

2015

# UMass Amherst Campus Master Plan Sustainability Chapter

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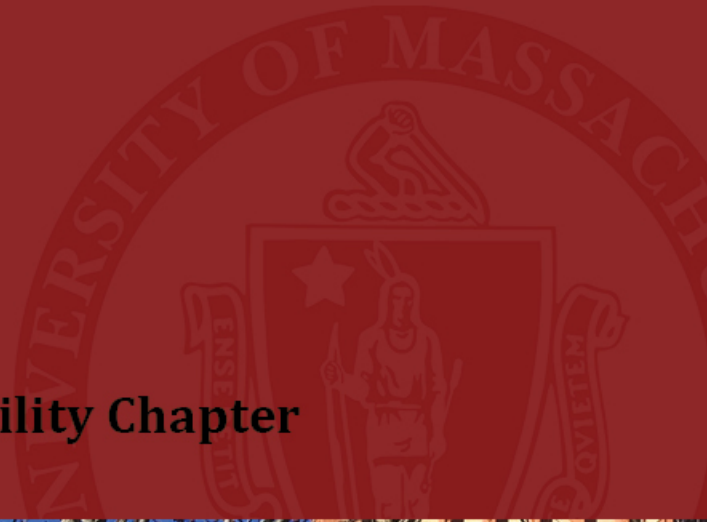
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**UMASS AMHERST  
CAMPUS MASTER PLAN Sustainability Chapter  
June 2015**









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June 22, 2015

With the completion of the 2012 Campus Master Plan that utilized a highly participatory process during its development, the university is now poised to chart a framework for future development that is consistent with our land grant status, environmental heritage, and smart growth principles. Also, in order to meet the challenges of climate change – perhaps one of the greatest challenges of our generation - we have worked hard to make our future development plans responsive to the basic principles of sustainability, including economic, environmental, and social responsibility. The addition of this Master Plan Sustainability chapter to the physical campus master plan will help all within the university and particularly those within Facilities & Campus Services – and all of our campus and community partners - to be coordinated and complementary in implementing our strategic plans in a responsible manner for future generations of students, staff and faculty.

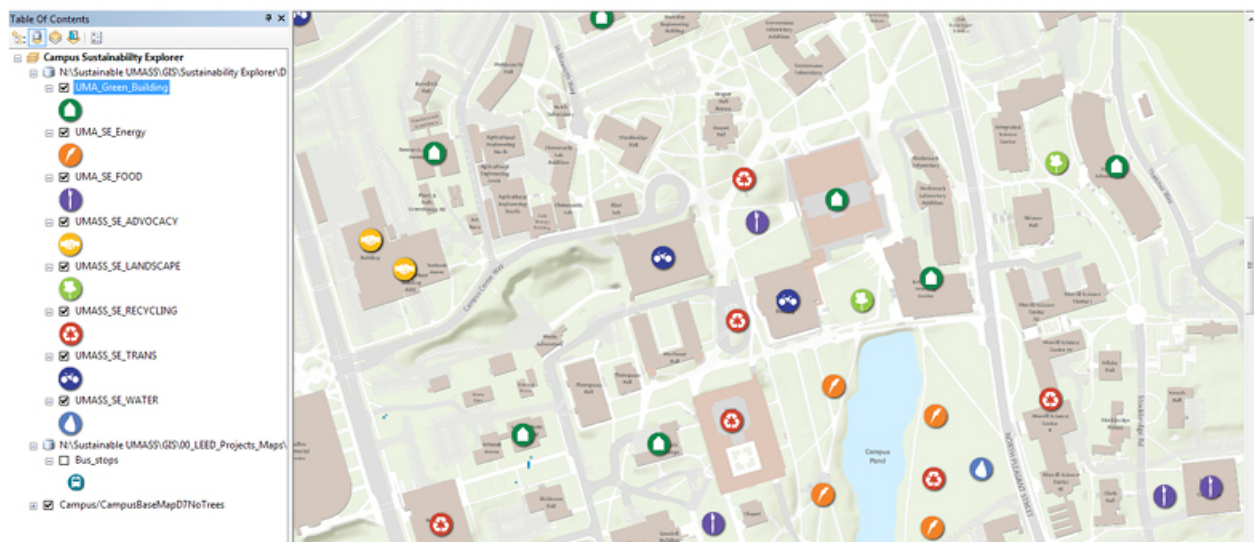
I commend the Master Plan Sustainability Committee for extending the culture of planning and articulating the socially responsible actions that will help sustain our great campus and support the health of our planet.

Sincerely,

A handwritten signature in cursive script that reads "Juanita M. Holler".

Juanita M. Holler, FAIA  
Associate Vice Chancellor  
Facilities and Campus Services

## CAMPUS SUSTAINABILITY EXPLORER





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# INTRODUCTION

In September 2010, the University of Massachusetts embarked on a public, participatory and intensive Master Planning effort lead by Campus Planning with support from the following consultants; Wilson Architects, Ayres St. Gross, VHB, and Tighe and Bond. In April 2012 the University adopted a Campus Master Plan that provides the vision and framework for a long term view of the institution's growth for the next 50 years<sup>1</sup>. While the Campus Master Plan illustrates the ability to accommodate growth over the long term, it also addresses many of the near term physical needs to become the best public university in the country. Over the next 10 years or so, UMA plans to expand from a total of 10.8 million GSF in 2010 to roughly 12.2 million GSF by 2020. It is anticipated that the on-campus student population will rise from 24,300 to about 27,700 and faculty and staff will grow from 8,000 to about 8,800.

The adoption of the UMass Amherst Campus Master Plan aligned academic and physical planning for campus systems and provided a platform for ensuring that short-term facility decisions support the long-term vision of the institution. By articulating the manner in which the campus guiding principles translate into specific recommendations for campus systems development in support of future smart growth, the Master Plan embodied the campus approach to sustainable development throughout its discussion of system frameworks such as open space, circulation, flexible mixed-use development, building heritage and community connectivity.

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1 University of Massachusetts Amherst Campus Master Plan 2012: [http://scholarworks.umass.edu/cp\\_masterplans/1/](http://scholarworks.umass.edu/cp_masterplans/1/)

Planning for campus sustainability is an ongoing process, and at UMass Amherst it is steered by the Chancellor's Sustainability Committee ("CSC"), which advises the Chancellor's Leadership Council on all matters related to the campus environmental performance and develops plans for tracking environmental performance and for reducing the campus' carbon footprint. In 2013 the CSC established a Master Plan Subcommittee ("MPS") to support a broad conversation on how community sustainability planning methods apply to campus physical planning. The committee was charged to evaluate the Campus Master Plan's ability to support the goals of the campus Climate Action Plan, particularly greenhouse gas emission, energy, green infrastructure and transportation. The committee is comprised of faculty, staff and students from multiple disciplines, including Architecture, Building and Construction Technology, Environmental Sciences, Facilities Management and Operations, Transportation, Landscape Architecture and Regional Planning. Currently, the MPS provides support for the writing of a Master Plan Chapter that addresses sustainability.

This chapter is the product of regular MPS meetings, which adopted a system-by-system approach for evaluating current and future campus development. During its first year, the MPS hosted conversations on calculating greenhouse gas emissions, analyzing resource use intensity in buildings, calculating the carbon sequestration value of campus trees, carbon emissions related to employee commuting and transportation, analyzing the campus renewable energy potential,

In its second year the MPS supported the Chancellor's Sustainability Committee Implementation team during the ADQUAD review process. The committee continued its partnership with the Green Building Committee in developing guidelines for measurement and verification of the post-occupancy performance of buildings, and developing an in-house team to perform continuous commissioning. The MPS also hosted discussions on developing the solid waste management system and supported an academic study of construction waste management. MPS faculty and staff worked with students in the Landscape Architecture and Regional Planning program to study opportunities for district-based storm-water solutions and rain-gardens.

This substantial list of efforts to coordinate planning for sustainability by the University is a tribute to the importance the flagship campus places on sustainable efforts for teaching, learning and the future of the community and the environment.

Ludmilla Pavlova-Gillham, AIA, LEED AP, Chair, Master Plan Sustainability Committee

## ACKNOWLEDGEMENTS

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# I. SUSTAINABILITY OVERVIEW

## 1. CAMPUS SYSTEMS

Each learning place has a unique character that is largely defined by its mission, location, character, financing structures and operating systems. The mission of UMass Amherst is to provide affordable and accessible education of high quality and to conduct programs of research and public service that advance knowledge and improve the lives of the people of the Commonwealth, the nation and the world. So at the very foundation of UMass Amherst lies a charge to prosper within our community and contribute to human endeavor – in a sense to sustain our learning place.

How we do this is continuously changing. Priorities shift gradually as the commonwealth's priorities evolve and as different individuals take leadership roles at the University. We experience mostly slow, yet sometimes sudden shifts in organizational culture that adapt to the changing patterns in national and international education. Our finance structures have a conservative, stabilizing effect on our business practices, yet can also be challenged by changing markets. The processes that allow us to make wise and well informed decisions often determine how well we meet the continuing challenges of the education mission. And we succeed on the strength of our human capital – our faculty, staff and most importantly, our students.

Educational institutions that provide place-based education also encompass multiple systems with varying degrees of complexity. Much of the education that takes place happens in a living campus environment that is a laboratory for learning. Every decision that is made affects hundreds of individuals, every dollar spent engages multiple campus participants and every academic home is a building that is intricately connected to a complex system of infrastructure, programs and people.

UMass Amherst offers more than 200 degree programs taught in over 400 classrooms, with over 400,000 net square feet or a total of 15,000 seats. The core UMass campus sits on 1,452 acres of land with over 350 buildings. We annually process almost 7,000 tons of waste (with a recycling rate of 56%) and we serve about 40,000 meals per day. Our energy use was about 2 trillion Btu in 2013, costing approximately \$26M. We have complex accounting structures that follow public laws and administer an operating budget of approximately \$1B in revenues and expenditures; decision making takes place both in a distributed and centralized fashion, and we ultimately answer to our Board of Directors and the legislature of the Commonwealth. Our community is truly diverse and is comprised of 30,000 individuals, over 12,000 of which live on campus. Our transit operations provide safe, efficient, and economical mobility for over 16,000 riders every school day. We have approximately 19 miles of roadways, 24 miles of steam lines, and 10 miles of electrical lines; and we spend approximately \$25M each year on new capital construction, deferred

maintenance, renovation and other capital projects and equipment (See Figure 1).

## 2. SUSTAINABILITY IN OUR PAST

The history of UMass Amherst is firmly anchored within the environmental traditions of the Massachusetts Commonwealth. It was established in 1864 with funds from the Morrill Land Grant Act as the Massachusetts Agricultural College, and has been at the forefront of sustainable practices, leading efforts in sustainable agriculture, food production and environmental conservation for 150 years. The environmental consciousness of the campus is directly reflected in the nature of its physical

environment and continues to inform current planning efforts.

The initial Vaux and Richards plan for the campus, augmented by Fredrick Law Olmsted in 1866, recreated a New England village that focused on a central open space/village green system. The most prominent buildings of the college formed a row facing the green with streets radiating out from it. The Campus Pond, not constructed until 1893, was not only an “ornament to the grounds”, but a working landscape – it was used as a facility to manufacture ice. Subsequent Master Plans developed the upland, midland and lowland sections of the campus. They created a land use pattern of classrooms, labs, offices and

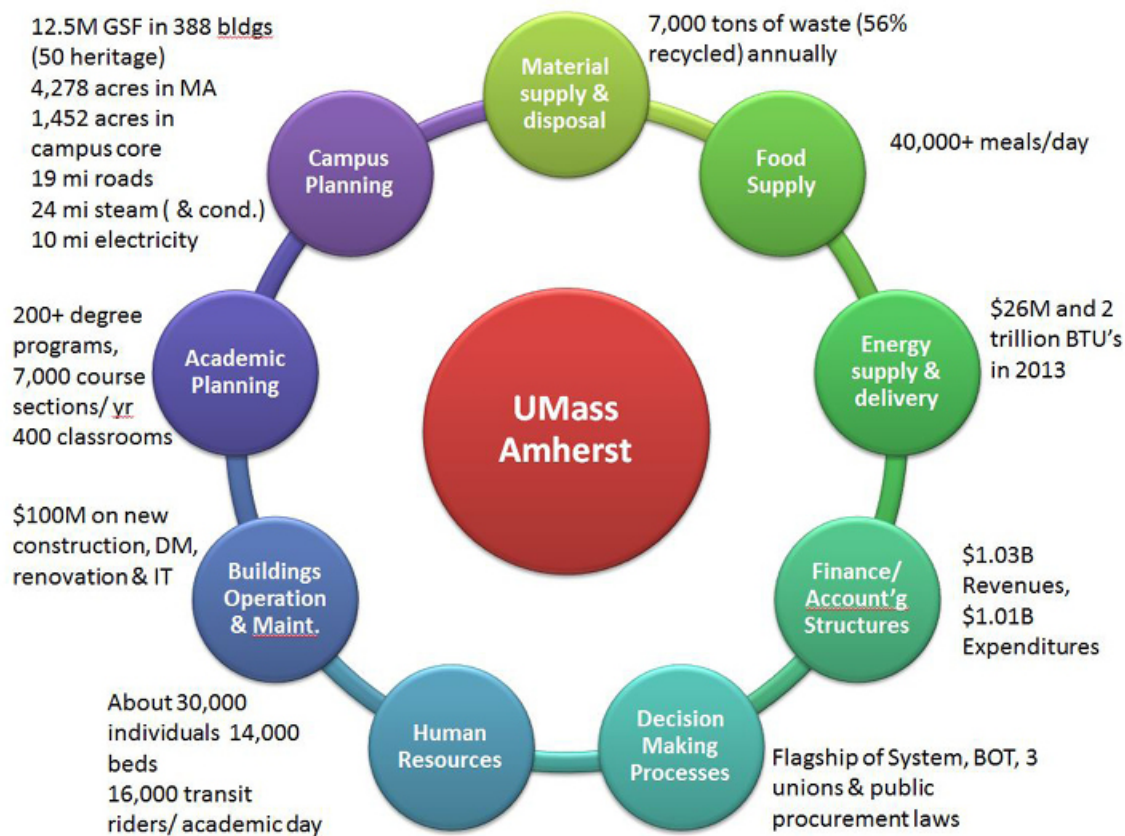


Fig. 1: Systems of UMass Amherst as an educational institution



residential halls within close proximity to each other and to learning landscapes, in a manner that reflected the agricultural mission of the University. Major circulation for the campus was moved to the east, west and north edges, enforcing a notion of the campus as the “Central Park”, while North Pleasant Street and Ellis Way served as the main roads within the core.

By the 1960s, the campus mission had evolved to match those of major undergraduate/graduate facilities. There was emphases on agriculture, engineering and general liberal arts; and anticipated student enrollments increased from 5,000 (1958) to 10,000 (1964). The Sasaki plan of 1962 developed Massachusetts Avenue as a boulevard for vehicular conveyance to address the expected growth of the campus, at that time projected to 35,000. They applied new planning principles of segregated land use and the campus began to focus on creating pedestrian only zones in its core.

The campus historic development from an agricultural college to a research university resulted in a significant transformation from a rural to semi-urban population density. Although aesthetic concerns have been constant since the design of the earliest campus facilities, there has been a gradual transition from the utilitarian and practical land use management to grounds maintenance and building design focused on the requirements of complex academic and research programs, beautification, recreation and community service.

As stated in a recent strategic document<sup>2</sup> : “the original ‘agricultural and mechanical’ focus [of UMass Amherst] has broadened into nearly every aspect of modern life, and into a larger obligation to the community it serves. Teaching and research remain at the core of our mission, but they are also carried into the community in many ways. We advance socially just learning and working environments that foster a culture of excellence through diverse people, ideas, and perspectives. We form community-university partnerships designed to transform lives and strengthen society.”

Definitions of environmental stewardship and sustainability have also changed over the last 150 years, and most notably over the last thirty years, as communities around the globe have begun to redefine health, wealth and success. The UN World Commission on Environmental Development established a definition in 1987 that is widely adopted around the globe: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”<sup>3</sup> Expanding on this concept in 1992, the United Nations Conference on Environment and Development (the Earth Summit in Rio de Janeiro) adopted the Three-Dimension Concept, recognizing that sustainable development was a balance of

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2 Innovation and Impact: Renewing the Promise of the Public Research University Phase One Report: Setting the Agenda; p. 1. <https://www.umass.edu/provost/sites/default/files/uploads/JTFSO%20Phase%20I%20Report.pdf>

3 UN Document A/42/427: Report of the World Commission on Environment and Development: Our Common Future <http://www.un-documents.net/wced-ocf.htm>

three dimensions: environmental protection, economic growth, and social development.<sup>4</sup>

In 2007, University of Massachusetts President, Jack Wilson, signed the American College and University Presidents' Climate Commitment (ACUPCC)<sup>5</sup>. The ACUPCC is a high-visibility effort to address global climate disruption. It was undertaken by a network of colleges and universities that have made institutional commitments to equip society to re-stabilize the Earth's climate. This effort works to eliminate net greenhouse gas emissions from specified campus operations and to promote the research and educational efforts offered through higher education. The group's mission is to accelerate progress towards climate neutrality and sustainability by empowering the higher education sector to educate students, create solutions, and provide leadership-by-example for the rest of society. In order to fulfill the requirements outlined in the ACUPCC, UMass Amherst Chancellor Thomas Cole formed the Environmental Performance Advisory Committee (EPAC) later that year to write the University's first Climate Action Plan<sup>6</sup> and to develop and implement projects that would guide the campus towards greater sustainability.

