the use of alternative fuel vehicles, refueling stations for a variety of these (electric plug-ins, hydrogen, etc.) will be included in parking areas around the campus to meet demand, meeting yet another LEED credit for alternative transportation.

Phase V: Within 30 years:

The goal for SOV trip reduction will increase to 75% of the baseline in Phase I. Further, the university will complete the loop road system and the relocation of parking structures to the campus perimeter. Also, the university village development and other on-campus

housing will be finalized and available parking will be further reduced. By this time the campus fleet will consist entirely of alternate fuel vehicles; exclusive purchase of alternate fuel vehicles will occur for the future fleet. Though the choices are limited presently, with the advances in technology expected over the next 30 years, many more options should be available including hydrogen, fully electric, and solar powered vehicles. Intriguing ideas are emerging from studies such as Mitchell Joachim's ecotransology, a new design field that combines ecology, urban design, transportation planning, automotive engineering, and energy consultation (Joachim 2006). Within this study are concepts for "gentle congestion" and smart cars that respond to congestion via flocking like many animal species; Joachim (2006) refers to this as "urban mobility through ecological design."

AREA OF FOCUS 10: FOOD RESOURCES

Many faculty and students will consume at least one meal or snack supplied by a campus vendor or vending machine every day that they are on campus, spending millions of dollars annually for food and beverages. The University of Oregon spent approximately $6 million on food products in 2005-06 (Mital et al. 2007). The environmental impacts of production, transportation, packaging and disposal of these goods is immense. Therefore, methods to reduce or eliminate these negative impacts should be embraced as part of any sustainability strategy.

Production, processing and transport of food are sources of tremendous environmental perturbation. Clearing of natural areas to create agricultural fields has resulted in the loss

of millions of acres of habitat. Livestock agriculture uses 30% of the global land surface, contributing to the current biodiversity loss noted in many ecosystems (FAO 2006). Clear-cutting of South American rainforests for livestock grazing and crop planting has not only destroyed habitat, it has also reduced natural carbon sinks, thus contributing to the build-up of GHGs. Worldwide, livestock agriculture accounts for more GHG emissions than transportation (18% vs. 13.5%, based on CO_2 equivalents), and global meat and dairy production and consumption are increasing more rapidly than any other sector of agriculture (FAO 2006).

Habitat degradation is also caused by wastewater and stormwater run-off from large farms. This run-off often contains sediments, animal wastes, residual antibiotics and growth hormones, pesticides, herbicides and fertilizers. As these products enter the aquatic environment they degrade it through water pollution and eutrophication; many scientists attribute the "Dead Zone" found in the Gulf of Mexico to the vast amount of agricultural run-off from the central United States into the Mississippi River.

Transporting food over great distances also causes negative environmental effects. The average item in an American meal travels 1,500 – 2,400 miles to reach its final destination, and locally grown food is increasingly uncommon (M'Gonigle and Clark 2006). Most food is now produced at large factory farms that are located far from the majority of food demand. As M'Gonigle and Clark (2006) note, a food supply reliant on long-distance transport and hydrocarbon-based fertilizers is increasingly vulnerable as oil supplies dwindle. Long-distance transport also makes the current production and

delivery system for food unsustainable. Jones (2003) points out that more energy (as fossil fuels) is put into the system than is received (as food calories). He cites that for every calorie of iceberg lettuce flown to the UK from Los Angeles, 127 calories of fossil fuel are used; in a sense, the world is "eating oil" (Jones 2003).

In an effort to save money, many universities contract their dining and food services to private firms. In turn, due to economies of scale, these companies purchase food from large factory farms at home and abroad. This negatively impacts not only the environment but also local economies, as small local farmers are unable to compete. However, were Jones' "proximity principle" followed, many of these unsustainable practices could be reversed. The proximity principle states that products should be sourced as closely as possible to the consumers (Jones 2003). Door to door delivery of food, farmers' markets, and shops selling locally produced food replace imported and centrally-distributed foods, resulting in fewer GHG emissions and a boost to local economies (Jones 2003). One study found that sourcing of certain local produce via farmers' markets would reduce GHG emissions from distribution by a factor of 650 (Jones 2003).

Many universities have begun to implement strategies to decrease the environmental impacts of their food resources. In some plans, these are included with other goods and services in Procurement/Purchasing, but acquisition of food for the campus presents unique opportunities for sustainable and regenerative policies. As such, this strategy separates food resources from other goods and services. Similarly, food waste is often

discussed with waste management and recycling, but will be reviewed within this section.

The Food Services Department at Penn State makes "concerted efforts to partner with environmentally friendly and conscious companies" (Penn State Food Services 2007). This department has also made buying locally and regionally produced foods a priority. As such, Food Services has joined the Farm to College program, a national effort to connect universities with local growers to provide products for meal services (Penn State Food Services 2007). Penn State purchases 100% of its milk and much of its produce from local farmers (Penn State Food Services 2007). Penn State has also facilitated vegan and vegetarian dining on campus through menu choices and clear labeling of selections (Penn State Food Services 2007).

Food waste is also being addressed with a more sustainable strategy at Penn State. A pilot program created in 1997 to compost pre-consumer food waste has grown into a large-scale composting program at the Organic Materials Processing and Education center on campus (Penn State Physical Plant 2007j). Pre-consumer food waste and dirty paper napkins collected at 11 dining facilities across the campus are combined with manure from animal research facilities to produce compost for campus landscaping (Penn State Physical Plant 2007j). Approximately 1.6 tons of waste are diverted daily from local landfills, which represents an economic savings of over $16,000 annually (Penn State Physical Plant 2007j). The school is looking to expand the program to include post-consumer food waste as well.

Though the University of Oregon has no formal policies governing food purchase and disposal, the University Housing Division and the Student Union Food Services group compost pre-consumer food waste, donate excess cooked food to charity, and perform waste audits (UO Campus Recycling Program 2007; Mital et al. 2007). Used cooking oils are sent to a biofuels company (Mital et al. 2007). Further, for an additional fee, University Catering customers are offered an option to have the food waste from their events composted by an outside composting company (Mital et al. 2007). Combined, these efforts led to more than 50 tons of food waste being diverted from landfills in 2005-06 (Mital et al. 2007).

The food services units have also begun purchasing locally and regionally grown foods, including beef, produce and dairy products as well as baked goods and coffee (UO Housing 2007). The student union oversees several food vendors and works to increase the sustainability of the products they offer. For example, 75% of the coffee offered is Fair Trade Certified, organically produced and shade grown, while the remaining 25% is provided by a vendor that is a member of the Rainforest Alliance (Mital et al. 2007). However, efforts to influence the practices of national vendors have met with little success (Mital et al. 2007).

Harvard has also made several efforts to increase the sustainability of the food offered at its dining facilities. Harvard Dining Services acquires food from seven local farms and 60 local producers such that, depending on the season, anywhere from 35-70% of the fruits and vegetables served at Harvard dining facilities are from local sources; some of

this produce is organically farmed, though no percentage was available (SEI 2007). Dining Services also established a farmer's market on the campus to sell local produce directly to the Harvard community. Fair Trade Certified coffee is served by Dining Services. And, several of the dining halls have their own composting machines and accept both pre- and post-consumer food waste (SEI 2007).

The UC Merced Dining Services group has incorporated sustainable practices into its operations. Purchasing practices include buying from local and/or "green" businesses, favoring products with biodegradable packaging, and buying in bulk to reduce costs and packaging (UC Merced 2007l). UC Merced is also planning to offer "locally grown and environmentally friendly" food to students (UC Merced 2007l). To reduce food waste, UC Merced Dining Services is planning a compost pile and recycling of coffee grounds. And for 2007-08, a goal of reducing disposable wares by 60% has been established, as has a goal to install an energy efficient dishwashing room (UC Merced Dining Services 2007).

UCF has contracted the ARAMARK Corporation to provide dining services for the campus. ARAMARK serves in the same capacity at hundreds of colleges and universities across North America. Though a detailed review of ARAMARK's policies and practices is beyond the purview of this study, the company has numerous sustainability initiatives and has worked with several student groups and school administrations to increase the environmental sustainability of food supplies and dining service practices. ARAMARK has also made its corporate practices and facilities more

environmentally friendly. For example, ARAMARK has committed to purchase local and organic foods when available through its "Farm to Table" program (ARAMARK 2007). ARAMARK has also established a Vice President for Sustainability.

As at UCF, ARAMARK is the food vendor for the UF. At UF, the Office of Sustainability has worked with ARAMARK to increase the sustainability of food service operations. Areas of focus have included purchasing from regional food suppliers, reducing food waste, and offering green catering. As a result, two dining halls at UF offer locally grown food and vegan options. According to the Director of Sustainability, dining facilities on campus as a whole purchase approximately 30% of their produce from local farmers (UF 2007). The efforts to provide a vegan menu led to the People for the Ethical Treatment of Animals naming UF a Top 10 Best Vegetarian Friendly College (UF Office of Sustainability 2007j). UF's Dining Services are also replacing disposable service items to biodegradable and reduced waste options (UF Office of Sustainability 2007j).

UBC Food Services has instituted several sustainability measures in conjunction with other departments. Food Services provides waste cooking oil for the biodiesel fuel used to power maintenance vehicles and has worked with the Waste Management Department to create a composting program (UBC Food Services 2007). The compost is in turn used as fertilizer for the campus landscape. Food Services also coordinated with the Sustainability Office and other groups on the Sustainable Seafood Project to create procurement criteria for fish and shellfish and to institute programs educating students about the environmental impacts of consuming various seafood items (UBC Food

Services 2007). The education initiatives of the Food Services department extends into the research and classroom arenas as well; the department has worked with over 400 students on projects and assists in instructing a Food Systems course (UBC Food Services 2007).

Food Services has also developed its own initiatives as well, particularly in its efforts to offer more sustainably produced food choices. Some produce is purchased from the UBC Farm, a student project to create a working farm that yields all organic produce (UBC Farm 2005). Food Services also offers Fair Trade and organic coffees at outlets across the campus. The purchasing arm of Food Services gives preference to local vendors and manufacturers, particularly those who use environmentally friendly packaging (UBC Food Services 2007). Finally, several incentives for faculty, students and staff to utilize reusable containers, utensils and mugs have been implemented in efforts to reduce waste generation.

ARAMARK also provides the majority of food services at Duke, and the university has made efforts to include more locally produced food in its meals. Several initiatives were implemented after a student study inventoried the environmental impacts associated with campus dining (Capps 2007b). Following the inventory, the Divinity School at Duke sought out and subsequently hired a socially and environmentally responsible food vendor, resulting in a menu filled with locally grown and organic food options (Capps 2007b). Vegan and vegetarian options are provided there and at other facilities across the

campus. Duke also has two sustainable dining advisory committees and a Green Dining Coordinator within the Dining Services Department (Capps 2007b).

Table 9: Sustainable Food Resource Strategies at Eight Subject Universities

	Duke	UCF	Penn State	UO
Purchase local and regional food	Yes	No	Yes	Yes
Fair Trade or organic food choices	Yes	No	Yes	Yes
Composting and /or other waste reduction	No composting; non-specific mention of waste reduction	No	Yes – compost pre-consumer food and paper napkins	Yes – compost pre-consumer food; waste oil to biodiesel
Vegan and vegetarian options	Yes	No	Yes	Yes

	Harvard	UBC	UF	UCM
Purchase local and regional food	Yes	Yes	Yes	Yes
Fair Trade or organic food choices	Yes	Yes	Yes	No
Composting and /or other waste reduction	Yes - compost	Yes – compost; waste oil to biodiesel; others	Yes –biodegradable utensils and containers	Yes – compost
Vegan and vegetarian options	Yes	Yes	Yes	Yes

Food Resources Goals:

To achieve regenerative status, the goals for food resources on the campus are to have 100% of its food organically grown and raised on the campus, and all food waste eliminated. To provide further synergies for the campus, these wastes will be converted into compost for use on the campus grounds as fertilizer for landscape and future crops. Because the first goal may be impossible due to land constraints, an alternative is to have

100% of food come from a combination of organic, regionally produced and campus-grown sources.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

During the initial campus assessment, the Office of Sustainability will determine the percentage of food provided on-campus that is grown locally or regionally (within 500 miles as defined in LEED). Further, the assessment will quantify the amounts of all food offered on campus that is organically farmed and Free Trade or otherwise certified. If a private company has been contracted by the school to provide dining/food services, the sustainability of its operations and practices will also be evaluated as well.