At the same time, student involvement in sustainability grew into the Campus Sustainability Initiative. Led by the first UMass

Amherst Sustainability Coordinator, they launched the Eco-Rep Program, designed to promote student-facilitated learning that addresses issues of sustainability. The Eco-Rep Program focuses on peer education within residence halls and has become one of the largest programs of its kind in the country; engaging over 80 Eco-Reps<sup>7</sup> and 10 student Sustainability Fellows<sup>8</sup>.

In 2012 Chancellor Subbaswamy approved the reorganization of EPAC into the Chancellor's Sustainability Committee<sup>9</sup>, which published the Climate Action Plan 2.0: A Roadmap to Carbon Neutrality<sup>10</sup>.

### 3. SUSTAINABILITY TODAY

In Fall 2013, the Campus Sustainability Initiative re-branded and grew into the campus-wide Sustainable UMass campaign. It launched its new sustainability website, [www.umass.edu/sustainability](http://www.umass.edu/sustainability), which further defines the institution's commitment to engage in research and educational efforts that equip our society with the knowledge and tools to re-stabilize the Earth's climate and to be a responsible steward of the campus physical resources.

As of 2007, all five UMass Campuses and the President of the UMass System were signatories of the American College & University Presidents' Climate Commitment (ACUPCC). By

4 UN Conference on Environment and Development (1992) <http://www.un.org/geninfo/bp/enviro.html>

5 American College and University Presidents' Climate Commitment <http://www.presidentsclimatecommitment.org/about/commitment>

6 UMass Amherst Climate Action Plan <http://scholarworks.umass.edu/csi/1/>

7 <http://www.umass.edu/sustainability/get-involved/eco-reps>

8 <http://www.umass.edu/sustainability/get-involved/sustainability-fellows>

9 <http://www.umass.edu/sustainability/get-involved/chancellors-sustainability-committee>

10 <http://scholarworks.umass.edu/csi/3/>

signing the commitment, each campus pledged to: i) develop a comprehensive Climate Action Plan to achieve climate neutrality by 2050, ii) take tangible actions in the near term to reduce greenhouse gases, and iii) publicly report on progress.

#### **4. CLIMATE ACTION PLAN 2012**

The 2012 Climate Action Plan outlined the following summary of sustainability goals:

##### **A. EDUCATION/ENGAGEMENT:**

Continue to integrate and expand sustainability across the curriculum and campus life:

- Extend sustainability learning outcome requirements to a majority of majors and degrees.
- Offer more sustainability focused and related academic courses.
- Increase student engagement in residence halls and student organization activities and increase faculty and staff engagement in classroom and administrative offices.
- Conduct a biannual assessment of sustainability literacy of all students, focusing the assessment on knowledge of topics, and not merely on values or beliefs.
- Renew the ACUPCC: Reaffirm leadership and recommit the University to the goals within the commitment text.
- Restructure and grow EPAC to include members from University Relations, Budget office, Student Affairs and

Residence Life, Diversity Office, Alumni & Development, and Athletics.

- Place a spotlight on research that is contributing to a just and sustainable future; begin tracking the financial commitment to sustainability related research to highlight how it can potentially offset campus emissions.

##### **B. ENERGY/EMISSIONS/BUILDINGS:**

Meet the state (EO484) energy and carbon emission goals by converting to renewable energy sources, greening existing buildings, encouraging reductions in individual energy consumption, and adopting net-zero growth policies:

- Develop a campus renewable energy plan to produce electricity from 30% renewable energy sources by 2020 (EO484), ultimately reducing campus emissions by 25-30%.
- Develop a Reduce Your Use Campaign, including the piloting of innovative energy management technologies, reductions in individual energy consumption through student energy competitions and green office programs, reducing energy usage and campus emissions 5-10% by 2020.
- Continuously commission existing buildings across campus to improve energy efficiency, yield an average of 16% energy costs per building, reduce energy usage and emissions 10-25% by 2020.
- Develop campus wide a sustainable development policy for carbon neutral growth, which recovers the costs of



greening new and existing buildings through energy efficiency measures.

- Preserve the E+ Energy Efficiency Program by continuing to improve the project selection process and ultimately the effectiveness of the program.

### C. FUNDING:

Fund our ongoing advancement in sustainability through a Student Green Fee, creating revolving loan funds, and by developing new external partnerships:

- Seek approval for a student green fee to help finance objectives A and B above by funding highly visible projects on campus chosen by students that improves the quality of campus life and increases the opportunities for hands-on learning for all students.
- Appoint a taskforce to report on the advantages and drawbacks of establishing a revolving loan fund (RLF) to finance our energy efficiency upgrades.
- Bring in new sustainability funding through external partnerships and alumni support.

Like any other strategic plan, these goals have gone through several iterations since they were originally set. Many have been pursued and achieved and many others have been revised to address new issues. For example, in 2013 the University decided the best pathway to financing sustainability initiatives was not to establish a student green fee, but rather to establish its first Sustainability Fund of \$50,000. This revolving fund was established to foster a

strong culture of sustainability on our campus by providing incentives for students, faculty, and staff involvement. The fund supports two types of projects: i) projects that have a quantifiable economic payback and will refresh the fund over time; and ii) projects that don't have quantifiable payback but engage the campus community in reducing environmental impact or enriching student experience.<sup>11</sup>

UMass Amherst now faces a critical challenge: to continue to grow the campus in pursuit of the strategic vision for excellence in a sustainable way. A safe, constructive, community dialogue that addresses the need for growth and delineates a plan for how the University can achieve and maintain its excellence on a long term basis could begin to further align current efforts with the strategic vision. UMass hopes to foster productive conversation whose outcome does not require pursuit of a growth model.

Today UMass Amherst has over 12.3 million gross square feet of physical assets, divided among almost 390 buildings of various sizes and 4,400 acres of land, including locations in Amherst, Hadley, Belchertown, Boston, Concord, East Wareham, Gloucester, Montague, New Salem, Pelham, Princeton, Shutesbury, South Deerfield, Springfield, Sunderland, Waltham, Wareham and Worcester. The Amherst campus comprises 12.1 million gross square feet of facility space on 1,452 acres of land, primarily in Amherst and Hadley.

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11 <http://www.umass.edu/sustainability/get-involved/sustainability-innovation-engagement-fund>

Since the writing of the 2012 Climate Action Plan at the end of calendar year 2013, the campus has grown by 947,500 GSF (a 7.7% increase) by completing the Life Science Laboratories and seven dormitory buildings in the Commonwealth Honors College Residential Area. By fiscal year 2017 the campus has committed to add 1,012,000 GSF of additional space in academic/laboratory and athletic buildings and 244,000 GSF of additional occupied space is planned to be constructed by fiscal year 2021. This expansion of the physical infrastructure will constitute a significant improvement in the campus academic, research, outreach and student life activities, but it is also likely to be accompanied by increased energy use and a greater carbon footprint (see fig.14). Therefore it is critical that the campus accelerate its conservation efforts and develop a framework for balancing this growth with sustainable measures aimed to reduce its environmental impacts and meet its climate action plan targets.

## 5. GREENHOUSE GAS EMISSIONS

Reporting greenhouse gas (GHG) emissions for the UMass Amherst community is a complex activity. Multiple federal and state agencies mandate environmental reporting such as EPA, DOER (Leading by Example), and MEPA, and there are additional voluntary agencies for which UMass Amherst prepares annual or biannual reports, such as the ACUPCC, AASHE/STARS, the Princeton Review, and Sierra Club. The means and methods of reporting data vary among agencies and organizations, particularly with respect to the level of detail required to report actual emissions measured at the Central

Heating Plant (“CHP”). Since CHP emissions are calculated on the basis of fuel consumption and the GHG emission factors associated with each fuel type, information collection and the reporting process require complex methods. Since it does require specialized efforts, this example demonstrates some of the roadblocks to streamlined GHG reporting.

In addition, the existing data on the fuel mix used on campus is not always clear: for some fuels we have “purchased” energy data, while for others, fuels are measured as they are “consumed.” Depending on fuel type, the purchased amount is often more than will be needed in the same month or year of purchase. On the other hand, there are some emissions occurring at the campus level (not building level) which are not captured in GHG calculations, such as emissions associated with landscape management. Finally, each agency updates its requirements periodically, increasing the detail and scale of information that the campus must track. Due to the ambiguity of the measurement and accuracy of GHG, and the diverse requirements by different parties, it is difficult to compile consistent, useful information that could help to direct future endeavors in this area.

Administration & Finance staff report GHG emissions directly to each agency and the Campus Sustainability Manager reports to the campus community in the form of the UMass Climate Action Plan <sup>12</sup>.

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<sup>12</sup> UMass Amherst Climate Action Plan <http://www.umass.edu/sustainability/about/climate-action-plan>



GHG Emissions are generally separated into three levels (See Figure 2<sup>13</sup>): Scope I (Direct), Scope II (Indirect/Purchased) and Scope III (Indirect) as defined by the World Resources Institute. Scope I emissions are GHG emissions from sources that UMA owns or controls and are categorized as Stationary Combustion (with the exception of biogenic CO<sub>2</sub> emissions), Mobile Combustion (institution-owned transportation devices), Process Emissions (emissions from physical or chemical processes rather than fuel combustion) and Fugitive Emissions (GHG emissions occurring from production, processing, transmission, storage and use of fuels and other substances). Scope II emissions are those that occur at sources not controlled by UMA but are indirect consequence of activities on-campus, such as purchased

electricity, heating, cooling and steam. Scope III emissions are the indirect emissions caused by automobile commuting, air travel and solid waste processing.

### A. SCOPE I EMISSIONS AND REPORTING AGENCIES

The campus calculates Scope I and II emissions to report to multiple organizations, many of which have different requirements and methodologies for tracking information. Below is an overview of the latest total GHG emissions, and a discussion of the reporting requirements for each organization.

#### I. US Environmental Protection Agency (EPA) Reporting

The EPA tracks Scope I emissions. In 2009, they passed a ruling making greenhouse

13 Ravin, Ameila and Raine, Teresa; Best Practices for Including Carbon Sinks in Greenhouse Gas Inventories. See <http://www.epa.gov/ttnchie1/conference/ei16/session3/ravin.pdf>

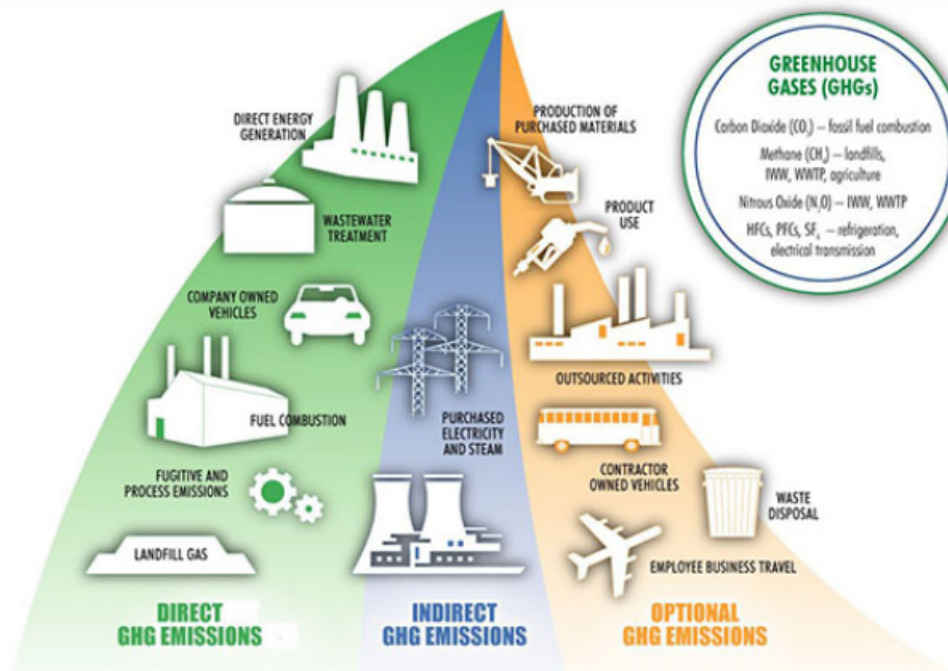


Fig. 2: GHG Protocol Emissions Scopes (Ravin Fig. 1)

gas reporting mandatory. All facilities with annual emissions over 25,000 metric tons CO<sub>2</sub> equivalent are required to report their GHGs, including total CO<sub>2</sub> emissions. They must also provide greater detail for each GHG, Source/ Process emissions excluding biogenic CO<sub>2</sub>, and types of stationary combustion fuel sources. The EPA reported that the Scope I total CO<sub>2</sub>e emissions at the UMass CHP in 2012 amounted to 102,611 metric tons. This data is available to the public through the EPA's GHG Reporting Program (GHGRP)<sup>14</sup>. Annual campus emissions information is gathered by UMass Physical Plant and Environmental Health & Safety, and analyzed by Berkshire Environmental Consultants using the required EPA methodology and conversion factors. The report includes CO<sub>2</sub> equivalent, Biogenic CO<sub>2</sub>, Methane, and Nitrous Oxide emissions from fuel combustion at the CHP, as well as at individual locations in buildings that are not connected to the campus steam utility network, and at emergency generators.

## II. Leading By Example (LBE)

LBE tracks Scope I and II emissions. The LBE program was created by Executive Order No. 484<sup>15</sup> and given the full title "Leading By Example - Clean Energy and Efficient Buildings." The program is overseen by the Executive Office of Energy and Environmental Affairs (EEA) and the Executive Office for Administration and Finance (A&F)<sup>16</sup>. It sets aggressive GHG emission targets for facilities

14 US EPA Greenhouse Gas Reporting Program: <http://www.epa.gov/ghgreporting/>

15 Executive Order No. 484 <http://www.mass.gov/governor/legislationexecorder/executiveorder/executive-order-no-484.html>

16 The Official Website of the Executive Office of Energy and Environmental Affairs <http://www.mass.gov>

owned and operated by the Commonwealth of Massachusetts. It also addresses energy conservation and efficiency, renewable energy opportunities, "green" buildings, and water conservation. In accordance with the EO No. 484, the state universities and campuses should implement efforts to reduce their energy use and GHG emissions as follows:

- Reduce greenhouse gas emissions by 25% by FY 2012, 40% by FY2020 and 80% by 2050 using FY2002 as the baseline
- Reduce overall energy consumption in buildings by 20% by FY 2012 and 35% by 2020 using FY2004 as the baseline
- Procure 15% of annual electricity from renewable sources by 2012 and 30% by 2020
- Utilize bio heat products with a minimum blend of 3% bio-based materials for all heating applications that use #2 fuel starting with the winter of 2007-2008, and 10% bio heat blend by 2012
- All new construction and major renovations must meet the MA LEED Plus green building standard established by the Commonwealth of Massachusetts Sustainable Design Roundtable<sup>17</sup>
- Reduce potable water use 10% by 2012 and 15% by 2020 using FY2006 as the baseline

The annual campus information reported to the LBE is gathered by UMass Physical Plant and includes total fuel consumption at the CHP

[gov/eea/grants-and-tech-assistance/guidance-technical-assistance/leading-by-example/](http://www.mass.gov/eea/grants-and-tech-assistance/guidance-technical-assistance/leading-by-example/)

17 Leading by Example: An Action Plan for Green Buildings in Massachusetts State Construction Projects: Final Report of the Massachusetts Sustainable Design Roundtable, October 2006; <http://www.mass.gov/eea/docs/eea/lbe/susdesign-report.pdf>

and at individual locations in buildings that are not connected to the campus steam utility network. In addition to Scope I reporting, the campus also reports on Scope II emissions from purchased grid electricity, heat and electricity generated at the CHP, and gasoline and diesel consumed in vehicles. The LBE program analyzes the resulting emissions using MA conversion factors and reports on a variety of metrics, including change in emissions, total campus energy, energy utilization intensity (BTU/sf) and change in electricity consumption.

**UMass met the state’s GHG reduction requirement of 25% early by 2011 and exceeded it by the end of FY 2013**, when the UMass Amherst campus reported a total of 106,847 CO<sub>2</sub> metric tons of Scope I CO<sub>2</sub>, or a 27% reduction in combined Scope I and Scope II GHG Emissions over baseline – see Figure 3.

The campus electricity consumption profile has changed considerably, with 71% of electricity generated from on-site clean CHP electricity,

and the remaining 29% procured from the grid – see Figure 3.

### III. The American College & University President’s Climate Commitment (ACUPCC)

ACUPCC tracks Scope I, II, and III emissions. The ACUPCC<sup>18</sup> provides a framework and support for higher education institutions to pursue a long-term climate neutrality plan. The commitment requires biannual reporting of the campus emissions inventory, an action plan for becoming climate neutral, creation of institutional instruction to direct the development and implementation of the plan, and initiation of effective actions to reduce GHGs while the strategic plan is being developed. The campus Sustainability Manager oversees reporting to ACUPCC and the development of the Campus Climate Action Plan. All ACUPCC Reports are accessible to the public, including the latest GHG Report from 2013.<sup>19</sup> In 2013,

18 <http://www.presidentsclimatecommitment.org/about/mission-histor>

19 <http://rs.acupcc.org/ghg/2933/>

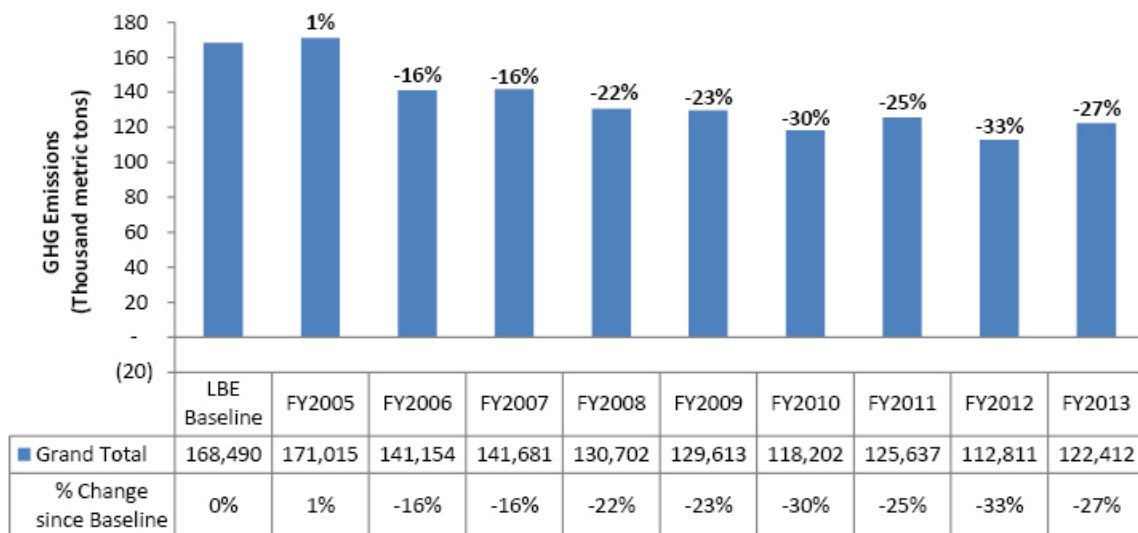


Fig. 3: LBE- UMass Amherst Change in GHG Emissions from Baseline to FY13



UMass Amherst reported total net emissions (Scopes I-III) of 153,758 CO<sub>2</sub> metric tons.

#### IV. The Sustainability Tracking, Assessment & Rating System (STARS)

STARS is a self-reporting framework for schools developed by AASHE (the Association for the Advancement of Sustainability in Higher Education)<sup>20</sup>; it uses the ACUPCC GHG Inventory as a vehicle for GHG reporting. Reporting on STARS is coordinated by the Campus Sustainability Manager, and includes information from multiple areas of the campus. Efforts are supported by the Chancellor’s Sustainability Committee, particularly subcommittee chairs. The report requires quantitative and qualitative data within these five primary categories: academics, engagement, operations, planning & administration, and innovation. UMass Amherst was awarded the STARS Gold rating (v1.0 and v1.2) in recognition of campus sustainability accomplishments in energy and water conservation, innovative transportation re-configuration, the creation of a sustainable permaculture garden and composting of

dining hall food waste. As of July 31, 2013 there are 47 STARS Gold institutions. UMass ranks in the top 10, even compared with large doctoral universities in the U.S. (i.e., research universities with more than 20,000 students). The University will be submitting the STARS v2.0 report in early 2015. Published UMass Amherst STARS reports are accessible to the public.<sup>21</sup>

#### V. MEPA Expanded Environmental Notification Form- UMass Amherst 2012-2021 Capital Improvement Projects- Stationary Source Emissions (MEPA EENF)

MEPA requires reporting of Scope I and II emissions on a project basis. In June 2013, UMass submitted an Expanded Environmental Notification Form to the Massachusetts Environmental Policy Act Office (at the Executive Office of Energy and Environmental Affairs), summarizing a decade of planned Capital Improvement Projects (“CIP”) and evaluating the environmental impacts associated with

21 <https://stars.aashe.org/institutions/university-of-massachusetts-amherst-ma/report/>

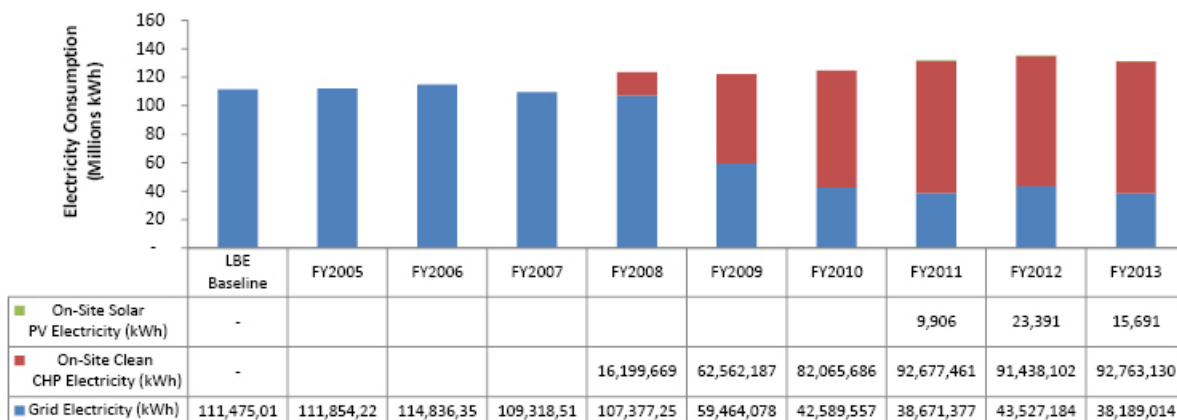


Fig. 4: LBE- UMass Amherst Electricity Consumption to FY13

planned growth of the campus<sup>22</sup>. EOEAA approved the application. They commended UMass Amherst on its Campus Master Plan engagement process and commitment to sustainability, including the UMA mandate to achieve LEED Silver certification or better for all new projects, and the variety of additional measures expected to further reduce CO<sub>2</sub> emission and environmental impacts of development.

The MEPA review process required UMA to identify and describe the feasible measures to minimize both mobile and stationary source GHG Emissions generated by proposed projects – in this case the Campus Master Plan development projects identified during the period 2012 – 2021. These projects included 13 building/space, 7 site/landscape, and 5 facility/ utility scale improvement projects . Employing a variety of methods to estimate the emissions associated with the building projects in different phases of development, the application projected 13,922 tons per year, or 11.5% growth of stationary emissions (Scope I and II) over the next decade.

## B. SCOPE II EMISSIONS

Scope II emissions are those that occur at sources not controlled by UMA, such as grid electricity purchased from the Western Massachusetts Electric Co. Based on campus reporting to LBE, the purchase of 43,527,184 KWh of electricity in 2012 (see LBE section above and Figures 4) has resulted in 17,741 metric tons of CO<sub>2</sub>. To date, the campus generates about 1/100 of a

<sup>22</sup> University of Massachusetts Amherst 2012-2021 Capital Improvement Projects [http://scholarworks.umass.edu/cp\\_masterplans/3/](http://scholarworks.umass.edu/cp_masterplans/3/)

percent of energy from renewable sources, which poses a challenge to its ability to reach the goals established by EO 484.

## C. SCOPE III EMISSIONS AND METHODOLOGY

All agencies requiring Scope I and II emissions reporting have established calculation protocols. As there are no specific instructions for Scope III emissions reporting, the University calculates previous years' Scope III emissions using a variety of methods that are adapted to multiple agency objectives.

### I. MEPA EENF - Mobile Emissions

As part of the requirements of the MEPA Extended Environmental Notification Form filing, UMass Amherst's project consultant, Vanasse Hangen Brustlin, Inc. (VHB), calculated the environmental impacts associated with campus growth for the next decade, including the resultant growth in transportation-related emissions. VHB used a mesoscale analysis to calculate mobile source GHG emissions and estimate the area-wide emissions from traffic for one year. They used traffic data (volumes, delays and speeds) for weekday and weekend periods based on observed traffic flow characteristics and roadway capacity. VHB established the existing conditions estimate of mobile source CO<sub>2</sub> emissions for 2012 at 46,023 tons per year- a figure indicating the mobile source emissions within the borders of the UMass Amherst campus. In addition, VHB calculated a growth in mobile source emissions of 1,616 tons per year, or 3.5% by 2022.

## II. UMass Scope III Emissions Associated with Employee & Student Commuting

Scope III Emissions accounting is still in its early stages of development within higher education institutions as well corporate entities. It often constitutes a large percentage of total GHG emissions and is directly tied to institutional operations and culture. As there are no regulatory reporting requirements, each institution develops its own priorities for developing accounting mechanisms to calculate the GHG effect of upstream and downstream activities, and establishing goals for improvement based on the information.

Knowing that GHG emissions from transportation account for 27% of total US emissions, Campus Planning prioritized the development of a method for calculating GHG emissions associated with employee and student commuting. As a campus that houses approximately 60% of its students, UMass has an opportunity to reduce emissions associated with commuting and lead the way in developing methods that account for understanding regional GHG impacts.

In spring 2013, a Campus Planning team of staff members compiled 10,270 records of parking permits from UMass Parking Services. Utilizing the ESRI Online Geo-Coding Service and Online North America Routing Service, as well as a variety of software, such as ESRI ArcMap and Feature Manipulation Engine (FME), the team was able to calculate commuter routes and estimate the average vehicle miles traveled (VMT) per day by each permit holder. Calculating the total commuting days for employees was based on the general assumption that each

person works a maximum of 52 weeks, with 5 days per week, and 15 days deducted for vacation. The maximum commuting days for students were similarly calculated by assuming 32 academic weeks, with 5 days per week, and 5 days deducted for miscellaneous reasons. It was also assumed that employees and students use their personal vehicle 80% of the time on average<sup>23</sup>. Using these parameters, the team deduced that there are an average of 196 commute days for employees and 124 commute days for students. Figures 5 and 6 contain histograms indicating the distribution of annual commuter distances over the number of commuters for employees and students.

A number of difficulties were encountered with the initial data set, such as multiple vehicles associated with one permit holder, inaccuracies in data input related to individuals' home addresses, "home addresses" that did not indicate whether they were local or permanent, and fields that lacked a standard identification method for vehicle types. In order to eliminate commute distances that appeared unrealistic (such as a home address in Los Angeles, CA), the team reduced the maximum travel distance to 76 miles one way (the distance from Amherst to Boston). The researchers hope that improvements in data collection will resolve these discrepancies in the future (For the resultant distribution of commuters see Figure 7).

The study estimates that the total annual VMT for UMass employees is 24,179,160 miles and for students is 10,872,154 miles. To calculate emissions associated with commuting, the  
<sup>23</sup> These assumptions would be improved by the ability to connect permit holder data to employee human resources data, which lists employment type appointments (i.e. full time, part-time, 34 weeks, etc.).

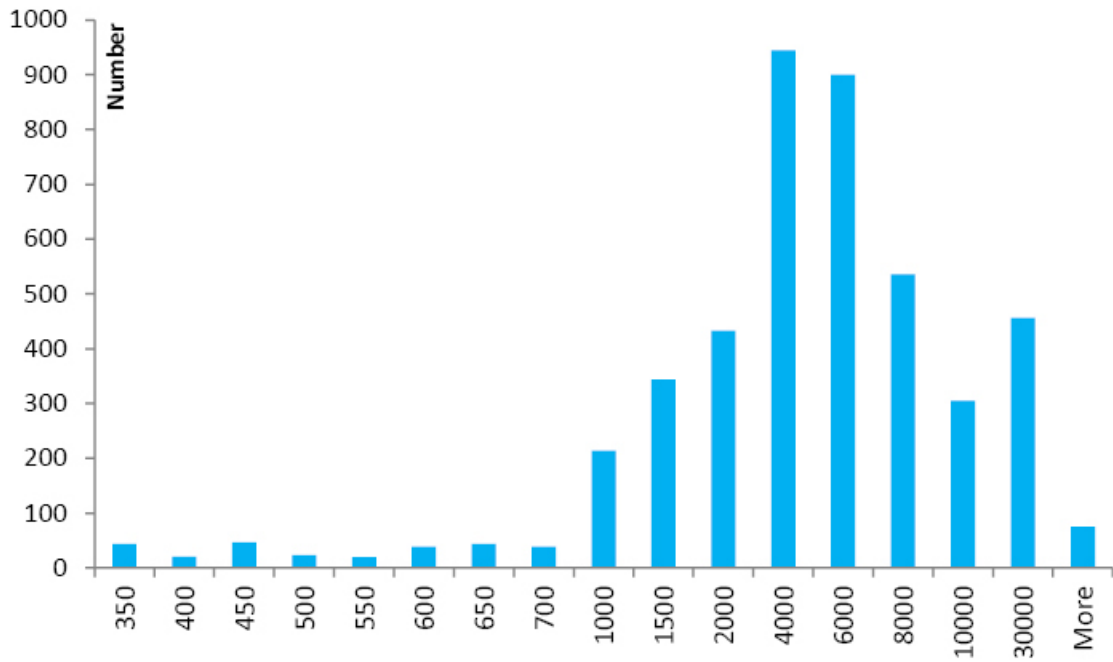


Fig. 5: Number of Employees by Annual Vehicle Miles Traveled

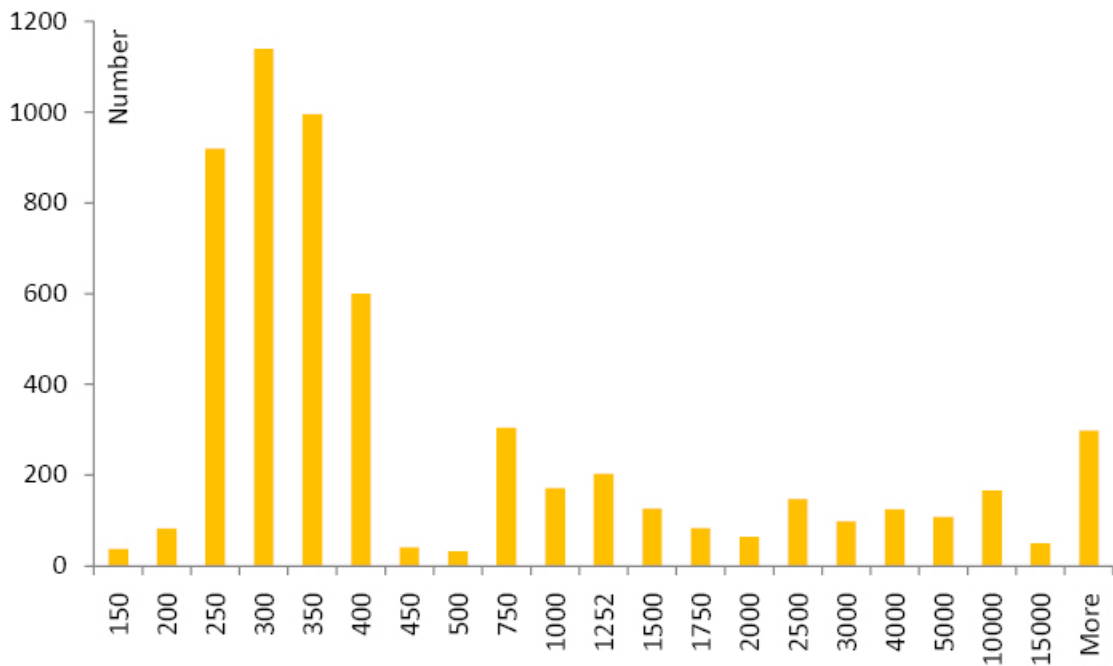


Fig. 6: Number of Students by Annual Vehicle Miles Traveled



Calculations and References page on the EPA's website served as a main reference, specifically the section discussing miles driven by the average passenger vehicle per year. The formula establishing the CO<sub>2</sub> emissions related to the weighted average of gasoline consumed per mile by passenger vehicles is as follows:

$$8.89 \times 10^{-3} \text{ metric tons CO}_2/\text{gallon gasoline} \times 1/21.4 \text{ miles per gallon car/truck average} \times 1 \text{ CO}_2, \text{ CH}_4, \text{ and N}_2\text{O}/0.988 \text{ CO}_2 = 4.20 \times 10^{-4} \text{ metric tons CO}_2\text{E /mile}$$

The total estimated campus Scope III emissions resulting from employee and student commuting for FY13 were thus calculated at 17,807 metric tons of CO<sub>2</sub>.