The Office of Sustainability, coordinating with the food/dining services group, will investigate sources of locally and regionally produced foods, particularly organic items. The Farm to College program created by the Community Food Security Coalition is a valuable resource for this, as its purpose it to "connect colleges and universities with producers in their area to provide local farm products for meals and special events on campus" (Community Food Security Coalition 2007). For meat products, the investigation will include a review of farm operations to determine if the supplier has implemented waste recovery technology to minimize GHG emissions and run-off pollution; for example, some small farms have installed anaerobic digesters to convert the livestock waste into energy to run the farm (biogas). Another issue to assess is whether antibiotics or growth hormones are part of the livestock diet, pollutants that can be

washed into the water environment via run-off. If food services are independently operated, the university will discuss goals to increase the amounts of regionally and organically grown foods available to the campus with these contractors. One company that has incorporated local buying into its strategy is Bon Appétit Management Company, the firm that provides food services to Eckerd College, MIT, and Oberlin, among others.

To begin addressing food waste reduction, the Office of Sustainability will facilitate a dialogue among waste management, dining/food services and grounds maintenance to create or expand compost programs for the school. Following the example of UBC, these groups will conduct an audit of waste produced from food services, including pre- and post-consumer food waste, eating utensils and containers, etc. Further, the university will also contact area homeless shelters, after-school programs and other non-profit centers about the possibility of these groups accepting excess prepared food from the campus.

Phase II: Within the first five (5) years of plan implementation:

Directly or through the contracted food services company, the university will purchase organically and regionally grown produce so that 25% are from these sources. For meat products, food services will offer a minimum of 10% from sustainable, organic farms. If independent food vendors operate on campus, the university will mandate the same benchmarks from them.

The university will eliminate 50% of food and beverage waste (based on assessment year baseline), including packaging, containers and utensils, through a combination of

strategies. First, composting food wastes will begin. Pre-consumer food wastes are easily recovered, so 100% of these will be composted, and in another synergy, use the compost to replace fertilizer use on the campus. No styrofoam packaging will be allowed on the campus, as it is an unsustainable product. As an incentive for campus community members, food services will offer discounts to those who use their own mugs. Further, fewer portable food options will be presented; instead, food/dining services will make reusable plates, glasses, etc. available for sit down meals to reduce waste and encourage more interaction among diners. The proposed program to deliver leftover prepared meals to homeless shelters will be formalized. Finally, the university will request that food and beverage suppliers reduce the packaging of their food products and that the packaging and containers that is necessary contains recycled content. These suppliers will receive a five-year period to modify their packaging to be 100% recycled and recyclable within; the university will also alert competitors for these suppliers of these mandates so that options will be available after the five-year period.

As part of the regenerative development plan that will be created by the Office of Sustainability during Phase II for the Administration Area of Focus, campus farming will begin. Potential sites will be located for traditional organic farms and community gardens across the campus. In an effort to maximize space, proposed designs will incorporate "forest" or "woodland" gardening, in which plants from herbaceous species to trees are layered. Should land be unavailable, building roofs and walls, as well as university commons will serve as locations for agriculture, much like the Lyle Center for Regenerative Studies. Coordination with facilities and construction units within the

campus will be vital to determining which buildings will be appropriate for these projects.

Another regenerative option for land-limited campuses is vertical farming. The term "vertical" farming is used because the structures in which the agriculture takes place are several stories in height due to their urban locations. Though still in the conceptual stage, a team at Columbia University has compiled a study to design an urban, indoor farm that will be capable of feeding 50,000 people (Buck et al. 2004). Other design mandates of the farm include providing areas for organic poultry and fish production, producing zero net emissions, converting black and gray water into drinking water, recycling all evapotranspiration water vapor, allowing for extensive use of hydroponic farming, and planning for the incorporation of renewable energy (Buck et al. 2004).

The Columbia study reveals that a vertical farm capable of meeting the established goals would require two buildings, one 49 stories and the other 18 stories in height, which would fit within a typical city block (Buck et al. 2004). A similar system built on-campus to provide for the needs of a university would provide the vast majority of food for an entire campus community and eliminate the environmental impacts of traditional, non-sustainable farming. A major benefit of vertical farming is that land that had been used for conventional farming could return to its pre-agriculture condition, be it forest, grassland, etc. Should this occur, the result would "be a major counterweight to global warming. Deforested areas could be returned to their natural states, replenishing plant and animal species, reducing CO_2 in the atmosphere and providing beautiful park and

woodland spaces for recreation and tourism" (Silverman 2007). The feasibility of vertical farming as an option for the campus will be explored in this phase.

Phase III: Within 10 years of plan implementation:

Purchase of organically and regionally grown produce will continue and increase such that 50% are from these sources. A minimum of 25% of meat products will come from sustainable, organic farms. The university will mandate the same changes from any independent food vendors that operate on the campus. Construction of the campus agricultural projects will begin, including green roofs and common area gardens; as the first few are completed, require that 10% of the produce for the campus community comes from these sources.

The effort to diminish food waste will continue as well. Building on the Phase II requirement, 75% of food and beverage waste (based on assessment year baseline), will be eliminated, including packaging, containers and utensils. Expansion of the composting program to include post-consumer food waste and paper products will also aid in reaching this goal. Finally, no products that are packaged in non-recyclable materials will be made available for purchase on campus.

Phase IV: Within 25 years:

The university food/dining services group will purchase more organically and regionally grown produce such that 75% are from these sources. Similarly, it will provide a

minimum of 50% of meat products from sustainable, organic farms. These same levels will be required from any independent food vendors that operate on the campus.

Construction of the campus agricultural projects will continue, including green roofs and common area gardens; as these are built, the university will require that 25% of the produce for the campus community comes from these sources. If a vertical farm is part of the chosen strategy, construction will start within this phase. By expanding strategies used in Phases II and III, as well as novel ideas from food services staff and others, food and beverage waste reduction will reach 90% (based on assessment year baseline).

Phase V: Within 30 years:

Through vertical farming or other options, the campus will provide 100% of its food organically grown; any shortfall will be met through local, organic producers. All food waste will be eliminated, converted to compost for use as fertilizer for landscape and future crops or as a methane source for biogas generation.

AREA OF FOCUS 11: PROCUREMENT

Changing the infrastructure and operations of a university is vital for any successful sustainability strategy. One often-overlooked yet important aspect is the purchasing policy of a school. Part of the resource consumption and pollution for which a university is responsible is embodied within the production, transportation and disposal of the products it buys. Collectively, universities purchase billions of dollars in goods and services annually; M'Gonigle and Starke (2006) report one study that showed 1,900

urban universities in the U.S. spent $136 billion per year; however, there are over 4000 colleges and universities in the U.S., so the expenditures are much higher.

Therefore, to further reduce their environmental impacts, universities can alter their policies to conduct business with vendors that institute sustainable practices. Products used by and/or sold by the university will in turn become more sustainable, and eventually be manufactured and shipped in as regenerative a manner as the proposed campuses of the future.

Several universities have already formulated and implemented plans for increasing the sustainability of their purchasing policies. In its Campus Sustainability Assessment (Mital et al. 2007), the University of Oregon highlighted its Recycled Paper procurement policy and Wood Products purchasing policy. The Recycled Paper Policy recommends that all paper products contain a minimum of 50% recycled content, with 30% post-consumer content and be chlorine free (Mital et al. 2007). Because each department makes its own purchases, however, this is not mandatory. Similarly, the Wood Products Purchasing Policy encourages the procurement of certified sustainably harvested wood products, and discourages use of old-growth wood products (Mital et al. 2007). Further, the purchasing manager within Facilities Services indicated that beyond these policies, all procurement is "based upon best value and sustainability guidelines set up by[each] department," and that the Oregon is developing a benchmarking program to track their purchasing decisions based on sustainability criteria (Mital et al. 2007). This same purchasing manager has organized workshops for buyers and supervisors to promote

sustainable purchasing throughout the campus (Mital et al. 2007). Finally, Oregon's Business Affairs Office has produced a webpage of "Environmentally Preferable Purchasing Tips and Resources" promoting the benefits of and educating procurement agents in the purchasing of sustainably produced products. However, despite these initiatives, Oregon had not developed any method to track the purchase of sustainable goods and services in its various schools and departments as of May 2007 (Mital et al. 2007).

At Harvard University, the HGCI has been involved in creating environmental procurement practices for the university and launched research projects with students to determine benefits and drawbacks. The Financial Administration Department hired the Harvard Green Campus Initiative to update its purchasing practices. No cohesive policy exists for the university, but Financial Administration began a pilot-purchasing program in June 2007 called "eProcurement." This pilot program, being conducted at the Financial Administration Department, the Law School, and parts of the Medical School, is focused on lowering costs, increasing purchasing power with vendors, and facilitating procurement from companies that more sustainability-oriented companies (Ireland 2007).

The University of Central Florida purchases ENERGY STAR-certified products when available, and a provision requiring these products to be purchased is part of the proposed energy and sustainability policy for UCF (Binette 2007). This meets the second standard of the ACUP Climate Commitment calls for an energy-efficient purchasing policy, which requires the purchase of ENERGY STAR-certified products whenever they are available.

Beyond this measure, no other environmental or sustainable purchasing policy was discovered.

The University of California at Merced has created a purchasing policy that won the 2006 UC Best Practices Achievement Award (UC Merced 2007m). The University's Purchasing Policy and Procedures state that "Special consideration and preference shall be given to environmentally sustainable products and services that offer the following environmental benefits: minimize environmental impacts such as, but not limited to, toxics, pollution and hazards to workers; promote community safety; are durable and long-lasting; conserve energy and water and use agricultural fibers and residues; reduce waste through product efficiency and effectiveness; are comprised of recycled content; include environmentally-friendly packaging; have earned Environmental Sustainability Certifications" (UC Merced 2006). UC Merced is going beyond this, developing an Environmentally Preferable Purchasing (EPP) program. The EPP specifically addresses certain items, including furniture, appliances, and carpeting; it also establishes recycled paper and reprographic services criteria, creates a method to track purchases that contain environmentally friendly facets, and discusses incorporation of contract language and bid criteria to promote environmental responsibility from suppliers (UC Merced 2007m). However, the EPP remains a work in progress and has yet to be formally adopted into the Purchasing Policy and Procedures.

In its 2002 Final Report, the Sustainability Task Force at the University of Florida recommended that the university should assess the environmental and social impacts of

its purchasing and contracting policies, and revise them to incorporate sustainable practices. In 2003, UF produced a comprehensive environmental purchasing policy, stating a preference for "the purchase of environmentally preferable products whenever they perform satisfactorily and are available at a reasonable price" (UF 2003). Within this policy are requirements that the University use stationery, envelopes and business cards manufactured from recycled paper, publicize the program to serve as an example to students and the community, and make efforts to contract with vendors that are environmentally responsible (UF 2003). Further, the University has created Sustainable Purchasing guidelines through the University Controller's Office. Many of these are similar to those found in the environmental purchasing policy, but others are new or expanded. The acquisition of office products that are both created from recycled materials and recyclable, compostable, or reusable at the ends of their useful lives is encouraged (UF University Controller's Office 2007).

Other practices that are promoted include purchasing durable and reusable goods, leasing equipment instead of buying when appropriate, specify product and packaging take-back by vendors, purchasing goods in bulk or concentrated form to reduce packaging, managing surplus effectively to reduce necessary purchasing, procuring commodities that are certified to meet sustainability standards including LEED and Green Guard, procuring remanufactured goods and using refurbishing services, and purchasing goods containing fewer toxic constituents (UF University Controller's Office 2007). The Follett Higher Education Group, which supplies campus bookstores, is developing a "Green Textbook"

initiative that encourages publishers to use a minimum of 30% post consumer recycled paper in their products and informs professors as to which publishers are members of the program (UF Office of Sustainability 2007d). Finally, "The University Purchasing and Disbursements Department will make every effort to secure contracts with vendors that are socially and environmentally conscientious, and certified green whenever practicable" (UF University Controller's Office 2007).

Similarly, in 2004 Duke instituted a comprehensive Green Purchasing policy in which the possible environmental impacts of purchasing are acknowledged and guidelines for campus procurement agents are presented (Capps 2007b). This policy addresses six particular "areas of focus:" source reduction, recycled product contents, energy and water savings, landscaping, toxics and pollution, and forest conservation (Duke 2004). Though some of these are addressed elsewhere by Duke (and within this proposed strategy), their inclusion in purchasing displays the commitment of Duke to sustainability across all disciplines. The source reduction area addresses office products and other purchasing in manners similar to those proposed by UF and UC Merced, including reduced packaging, long-term versus short-term costs, and reusable or remanufactured products (Duke 2004). To "close the recycling loop," Duke, like UC Merced, UF, and UO, encourages the purchase of products with recycled content (Duke 2004). Products that meet the EPA minimum recycled content standard guidelines are given priority in purchasing (Duke 2004). Purchase of viable replacements for cleaning products and other toxic chemicals is encouraged (Duke 2004).

The Duke Stores, which are the primary book and retail stores on the campus, also have a purchasing policy commitment to "green" its product offerings (Capps 2007b). Duke has instituted a remanufactured toner cartridges policy that requires its office supply vendors to replace spent cartridges with remanufactured ones, and an ENERGY STAR policy mandating that all purchases for qualifying products be ENERGY STAR certified (Capps 2007b). Finally, in cooperation with the office supply vendors, Duke's Procurement Office has created a "Green Shopping List" available to all campus purchasing agents; this effort has resulted in environmentally friendlier products comprising over 30% of all purchases (Capps 2007b).

In 2002-03, Penn State's Physical Plant adopted policies for environmental purchasing. These policies encourage life cycle costs, energy use, long-term implications, disposal and relative environmental harm of products be included in purchasing decisions (Penn State Physical Plant 2007a). Within the policy is a provision that all purchasing bid requests encourage vendors to provide alternate bids for more environmentally responsible products. All University purchasing card-holders were notified of the University's commitment to purchase ENERGY STAR products. Local vendors were also notified and asked to promote this policy to University purchasers (Penn State Physical Plant 2007a). A second policy "encourages obtaining goods that minimize waste products, have high recycled content, use environmental production methods, demonstrate maximum durability or biodegradability, reparability, energy-efficiency, non-toxicity, and recyclability" (Penn State Physical Plant 2007a).

Penn State's purchasing group encourages suppliers to identify products or services that advance environmental stewardship, and during the bidding process, to offer an additional bid for products, services, or processes that are more environmentally friendly (Penn State Auxiliary and Business Services 2006). Environmental benefits that Penn State recognizes include decreased life cycle costs, lower energy consumption, recycled content, extended product life, reduced maintenance, and ability for the product to be recycled at the end of its useful life (Penn State Auxiliary and Business Services 2006). Also, Penn State is finalizing a *Finance and Business Strategy for Environmental Stewardship*.

Finally, one of the stated aims of the UBC procurement policy is to use the school's purchasing power to leverage social, ethical, and environmental benefits (UBC 2007a). Sustainability components/criteria were established in bid documents by the Supply Management department in 2005. Supply Management initiated a procedure to recommend the inclusion of a sustainability component phrase in the evaluation of contract bids (UBC 2007a). Energy efficiency standards are also included in bid documents on a case-by-case basis, including the acquisition of photocopiers and other major appliances (UBC 2007a). By 2006, almost 2/3 of all requests for proposals included at least one sustainability element (UBC 2007a).

Table 10: Sustainable Purchasing Strategies at Eight Subject Universities

	Duke	UCF	Penn State	UO
Mandatory Environmental Purchasing Policy	Yes	No	No	No
Purchasing guidelines for specific products	Yes	Yes – ENERGY STAR when available	Yes –ENERGY STAR, others	Yes – Recycled paper; wood products
Education of purchasing staff	Yes – "Green Shopping List"	No	Yes	Yes
Work with vendors to increase sustainability of products	Yes – "Green Shopping List"	No	Yes	No

	Harvard	UBC	UF	UCM
Mandatory Environmental Purchasing Policy	No – pilot program	Yes	Yes	No – proposed
Purchasing guidelines for specific products	No	Yes	Yes – LEED and Green Guard	Yes – LEED and Cradle-to-Cradle in proposed EPP
Education of purchasing staff	No	Yes – through bid documents	Yes	Yes – within proposed EPP
Work with vendors to increase sustainability of products	No	Yes – through bid documents	Yes – textbook supplier	Yes – within proposed EPP

Procurement Goals:

Items purchased by the university will be constructed from renewable, recycled materials, and these products in turn will be recyclable. Eventually, 100% of these products will be recycled or will be capable of biodegrading to return nutrients to the earth. Further, the

manufacture of all products purchased by the school will occur in a sustainable manner – vendors that universities choose to enter into contracts with will operate sustainably, and the factory workers will operate in humane conditions and receive living wages.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

During the initial campus review, the Office of Sustainability will obtain and review existing university purchasing policies to determine if sustainability factors are required or encouraged. Sustainability factors will include recycled and recyclable content of the products, reusability of the products, longevity and durability of the products, toxic/pollutant content of the products, worker protections and environmental policies of the manufacturers of the products or suppliers of a service, and the locations of the manufacturers in relation to the university. If differences in policies exist among various departments on campus, the individual policies for each department will be reviewed for elements of sustainability. The purchasing department will then contact current vendors to inform them of the university's desire to purchase more sustainable goods. The commitments of these vendors to create more recyclable and recycled goods and to operate in sustainable fashion will be assessed. If a company has no plan modify its practices, the university will provide benchmarks and deadlines for such practices and allow the business the opportunity to achieve these. Concurrently, the purchasing group will identify companies that meet the sustainability targets. The university will shift its purchasing to these companies should the current vendors not meet the benchmarks and deadlines.

Phase II: Within the first five (5) years of plan implementation:

The purchasing group, in coordination with the Office of Sustainability, will institute an education plan for purchasing groups at the university, much like the programs begun at UBC and University of Oregon. Like many of the schools above, the university will encourage that sustainability characteristics be included in bid documents. No school reviewed made purchasing of sustainable products, aside from paper, mandatory, however. Because of the environmental impacts noted in the introduction to this Area of Focus, however, the university will begin to require procurement of these products. In this phase, the school will mandate that at least 10% of all products (measured in dollars spent) purchased by the university be certified as environmentally preferable by a third-party organization such as Greenguard Environmental Institute or Green Seal. Further, all appliances will be ENERGY STAR certified to aid in reducing energy consumption. Finally, the university will review travel policy and study ways to reduce impacts of students and faculty travel to conferences and field research areas. Carpooling or riding a train to regional conferences will be prioritized, as airplane emissions are considerably higher than from other modes of travel for short trips (Tufts Climate Initiative 2007). Where available, university travelers will frequent hotels that participate in Green Seal's Green Lodging Program.

Finally, in this and all subsequent phases, the university will purchase as many local and regionally produced goods as possible. Not only will this aid in reducing the embodied energy and pollution that for which the university is responsible, it improves the regional economy. At the University of Pennsylvania, a program to buy local products increased

local spending from $1 million in 1986 to $57 million in 2000 (M'Gonigle and Starke 2006).

Phase III: Within 10 years of plan implementation:

Minimally, 50% of all products (measured in dollars spent) purchased by the university will be certified as environmentally preferable by a third-party organization. Focus will be placed on products that can be recycled or reused, to aid in reducing waste generation from the campus. Of these certified manufactured goods, 10% will be required to meet the highest Cradle-to-Cradle (C2C) Product Certification standard available for each type of product. Cradle-to-Cradle is a product evaluation tool developed by McDonough and Braungart to determine the environmental impacts. But C2C goes beyond other systems in that it is a hierarchical approach that leads products and companies to become regenerative in nature, much like the overall Regenerative Strategy presented in this study. C2C certification indicates that a company has committed to producing goods using chemicals, materials, and processes that promote environmental and human health and perpetual recyclability (MBDC 2007). All C2C products meet and often lead the highest international regulatory and industry standards (MBDC 2007). C2C labeling is applied to certified products, much like ENERGY STAR; the labels help consumers identify these products that "move us to a positive world of safe, healthy and fair economic enjoyment" (MBDC 2007).

Achieving the 10% goal should not be difficult, as several office products, furniture and building materials are currently C2C certified, and more are certified yearly. The

USGBC has recently ruled that incorporation of C2C products (2.5% of the total value of all building materials and products used in the project) will achieve one LEED Innovation in Design credit. Meeting this goal will begin university purchasing on the road to regenerative development; as C2C certification expands, so will opportunities to buy more regeneratively produced products.

Phase IV: Within 25 years:

The university will require that all products purchased by the school will be certified as environmentally preferable by a third-party organization. To move closer to the overarching goal of creating a regenerative campus, 50% of the products will be required to meet the highest Cradle-to-Cradle (C2C) Product Certification standard available for each type of product.

Phase V: Within 30 years:

The university will require that all products purchased by the school will be those that have achieved the highest C2C standard available for that product type. As products and companies become more regenerative, higher standards will be met until all products achieve C2C Platinum. If C2C is unavailable for particular goods, the most sustainable version on the market as certified by one of the third-party organizations discussed above will serve as an acceptable replacement.

AREA OF FOCUS 12: INVESTMENTS

Another area often overlooked by institutions when planning their sustainability efforts is the placement of university endowment funds. This oversight can prove detrimental to global sustainability efforts. As Baue (2006) notes, "Positive action on campus can be dwarfed and counteracted by inactions on the investment front," for individual university endowments range from hundreds of millions to billions of dollars, and where universities invest these monies can alter the practices of private firms and investment funds. The economic power wielded by universities can drive the market toward greater sustainability; these institutions can be powerful shareholder advocates to influence corporate behavior (Green Century Funds 2007). Investing their significant funds in "green" funds and companies, or removing money from those that have poor environmental records, sends a message to the market.

Green investing focuses on environmentally proactive companies, including those involved in alternative energy, community investment, organic and natural foods, and other eco-friendly technologies (Green Century Funds 2007). Further, the environmental effects of the operations and practices of companies are evaluated in green investment. Companies that are developing fossil fuels, nuclear technology, factory farming, and other unsustainable practices are avoided (Green Century Funds 2007). As the market shifts to favor these greener companies, those conducting unsustainable practices will be encouraged to change their practices to remain competitive. As an added benefit, the resultant, greener products of these companies will facilitate the procurement goals of this strategy, displaying yet another synergy within sustainability.

While some universities have begun to invest in environmentally and socially responsible funds, many have just begun to consider this area when investing. The Sustainable Endowments Institute (SEI) notes that 19% of the schools with the largest 200 endowments invest in renewable energy (SEI 2007). Other sustainable funds supported by universities include community development and redevelopment initiatives.

At $34.9 billion, Harvard has one of the largest endowments of any university in the United States. To help oversee the ethical responsibilities of Harvard's investments, two committees were established: the Corporation Committee on Shareholder Responsibility and the Advisory Committee on Shareholder Responsibility. Student representatives are included in the latter. Though no formal policy on investing in environmentally or socially responsible funds has been established, Harvard has invested $20 million in local community development loan funds and financial institutions granting low-interest loans for affordable housing (SEI 2007). The Advisory Committee on Shareholder Responsibility has also been vocal in asking for sustainability reports from corporations in which Harvard invests, and in 2007 coordinated with the Corporation Committee on Shareholder Responsibility to investigate divesting funds from companies that continued to conduct business in Sudan during the genocide in that nation (Harvard University 2007). Harvard publishes an annual report giving general information on its endowment, and proxy voting records are available to interested parties upon request (SEI 2007).

The University of Oregon also has no formal policy regarding environmental sustainability in its investment portfolio. Further, neither its Investment Policy Statement

nor a list of companies in which it invests is publicly available (SEI 2007). However, the University of Oregon Foundation staff members "address sustainability concerns on a case-by-case basis when screening potential new investments" (Mital et al. 2007). Also, the Environmental Issues Committee noted the need for plans to begin a sustainability endowment fund in its 2006-07Annual Report (University of Oregon 2007b).

Duke currently invests in renewable energy and community development loan funds, including a $5 million investment in the Latino Community Credit Union based in Durham, NC (SEI 2007). Duke has created a President's Advisory Committee on Investment Responsibility, and in February 2004, the board of trustees adopted guidelines for investing the university's finances in a socially responsible manner (Duke Magazine 2004). Endowment information can be accessed via a website and a password, but is not readily available to the public (SEI 2007).