### III. Scope 3 Emissions Associated with Employee Air Travel

Air travel data, which includes departure locations, destinations, and dates of travel, was collected from the UMass data set of U.S. Airport Maps produced by ESRI, as well as other sources, including data sets of air travel emission factors from the Campus Carbon Calculator (produced by Clean Air-Cool Planet) and the U.S. Airports Map. Other resources were used to compile international air travel data, including the Great Circle Mapper website.

From the 15,896 personal and departmental flights, 13,629 have been analyzed. The total annual air travel mileage for UMass employees and students, based on this sample, is 11,661,422 miles. To convert mileage to metric tons of CO<sub>2</sub>e, the team used emission factors for air travel from the Campus Carbon Calculator.

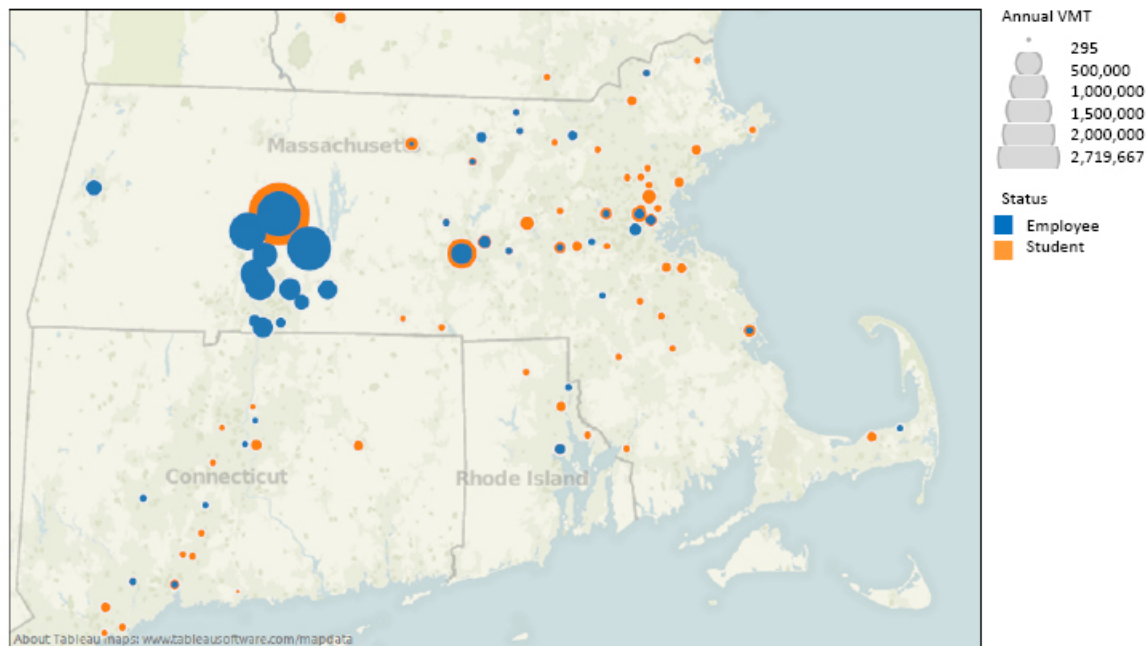


Fig. 7: Distribution of Annual Vehicle Miles Traveled by Students & Employees



The average person contributed to 0.9014 tons of CO<sub>2</sub>e due to air travel and total GHG emissions from air travel are approximately 12,285 tons of CO<sub>2</sub>e.

## D. CARBON SEQUESTRATION

### I. UMass Amherst Core Campus

The 1,452 acres (2.3 square miles) of the UMA core campus contain 298.4 acres of forested land, as well as an urban arboretum of over 5,000 trees (native and foreign species) that have been intentionally planted and are managed by the Physical Plant Division<sup>24</sup>, providing both human health and ecological benefits to the area.

To quantify the benefits of this urban forest, Physical Plant staff prepared a Tree Inventory Assessment utilizing i-Tree, a peer-reviewed collective package of different software tools developed by the United States Forest Service (USFS). i-Tree provides a better

understanding of urban forest resources, and enables data generation to inform the planning and management processes that include environmental and health consequences of urban green space. It provides a quantitative analysis of green cover benefits, such as carbon sequestration, air quality improvements, rain water interception rates, and aesthetic improvements. I-Tree is capable of assessing urban forest composition, taking either a top-down (aerial assessment of canopy cover) or a bottom-up (collecting field data on the composition of the species and vegetation physical attributes) approach.

The most recent inventory of UMA campus trees includes only trees actively managed by the University. The campus contains large parcels of naturally forested land such as Prexy’s ridge and the area north of Eastman Lane, that have yet to be incorporated into the managed trees inventory.

The general characteristics of UMass campus trees are summarized in Tables 1, 2 and 3; these are based on the most updated campus tree inventory, which is continuously being updated.

24 UMass Amherst Physical Plant – Campus Trees website <http://www.umass.edu/physicalplant/trees/index.html>

**Inventory Features**

<i>Area Surveyed</i>	<i>2.3 square miles</i>
<i>Number of Trees</i>	<i>4,095</i>
<i>Canopy Cover</i>	<i>35.2% +/- 2.75 standard error</i>
<i>Grass/Permeable Surface Cover</i>	<i>30.9% +/- 2.66 standard error</i>
<i>Impervious Cover</i>	<i>33.9% +/- 2.73 standard error</i>

Table 1: UMass Campus Inventory Features

**Species**

<i>Red Oak</i>	<i>10.2% of total; 829,287 ft<sup>2</sup></i>
<i>Eastern Red Cedar</i>	<i>9.6% of total; 783,771 ft<sup>2</sup></i>
<i>Easter White Pine</i>	<i>7.8% of total; 631,678 ft<sup>2</sup></i>
<i>Sugar Maple</i>	<i>5.2% of total; 425,180 ft<sup>2</sup></i>
<i>Thornless Honey Locust</i>	<i>4.5% of total; 362,036 ft<sup>2</sup></i>

Table 2: Most Dominant Species by Number

Table 4 shows the carbon sequestration (285 MT CO<sub>2</sub>) and other GHG emissions avoided by campus trees; it also quantifies other important benefits, such as total annual energy savings of \$193,545.

## II. UMass Amherst Other Landholdings

In addition to the land that comprises the core of the UMass Amherst campus, the University also owns properties in locations throughout Massachusetts, including Belchertown, Concord, Deerfield, Gloucester, Leverett, New Salem, Plainfield, Princeton, Shutesbury, Sunderland, Waltham, Wareham and Windsor. The land use for these properties varies from urban to cropland to forest, and supports

the campus teaching, research and outreach mission in various ways. Many of these properties also serve a carbon sequestration function that reduces the campus overall greenhouse gas emissions profile.

About 2,455 acres, or 85% of our off-campus properties are categorized as forested/forested wetlands. Based on EPA Clean Energy Calculations and References<sup>25</sup>, each acre of forest preserved from conversion to cropland sequestered 129.51 MT CO<sub>2</sub> annually. This translates to approximately 318,000 metric

<sup>25</sup> See <http://www.epa.gov/cleanenergy/energy-resources/refs.html>

**Major Tree Species**

Eastern White Pine	8.8% of all trees; 360
Red Maple	8% of all trees; 330
Eastern Red Cedar	7.5% of all trees; 308
Apple	5.5% of all trees; 229
Red Oak	4% of all trees; 166

*Table 3: Most dominant species by leaf area*

**Benefits of On-Campus Trees**

Total annual rainwater interception	5,777,381 gallons
Total annual VOC, O	3,817 lbs. (\$20,637)
Total annual avoided VOC, NO	4,046 lbs. (\$17,527)
Total stored CO	6,344 tons (\$41,871)
Annual carbon sequestration	285 tons (\$1,883)
Total annual energy reduction	\$193,545
<b>Total annual benefits</b>	<b>\$439,759</b>
<i>Average annual benefits</i>	<i>\$108 per tree</i>
<b>Total replacement value</b>	<b>\$20,940,696</b>

*Table 4: UMass campus tree benefits as estimated in iTrees*

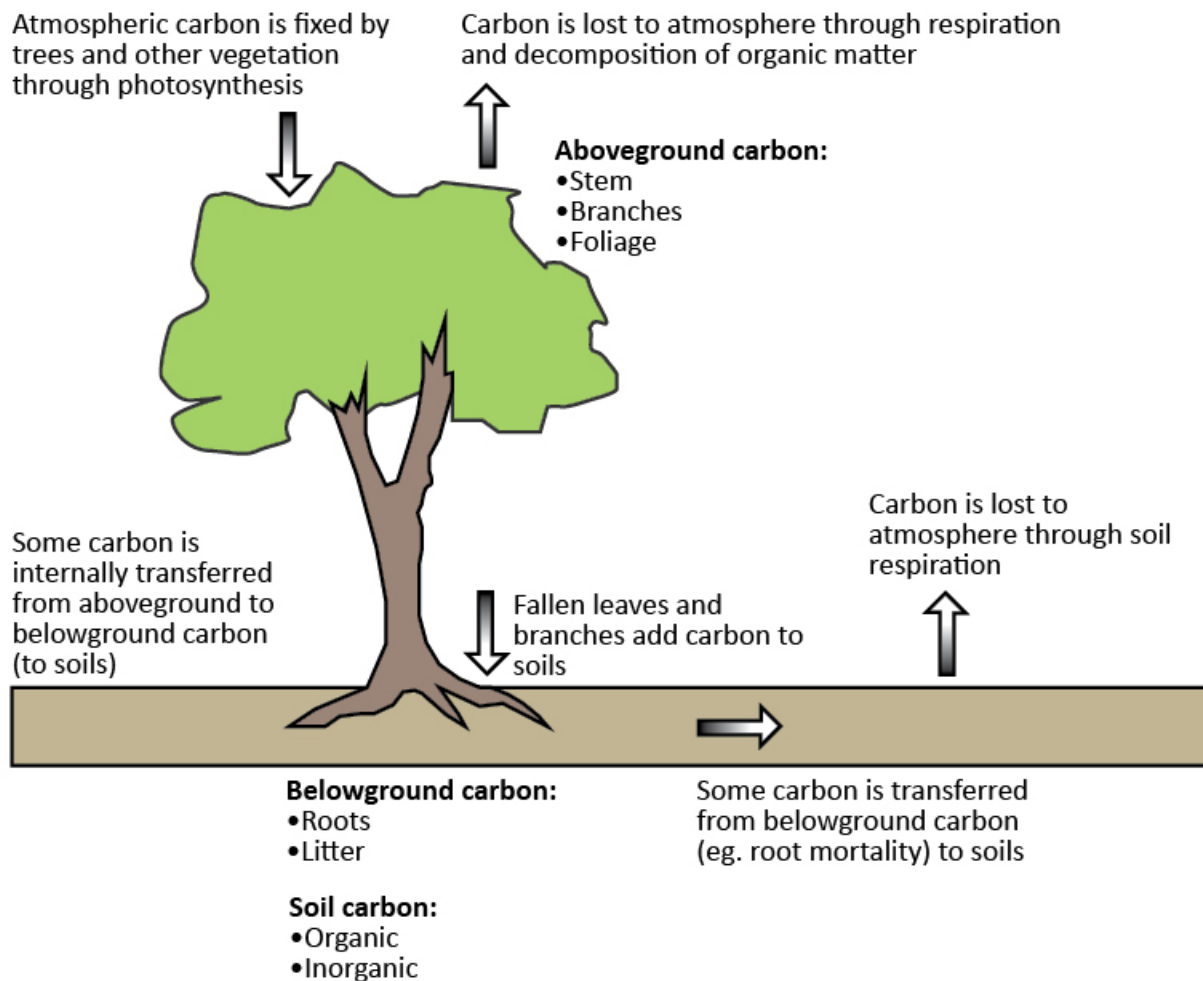


Figure 8: Carbon Sequestration in Trees and Soil. Source data: EPA 2007

<b>Location and Name (Forest, Forest-Plainfield and Forested Wetlands)</b>	<b>Acreage</b>	<b>MT CO<sub>2</sub> Sequestered</b>
Amherst, Adam's Brook Tract	44.9	-5,816
Belchertown, Horticultural Research Center	40.0	-5,179
Belchertown, Rt . 183	3.6	-460
Belchertown, Rt . 187	72.3	-9,358
Concord, Former Middlesex County cooperative Extension	0.2	-19
Pelham, Cadwell Memorial Forest	1,046.1	-135,477
Princeton, ManConnell-Bond Forest	238.8	-30,930
Shutesbury	3.0	-382
South Deerfield, Agronomy Farm, Dairy Biotech Center	15.2	-1,969
South Deerfield, Farm Field	22.9	-2,971
South Deerfield, Hillside Road	126.5	-16,388
South Deerfield, Turf Research	2.2	-289
Sunderland & Leverett, Mt.Toby Demonstration Forest	719.4	-93,167
Waltham, Eastern Extension Center	3.6	-461
Wareham, Cranberry Experiment Station	3.4	-440
Windsor, Plainfield, Ross Lot	112.8	-14,609
<b>Grand Total</b>	<b>2,454.8</b>	<b>-317,916</b>

Table 5: UMass Amherst off-campus landholdings

tons of carbon per year sequestered by UMass Amherst forests (see Figure 8<sup>26</sup> and Table 5).

### E. GHG EMISSIONS SUMMARY

GHG emissions reporting has become an important tool for combating climate change, particularly for government agencies, and the Commonwealth of MA is leading the nation in developing policies, such as the Global Warming Solutions Act of 2006, that inventory emissions and chart a path to reduce them. UMass Amherst continues to support this work through education, research, outreach and best practices and has made significant strides in both GHG reporting and emission reductions.

26 Ravin, Ameila and Raine, Teresa; Best Practices for Including Carbon Sinks in Greenhouse Gas Inventories. See <http://www.epa.gov/ttnchie1/conference/ei16/session3/ravin.pdf>

The large scale, diversity and complexity of the sustainability reporting outlined above poses a serious challenge on campus to maintain quality information with authoritative sources of data at high levels of detail. As a result, coordinating this information across reporting agencies remains a challenge, yet also offers an opportunity to streamline the process in a way that supports the strategic planning function of the Chancellor’s Sustainability Committee.

As we move forward with our Campus Master Plan, the following Summary GHG Emissions Table 6 can serve as a baseline for reporting on our efforts to plan for a sustainable campus.

Description	Emission type	Year	Annual MT CO <sub>2</sub>
Campus Emissions - EPA Reporting	Scope 1	FY2012	102,611
Campus Emissions - LBE Reporting	Scope 1 and 2	FY2013	122,412
ACUPCC	Scope 1, 2 and 3	FY2013	153,758
Carbon Sequestration - Core Campus		FY2012	-285
Carbon Sequestration - off campus properties		FY2012	-317,916
MEPA/Mobile sources emissions	Scope 3	FY2012	46,023
UMA Employee Air Travel	Scope 3	FY2012	12,285
UMA Employee & Student Commuting	Scope 3	FY2012	17,807

Table 6: UMass Annual GHG Emission summary



## II. CAMPUS MASTER PLAN SYSTEMS

The Campus Master Plan embodies sustainable development. It focuses on land use and site location within the campus core to achieve a compact, walkable campus with a wider variety of activities and facility types that are tightly knit and fully utilized. The Campus Master Plan emphasizes building density, efficient utilities, and district-level infrastructure solutions that reduce energy use, water use and storm water runoff, and encourages other beneficial building practices, such as policies that improve indoor air quality and provide support for locally sourced materials. Site planning and development locations within the campus core support buildings that emphasize human-scale proportions and preserve landscape and cultural assets. The Campus Master Plan illustrates how strong, vibrant streetscapes can be designed to support many modes of transportation and reduce related carbon emissions. The campus street system is envisioned as a multi-modal network that extends its connections to the adjacent communities and to the region.

### 1. LAND USE

The campus land use supports a campus community that is active all day every day of the year. The land-use component of the Campus Master Plan reinforces a mixed-use environment and creates growth opportunities in the core of the campus through three main strategies:

- Continue to site community buildings around the edge of the pond and lawns to support 24-hour-a-day activity in the heart of the campus and increase the mixed use and density of community support functions.
- Illustrate how living facilities can be developed within building sites in the main campus core to reduce the negative transportation impacts related to off-campus housing development. This would leverage core campus land assets to generate activity throughout the day.
- Create appropriate and visible sites for iconic public facilities like museums and the expansion of the library, which will help to make the campus a destination of choice for citizens of the commonwealth and the general public.

As the MEPA Expanded Environmental Notification<sup>27</sup> documented, the Campus Master Plan's focus on infill development over the next decade will result in only 3.0 new acres of land alteration and 0.5 new acres of impervious area. Total campus facility area (within the campus core) will increase by approximately 1M GSF, for a campus total of 12.2M GSF, and a net parking spaces increase of 683 (mostly associated with the proposed construction of a Central Parking Structure located on the site

27 Certificate of the Secretary of Energy and Environmental Affairs on the Expanded Environmental Notification Form, University of Massachusetts Amherst 2012-2021 Capital Improvement Projects <http://www.env.state.ma.us/mepa/mepadocs/2013/082113em/sc/enf/15069XENF.pdf>

of the recently demolished coal-fired power plant).

The definition of future building sites in the Campus Master Plan and the guidelines for preservation and development of important open space landscapes clarify the availability of the remaining campus sites for future development of district utility systems. These systems might include renewable energy generation and storm water management. A 2013 Draft UMass Amherst Solar Energy Plan<sup>28</sup> outlined future renewable energy generation options and proposed the development of parking lot solar canopies.

28 Small, Ezra; UMass Amherst Solar Energy Plan, Draft 7/9/2013 <https://www.umass.edu/sustainability/sites/default/files/UMA%20Renewable%20Energy%20Plan.pdf>

## 2. CAMPUS MASTER PLAN OPEN SPACE FRAMEWORK

The Campus Master Plan open space framework (see Figure 9) is the mechanism for enabling a rich university life — it serves as a nexus of meetings, recreation, relaxation and pleasure for all who live, work and visit the campus. To achieve this, the Campus Master Plan connects existing open spaces with new courtyards, pedestrian spines and complete streets. This landscape for living and learning supports the overall beauty and health of the campus environment, and will serve as a framework in which buildings are developed. Through the development of Campus Guidelines that are an extension of the Campus Master Plan, each project will look at the surrounding area, consider circulation and connections, and the impacts on the viewsheds — all in an effort to build campus, not just buildings.

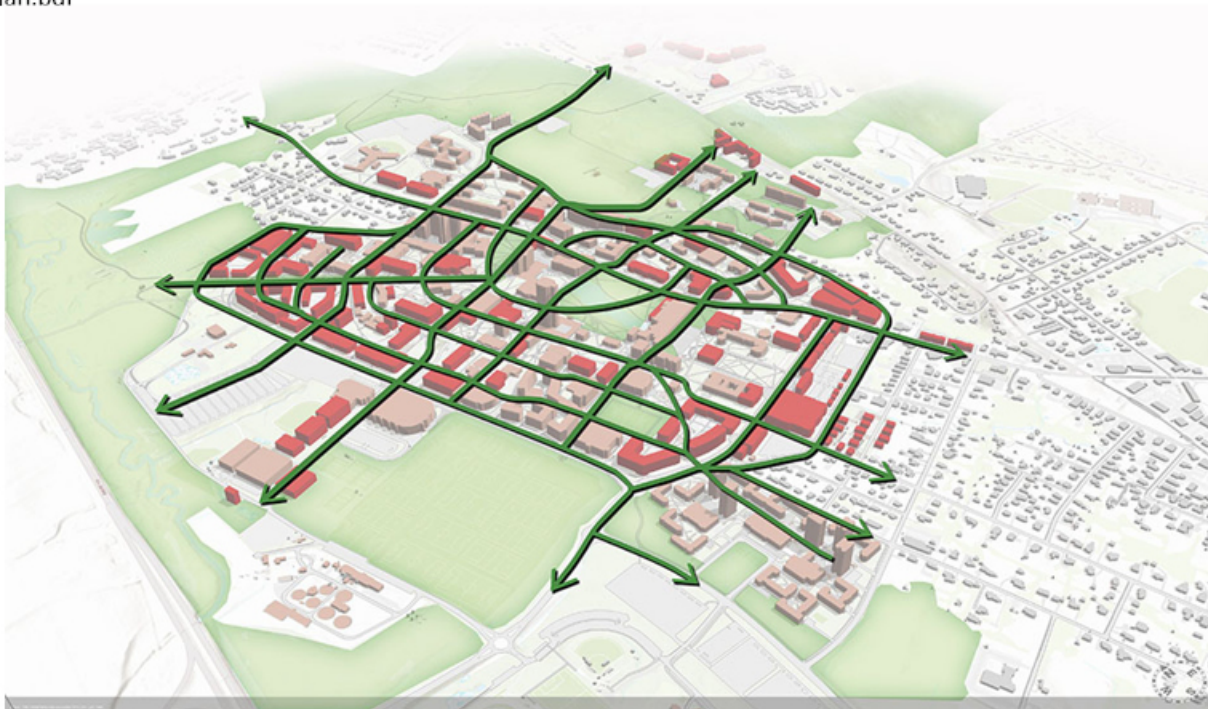


Figure 9: Master Plan Open Space and Pedestrian Circulation Systems



A historic form-giving element in the campus landscape is the defining arc of Ellis Drive, renamed “**Ellis Way**” in the Campus Master Plan. Pedestrian only, the Ellis Way plan is notable in that it includes a bridge across the pond element that was drafted into five of seven previous plans for the campus. Ellis Way passes north of the Campus Center, west of the Student Union, east of the Library and across the center of the Campus Pond, clarifying pedestrian and service vehicle circulation, and providing structure to the open space framework within the center of the campus. The plan for Ellis Way reduces hardscape surfaces, increases trees and vegetation, and serves to unify the east and west areas of the campus by making this landmark cultural landscape a central hub of the campus community.

The **East Campus Pond Lawn** is one of the largest and most visible of the campus green spaces. Together with the West Lawn, it is also one of the most historic landscapes on the campus. Both lawns are remnants of the “Central Park” or “Campus Green” shown in historic plans. The Campus Master Plan proposes to protect and enhance these green spaces.

The proposed northwest viewshed corridor, or **Feather**, has also been an element in past plans and provides a permanent connection between the regional landscape and the center of campus. Together with other open space and building renovation projects, the Campus Master Plan will help ensure that as the campus evolves to meet the ever-changing demands of the higher education environment, it will maintain its connection to the heritage and legacy of the institution that was founded in



Figure 10: UMass Amherst Master Plan - Feather Working Landscape

by Frank M. Costantino©



1863. The Feather is also seen as an opportunity to initiate a district-level storm water solution for the north section of campus. It will provide a working landscape of terraces and gardens that capture, treat and infiltrate rainwater in an integrated fashion, and provide tangible connections to the natural environment and the Mill River watershed to the northwest of campus.

The **Stockbridge Pedestrian Corridor** provides an example of campus open space transformation that is executed through the multi-year coordinated development of major building projects. In the last decade, the University engaged in major construction projects on the east side of the campus that included the Studio Arts Building, Skinner Hall renovation for the School of Nursing, the Integrated Sciences Building (ISB) and the most recently constructed Life Sciences Laboratories. In 2004 the University and the UMass Building

Authority sponsored a planning charrette to coordinate the design of these separate projects and consider the effect they would have on the east district and Stockbridge Road, a significant part of the historical fabric of the campus. The resultant Stockbridge District Master Plan became known as the “Fish” and has largely influenced subsequent design and planning for the area. A major component of this plan was the reconfiguration of Stockbridge Road, which was envisioned as a primarily pedestrian way that would be enhanced with landscape improvements clarifying building entrances and service roads, and connecting to existing landscapes such as Durfee Gardens.

The completion of the Integrated Sciences Building initiated the implementation of the Stockbridge Pedestrian Corridor by closing the north end of Stockbridge Road and providing a pedestrian path that terminates at the south entrance of the ISB’s spectacular atrium. The



Figure 11: Integrated Design Building Site Plan Phase 1

Life Sciences Building, certified LEED Gold, has developed the north end of the pedestrian corridor by providing a carefully landscaped gathering space, rain gardens and accessible entrances to the new building. The planned design and construction of the Integrated Design Building (see Figure 11) will continue to develop the Stockbridge Pedestrian Corridor at its south termination at the Studio Arts Building within Phase 1 of the campus development and plan implementation. This project is undergoing a rigorous integrated design process with a focus on sustainable design and will include educational landscapes. The Stockbridge Road entrances on Infirmiry Drive will be maintained to provide service access to buildings within the area, while the planting of trees, articulation of paths and knitting together of landscape elements, such as the new permaculture garden and the structured

gardens at Durfee, will enhance the pedestrian experience and historical fabric of the area.

Above are descriptions of just some of the major open spaces outlined in the Campus Master Plan, underscoring the fundamental approach that the campus is planning to take toward sustainable open spaces for the campus community; for further descriptions please refer to the document available on the Campus Planning web page.<sup>29</sup>

### 3. CIRCULATION AND PARKING

The Campus Master Plan illustrates physical improvements to all modes of circulation

<sup>29</sup> See April 2012 UMass Amherst Campus Master Plan Final at UMass Amherst - Campus Planning - Maps & Information <http://www.umass.edu/cp/maps.htm>

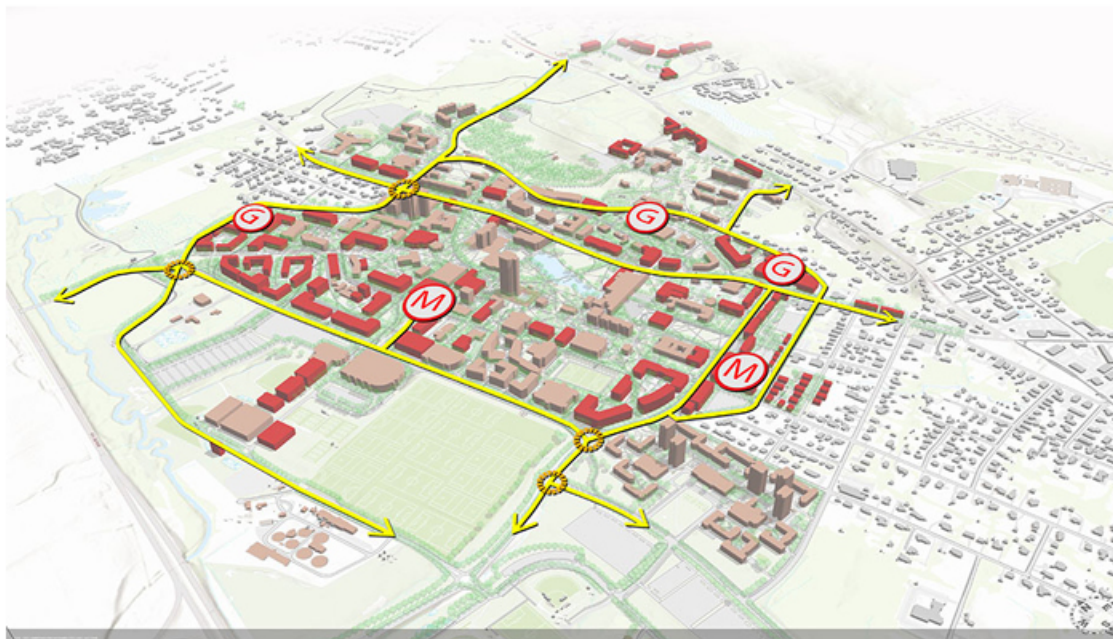


Figure 12: Master Plan Transportation System

(pedestrian, bicycle, vehicular and mass transit) and parking, with an emphasis on balancing the use of automobiles with other, more sustainable modes of transportation. It outlines important street redesigns for Commonwealth Avenue, Massachusetts Avenue, North Pleasant Street and Governor’s Drive in order to surround the campus core with “complete streets.” These projects will enhance multi-modal transport by maintaining vehicular access to the campus while strengthening two alternative modes to automobiles: bicycles and transit (see Figures 9 and 12). All of the proposed improvements intend to reduce reliance on single occupant vehicles, reduce impervious surfaces, provide ample room for street trees and increase vegetation and rainwater infiltration.

#### A. ROADS NETWORK

The proposed elimination of the north barrel of traffic (westbound lanes) from Massachusetts Avenue will result in the development of a pedestrian-scale street and a true campus gateway at a new roundabout with North Pleasant Street (see Figures 9 and 12). The scale of the corridor will be more appropriate in relation to the surrounding neighborhoods and will allow for the expansion of Haigis Mall, and the development of new academic, residential, campus life and parking facilities along the south edge of the campus core where it interfaces with the Town of Amherst.

The Campus Master Plan capitalizes on the existing parking supply, removing surface parking from the core and planning for structured parking facilities to achieve a compact, walkable campus with clearly defined

pedestrian routes. Together with the Mullins Way Extension (northwest of the CHP) and the completion of the bicycle network that connects the existing Norwottuck Rail Trail Connector, as well as the completion of the Stockbridge and Hicks Way pedestrian corridors, these projects will untangle vehicular and pedestrian circulation conflicts around the campus core and build living streets that support the campus community. In doing so they will contribute to reductions in mobile source GHG emissions, greater carbon sequestration from the increase in tree cover, and better rainwater management through the increased vegetated areas .

#### B. PARKING

The Campus Master Plan proposes transportation improvements and modifications in the parking structure that will accommodate the planned growth of the campus, while improving traffic conditions and the level of service at campus roadways and intersections. The MEPA EENF determined that overall increases in traffic trip generation are expected to be relatively minimal, with an increase of 211 added daily trips (ADT) in the morning peak period and an increase of 153 ADT in the evening. Proposed infrastructure development projects such as the Mullins Way Extension, North Pleasant Street, Massachusetts Avenue and Commonwealth Avenue, will implement complete strategies to improve pedestrian travel between campus locations. These improvements include reduced vehicle travel lanes, additional bicycle lanes and sidewalks, and intersection improvements.



In 2013 and with the assistance of VHB, the University completed a Campus-Wide Parking Vision Plan<sup>30</sup> to define an efficient, implementable and sustainable strategy for the campus that compliments the over-arching goals and objectives of the Campus Master Plan. The Parking Plan defined near-term and long-term actions. The near-term actions are intended to be implemented within ten years and are designed to support the development identified in the first phase of the Campus Master Plan. Long-term actions are intended beyond the ten-year horizon, supporting the later phases of the Campus Master Plan. The timing and exact nature of these actions will be dependent on the timing, location and funding of future development and could change as the Campus Master Plan evolves over time.

Within the first 10 years the Parking Plan includes the construction of an approximately 700-space garage adjacent to the existing Campus Center Garage and the provision of direct shuttle service to Lots 11 and 12. The shuttle service, if introduced early in the 10-year period and

30 Campus-Wide Parking Vision Plan [http://scholarworks.umass.edu/cp\\_masterplans/2/](http://scholarworks.umass.edu/cp_masterplans/2/)

Commute Modes (%)	2000	2013	2014
SOV	73	57	52
Carpool	4	10	8
Transit	17	22	28
Bicycle	1	4	7
Walk	3	4	4
Tele-commute	N/A	1	1
Combo/Other	2	2	0

Table 7: UMass Commute Mode Breakdown (%)

before construction of the 700-space garage, would relieve pressure on the Campus Center Garage as development eliminates surface spaces in the campus core. As existing parking facilities are closed to accommodate Campus Master Plan development, new employees could be assigned to outlying parking lots, leaving any available close-in spaces for the reassignment of existing employees from lots that are closed.

### C. TRANSIT

UMass holds a unique position as part of a community that is notable for having reduced the number of single occupancy vehicles by 16% since 2000, increased carpools by 6%, bus travel by 5%, bicycle commuting by 3%, and walking, telecommuting and other modes of travel by 2% (See Table 7). This is the impressive baseline that the Campus Master Plan and general campus sustainability planning aim to improve upon further.

The number of passengers utilizing the PVRTA system to commute to campus has also been

Fiscal Year	Total Passengers	% Change
2007	2,553,359	0
2008	2,647,146	3.67
2009	2,828,766	6.86
2010	2,766,374	-2.20
2011	2,816,431	1.81
2012	2,841,826	0.90
2013	2,945,105	3.63
2014	2,947,832	0.09

Table 8: Passenger Comparison 2007 - 2014

steadily increasing (See Table 8). Ridership in 2015 has seen an even greater increase since 2014 (projected at 14%) and Transit services is anticipating that it will exceed 3,000,000 riders.