Little information was available regarding the funds in which UBC's endowment finances are invested. The development of the sustainable University Town community on campus lands is projected to increase the University Endowment by approximately $500 million (UBC 2007g). According to the SEI (2007), "New investment managers are asked about their understanding of the social, ecological, and economic consequences of their investment decisions in order to clarify their approach and values in making investments on behalf of the university." However, though desired by some employees, socially responsible investment funds are not available as an option within the university's pension plan because of legal constraints obligating the Board of Governors

to follow investment criteria solely based on the best financial interests of the pension plan members (UBC Faculty Pension Plan 2006).

The University of Florida is not forthcoming about its investments, so it is unknown as to which funds and companies the university invests its endowment (SEI 2007). Similarly, no policies for investment in sustainable technology or companies were found for the University of Central Florida. UC Merced is part of the UC system and therefore has no stand-alone endowment. However, like many schools, the University of California "has not made any public statements about investigating or investing in renewable energy funds or community development loan funds" (SEI 2007). And finally, according to the SEI (2007), some of Penn State's funds "may" be in companies with renewable energy strategies. However, no formal policy to invest in socially or environmentally responsible funds has been established by the school.

Table 11: Sustainable Investment Strategies at Eight Subject Universities

	Duke	UCF	Penn State	UO
Formal policy to invest in sustainable funds/projects	Yes	No	No	No
Investment in sustainable funds/projects	Yes	Unknown	Possibly in renewable energy	Unknown
Investment information publicly available	Limited	No	No	No
Campus community involvement in investment decisions	Yes	No	No	No

	Harvard	UBC	UF	UCM
Formal policy to invest in sustainable funds/projects	No	No	No	no
Investment in sustainable funds/projects	Yes	Yes	Unknown	Unknown
Investment information publicly available	Limited	No	No	No
Campus community involvement in investment decisions	Yes	No	No	No

Endowment Investment Goals:

The 30-year goal for this Area of Focus is that 100% of the university's investments be in companies that implement regenerative operations and practices or in funds that support initiatives to sustain human and ecological communities, all while receiving a healthy

financial return on the investments. Though the university is somewhat at the mercy of the businesses, careful research into companies and advocacy by the university as a powerful shareholder will help ensure these options are readily available for investment in the future.

Phase I: Immediate implementation, to be completed within the first year of adopting the strategy.

As part of the initial sustainability assessment of the campus, the Office of Sustainability will determine the percentage of the university endowment investments that are in socially and environmentally responsible funds. The university will then contact companies that are not operating in sustainable fashion and fund managers of non-sustainable funds to inform them of the university's desire to invest in more sustainable funds. As in the Procurement Area of Focus, the assessment will determine the commitments of these companies and funds to become more sustainable; timetables and benchmarks are particularly helpful. If no plan exists, the university will develop the benchmarks and deadlines and allow the business/fund the opportunity to meet these. Simultaneously, university representatives will research financially viable funds and companies that are environmentally and socially responsible; should the required benchmarks not be met, the university may potentially shift all or part of its portfolio into these.

To facilitate changes within university endowment investment, it is also important that information about the endowment be accessible to the campus community (SEI 2007). In

addition, the inclusion of representatives from across the campus in discussions of the sustainable aspects of investments assists the trustees and university foundation members in making better-informed decisions. Therefore, the administration and endowment foundation will lay the groundwork for an advisory board regarding environmental and social responsibility in investments. Per the recommendation of the SEI (2007), the university will also release an annual report of shareholder proxy votes and a list of the funds in which the university has invested.

Phase II: Within the first five (5) years of plan implementation:

The advisory board to evaluate the sustainability of the university's investments will be established in this phase. Shareholder responsibility committees like these, which aid in proxy votes, are found at Harvard, Yale, Stanford, and several other schools (Baue 2006). A good model is the committee at Clark University, for it contains representatives from across the campus community. Clark's committee consists of four trustees, three faculty members, three students, one staff member, and one alumnus, who deliberate and make recommendations or decisions on proxy votes for the university.

By the end of Phase II, a minimum of 10% of endowment investments will be in socially and/or environmentally responsible funds, or in companies that are environmentally proactive, as discussed above.

Phase III: Within 10 years of plan implementation:

By the end of Phase III, at least 25% of investments will be in socially and/or

environmentally responsible funds, or in environmentally proactive companies.

Phase IV: Within 25 years:

At the end of this phase, the university will have invested as close to 100% of its endowment as possible into socially and/or environmentally responsible funds. Of these, 50% will be within funds that focus on businesses that conduct regenerative business practice and/or produce regenerative goods. A source for companies that perform in a regenerative manner is the Cradle-to-Cradle program discussed in the Procurement Area of Focus. If it appears that the business community is not responding rapidly enough after Phase III to meet the Phase IV benchmark, universities that share a geographic region or governing agencies (e.g., the Florida public university system) could consider creating a sustainable investment consortium to bring an even more powerful voice to altering traditional, non-sustainable business practices via proxy votes and other avenues.

Phase V: Within 30 years:

100% of investments will be in regenerative funds or businesses.

Chapter 2: USF Assessment

This chapter provides a preliminary assessment of the environmental sustainability of the policies and practices at USF. The Regenerative Strategy synthesized and described in Chapter 1 serves as the assessment tool. Options for implementation of the various Areas of Focus within the proposed strategy at USF are also discussed. Though USF would begin in Phase I of most of the Areas of Focus, possible ideas of what the campus may implement through Phase V are also explored.

1. ADMINISTRATION:

As of January 2008, the USF administration has made no public commitment to setting and achieving goals for campus sustainability. The USF President has signed neither the Talloires Declaration nor the ACUP Climate Commitment. Further, no Office of Sustainability or similar department has been established at USF. However, the Facilities Planning and Construction Department (FP&C) has two LEED Accredited Professionals (APs) on staff, and some aspects of the 2005 Campus Master Plan address sustainability issues. Master Plan topics include energy and water consumption, recycling, transportation, and preservation of green space, and are discussed in more detail in their respective sections below. The FP&C Department lists within its values such ideas as "conservation/energy efficiency, environmental responsibility, climatologically responsive designs, high quality contextual design, and [to] enhance landscape/ indigenous species" (USF FP&C 2005). Yet despite the mentions of energy efficiency

and other sustainability strategies, no benchmarks have been established and few programs enacted to increase the sustainability of the USF campus and operations.

Without a commitment from the administration to sustainable practices and without the formation of specific strategies and concrete goals for campus sustainability, this will remain a low priority for USF. Charles Kibert, Director of the Powell Center for Construction & Environment at UF and a 1982 Ph.D. graduate of USF, has attempted to introduce concepts of sustainability into plans for USF with little success. However, his efforts have helped UF become a national leader in campus sustainability. As he noted in a recent presentation, his experiences at both schools show that no sustainability movement on campus will succeed without the support of the administration.

Therefore, USF would begin in Phase I of this Regenerative Strategy. Emulating the best practices at institutions with advanced sustainability efforts, President Genshaft would sign both the Talloires Declaration and the ACUP Climate Commitment. The administration, with input from students, faculty and staff, would then develop an environmental policy that includes the goal of becoming a regenerative campus within 30 years. Immediate creation of an Office of Sustainability, similar to those at Duke, UF, and UBC would occur, with its first duty the implementation of a comprehensive assessment of the USF campus based in part on the findings in this study. This Office will serve as the hub for all programs related to sustainability issues and its Director be the champion for sustainability at the university. To be most effective for these duties, the Office would be placed high within the Office of the Executive Vice President and

coordinate closely with the Director of the Physical Plant and the Director of Facilities Planning and Construction.

2. ACADEMIA

Currently (January 2008), USF offers at least 136 courses involving sustainability issues. USF also houses several research groups conducting studies into sustainability and green technology; these groups include the Clean Energy Research Center (CERC), the Center for Urban Transportation Research (CUTR), and the Florida Center for Community Design and Research. Faculty and students in the College of Business Administration (COBA) edit and produce the journal *Organization and Environment*, and COBA hosts the Annual Business Sustainability Symposium. The newly created Patel Center for Global Solutions incorporates the triple bottom line of sustainability into its research goals and values (USF Patel Center 2006). And, the Patel Center was one of the major organizers of the May 2007 Florida Climate Change Conference.

Several student groups have arisen at USF as well. The Student Environmental Association, Engineers Without Borders, Coalition for Global Justice, and Engineers for a Sustainable World work on various sustainability issues. The recently created Emerging Green Builders, a student arm of the USGBC, has hosted a panel discussion on green building and is conducting a mock LEED certification for the new Marshall Center as an education tool for group members and the university. Another educational opportunity occurred during the implementation of the Green Lights Program (see Buildings section below). “Through the Green Lights Program, the University has trained

engineering students to survey and design lighting while giving them project management experience" (USF Physical Plant 2004a). USF also encourages soliciting the involvement of faculty, staff and students to address and develop plans for sustainability on campus (Policy 15.1.5), a policy that has translated into a successful partnership between USF and CUTR for transportation issues.

USF has a strong nucleus of courses, research and student groups focused on sustainability issues. A more comprehensive review than this study is necessary to determine exactly where USF is in these areas, particularly regarding funding levels for these programs. Therefore USF would begin by evaluating the current academic support for and interest in "green" issues, as per Phase I of the Regenerative Strategy. Eventually, all USF graduates will be environmentally literate and have a working knowledge of sustainability learned both in the classroom and through daily life on the campus.

3. BUILDINGS:

Elements of the 2005 Master Plan address LEED and sustainability. Within the plan elements, "USF embraces the concepts of sustainable building and site design. The University also recognizes that the techniques, technology and costs of sustainable design are continuously evolving and improving. Therefore, it is the intention of the University to build the most sustainable, efficient, and healthy buildings practical and financially feasible at the time of their construction."

As for LEED standards within construction, 2005 Campus Master Plan Policy 15.1.4 states: "The University shall encourage all future buildings to be designed in accordance with LEED (Leadership in Energy and Environmental Design) design criteria established by the United States Green Building Council as much as practical, possible and financially feasible." Policy 10A.3.12 mentions that "the University shall develop a plan to provide LEED based projects to promote less energy use reducing the electric and fossil fuel demand." Further, Policy 10C.2.4 mandates that "the electrical design of all future building construction shall be designed to achieve at minimum a Certified LEED rating."

Other policies include installing low volume plumbing fixtures and energy efficient lighting, creating a water leak detection program, encouraging building designs to incorporate operable windows and solar screens, and requiring buildings to be designed to Florida's climate. The Master Plan encourages the design, construction, and renovation of all building exteriors to have a minimum useful life of 40 years and interior spaces and building systems 20 years without need of major overhaul within that time period.

A past initiative to address energy conservation was the implementation of the USEPA Green Lights Program by former President Betty Castor. This program aimed to decrease energy consumption by retrofitting lighting systems throughout USF. Lighting surveys were conducted in all buildings to identify opportunities to improve lighting conditions, lighting system design, use of efficient lamp and ballast types and use of modern controls

to shut off lighting when not in use, thus improving efficiency and reducing waste (USF Physical Plant 2004a). At the time the program was begun, it was estimated that over $600,000 per year would be saved in utility costs after the program was fully implemented (USF Physical Plant 2004a). The first major demonstration project took place at the Life Science Facility (LIF) where electricity consumption dropped by 250,585 kWh and costs were reduced by over $20,000 per year (USF Physical Plant 2004a). Green Lights at USF has proven to be even more successful than planned, however, as Nainan Desai of the Physical Plant reported that approximately $1 million annually is saved due to these retrofits (Hanna-West 2006). Further, the overall project came in at almost $2 million under the original $5 million budget (Hanna-West 2006). Other current energy conservation measures include Building Schedule Optimization, replacement of chillers and boilers with higher efficiency versions, and installation of new electric transformers across the campus (USF Physical Plant 2004a). Another option under consideration in the Master Plan is the construction of a cogeneration facility or other on-site power-source to address peak demand periods.

Discussion to construct the new Patel Center building to achieve minimum LEED-NC certification has occurred, but no decision has been made. Another new building, the Marshall Center student union, is currently under construction and has some green design elements and technology. However, it will not be a LEED-NC certified building.