In order to continue to make significant progress, UMass currently partners on a biannual transportation survey with the University of California Davis Center for Environmental Policy and Behavior, and Institute of Transportation Studies. Under consideration is the adoption of an annual transportation monitoring program to evaluate the effectiveness of the mitigation strategies associated with complete streets infrastructure projects. In addition, UMass is continually re-evaluating on-campus shuttle routes to maximize service to students, faculty and staff.

#### **D. PEDESTRIAN CIRCULATION**

The proposed pedestrian network in the Campus Master Plan places emphasis on pedestrian safety first by aiming to eliminate conflict with other modes of transportation. Proposed site and landscape improvements in the Campus Improvement Plan (Phase 1 of the Campus Master Plan) include new pedestrian connections through campus, complete street roadway upgrades, improved compliance with the Americans with Disabilities Act (ADA) for sidewalk ramps grading, and crosswalk signage, as well as pavement markings.

#### **E. BICYCLE NETWORK**

The Campus Master Plan has adopted a plan to promote shared use of all paths on campus for both bicyclists and pedestrians to emphasize

safety and good judgment, and does not promote high speed bicycle use through the center of campus. The Massachusetts Avenue, North Pleasant Street, and Commonwealth Avenue improvement projects will all include the construction of four or five-foot wide bicycle lanes to promote safe bicycle travel along the campus's primary roadways.

UMass recently received "Honorable Mention" status by the League of American Bicyclists – Bicycle Friendly University List and established a Bicycle Advisory Committee to support additional bicycling services on campus, with the goal of achieving Bicycle Friendly University Certification. Other programs include a Bike Share Program initiated in 2011, located in the Student Union and supported by the Bike Co-op. There is also a NuRide incentive program for avoidance of single occupancy vehicle trips to campus and a WeCar sharing plan run by Enterprise Rent-A-Car that allows students, faculty, staff and Amherst residents to rent cars on the UMass campus. These, and other similar initiatives continue to reduce the negative environmental impacts of transportation associated with the future growth of the campus.

#### **4. UTILITIES**

Delivering reliable energy, water and other utilities to the campus community is a primary function of Facilities & Campus Services, particularly the Physical Plant, and requires a large investment in infrastructure, capital and human resources. UMass Amherst prides itself on the utility infrastructure investments it has made over the last decade,



Figure 13: Carbon Dioxide Projections for 2020

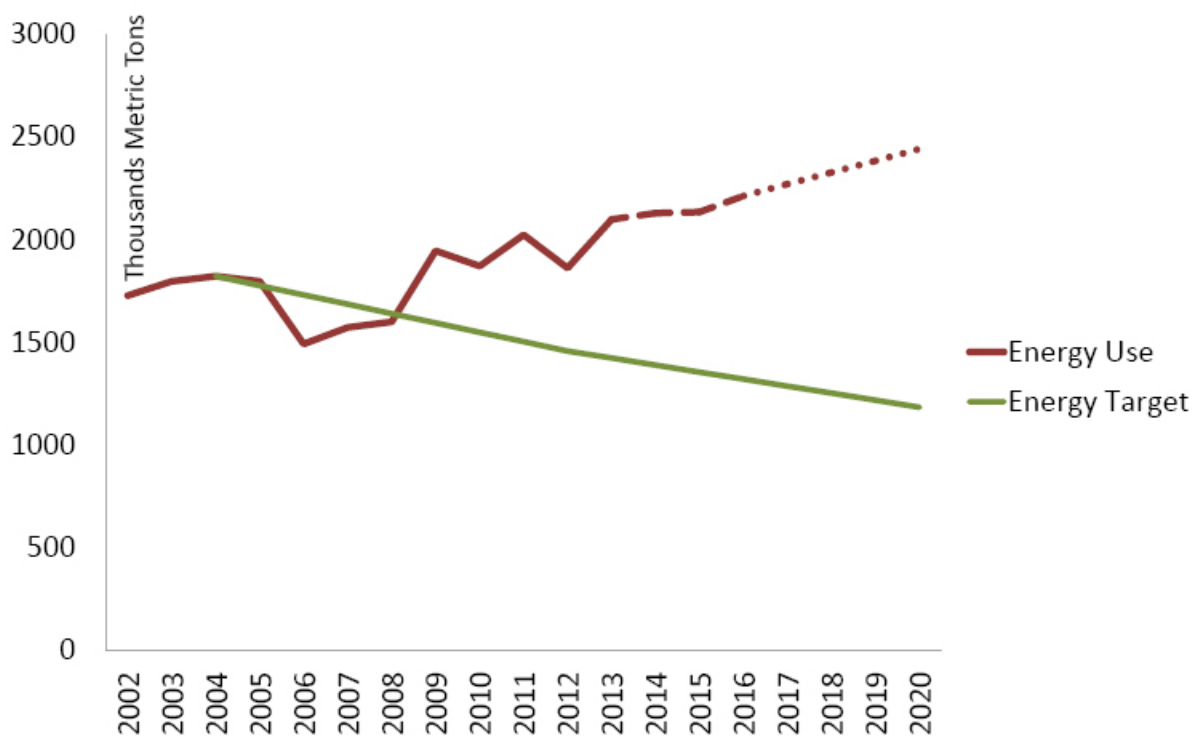


Figure 14: Energy Projections for 2020



both in energy production (construction of a new combined heat and power plant completed in 2008 that received multiple awards from the EPA and other agencies<sup>31</sup>) and energy conservation (E+ that is part of the UMass Amherst renovation and deferred maintenance program<sup>32</sup>). Campus-wide energy use information is directly related to GHG emissions reporting (see section I.5 above) and the Scope 1 and 2 emissions information submitted to the LBE program provides a baseline for tracking energy from 2002 to the present day.

#### A. ENERGY PROJECTIONS OF CAPITAL PLAN TO 2020

Combining the historical data on GHG emissions and energy consumption submitted to the Commonwealth's LBE Program and the MEPA EENF for UMass Amherst 2012 – 2021 Capital Improvement Projects, allows UMass to estimate the impact of the Campus Master Plan's decade of growth on our future energy use. Figure 13 illustrates the progress UMass has made to reduce carbon emissions since the introduction of the . The future projections demonstrate the challenges the University faces to maintain those improvements, given its implementation of the FY 2013 – 2017 Capital Plan which includes planned projects that will be completed by 2021. Figure 14 illustrates the pattern of steady increase in energy use

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31 See UMass Amherst Website - Sustainability - Award Winning Central Heating Plant: <http://www.umass.edu/sustainability/green-campus/award-winning-central-heating-plant>

32 See UMass Amherst Website - Sustainability - E+ Program: <http://www.umass.edu/sustainability/green-campus/e-program>

that has been the result of capital construction and building renovation projects since 2008.

Shifts in campus functions, such as the growth of energy demand associated with scientific research, and the improvements in environmental quality required by building codes, have increased the performance demands of the campus facilities. New facility projects and renovations of existing buildings are replacing aging buildings that have low energy utilization intensity. Despite efforts to meet green building targets, the new building and facility modernization projects tend to correlate with higher energy utilization intensity.

The energy projections data illustrates that climate reduction targets will not be met without further campus policies supporting energy conservation and renewable energy development as part of campus growth and renewal.

#### B. WATER PROJECTIONS OF CAPITAL PLAN TO 2020

Amherst is a pilot community under the Massachusetts Energy and Environmental Affairs Sustainable Water Management Initiative<sup>33</sup> framework. The University's water is supplied by the Town of Amherst public water system. UMass Amherst is working with the Town to implement water efficiency measures on campus and to find creative ways to re-

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33 MA EEA Sustainable Water Management Initiative <http://www.mass.gov/eea/agencies/massdep/water/watersheds/sustainable-water-management-initiative-swmi.html>

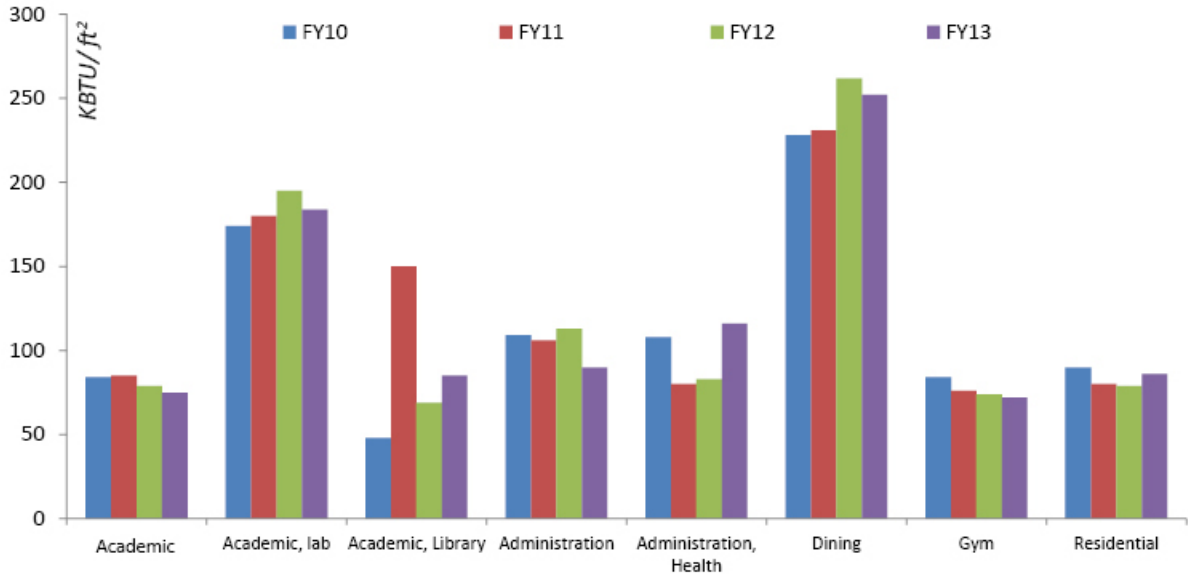


Figure 15: Campus Energy Utilization Intensity (Site EUI)



Figure 16: UMass Water use intensity for FY09-13

use treated wastewater as a path to reducing consumption.

All potable water supplies coming into the campus, whether directly, to produce steam in the CHP, or for human consumption or other uses, is provided by the Town of Amherst. Similarly, all wastewater generated and discharged to the campus sewer collection system is sent for treatment at the Amherst Wastewater Treatment Facility (WWTF). The Town of Amherst considers the amount of waste water treated at the facility equal to the amount of potable water consumed by the University. There are no separate metering facilities for wastewater, so the volume of water into campus equals the amount of wastewater discharged. The cost of wastewater treatment is determined by these metered water volumes. In reality, not all water consumed is discharged to the sewer system, as irrigation, steam, and other evaporative losses reduce the volume of wastewater returned to the Amherst WWTF.

Most of the existing buildings on campus are equipped with water consumption meters for both steam and potable uses, and therefore provide a useful backlog of actual water consumption data from which to estimate future building use. The CIP Plan for campus development utilized this data to estimate the potential future increase in water use and wastewater generation at 79,880 gallons per day (GPD) each, for total campus wastewater discharge and water demand at approximately 1,079,880<sup>34</sup>.

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34 Certificate of the Secretary of Energy and Environmental Affairs on the Expanded Environmental Notification Form, University of Massachusetts Amherst 2012-2021 Capital Improvement Projects <http://www>.

### C. ENERGY & WATER BENCHMARKING STUDY

Campus Planning partners with Physical Plant to gather information from the building meters that are part of the campus Energy Management System (Metasys) to develop tools to track energy and water use at the building level. This partnership creates the opportunity to analyze the impact of the growth of particular campus functions. The team looks for opportunities to target energy conservation improvements and behavior change programs at specific facilities. Beginning in 2013, multiple green building researchers have endeavored to evaluate campus buildings' energy demand and performance across multiple metrics, publishing their findings in the FY 2010 - 2012 data by Katherine McCusker<sup>35</sup>. The project developed a 3-year energy (steam and electric) and carbon emissions comparison for all metered buildings, and analytical reports that allow for in-house benchmarking and deeper data analysis of energy use in buildings by location, occupancy, functional type and age. The current study includes energy demand trends spanning 4 years (FY2010 – FY2013) in approximately 100 buildings (minimum 20,000 GSF), which account for over 80% of the campus energy consumption (see Figure 15).

Green building researchers recently added FY2013 energy and building level water demand to the campus benchmarking study.

[env.state.ma.us/mepa/mepadocs/2013/082113em/sc/enf/15069XENF.pdf](http://env.state.ma.us/mepa/mepadocs/2013/082113em/sc/enf/15069XENF.pdf)

35 McCusker, Katherine: "Measuring, Managing and Visualizing Building Energy Consumption & Carbon Emissions: Benchmarking at the University of Massachusetts Amherst". <http://scholarworks.umass.edu/csi/7/>



UMass collects building level data on water consumption for buildings greater than 29,000 GSF, but still does not have metering data for condensate, sewer and storm-water. The University has had 29,930,000 FT<sup>3</sup> of metered water use or 3.322 FT<sup>3</sup>/sq. ft. for FY2013. One of the remaining challenges lies in the fact that there are no sub-meters, which limits data analysis since researchers cannot allocate a percentage for building water, landscaping, or chilled water use. Figure 16 shows the water use intensity (WUI) for different functional building types.

The energy and water utilization for campus buildings not only establishes baselines for use in future energy conservation strategies aimed at building managers and occupants, but also provides an invaluable source of benchmark information for future system and facilities planning. The Master Plan Sustainability Committee routinely partners with the Green Building Committee to share this information with consultants and leverage it in multiple efforts to improve performance, particularly with respect to energy and water use.

#### D. RENEWABLE ENERGY

UMass Amherst has 106 solar panels which produce approximately 25kW of solar photovoltaic (PV) power at its South Deerfield Farm. The solar experiment brings together agriculture and energy generation to create a multi-functioning landscape in the spirit of UMass ingenuity. However, expanding solar energy use to make it a more significant portion of the energy consumed by the institution and bringing it closer to the heart of campus,

is crucial to the achievement of University commitment to renewable energy. As of June, 2014 the campus is planning two renewable energy projects, both of which have received funding from a mix of UMass Amherst central operating funds and state clean energy grants, including a solar thermal project at the CHP and a solar PV parking lot canopy at the Robsham Visitor Center.

The Campus Sustainability Manager has prepared a Draft UMass Amherst Solar Energy Plan that summarizes campus renewable energy goals (solar PV), outlines funding opportunities, and describes existing solar energy proposals<sup>36</sup>. The plan explores three types of solar energy systems for the core of the campus, including ground mounted, roof mounted, and parking lot canopies. An academic independent study conducted by James Bell, with Professor Dragoljub Kosanovic of the Mechanical and Industrial Engineering Department, indicates that the campus has the capacity to generate up to 25,000,000 kWh per year on solar PV canopies above all campus parking lots. This annual production could offset approximately 18% of the total University purchased electricity<sup>37</sup>.

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36 Small, Ezra; UMass Amherst Solar Energy Plan, Draft 7/9/2013 <https://www.umass.edu/sustainability/sites/default/files/UMA%20Renewable%20Energy%20Plan.pdf>

37 Bell, James; Feasibility Study of Potential Solar Photovoltaic economics and Performance at the University of Massachusetts, Amherst, Independent Study MIE 4972; Fall 2013; Department of Mechanical and Industrial Engineering;.

## 5. BUILDINGS

The MEPA EENF submission report (see section I.5.A.) summarizes existing conditions and current campus land use, the proposed CIP projects and their programmatic and physical elements, and summarizes proposed mitigation measures to minimize the negative environmental impacts of future growth.

The Campus Master Plan focuses on building a series of systems that serve as a framework for growth. The cornerstone of this growth is premised on creating a better campus environment, not only new buildings. The Plan illustrates improvements of circulation and parking, and seeks to develop an active mixed-use campus core with an emphasis on preserving the landscape and cultural assets. A walkable, compact campus that provides tightly networked and fully used spaces for a wider variety of activity types makes it more efficient to implement utilities and district-level solutions. This in turn creates opportunities for reduction of energy/water use and stormwater runoff, improvement of indoor air quality and promotion of the use of locally sourced materials.

### A. EFFICIENT UTILITIES

As of today, UMass Amherst is comprised of nearly 12.5 million GSF of academic, research, administrative, residential and athletic facilities. The campus annual energy demand totals approximately 2,400,000 MMBtu and costs \$30 million. This demand is primarily met by fuel supply to the CHP, and a resultant steam and electricity generation that is distributed

to the core campus buildings (a small number of buildings are not connected to the CHP and have separately serviced boilers). The majority of campus is connected to the CHP via approximately 24 miles of underground piping network (steam and condensate lines). The CHP generates almost 85% of the campus power needs.

About 63% of the total campus energy use supports building operations (32% heating, 22% electric, and 9% cooling loads), while the other portion is released through inherent system losses (8% distribution losses, 24% plant losses, and 5% process loads). Considering the significance of the building loads' share in the total energy use profile of the campus, UMass seeks every opportunity to reduce its building loads. The University continuously reviews the condition of existing systems, operating efficiency and future capacity required to reliably support planned load growth, and has developed a Comprehensive Campus Energy Master Plan (see section III.5. below). The energy plan builds upon the 2012 Campus Master Plan and the 10-year CIP that outlines specific campus needs for long-term vision and short-term growth.

### B. BUILDING LOADS

With the planned facility growth, campus cooling, heating and electrical loads are anticipated to increase significantly by the time the vision of the Campus Master Plan and CIP have been carried out. UMass routinely monitors the performance of its built environment by metering, recording and tracking consumption data on an hourly basis. Nearly all of the major

buildings (area greater than 29,000 SF) have meters for steam, electricity and chilled water and domestic water (92% of the gross square footage for steam, 95% for electric and 15% for chilled water). This creates a basis for analyzing facility load profiles, discovering anomalies and potential energy saving opportunities. The University seeks to minimize campus loads via building energy conservation projects, alternative energy projects, steam distribution renewal, chilled water plant capital renewal-optimization, and expansion of the cogeneration system to supply all campus electricity and steam (see Section II.4.C on Energy Benchmarking).

### C. GREEN BUILDING PRACTICES

Following the LBE ( see section I.5.A above) UMass has adopted a green building policy that requires LEED Silver certification (at minimum) for new buildings and major renovation projects over 20,000 GSF. In addition, the University has committed to Executive Order 484, which requires that all new construction and major renovations achieve energy performance that is 20% better than the baseline code threshold. UMass is a member of the U.S. Green Building Council (USGBC), takes an active role in the ongoing improvement and refinements of the LEED rating system, and develops campus Green Building Guidelines to assist designers in integrating LEED standards in campus projects. UMass also hosts meetings of the USGBC Massachusetts Chapter - West Branch as a means of supporting the green building community in Western Massachusetts.

### D. EDUCATION AND ADVOCACY

At UMass a large cross-disciplinary group of faculty, staff and students helps the University stay true to its goal to build a more sustainable campus. Committees and sub-committees at multiple academic and administrative levels support the “greening” of the campus. Through research and advocacy, these committees (such as the Green Building and Master Plan Sustainability Committees) develop strategies for increasing sustainability in the design and construction of new buildings, maintenance of campus landscapes, and existing building operations.

These committees not only collaboratively advocate for more energy efficient, comfortable and healthy campus buildings; they also serve as the community “think tanks” tasked with originating innovative and affordable solutions to bring the vision for a more sustainable built environment to life. The dialogue between students, faculty, and staff at a committee level is fundamental to ensuring an environmentally sound future. The committees also assist with curriculum development by providing support for UMass faculty and staff, aiming to weave Green Building concepts into interrelated curricula. They support students working on research for thesis projects rooted in sustainable building practices and generally aid research projects on green building materials by project teams, students, faculty and staff. In addition to providing educational resources, these committees provide leadership and assistance in evaluating net zero building concepts and conceptual planning in pursuit of advancing UMass to a net zero campus.



The Green Building Committee has created Green Building Guidelines<sup>38</sup> to outline the University's specific priorities as a basis for major new construction and renovation projects. The document was introduced in 2010 for LEED v3 2009, and was updated at the end of 2013 with Measurement and Verification guidelines<sup>39</sup>. The committee is currently developing guidelines for LEEDv4.

From the inception of any new project, the Green Building Guidelines are a resource for planning, design and construction project managers and external consultants. The document continues to be a valuable reference throughout the LEED documentation process and for post occupancy analysis. In 2014 the committee also partnered with the Master Plan Sustainability committee to develop Energy Modeling Guidelines<sup>40</sup> that guide projects from the earliest phases of design study to incorporate best practices that model energy efficiency measures in a manner that is consistent with University objectives for the life of the facility.

Through education, these support committees aim to promote a sustainable physical campus. Their engagement also includes on-going support for sustainable on-campus living, through the development of written and graphic material describing sustainable features, developing building user manuals

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38 UMass Amherst Green Building Guidelines 2013 [http://scholarworks.umass.edu/cp\\_reportsplans/3/](http://scholarworks.umass.edu/cp_reportsplans/3/)

39 UMass Amherst Building Measurement, Verification, Coordination and Template Plan [http://scholarworks.umass.edu/cp\\_reportsplans/2/](http://scholarworks.umass.edu/cp_reportsplans/2/)

40 UMass Amherst Campus Energy Modeling Guidelines [http://scholarworks.umass.edu/cp\\_reportsplans/1/](http://scholarworks.umass.edu/cp_reportsplans/1/)

and “green tips” that will appear on electronic dashboards in new buildings, as well as other marketing media.

As the Campus Master Plan continues to develop, and new iterations are published, this base of institutional knowledge and practice ensures that planning will continue to embody the deep-rooted dedication to sustainability that is at the heart of all University facility services.

## E. LIFE CYCLE COST ANALYSIS

UMass champions efforts to complete a thorough analysis of existing buildings in order to make informed decisions about renovation and new construction options. Each project undertakes life cycle cost analysis as part of the project design process. In addition, the university supports internal research to further life cycle and embodied energy analysis of materials, systems and operations. The collected data is a valuable resource on lessons learned from both renovation and new construction projects, and supports campus efforts to implement sustainable practices. The commitment to LEED Plus certification, Life Cycle Cost Analysis and the development of Life Cycle Analysis methods will contribute to smart planning decisions that make the best use of available resources and contribute to the greatest possible reduction in resource use. These efforts not only support the natural environment, but also best serve the University by reducing financial costs and material waste.

## F. BUILDING MAINTENANCE

UMass Amherst works consistently to institutionalize green building practices into its capital projects and is committed to improving the physical condition of its buildings. Maintenance is a major undertaking, considering that approximately 40% of the campus gross square footage is in buildings over 50 years old, and another 42% in buildings that are 25 - 50 years old. Since 2009, 25% of the campus (buildings and their systems) are being evaluated annually with the help of facilities asset advisory consultants (Sightlines). UMass Physical Plant personnel and maintenance staff prioritize maintenance work orders for facilities in a continuous dialogue with the Sightlines consultant team in an effort to improve the overall condition of campus buildings.

The University also makes use of an Integrated Facilities Planning process that is inclusive of multiple units across campus, and makes use of specialized knowledge of campus buildings by staff and external consultants. Improvement plans are flexible to adjust to UMass environmental goals, and financial & academic priorities. The University employs consultants to create inventories of identified improvement projects and to set time frames for completion. Projects are grouped based on building portfolios, level of necessity, time frame, and investment criteria - all data that influences and informs the capital investment plan. UMass takes advantage of a collaborative process to track and repair required and deferred maintenance cases and has over 14 years of electronic data on over 4,000 projects as a basis for facility analysis and planning.

## 6. STORM WATER

Few campuses boast a large pond as their iconic center and UMass Amherst is among the few who use their main body of water to regulate water flow on the campus. The Campus Pond is the central feature in a campus storm water system that consists of surface water, wetlands and their associated buffer zones that cover 30% of the University's land, as well as a drainage system that includes pipes, box culverts, swales, open streams, detention/retention ponds, underground storage chambers, and infiltration systems. The Mill River at the campus's western edge and the Wildwood Brook at the campus's northern end creates most of this wet area. Most of the length of the Tan Brook now exists in culverts on the south and is the principal drainage way for central Amherst and the southern half of the campus. This water way and the dike that crosses it at the Metawampee Lawn creates the Campus Pond.

While the Pond is not specifically engineered for storm water collection, it serves this function due to recent improvements. For example, the Integrated Learning Center project installed appropriate emergent wetland vegetation, improved water quality and created new wildlife habitats that improved the health of the pond. The installation of a storm scepter device at the Tan Brook overflow culvert location just south of Massachusetts Avenue helps manage storm water overflow from the Town of Amherst during expected storms.

To facilitate system-wide understanding and improvement of the campus storm water system, the University is conducting a

detailed inventory and analysis of the existing infrastructure in order to analyze alternatives to alleviating flooding and develop in-house resources to model the system and continue analytical work.

New green buildings on campus implement industry best practices that address stormwater quality and quantity control; nevertheless the campus stormwater system is currently at capacity. New facilities will continue to address on-site stormwater issues, in addition the campus is developing connections between academic faculty and programs and the operational management of our landscape resources in a way that will advance understanding of how regional level solutions to the problem can be maximized.

One example is the exchange of ideas between Landscape Architecture and Regional

Planning academic activities and staff in the Division of Facilities and Campus Services on stormwater mitigation opportunities that present themselves at the south edge of the athletic fields at the West Gate of the campus. Prof. Michael Davidsohn's studio proposed phased construction of a mitigated wetland that would handle the overflow capacity of stormwater from Tan Brook at the south edge of campus where it is carried underground until it discharges at the southeast edge of the athletic fields. University staff and consultants on the Integrative Learning Center worked with graduate students and reviewed the project for opportunities to adopt a bio retention project that addresses stormwater issues at the system level in conjunction with strategies at the project site.

As the campus develops pilot projects of this nature it will lay the foundation for even more

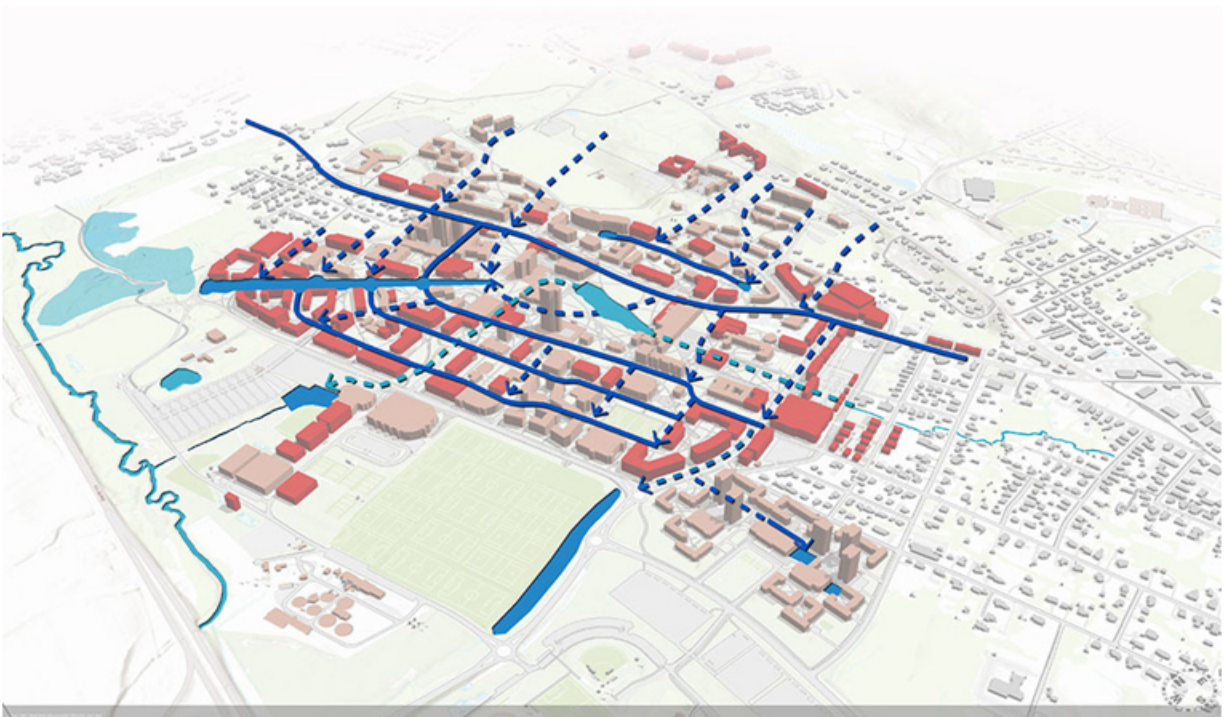


Figure 17: Master Plan Storm Water System



ambitious projects, such as the future working landscape planned for the northwest edge of campus. The Campus Master Plan refers to this project as “the feather” and envisions it as emphasizing the spectacular viewshed to the mountains in the northwest while addressing stormwater storage capacity and treatment in that district of the campus as part of future development (see Figure 17).

Another example is the commitment to “complete streets” in the Campus Master Plan that illustrates how strong, vibrant streetscapes can be designed to support many modes of transportation and reduce related carbon emissions. The campus street system is envisioned as a multi-modal network that extends its connections to the adjacent communities and the region. It will also facilitate the addition of street trees that will enhance stormwater management, reduce

the heat island effect and improve open space connectivity.

## 7. FOOD

UMass Amherst is an institution known for the delicious food served in its dining halls. However, the University is leading the foodservice industry in more than taste. As the largest foodservice provider in the nation, UMass is proud to be able to set the precedent for the wholesome, balanced, healthy nutrition that it offers students and faculty. UMass Dining Services incorporates sustainable growing practices and healthy food systems into the dining experience. Their mission is to “move beyond sustainability globally by serving as the model for institutions to follow worldwide”. Like all other UMass campus endeavors, Dining Services is committed to the



Figure 18: Franklin Permaculture Garden Under Construction

mission of sustainability and strives to provide fresh food that supports the campus and local communities.

Menus are planned according to simple principles of healthy eating. Whenever possible, they incorporate seasonal foods that are fresh and organic. The University builds healthy relationships with local vendors that are mutually beneficial to our campus mission as well the livelihood of small, local businesses. The dining halls serve local honey, maple syrup, fish, meat, milk, yogurt and cage-free eggs among many other products.

As an institution of higher learning, UMass firmly believes that good nutrition should be an integral part of any education. Delivering on these convictions, the University has five thriving permaculture gardens that provide organic fruits and vegetables to the Dining Commons each year. The UMass Permaculture Initiative, which was founded in 2010, brings together students, faculty, staff, and community members to convert underutilized grass lawns that previously required maintenance and resources, while contributing little benefit to the campus, into edible, educational and beautiful gardens ( see Figure 18). As key figures in the initiative, students play an important role in bringing the food from “farm” to table. The ¼ acre flagship garden at Franklin Dining Commons supports 150 different plant species and produces approximately 3,000 lbs. of food each year. To support these campus garden plots, 30% of produce is also sourced from other local farms, including some from the UMass student Farming Enterprise. Students engage in valuable educational opportunities

by participating in the Student Farmer’s Market each Fall Semester.

Food origins are an important part of health and sustainability. However, equally important from a holistic, environmental perspective is the issue of waste. According to the Environmental Protection Agency (EPA), over 97% of food waste generated nationally goes to the landfill. This is a systematic national problem. UMass is determined to be part of the larger change to affect statistics like these in the United States. At UMass, we compost 100% of food waste - that’s over 1,200 tons of organic material each year being diverted from the landfill. In addition to composting food waste, dining locations provide compostable to-go containers, flatware, cups and plates to reduce plastic waste in landfills. For diners eating in the dining commons, “trayless” dining was introduced in 2009. Eliminating trays had a tremendous impact on waste reduction, reducing average post-consumer food waste by 30%. Waste initiatives on campus help to track waste trends over time, reducing waste and also reducing cost. The LeanPath waste tracking system, for example, saved the University \$300,000 in the first year of implementation. UMass also partners with the national Food Recovery Network to donate meals which would otherwise go to waste to local homeless shelters.

Since UMass has a strong community of support for sustainable efforts, the campus is able to establish guidelines that will continue to improve the sustainable food systems the University has remained committed to, as part of the campus mission for sustainability. For example, the campus mandates that only



Organic and Fair Trade coffee be served, and seafood is certified in accordance with the Seafood WATCH guidelines.

## **8. WASTE**

UMass processes approximately 7,000 tons of waste annually. The waste management report for FY13 indicates that the recycled portion is about 4000 tons; 56% of the total waste stream. Food waste and compostables (1,300 tons last year) are the largest recovered component of the UMA solid waste stream. The quantities by the type of managed UMass waste stream for two consecutive years is shown in Table 5. It should be noted that currently, the University Office of Waste Management has no responsibility for construction waste disposal. Construction managers are responsible for managing demolition and construction debris per the stipulations of their contracts and Massachusetts Waste Ban Regulations 310 C.M.R. 19.017.

UMass Amherst has plateaued at a 56% recycling rate for the past seven years. Staff, faculty and students use the single stream recycling system to dispose of bottles, cans and paper waste produced during the course of the day at desks, labs and classrooms. This streamlined system simplifies the task of waste collection reducing the waste containers at desks and labs from 3 to 2 types and by reducing the truck circuits of campus pickup points from twice per building weekly to once weekly. The single stream system is also thought to encourage participation in recycling by simplifying the sorting process. Opportunities for improvement still exist and will require both

expanded education endeavors and policy enforcement.