As of January 2008 USF had no policy to require buildings to be LEED-NC certified or as an alternative, to be constructed to LEED standards but forego certification. No

mandate for existing buildings to achieve LEED-EB ratings exists either. The Master Plan contains language that does not commit the University to many goals; instead, sustainability in operations and construction is to be "encouraged" or to be incorporated "if feasible" or "practical." Facilities Planning and Construction staff indicate a willingness to build to LEED-NC, but have not received the administrative support necessary to begin these programs. In an interview, staff noted that they incorporate technology and ideas into new buildings where they can to create "greener" structures while simultaneously meeting other university mandates including minimum square footage for buildings, budget limitations, etc. (Donerly and Isenbeck, 2007).

The proposed growth for USF over the next 10 years provides a tremendous opportunity to begin the journey towards becoming a regenerative campus. The 2005 Campus Master Plan update establishes several future building sites for the next decade, with at least 778,716 gross square feet of structures planned. If the Regenerative Strategy is implemented in 2008, these new buildings will be constructed and subsequently operated to decrease their environmental impacts. Further, as almost 25% of the 240 buildings at USF will reach the age of 50 years during the next decade, the plan includes renovation of these as well. Policy 15.1.6 of the Master Plan provides a starting point for this, as it requires the evaluation of all existing buildings with respect to energy efficiency as well as the establishment of a campus-wide energy management system.

To begin achieving the requirements of Phase I of the Buildings section of the Regenerative Strategy, USF would expand the Master Plan-mandated evaluation of

existing buildings to include all criteria within LEED-EB. Further, USF would continue to replace all light fixtures in all existing buildings with high efficiency versions. Much as UBC did in its ***Ecotrek*** project, Physical Plant staff would inspect all doors and windows and repair any leaks or damage, and inspect and repair all water lines and fixtures as well.

Following the best practices established by several schools noted for their sustainability initiatives, USF would mandate that all new buildings and major renovation projects apply for and achieve LEED-NC Silver certification beginning one year after the Regenerative Strategy is initiated. USF would use LEED-NC criteria to evaluate all younger buildings and proposed buildings, and determine the costs to upgrade these to attain LEED-NC Silver. If any recently completed structures meet the criteria or do so with minimal effort, USF would make immediate application for certification with the USBGC – the new Marshall Center is a likely candidate.

As building technology improves, and as the market for green building products expands thus reducing costs, USF will be able to construct and renovate buildings to achieve higher levels of sustainability; eventually all will be regenerative. An interesting technology that may prove useful in buildings on the USF campus is a cladding made with a super-conductive photosynthetic plasma cell skin; this technology was proposed in a design for a regenerative home awarded first place in the Cradle-to-Cradle Home Competition (Coates and Meldrum 2005). This technology has not been perfected, but the idea came from current research involving extracted spinach protein (Coates and

Meldrum 2005). According to the designers, this skin would be capable of generating 200% more electrical voltage per area than contemporary photovoltaics (Coates and Meldrum 2005). Not only is the cladding photosynthetic, it is also phototropic, meaning it will grow and follow sunlight (Coates and Meldrum 2005). With the intensity and duration of sunlight throughout the year in south Florida, this could be a tremendous power source for each building.

Coates and Meldrum (2005) also created a central core tower to facilitate the stack effect, in which temperature differences cause air pressure differences and thus movement of air into the building. This natural ventilation and airflow would serve USF buildings well during most of the year. The design team wrapped the central core with the superconductive skin to optimize its position relative to sunlight; a similar strategy could be used in USF buildings. And because the air in the Tampa region is often humid, placing a dehumidifier in the central core could generate sufficient amounts of high quality drinking water to meet the needs of building occupants, thus reducing pressure on the aquifer.

4. ENERGY SUPPLY:

USF currently has no policy requiring the purchase or production of energy generated by sources other than conventional fossil fuels. The 2005 Master Plan suggests that alternative energy sources be studied and that solar energy be evaluated as a potential option for irrigation systems, lighting, telephones and shuttles. Tampa Electric Company

(TECO) remains the campus electrical provider, while USF owns and operates the on-campus distribution system.

TECO does provide a Renewable Energy Program that offers alternative energy for purchase. Blocks of energy, each representing 200 kilowatt-hours of energy production from renewable sources at TECO plants, are available to residential and commercial consumers beginning at five dollars per block. TECO also has a program to connect solar panel systems to its grid and allow reverse metering so that power from these systems can be sold to TECO. However, USF has chosen not to participate in either program thus far.

USF would begin in Phase I of the Energy Area of Focus within the Regenerative Strategy, beginning by negotiating with TECO to purchase green power via its Renewable Energy Program. Harvard and Duke have implemented similar green power purchasing programs. USF could quickly move into Phase II, paying the extra few dollars per block of energy to achieve the goal that a minimum 15% of electricity be supplied via renewable sources. Purchase of RECs from a carbon offset program may be used to supplement the renewable energy use to achieve 15% if TECO does not produce adequate amounts of alternative energy to meet USF's demands. The requirements for renewable energy increase over the life of the Regenerative Strategy, so discussions with TECO to boost its generation of electricity via alternative sources would be vital to successfully implementing the Strategy.

5. GHGs:

There are policy statements regarding air pollution within the Master Plan. USF has committed to minimize air pollutants from and within buildings on campus through the installation of filters on fume hoods, and will monitor indoor and outdoor air quality. However, no specific policies to reduce GHGs have been enacted at USF. Further, the university has made no commitment to counter its GHG production, nor has it instituted any program to measure the contributions of campus functions and operations to GHG emissions. The USF President has signed neither the Talloires Declaration nor the ACUP Climate Commitment.

If it implemented the Regenerative Strategy, USF would sign the ACUP Climate Commitment and abide by all its requirements just as UCF, UF, Duke and UO have done. The initial USF campus sustainability assessment would include a GHG inventory to establish a baseline. Per the wording of the Commitment, within two years of signing on, USF would be required develop a plan of action to become climate neutral. Adding trees to the USF campus landscape is an inexpensive method of sequestering carbon emissions and in turn can enhance natural habitat and building shading. However, a combination of strategies including energy efficiency and use of renewable energy, along with sequestration would be employed to achieve carbon neutrality for the campus. Annual campus sustainability assessments like those at UF and UBC would include GHG inventories to monitor USF's progress toward the final goal of achieving climate neutrality. The target date for climate neutrality would be set at 30 years after implementation of the Regenerative Strategy.

6. WATER:

USF has established the Greenway as the location for all stormwater detention and retention facilities for current and future building projects. The Greenway is the primary open space at USF and runs from Lake Behnke in the southwest corner of campus to the natural wetland habitat to the northeast. Four stormwater ponds are within the Greenway and according to the Master Plan, one more will be built by 2015. Another seven are planned long-term within and outside of the Greenway. Using the regenerative design principle of integrating the development with the existing site conditions, the stormwater plan works with the natural drainage patterns on campus, taking advantage of the central ridge line that runs north-to-south and forces stormwater to the east and west.

Plans call for enhancement of the Greenway and the various stormwater ponds through native plantings and the installation of boardwalks and paths. The stormwater management plan also requests the incorporation of Best Management Practices (BMPs) including the use of porous materials to reduce run-off; the judicious application of fertilizers and pesticides, and education and licensing for grounds staff applying these chemicals; and the use of the least-polluting landscape maintenance products. Construction of bioretention areas is encouraged for parking lots.

Most of the potable water for USF is provided from wells located across the campus. Areas around these and proposed wells are considered "no build" zones to reduce the potential for fouling the water supply. To decrease consumption of potable water, USF has begun a water conservation program. The Campus Master Plan directs that this

program include xeriscaping for all new construction, sub-metering for all facilities to track water usage, and installing a computerized, rain-sensitive irrigation system. Results of the building sub-metering effort will be analyzed and incorporated into an education program for building occupants. Finally, USF will explore the use of municipal reclaimed water, collected stormwater, and gray water for irrigation purposes.

USF has some policies in place to minimize the use of potable water and to treat stormwater; other statements within the Master Plan support water use reduction, but do not require it. After conducting the assessment discussed in Phase I of the Water Area of Focus, USF would move immediately into Phase II. As USF has already met some of the goals set forth in Phase II, focus would be placed on achieving the remaining requirements and moving some operations into Phase III. If the Strategy is implemented, by the end of Phase V the campus would require little water for irrigation; any that necessary water would be supplied by water reclaimed from USF buildings. All paved surfaces would be constructed with permeable materials to eliminate runoff from these areas. One interesting option for USF is, working in conjunction with landscape and habitat restoration, to install a series of boardwalks to replace many of the paved sidewalks. This would not only remove impervious surfaces, but also allow contiguous habitat and wildlife corridors to be restored (see below).

7. LANDSCAPE AND NATIVE HABITAT

Much like in the Buildings section, USF recognizes the need for sustainability in campus planning and the landscape, and if "practical and financially feasible," will incorporate

the concepts of sustainability into these areas (Campus Master Plan 2005). To accomplish this, USF encourages all future site designs to adhere to LEED criteria (CMP 2005).

USF has over 600 "cultivated" acres on its campus, including the 156.4-acre Greenway (USF Physical Plant 2004b; Campus Master Plan). Campus landscape guidelines place the highest priority on installing native plants. Planting of exotic species is allowed if they are non-invasive and drought tolerant; these policies promote xeriscaping. Invasive exotics, particularly those listed by the Florida Exotic Pest Plant Council, are to be removed from campus. A campus tree inventory is planned that will assist in this and other projects.

Though little natural habitat remains on campus, what exists is protected under the 2005 Campus Master Plan. Areas designated for preservation are the wetland and buffer in the northeast corner of the campus, the Lake Behnke/Botanical Gardens district, and the 735-acre Ecological Research Area northeast of the main campus. The Florida Natural Areas Inventory denoted the Ecological Research Area as a Potential Habitat for Rare Species. Several have been recorded on the site including nine listed plant species and the threatened gopher tortoises (*Gopherus polyphemus*). Gopher tortoises also inhabit the protected area immediately north of the Botanical Gardens.

The majority of the open space on campus is park-like by design. The 2005 Master Plan states that campus edges along Fowler and Fletcher have "predominantly native oaks and

pines–in naturalistic groupings, within areas of open expansive lawn or associated native-community shrub massings." Observation of the campus edges suggests that the open lawn option is the most commonly used design for these areas. Further, most areas within the Greenway outside of the formal Central Quadrangle and the stormwater ponds are maintained as lawns or recreational fields.

To preserve campus land for future needs and to provide open space, the Master Plan requires that building heights be maximized. New construction must be designed to three stories, four if it is to face the Central Quad or Leroy Collins Boulevard. No development is allowed on the Greenway other than recreational fields and support facilities such as bathrooms. New building placement will also minimize impacts to existing trees. Siting is important for any proposed development adjacent to the environmentally sensitive areas on campus; the Master Plan requires that any new buildings near these areas be integrated into the existing landscape and that new landscaping for these structures preserve existing vegetation to act as a buffer. New outdoor lighting over 3500 initial lamp lumens must meet Full Cutoff Illuminating Engineering Society of North America (IESNA) Classification, and encourage high albedo materials for use in paved areas.

If USF were to implement the Regenerative Strategy, the school would begin the Landscape/Native Habitat Area of Focus in Phase I by fully assessing all ecological resources. Though an inventory of listed species on the campus has been conducted and another of campus trees is planned, an assessment of all areas and their potentials for habitat restoration is called for by the Strategy. The Master Plan requires removal of

invasive, exotic species, so the locations of these plants must be determined. Also, as observed in the Water section above, cautious use of the least polluting landscape maintenance chemicals is encouraged, so a review of current USF practices would also occur.

As the overarching goal of this Area of Focus is to restore or create native habitat on 50% of the remaining campus open space, identification of the best sites on the university grounds to accomplish this is imperative. Restoring and creating native habitat on the campus is important for reestablishing wildlife corridors, expanding opportunities for nesting and foraging areas, educating students about native Florida, and repairing some of the ecological damage caused by the construction of the campus. This goal excludes the Ecological Research Area, for these lands have been protected from development and need no restoration, and few members of the campus community are allowed to enter these lands.

Though the Master Plan calls for the edges of campus, particularly those along Fowler and Fletcher Avenues to be "naturalistic parks," these provide good opportunities for restoring the longleaf pine-turkey oak habitat that likely existed prior to development. The Master Plan also instructs that along with the lawn-like open areas, native oaks and pines with affiliated native-community shrubs be planted; merely removing the "lawn-like open area" option would move the campus toward the habitat restoration and creation goal. Another location that might prove suitable for restoration is the open area within the Greenway west of MLK Plaza, north of the Natural and Environmental

Sciences Building, and east of Magnolia Drive. Lawns and little-used concrete paths currently occupy this land. Its location near the NES building would serve environmental science courses and graduate student projects centered on restoring Florida habitat. Enabling re-growth of longleaf pine and turkey oak hammocks and constructing boardwalks to replace concrete paths would also provide shaded walks between buildings, habitat for species including gopher tortoises, and a rare opportunity for most students, faculty and staff to experience natural Florida.

8. MATERIALS MANAGEMENT (WASTE & RECYCLING)

Though the Master Plan states a goal of disposing of solid waste in an environmentally sound" manner, USF has so far fallen short on this goal. A rudimentary recycling program for mixed paper and aluminum exists for some campus buildings. Through agreements with the City of Tampa and the City of Land O'Lakes, USF placed a community recycling site on the east side of campus to collect these materials as well as cardboard, glass and plastic. Though percents of total campus waste were unavailable, between 2003-2006, USF recycled an average of 416.5 tons annually (Monroe 2007). The Campus Master Plan mandates an expansion of the recycling program by creating more drop-off locations in buildings and elsewhere and by developing an awareness campaign for the campus community.

Beyond standard office materials, compact fluorescent bulbs and fixture ballasts are also recycled due to their mercury content (Monroe 2007). A private contractor provides a bin at the Physical Plant to collect scrap metals, resulting in 91 additional tons being

diverted from landfills in 2005 (Hanna-West 2006). Other recycling programs on campus are coordinated either within individual departments or by student groups. According to Dot Monroe (2007), Program Assistant for Recycling at USF, individual departments are responsible for their e-waste disposal. The Biology Graduate Student Organization collects batteries from the Biology Department for recycling, and also hosts a webpage that informs users about local battery and e-waste recycling facilities.

USF lags behind many schools in its recycling and waste reduction efforts. If the university chooses to implement the Regenerative Strategy, it would immediately implement Phase I of the Materials Management Area of Focus. Each building would be provided bins to recycle paper, cardboard, glass, plastic and common metals campus-wide in order to address the LEED Materials and Resources prerequisite for Storage & Collection of Recyclables; without meeting this, no LEED certification can be attained. Most of the universities reviewed to create the Strategy provided recycling infrastructure to meet the LEED prerequisite. Because purchasing is intertwined with waste reduction, waste management teams and procurement teams would begin coordinating their efforts to minimize and eventually eliminate the purchase of non-recyclable products. Education of students and employees about their purchases, waste minimization and recycling is also important, and awareness programs would be established through the appropriate departments at USF to promote these efforts.

After Phase I of Materials Management is achieved, several other programs beyond recycling standard materials could begin. Expansion of the recycling program to include

batteries and e-waste would provide more environmental benefits, as long as those contracted to recycle these do so properly. USF would also establish a surplus equipment exchange, dormitory "move-out" days, and to reduce paper waste, default all printers to print double-sided. USF would move toward the goals of eliminating toxic cleaning products and minimizing the use of chemicals in the university. The custodial staff would be tasked to create and implement a plan to replace conventional cleaning products with "green" cleaners; several companies currently manufacture these products. Further, USF could further reduce its hazardous waste production by emulating the Green Chemistry Program developed at the University of Oregon. As more recyclable and non-toxic products become available, and as USF educates its employees and students about the necessity of waste reduction and recycling, the university would approach the goal of eliminating waste from the campus.

9. TRANSPORTATION

One Area of Focus in which USF has performed well is Transportation. The university has implemented several initiatives to reduce SOV trips. The free BullRunner shuttle serves not only the campus but also some nearby off-campus residential complexes. These shuttle buses have operated on biodiesel fuels since 2002. The Master Plan calls for this service to be expanded both on and off-campus. The university has also coordinated with Hillsborough Area Rapid Transit (HART) to provide free transit passes for students and reduced fares for employees. More use of mass transit options is desired, particularly light rail; the Master Plan sets aside land on the eastern edge of campus for a future light rail station. However, light rail remains only a distant

possibility in the Tampa area.

Carpooling and vanpooling are encouraged and the university has linked with Bay Area Commuter Services to provide information to the campus community about these options. However, no preferred parking or reduced permit fees have been offered as incentives for these programs. USF has also negotiated an agreement with ZipCar to provide a car-sharing program for campus users.

An Emergency Ride Home service is available to those who choose alternative transportation, including cycling and walking. USF supports these modes in numerous ways. Bicycle racks are located across the campus, and the Master Plan mandates their inclusion in all new construction and renovation projects. All HARTLine and BullRunner buses have bike racks as well. The university police department provides bicycle engraving services and registration to discourage theft (New North Transportation Alliance 2007). USF coordinates with local municipalities and government agencies to build bicycle and pedestrian linkages between the campus and surrounding neighborhoods. Plans for more pedestrian and bike lanes and corridors are contained within the Master Plan.

Other programs and policies implemented by USF include holding classes during off-peak hours and weekends, increasing the number of distance-learning and web-based courses, establishing a telecommuting policy for employees, and building new on-campus housing. One potential option for housing construction offered in the Master Plan is a

partnership between USF and private developers to build more residential facilities on the campus. Also, per Master Plan Policy 7.4.1, the university will work with local governments to promote new off-campus housing, retail and service developments near the school.

The road infrastructure at USF is being modified to minimize auto traffic in the campus interior. Planning calls for a loop road system, with most parking structures along the internal edge of this loop. Parking is a primary focus of the transportation plan. In 2007, USF offered 20,000 parking spaces for 46,180 permit holders, with another 5,000 spaces to be constructed by 2015. Up to 15 more parking structures are planned long-term. Parking pressures are due in part to the relatively low parking permit fees, at least compared to those at the schools reviewed in this study. Annual permits cost campus resident students $131.00, and off-campus resident students $106.00. However, the Master Plan indicates that an increase in these permit fees will be considered. Other measures USF will consider per the Master Plan include pursuit of off-campus Park and Ride lots, use of alternative fuel vehicles for the university fleet, and exploration of a campus monorail or trolley to link to the future light rail station.

A study by the New North Transportation Alliance (NNTA) revealed that almost 98% of students, faculty and staff commute to USF in automobiles, most often alone (Hagelin 2000). CUTR staff recently conducted a survey of campus community members about transportation options, and despite the efforts of the university, only 1% of students use their bicycles to commute to campus (Smithers 2007). In 2007, approximately 85% of

students and 91% of faculty and staff traveling to the campus during the week traveled in private vehicles (CUTR 2007b). Though the study protocols may differ, there appears to be a slight decrease in SOV trips between 2000 and 2007.

USF has coordinated with CUTR and NNTA to establish many strategies for SOV trip reduction, so if the Regenerative Strategy is implemented, Phase I of the Transportation Area of Focus has been accomplished; many facets of Phase II have been met as well. However, parking remains the primary focus of the campus transportation plan. Parking facilities, particularly structures, are costly both financially ($15-30,000 per space according to Toor and Havlick [2004]) and in land use; therefore, finding incentives to reduce the need for new parking would be cost effective for USF. A proposal in 2007 to require all freshmen not from Hillsborough, Pinellas or Pasco Counties to live on campus is a good beginning; if the Regenerative Strategy is instituted, the policy would be expanded to include all freshmen when the number of residences on campus grows to meet this number (Meinhardt 2007). Additionally, as many other schools have done, USF would prohibit all freshmen from purchasing parking permits. Not only would these policies reduce SOV trips, they would likely to encourage more interaction among students and improve academic achievement (Meinhardt 2007).

To further reduce parking pressures and subsequently increase funding for transportation initiatives, USF would increase the fees for parking permits. The 2005 Master Plan states that this option will be considered. However, the current fees for USF ($106 annually) are extremely low compared with Harvard ($880 annually) or UBC ($84-99 per month),

and therefore do little to discourage driving to campus. USF would also establish preferred parking and discounted parking permits for carpools. As the CUTR (2007b) study revealed, 26% of respondents would be very likely to participate in a carpool if carpool vehicles were given priority parking, and 24% if given reduced cost parking passes for carpools.

More on-campus housing will be necessary to further reduce SOV trips. To address funding issues, USF could partner with private developers to create not only dorms (as suggested in the Master Plan) but also campus villages that include restaurants, groceries, and entertainment venues. An October 2007 editorial in the USF Oracle newspaper focused on this issue, stating that USF is falling behind rivals like UCF in this area: "USF must revamp its campus by including more restaurants and more walking-distance and town-like offerings." Certainly this could also occur on private land at the periphery of campus as well, and the Master Plan recommends that USF to promote this as well.

The university's relationship with HART has been effective, particularly the establishment of the U-Pass for the campus community. USF has also shown interest in mass transit rail, but that option will not be available unless various government agencies coordinate to build it. However, USF could be a powerful voice to lobby for a light rail system in the area, with the backing of over 40,000 students as well as thousands more faculty and staff. However, the proposed idea to create a monorail on the campus to link to the future light rail station appears to be an unnecessary expense and would detract from the collegial pedestrian core of the campus.

Finally, as Toor and Havlick (2004) observed, marketing is a key element in any transportation initiative. They relate a study that observed a 6-14% reduction in automobile driving as a result of strong marketing to the campus community. Therefore, USF would allot funding for marketing campaigns to educate students and employees about transportation options, costs of driving, and benefits of alternatives. These policies, combined with technological improvements and expansion of mass transit options, would move USF towards the final goal of reducing SOV trips to and from campus by 75%.

10. FOOD RESOURCES

ARAMARK oversees food services at USF, as it does at UF and UCF. Attempts to contact Robbie Turner, ARAMARK Director of Operations for USF Dining Services, were unsuccessful. No USF-initiated programs to include local and organic foods in dining choices. The 2007 SEI review had similar findings, stating "the university's dining services department does not offer any notable amount of local or organic foods."

Therefore if USF decides to incorporate the Regenerative Strategy, it would begin with Phase I of the Food Resources Area of Focus. As part of USF's assessment, the university would quantify the amount of food provided on-campus that is grown locally or regionally (within 500 miles as defined in LEED), as well as the percentage of all available food that is organically farmed and Free Trade or otherwise certified. ARAMARK has some sustainability initiatives within its operations and practices, but these would be explored further. USF, much as UF has done, would work with ARAMARK to develop proposals to increase the sustainability of the food resources

provided to the campus community.

Because one strategy is to purchase more locally grown foods, the USF would also investigate sources for these, particularly organic items. The Farm to College program is one potential resource for this effort. The Tampa area also has at least one community farm, the Sweetwater Organic Community Farm, from which USF could purchase produce and learn about small-scale organic farming. One of the missions of Sweetwater is to serve as a model to educate the Tampa community about organic and sustainable farming (Sweetwater Organic Community Farm 2007). Also, campus planning would begin to set aside space for on-campus agriculture production, whether this be via developing a vertical farm or incorporating food crops into green roofs and campus gardens.

To address food waste reduction, coordination of a composting program with the Physical Plant and Dining Services would begin, emulating those created at Penn State, UBC and UC-Merced. The goal would be to create a compost system for USF such that composting of pre-consumer food wastes and landscape debris would occur within the first year of implementing the Regenerative Strategy. An audit of waste produced from Dining Services would be conducted to establish a baseline from which to measure progress in the waste reduction. USF would also contact Tampa homeless shelters, Hillsborough County after-school programs and other non-profit centers about accepting excess food from USF.

Beyond Phase I, USF will be able to provide most if not all of its own food through

vertical farming or other options. By growing food on campus, students will have the opportunity to learn about sustainable agriculture, adding to the environmental literacy each USF graduate will eventually achieve. Further, it could greatly reduce the energy used and the pollutants created in the current modes of food production and transport. All food waste could be eliminated either by converting it to compost for use as fertilizer, or by using it as a methane source for biogas generation to power a vertical farm or other building.

11. PROCUREMENT

USF has no policies regarding environmentally responsible or sustainable purchasing. However, according to Bill Gill (2007), Associate Director University of South Florida Purchasing & Property Services, the Department is learning about this issue and "will be implementing some [initiatives] in the very near future." Education of the procurement staff is a good first step in the effort to increase the sustainability of goods purchased by USF.

If implemented, USF would begin in Phase I of the Procurement Area of Focus within the Regenerative Strategy by contacting current vendors to inform them of the university's desire to purchase more sustainable products. If a vendor has no plan modify its practices, USF would provide sustainability goals and deadlines for the business to achieve. The USF Office of Sustainability and USF Purchasing Services would simultaneously research companies that meet those goals so that if the current vendors do not address the established benchmarks and deadlines, the university would shift its

purchasing to those that do. Further, to ensure that the waste reduction goals for USF are met, Purchasing and the Office of Sustainability would meet with the Physical Plant to determine where waste reduction needs are greatest. The Hanna-West (2006) study reports that 70% of USF purchasing is in paper products – purchasing recycled paper would help create a market for recycled goods, and if this paper is also recyclable, significant amounts of USF waste could be diverted from landfills. Eventually all procurement will focus not merely on the end product cost, but on the overall costs to generate, transport, use, and dispose of the goods that are purchased.

12. ENDOWMENT INVESTMENT

Like many of the universities examined for the strategy, USF has no policy regarding investment in environmentally and/or socially responsible funds or companies. However, the SEI Report (2007) notes that USF is exploring investment in renewable energy funds. Should it choose to incorporate the Regenerative Strategy, USF would begin in Phase I of the Endowment Investment Area of Focus. As part of the initial sustainability assessment of the campus, the percentage of the USF's investments that are in socially and environmentally responsible funds would be determined. Similar to the idea in the Procurement section, fund managers would be informed of the university's desire to invest in more sustainable funds. By the end of Phase II, existing funds would be required to be moving toward sustainability, or USF would shift its investments into funds that are environmentally and socially responsible as well as financially viable.

To facilitate changes to USF investment policy, the Investment Committee would release

detailed information on its investments. Providing financial support to companies that treat workers poorly, ignore environmental regulations, operate in nations with oppressive political regimes, or produce goods or services that are environmentally harmful reflects poorly on USF. However, USF is far from alone in not disclosing its investments; in fact, only 22% of surveyed schools release this information publicly (Baue 2006). As a public institution, this information should be available to the campus community so that it may participate in these decisions. Representatives from across the campus would be included in the evaluations of the investments to better inform the Investment Committee and the USF Foundation about the environmental and social ramifications of these funds. The Office of Sustainability would begin to work with the Investment Committee and the Foundation to establish the groundwork for an advisory board regarding environmental and social responsibility in investments similar to the Advisory Committee on Shareholder Responsibility at Harvard.

Table 12: Overview of Current USF Policies and Potential Next Steps

Area of Focus	Actions	Phase	Next Step
Administration	• Some mention of LEED, sustainability in Master Plan (MP)	I	• Sign Talloires/ACUP commitment • Create Offc. of Sustainability
Academia	• 136 courses • Research groups • Student groups	I	• Evaluate support for green issues
Buildings	• No LEED commitment • "Encourage" LEED • Green Lights program	I	• LEED-EB assessment • LEED Silver policy • Resume Green Lights
Energy Supply	• No policy • MP suggests study of alternatives – solar options	I	• Develop plan to purchase green energy via TECO
GHGs	• No policy	I	• Sign ACUP commitment • Conduct GHG inventory
Water	• Greenway • MP – automated irrigation – xeriscape all new const. – explore reclaimed, graywater	I/II	• Determine water budget • Install automated irrigation • Begin replacement of impervious surfaces • Hasten xeriscaping
Landscape/Habitat	• MP – encourages LEED – Landscape guidelines o Favor natives o Limit exotics – Preservation areas	I/II	• Assess areas for restoration • Review chemical application program • Begin to eliminate lawn-like areas
Materials Management	• Limited recycling program • MP mandates expansion	I	• Meet LEED prerequisite • Audit waste stream • Coordinate w/Purchasing Group
Transportation	• BullRunner – biodiesel • Free transit • Car-sharing • Bike racks, lanes, etc. • Planned loop system • Plans to increase campus housing	II/III	• Require all freshmen to live on campus • No parking permits for freshmen • Increase permit fees • Carpooling incentives • Marketing
Food Resources	• No policies • ARAMARK is supplier	I	• Assess sources of food • Increase local, organic options • Begin Farm-to-College program • Begin composting
Purchasing	• No policies • Discussions, education of staff • May implement policy in near future	I	• Contact vendors about sustainability initiatives • Investigate more sustainable options
Endowment Investment	• No policy • "Exploring" renewable energy funds	I	• Determine % endowment in environmentally responsible funds • Create advisory board for responsible investing

Chapter 3: Impediments to implementation and possible solutions

This final chapter explores potential obstacles that may inhibit the implementation of a sustainable development strategy at USF. Though various approaches to improving sustainability have been instituted at other universities, the USF administration has so far chosen not to incorporate many of them. And as stated previously, until the administration gives its support to increase the sustainability of USF's operations and policies, little progress can be made toward that goal.

CAMPUS LEADERSHIP SURVEY

To determine what impediments to implementing a sustainability plan at USF might exist, as well as gauge the interest in such plan by USF leadership, a survey of campus leaders was conducted. This survey was by no means comprehensive; it was developed to learn the general attitudes of decision-makers at USF about sustainability issues, as well as their receptiveness to specific technologies or policies. For the purposes of the survey, campus leaders included the President, Vice Presidents, Student Government Association officers, Faculty Senate Officers, Deans of each college, and Staff Senate officers (see Appendix A for a complete list of those surveyed). Of the 41 campus leaders to whom the survey was submitted, 19 responded (46.3%).

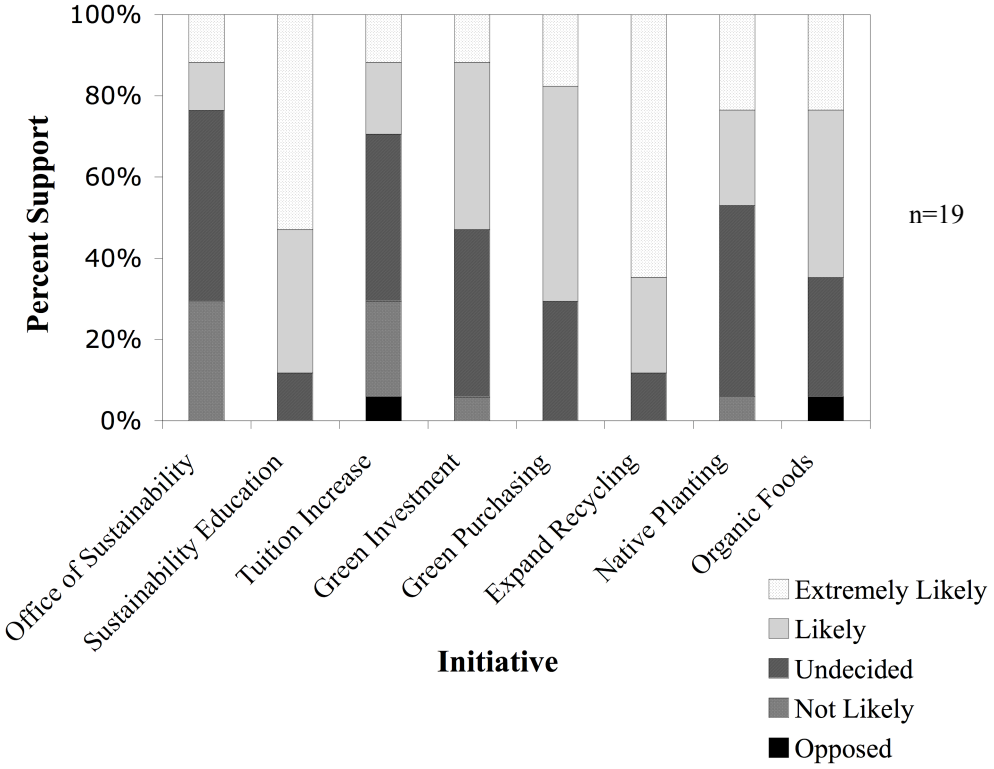
Based on the survey results, there appears to be strong support for sustainability at USF. When presented the Brundtland definition of sustainability, 94.7% of respondents indicated that it is an important or imperative goal to which USF should aspire. Further,

94.2% were somewhat or extremely likely to support the creation of a sustainable development plan for USF.

When specific strategies were offered to increase sustainability at USF, however, the support was not as enthusiastic (see **Figure 1**). Only 23.6% of respondents were likely or extremely likely to support the creation of an Office of Sustainability, and 29.4% tuition increases to improve buildings. Adding organic food choices (64.7%), replacing the existing landscape with native plants (47.0%), and instituting environmentally friendly purchasing (70.5%) and investing (53.0%) garnered more backing. The two areas receiving the highest interest were expanding the USF recycling program and educating students in the concepts of sustainability (88.2% each).

For several of the options presented, the majority of responses were "undecided/no opinion." Establishing an Office of Sustainability, increasing tuition to pay for building energy efficiency upgrades, and replacing the current landscape with native species all elicited this answer more than others. Increasing the university's investments in socially and environmentally responsible funds obtained this response at the same rate as "likely." Thus, these results could change significantly if respondents were more familiar with the concepts or had more information with which to assess many of these options.

Figure 1: Support (%) for Various Sustainability Initiatives at USF



The two options that received the least support were establishing an Office of Sustainability and increasing tuition. Of those responding, 29.4% were not likely to support the creation of an Office of Sustainability, while 23.5% were unlikely to agree to tuition increases. Further, 5.9% opposed the tuition increase; the only other idea to be opposed by any respondent (again, 5.9%) was the increased availability of organic food options on campus. No specific comments were submitted regarding the Office of Sustainability, but one respondent stated: "Tuition should not be used to fund buildings. It should be used ONLY for academic resources [emphasis from respondent]."

Most of the specific water conservation and wastewater reduction measures presented received moderate support (20-60%). Two options that were well received were the installation of cisterns to collect rainwater for irrigation and toilet use (86.7%) and the creation of gray water re-use collection systems for buildings (73.3%). No respondent indicated that USF currently does enough to conserve water.

Similarly, none of those surveyed responded that alternative transportation is unnecessary at USF. The transportation option that received the most support (70.6%) was the construction of a light rail station for the campus, should rail transit be constructed in the Tampa area; two respondents noted that this option is already in the plans for USF. Several other potential options obtained moderate support, including creating a bike-sharing program (52.9%), modifying USF to become a walking campus (52.9%), offering tuition incentives to carpoolers those not registering a vehicle at USF (47.1%), and extending the BullRunner system to serve more off-campus housing locations (47.1%). An increase in HARTLine service to the campus (41.2%) and preferred parking for alternative fuel vehicles and carpools (35.3%) received the least backing. Though 11.8% offered "other" as an answer, no specific options were given. However, one respondent stated that USF is already a walking campus, that HARTLine is "heavy enough on campus," and that extending the BullRunner service is not viable due to lack of funding.

The final question of the survey addressed carbon neutrality and whether USF should commit to achieving this by 2030. Carbon neutral was defined in the survey as "the process of neutralizing the greenhouse effects of carbon emissions by (a) reducing the

amount of carbon emissions produced and (b) off-setting any remaining carbon release by funding or developing projects that reduce carbon in the atmosphere. These projects often include planting trees or constructing alternative energy facilities." A small majority (53.3%) agreed that they would back such a commitment; no respondent opposed it, nor did any support extending or decreasing the 2030 deadline. However, though a definition was given with the survey question, 46.7% answered that they were not familiar enough with the concept to support the commitment.

Other comments written by survey respondents indicated the need to better inform campus leaders about sustainability issues, especially specific technology. In response to the question about support for particular water saving options, for example, one person answered: "It would depend on how sanitary these options are." Another acknowledged that he/she did not "know enough about some of these options to respond." Further, all respondents were somewhat to extremely supportive of including green building standards for all university buildings if evidence was provided to show that green building technology leads to healthier, more productive employees and students.

Several studies reveal increased productivity and improved health in occupants of green buildings, and presentation of these benefits to the administration may garner more support for incorporating green building at USF. As noted in the literature review, students in classrooms with daylighting performed at levels up to 20% higher than students who were taught in classrooms with minimal or no daylighting (Mendler et al. 2006). A 2003 report showed that workers having better views, measured by the size of

the view and secondarily by the content of observable vegetation, consistently performed better (Heschong Mahone 2003). In call centers, workers having the best view available processed calls 6 -12% faster than those having no view (Heschong Mahone 2003). Similarly, office workers performed 10% to 25% better on tests of mental acuity and memory when they had the optimal views versus those having no views (Heschong Mahone 2003).

Though "no standard for estimating the exact productivity impact of a green building" exists, one study attributes a 1-1.5% productivity and health gain to LEED-NC buildings (Kats et al. 2003). Though this may seem a modest increase, employee costs are approximately 10 times the costs of the building itself (Kats et al. 2003). Therefore, as Kats et al. (2003) state, "if green design measures can increase productivity by 1%, this would, over time, have a fiscal impact roughly equal to reducing property costs by 10%."

OBSTACLES AND SOLUTIONS

The unfamiliarity of almost half of respondents with the concept of carbon neutrality, accompanied by other comments noted throughout the survey responses, indicate that education of the leadership of USF will be imperative to the success of any sustainability initiative. Because the concern most expressed by respondents regarded the economic costs to implement sustainability initiatives, a vital component of that education is the discussion of the financial benefits of green building and other sustainability policies. Interestingly, though all respondents should have bypassed Questions 3-5 of the survey based on their answers to Question 2, several chose to respond to those three questions.

Many of their comments proved to be enlightening. One noted that a potential reason for not supporting a sustainable development plan at USF is that "funding is not there." For the specific technologies presented in the survey, again support "depends on costs and benefits" to one respondent.

The belief underlying these answers is that green building requires considerably higher financial costs to construct; further, it does not account for the financial benefits provided by green buildings as noted above. Alternatively, it could reflect the budgetary disconnect between operations and construction funds noted in Chapter 1. These ideas have influenced recent decisions regarding new building construction at USF. A student initiative to have the new Marshall Center achieve LEED-NC certification was stopped by the USF administration due to financial concerns. When a resolution was being prepared to submit to the USF Student Government Senate proposing that the Marshall Center be LEED certified, the Director of the Marshall Center sent a memorandum to the President of the Student Government Senate stating that LEED certification would require an additional 2% of the building budget; the Student Senate never voted on the resolution.

Though the 2% figure may be technically accurate, the way it was presented to the Senate was somewhat misleading. According to Kats et al. (2003), the average premium to construct green buildings is indeed slightly less than 2%. However, most of this cost increase is due to the additional architectural and engineering design time necessary to integrate sustainable building practices into the projects (Kats et al. 2003). The

memorandum from the Marshall Center Director indicates that the architects had already planned to design a sustainable building, so these costs were already accounted for in the architects' budget. Another, more recent study found no significant difference in average costs for constructing green buildings, including LEED certified structures, compared to non-green buildings (Morris and Matthiesen 2007).

At least one opportunity to construct a LEED certified building at USF appears to have been missed due to confusion about the costs involved. Though a building does not have to meet LEED criteria to be considered green, the rigor of the certification process ensures that the design meets accepted standards that many construction professionals use to define "green." The University of Florida notes that LEED "provides a roadmap for measuring and documenting success for ever building type and phase of a building lifecycle" (UF Facilities Planning and Construction 2007a). LEED is becoming the standard for green building and design in the US (Kats et al. 2003). So though the application and certification process adds some cost to the final project, the resultant operations cost savings from the building pay for the additional financial outlay well before the end of the useful life of the structure.

According to the survey respondents, 75% would be more likely to support a sustainable development plan if long-term operational cost savings resulted from minor construction cost increases. Beyond the university examples given in Chapter 1, research shows that operations savings will result from and pay for the incorporation of green technology in buildings. An analysis of the financial costs and benefits of 33 LEED certified buildings

at all levels (Basic – Platinum) revealed that a 2% upfront investment in construction costs typically resulted in life cycle savings of over ten times the initial investment (Kats et al. 2003). Again, this information would be valuable in educating the administration about the benefits of green building. Building to LEED standards will help assure that USF meets Campus Master Plan Policy 14.2.6: "The University shall adhere to sound fiscal policies in providing the capital improvements of this campus master plan and shall proceed with new capital improvements, expansions or replacements based upon the identification and commitment of adequate funding and resources."

However, even though the extra costs are typically minimal, to implement green building the university must find these finances. The Florida State University System currently faces budget cuts; USF is expected to lose $50 million in funding in 2007-2008. However, Florida's Governor released Executive Order 07-126 in July 2007 that directed the Department of Management Services (DMS) to construct all new buildings to LEED-NC standards and strive for LEED-NC Platinum; the Order also directed that LEED-EB is to be implemented for all DMS-owned buildings. Though State University System buildings are not owned by DMS, the Executive Order "encourages" universities to implement the same standards for new and existing buildings. This is beyond the control of USF; only the Governor and the state legislature can resolve this contradiction between the Executive Order and the budget reductions.

Another funding option for USF is the acquisition of grants from various sources. The Hanna-West (2006) study details several of these, from both government and private

sources. Grants are available for general sustainability initiatives as well as specific programs focused on energy conservation, recycling, and environmental education (Hanna-West 2006). Philanthropic gifts from environmentally conscious alumni and other donors, as well as soliciting venture capital from private firms are other suggestions presented in the Hanna-West paper.

Other institutions faced financial obstacles when beginning their sustainability efforts. Harvard began its Green Campus Loan Fund in 2000 with $3 million from Harvard's bank (HGCI 2007m). The Fund provides the up-front capital for projects to improve the sustainability of buildings and campus practices; applicants repay the Fund with the savings achieved through the resulting reductions in resource consumption or operating costs (HGCI 2007n). Any project that is funded must have a 5-year payback or less; alternatively, the Fund must be repaid within five years even if the project payback to the specific campus unit is longer (HGCI 2007m). And as noted in Chapter 1, the Fund's success has encouraged the administration to increase its funding to $12 million. USF could work with its financial institutions to create a similar program to get a sustainability strategy off the ground.

A final option for USF that would be used independently or in conjunction with the above loan program, is to hire a private company to design and install resource-saving technologies. Other campuses have taken this approach when implementing energy conservation projects. As noted in Chapter 1, both Penn State and UBC have entered into Energy Performance Contracts in which energy cost savings are used to repay the costs of

the infrastructure improvements. Private energy firms managed these Contracts via Energy Management Services Agreements with individual universities. These firms design, install and fund the new technology, and the Agreements mandate that payments to the firms are contingent on the performance of the system upgrades.

CONCLUSIONS

Sustainable development policies and initiatives have been established at numerous universities. Some have created plans and benchmarks, while others are just beginning to determine their strategies. A few institutions have even constructed buildings that approach regenerative status. Regardless, by incorporating sustainability into their practices, these schools have taken the first steps towards becoming regenerative places. As administrations have adopted strategies and benchmarks for sustainability, the concepts have permeated the philosophies of these schools as well.

Many institutions, including the University of South Florida, have not yet chosen to integrate sustainability into their policies and practices, however. These campuses represent opportunities to make rapid progress in the efforts to reduce and eventually eliminate the environmental impacts resulting from university construction, operations, and practices. The Regenerative Strategy developed in this paper offers a way for universities to achieve these goals.

This is the first study to create a comprehensive, broad-based strategy to lead universities to become regenerative places. The strategy is holistic, encouraging synergies among the 12 Areas of Focus developed from the best practices presented in other assessment tools and instituted at universities recognized as leaders in campus sustainability. The tools created by the University of Oregon, Penn State University, the University of British Columbia, the Sustainable Endowments Institute, and Good Company, Inc. each offered

sustainability indicators. However, none addressed all the indicators equally. The UO and Penn State assessment tools neglected Procurement, and Penn State's also did not include Endowment Investment. The SEI assessments, in turn, focused on Investments. And, though the Good Company tool incorporated all the Areas of Focus included in this paper, they were unequally weighted; some were primary indicators, while others were deemed secondary.

This strategy, because it moves beyond sustainable to regenerative, gives no preference to any of the Areas. Regenerative design is holistic, relying on the interplay of all elements within the development; extending this to a campus means that synergies among the various elements of the campus will be necessary to create a regenerative place. And though there are specific suggested technologies and tactics within the Strategy, due to the "place-based" nature of regenerative design, it is intended as a guide to achieve regenerative status, not a blueprint.

Another hallmark of this Regenerative Strategy is that the campus augments the advances in sustainability achieved in early phases until the regenerative level is met. No campus sustainability strategy reviewed followed a similar pattern, possibly because these use different definitions of sustainability.

This study is also the most comprehensive assessment of USF's sustainability measures to date. The Hanna-West paper focuses primarily on creating an Office of Sustainability, while the SEI assessment gives most weight to endowment investments. Results of this

thesis indicate that though USF has so far done little to embrace sustainability, the first steps in that direction will take modest efforts and minimal finances. Staff and students are interested in this issue and would benefit from the creation of an Office of Sustainability to coordinate their efforts per Phase I, much as initiatives at UO, UBC, and UF benefited from the institution of similar offices. Creating a baseline of USF's current campus is also necessary to gauge the starting point for the university, but need not be expensive; much if not all can be completed in-house. Based on the experiences of sustainability officials at both Duke and UF, the most important task is to gain a commitment from the current administration to support and finance sustainability initiatives at the school.

The survey results reveal that education of the administration at USF is important to gain support for any sustainability effort. Of particular importance are the economic benefits of green building and sustainable design. The financial costs of green building and other sustainability plans are the most common argument against implementation; however, several studies have shown that schools instituting these policies will expend little if any additional money, save money in the long term, and conserve natural resources and habitat.

Evidence also indicates that these schools will attract interest from greater numbers of faculty and students. USF's administration has often repeated the goal of becoming one of the top research universities in Florida and the United States. The sustainability of campus buildings and operations play a larger role in the decision-making process of

many prospective students and faculty across the country. For example, potential students visiting Cornell University have inquired about toilets flushed with rainwater, recycled material use in construction of residence halls, and percentage of renewable energy bought by the campus (Pierce 2008). According to Dean Koyanagi, the Sustainability Coordinator for Cornell, "The drivers… are the incoming pool of students. We're hearing that from alumni affairs and development, we're hearing that from admissions, we're hearing that from visitors who are asking, 'Where's your green building, I want to look at it'" (Pierce 2008). On the research end, Syracuse created its Center of Excellence in Environmental and Energy Systems, which has spawned a relationship with several private companies, including Carrier Corporation (Knauss 2008). This partnership has paired industry and university researchers, leading to the creation of over 180 jobs (Knauss 2008).

To some, this Regenerative Strategy may appear overly ambitious or even impossible. However, the technology to achieve these goals exists today, and will likely become less expensive and more widely available as demand grows for these products and design ideas. Further, the urgency to minimize and eventually reverse human impacts on the environment increases annually. As noted earlier, the 2007 United Nations Intergovernmental Panel on Climate Change Report states that GHG emissions must be halved by 2050 to limit the potential damage from global climate change. Water supplies, conventional energy sources and wildlife habitat are all on the decline as well.

By working across disciplines, with input from all campus users and administrative support, the creation of a regenerative campus can be successful. Implementation of the Strategy will benefit not only the environment, but also students, faculty, and finances at any university. USF is a prime candidate for this strategy due to the size of its enrollment, the academic and research resources on its campus, and the desires of its administration to become a better-known research university. Because no university has incorporated a similar strategy, should USF choose to embrace the Regenerative Strategy it would gain instant recognition as a leader in the sustainability movement and in turn become a unique destination for students, faculty and researchers alike.

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APPENDIX

Appendix A: List of University Leaders Surveyed*

USF Administration:
President
Executive Vice President and Chief Financial Officer
Provost
Vice Provost for Faculty & Program Development
Vice Provost Policy Analysis, Planning and Performance
Associate V.P. Academic Programs & Educational Outreach
Associate V.P. Enrollment Planning & Management
Associate Provost Facilities & Academic Staff
Director of Facilities Planning & Construction
Interim Director Environmental Health & Safety

SGA Execs.
Student Body President
Vice President
Chief Policy Advisor & Lobbyist
Director of Special Projects
Director – Dept. of University Affairs
Director – Marketing & Public Affairs

SGA Senate:
Senate President
Senate President Pro Tempore
University Relations Committee Chair

Deans of the Colleges:
Architecture
Arts & Sciences
Business
Education
Engineering
Florida Mental Health Institute
Graduate Studies
Honors College
Marine Science
Undergraduate Studies
College of Medicine
Nursing
College of Public Health
Visual & Performing Arts

Faculty Senate
President
Vice President
Secretary
Sergeant-at-Arms
Parliamentarian
Senator-at-Large

Staff Senate
President
Vice President

*N.B.: 46.3% of those surveyed submitted responses.