The service venues on campus could also benefit from expanded utilization of the single stream recycling system that is already in place. The four dining commons, Campus Center, and retail outfits, generate 1,300 tons of food waste annually. UMass effectively captures compostable waste. All organic food waste is processed at Martin Farms of Greenfield MA. Since the University already provides comprehensive composting services, the institution's best opportunity for improvement of its recycling/composting rate would be to capture a higher percentage of the recyclable single stream materials now being tossed in the trash by staff and students. The infrastructure already exists, with regular pick up routes throughout campus and easily accessible containers in required locations. However, participation continues to fall below system capacity. Again, education and broadened awareness of the available resources at UMass could dramatically improve total recycling participation. Given the already high waste recycling and composting rates in the campus' dining commons, the residence halls, which house 14,000 students, provide the next logical opportunity to expand the program.

All residence hall rooms and apartment suites are provided with recycling and trash bins. However, in a significant number of halls students must deliver their wastes to the ground level (versus floor trash rooms), empty and then return their recycling bins to their rooms. This arrangement discourages student participation in recycling. Residence Life is working with OWM to adjust to the physical



Waste Category	2013		2012	
	Tons	Percent Share (%)	Tons	Percent Share (%)
Animal Bedding	404.80	5.80	488.00	7.10
Ballasts, PCB	0.00	0.00	0.00	0.00
Batteries	0.00	0.00	4.00	0.10
Books	41.70	0.60	29.10	0.40
Cardboard	464.20	6.70	442.90	6.50
Clothing	7.80	0.10	3.00	0.00
Concrete	179.00	2.60	43.90	0.60
Electronic Scrap	98.50	1.40	98.40	1.40
Fluorescent Tubes	6.70	0.10	1.80	0.00
Fly Ash	0.00	0.00	0.00	0.00
Food Waste	1263.50	18.20	1218.50	17.80
Mattresses	10.30	0.10	0.00	0.00
Greenhouse Waste	26.50	0.40	25.30	0.40
High Grade Paper	84.50	1.20	324.20	4.70
Leaves/Yard waste	300.00	4.30	300.00	4.40
Magnetic Media	0.00	0.00	0.00	0.00
Single Stream	494.20	7.10	0.00	0.00
Mixed Paper + Mixed Containers	14.40	0.20	218.60	3.20
Paint	0.00	0.00	0.00	0.00
Scrap Metal	322.50	4.60	397.20	5.80
Scrap Wood	188.70	2.70	213.10	3.10
Tires	9.60	0.10	10.10	0.10
Toner Cartridges	2.80	0.00	4.60	0.10
Wood Chips	0.00	0.00	0.00	0.00
Total Recyclables	3920.00	56.40	3823.00	55.90
Total Refuse	3028.00	43.60	3015.00	44.10
Total Combined	6948.00	100.00	6838.00	100.00

Table 9: Solid waste produced for FY12 and FY13, provided by the Office of Waste Management

Material	Percent Share (%)	Tons	Priority Rating *
Metal	6.00	192.00	B
Electronics	5.00	160.00	B
Wood	6.00	192.00	B
Recyclable Paper + Cardboard	15.00	480.00	A
Non-Recyclable Paper/Cardbord/Tissue	10.00	320.00	C
Bottles/Cans	10.00	320.00	A
Plastic Packaging	13.00	416.00	C
Dirt/Ceramics/Shavings	3.00	96.00	C
Glass (non-beverage)	2.00	64.00	C
Non-Recyclable Furniture/Equipment	5.00	160.00	C
Carpet	2.00	64.00	C
Liquids	5.00	160.00	B
Food	5.00	160.00	B
Disposable Consumer Products	9.00	288.00	C
Remodeling waste: Sheetrock, plastic etc.	3.00	96.00	C
Textiles	1.00	32.00	B
<b>Total Materials in Trash</b>	<b>100.00</b>	<b>3200.00</b>	

* A= One or fewer of the following barriers: Existence of collection infrastructure, market reliability, or ease of capture
* B= Two or fewer of the following barriers: Existence of collection infrastructure, market reliability, or ease of capture
* C= Either non-recyclable or missing all three above elements

Table 10: Estimated composition of UMass trash (as disposed)

limitations of the older residence halls in a way that encourages greater student participation in recycling. While there is also evidence of increased percentages of food waste and biodegradable packaging in the residence hall trash (primarily due to the many decentralized retail eateries that have spread across the campus in recent years), OWM believes there are infrastructure, economic, health code and student behavioral barriers to be addressed prior to any large scale launch of composting collection service in the residence halls.

With the residence hall system accounting for up to 1,300 tons of annual trash generation, OWM has partnered with Residential Life to target the 20-30% of res hall trash that is potentially recyclable through aggressive efforts to increase student compliance. This effort includes: (1) improving consistency in hall recycling bin placement, labeling and color

coding as well as better and more pervasive signage, (2) expanding and maintaining routine educational efforts with hall occupants, (3) monitoring performance changes and ramping up efforts to enforce compliance.

In addition, the the Sustainability, Innovation & Engagement funded the NEw2U Reuse Collection and Tag Sale program, which collected more than 5 tons of materials over 2 days in the Southwest Residential area and is in its second year of operations, having expanded to all residential neighborhoods.<sup>41</sup>

With these and other initiatives, UMass hopes to rise above the 55% recycling rate plateau and make significant progress to increase the percentage of waste diverted for recycling and composting.

<sup>41</sup> See <http://www.umass.edu/sustainability/green-campus/new2u-reuse-collection-and-tag-sale>



### III. CURRENT INITIATIVES

This section provides an overview of campus wide sustainability initiatives that have been undertaken and/or completed since the creation of the Campus Master Plan.

#### 1. EDUCATION/ ENGAGEMENT

The Sustainability Curriculum Initiative (SCI) is a system-wide educational initiative of the UMass Amherst Libraries that partners faculty members and subject librarians to enhance sustainability teaching and learning in existing courses. The SCI selects faculty based on formal applications and awards up to \$1,000 for the addition or augmentation of sustainability curriculum content in an existing course. Librarians meet with each class to teach information literacy skills as related to sustainability research needs. Librarians and faculty co-create online course guides and learning exercises which integrate licensed library databases.

The SCI provides a valuable opportunity for faculty and librarians to engage in an interdisciplinary exchange that improves teaching and supports student learning and reinforces the American College and University Presidents Climate Commitment (ACUPCC), particularly the section which states that, “Campuses that address the climate challenge by reducing global warming emissions and by integrating sustainability into their curriculum

will better serve their students and meet their social mandate to help create a thriving, ethical and civil society.” The SCI strengthens the UMass commitment to these actions.

In the words of UWW Public Policy professor Marissa Carrerra (cohort 2013-2014): *“I asked students to specifically investigate a sustainability policy related to their experience or their degree, and the results were really exciting. Initially, many students felt this was an impossible task... given the diverse fields they were all coming from. However, they soon found that sustainability issues are relevant to policy in \*all\* fields, from early education to medicine to the military, and they were able to make networks of connections.”*

#### 2. CAMPUS-WIDE HARDSCAPE CONDITION ASSESSMENT

In 2014 the University completed (with VHB consultants) a Campus-Wide Hardscape Condition Assessment<sup>42</sup> of campus roadways, sidewalks and parking lots, as a means of identifying strategies that will gain the greatest value possible from the available improvement funding, while meeting the needs of the UMass community. Recognizing the fact that enhancements to the campus landscape have not kept pace with upgrades to facilities, the project developed an inventory and condition database for the entire campus hardscape, as well as GIS tools to assist in prioritization and improvement planning strategies. The inventory included:

<sup>42</sup> UMass Amherst Campus-Wide Hardscape Condition Assessment: [http://scholarworks.umass.edu/cp\\_masterplans/4/](http://scholarworks.umass.edu/cp_masterplans/4/)

- 18.8 miles of roadways
- 44.7 miles of curbing
- 95 surface parking lots (6 million square feet)
- 265 driveways
- 947 ramps/stairs
- 2.8 million square feet of sidewalks

The report findings highlighted the need to enhance key hardscape areas, such as sidewalks and walkways on campus. The following are key findings and recommendations from the report:

- **Roadways and Parking Lots:** The pavement condition of more than half of the campus roadways is poor or fair, requiring resurfacing or reconstruction. This total backlog of about \$20M in improvements needs provides an opportunity to invest in upgrades that apply complete streets/ low impact development principles to roadway, parking lot and driveway pavement improvement projects.
- **Sidewalks:** Conditions range from poor to excellent, with a fairly even distribution of sidewalks in each condition range - this is due to the fact that some areas have been more recently resurfaced than others. The heavily trafficked sidewalks along North Pleasant Street near the campus pond are in very poor condition.
- **Ramps and Stairs:** Pedestrian ramps and stairs are generally in good condition. Those in poor condition are planned to be addressed.
- **Curbing:** Most of the curbing on campus is in good condition (about 60% of curbs are granite and withstand the

impact from snow plows better than other materials).

The study developed a pavement management database that integrates with GIS and other work management technologies to readily collect information that can be leveraged for future project planning. It will allow support for future project selection, development and decision making. The database analysis tools can also be leveraged to establish proper funding levels. With appropriate financial program support, the University can achieve campus hardscape condition goals and facilitate comprehensive decision making. In addition, the University will be able to integrate a capital plan for maintenance and rehabilitation of existing campus hardscapes, along with capital plans for future campus expansion and modernization.

The information gathered in the Campus-Wide Hardscape Condition Assessment Report will serve as a baseline for tracking and reporting on future improvements of the physical landscape that supports the pedestrian, bicycle and vehicular transport systems.

### 3. ENERGY MODELING GUIDELINES

As per the requirements of Executive Order 484, the University adopted the LEED Plus green building standard established by the Commonwealth of Massachusetts Sustainable Design Roundtable. For new construction projects, this standard mandates the use of energy modeling to evaluate and optimize energy use intensity, and to minimize the negative environmental impacts of facility

construction. In addition to complying with the LEED certification process, UMass supports energy modeling in the early stages of design as an opportunity to target strategic energy efficiency investments and make intelligent design decisions. In 2015 the Green Building Committee with support from Facilities & Campus Services and Campus Planning's staff developed Energy Modeling Guidelines<sup>43</sup> for University projects, in which historic energy benchmarking data from the campus experience, in conjunction with high building performance standards, were used to propose space-use-based EUI targets for new construction and major renovation projects. These guidelines will provide energy modelers with a consistent set of model inputs and acceptable assumptions for occupancy, loads, and operational schedules.

#### **4. LANDSCAPE MASTER PLAN**

Campus Planning has begun a Landscape Master Plan (LMP) for the contiguous central areas of the campus. The goal is to create a living document that will outline design principles, character and function of all external areas. The LMP will ultimately encourage unity in the design of the landscape over time, so that all parts of the campus relate properly to one another and provide a visual transition between buildings of different eras and architectural styles.

The creation and support of a sustainable campus landscape is one of the key objectives

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43 UMass Amherst Energy Modeling Guidelines: [http://scholarworks.umass.edu/cp\\_reportsplans/1/](http://scholarworks.umass.edu/cp_reportsplans/1/)

of the LMP. Sustainable landscape initiatives include:

- Supporting continued development of the Frank A. Waugh Arboretum as a landscape for learning and increasing the tree canopy cover on the campus
- Significantly reducing the amount of impervious surfaces
- Green infrastructure, with the landscape becoming an integral part of the storm water management plan
- Low mow meadows replacing some lawn areas
- Native and low maintenance planting

#### **5. COMPREHENSIVE CAMPUS ENERGY PLAN**

In 2014 the University engaged RMF Engineering to conduct a Comprehensive Energy Plan<sup>44</sup> to assist the campus in development of a long range (50 year) vision for efficient and reliable utility generation, delivery and energy conservation, and to provide recommendations that address the short term needs associated with the 10-year capital plan. The plan provided an overview of the campus energy systems and provided existing and future projections for steam, chilled water and electrical utility systems, as well as general evaluations of building systems, alternative energy potential, energy management and sustainability (See Figure 19).

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44 UMass Amherst Comprehensive Campus Energy Master Plan: [http://scholarworks.umass.edu/sustainableumass\\_reportsplans/12/](http://scholarworks.umass.edu/sustainableumass_reportsplans/12/)



## A. STEAM

The majority of campus buildings are connected to the central steam system. Steam is generated in the CHP and distributed to campus through approximately 13 miles of underground distribution piping of which 65% is in good, 20% in fair and 15% in poor condition. 70% of steam generated is utilized by buildings and the estimated distribution loss is 15 % (representative of piping condition). In addition to the need to replace steam piping that is considered in poor condition, RMF reports that the most significant issue for the existing steam and cogeneration system is the fuel supply. The primary and least expensive fuel source for the campus is natural gas delivered through the regional pipeline. However, due to pipeline capacity constraints, a daily consumption limit is imposed on the campus. When the campus load exceeds the daily limit, the University supplements the fuel supply with on-site storage of liquid natural gas

and no. 2 diesel oil, which are approximately 2.4 times higher than piped natural gas and constituted 15% of the fuel burned at the CHP in 2014 at a cost premium of \$4.7M. Although there are current efforts to expand the pipeline capacity in the New England region, this may not occur until 2019, therefore future system analysis developed contingency planning options in the event that the pipeline is not expanded.

The campus steam load is anticipated to increase with the addition of the 10 year capital plan projects. While the existing system has adequate capacity to support this short term load, any addition load after 2022 will be beyond the firm capacity of the system<sup>45</sup>.

45 “Firm capacity” is a measurement of the reliability of centralized utility systems and refers to the plant output without the availability of the single largest generation unit. If the firm capacity is greater than the peak load, then the system can meet the load requirements at any period during the year even with

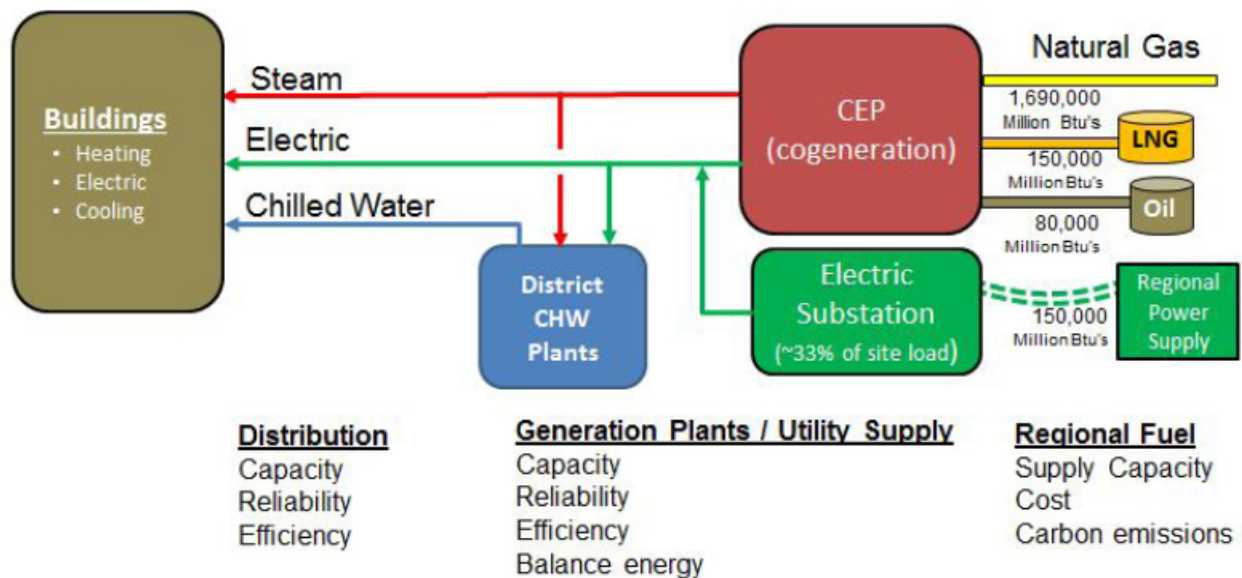


Figure 19: RMF Overview of the Campus Energy System

The results of a detailed energy cost model and life cycle cost analysis indicate that expanding the existing cogeneration system with a second combustion turbine, installed within the existing CHP facility, provides the greatest economic advantage. Considering the potential time frame for design, permitting and construction, RMF recommends the commencement of planning for new steam capacity in fiscal year 2015 and deeper analysis of the following two recommended options: i) if new gas pipe line is available, install 8MW combustion turbine (based on optimal economics and reliability); and ii) if a new gas pipe line is not available, install second phase of LNG storage, determine the value of carbon reduction associated with a biomass boiler, and consider installing a 8MW combustion turbine if risks associated with regional biomass are greater than the carbon reduction value.

## B. CHILLED WATER

The existing air conditioning needs of campus buildings are predominately served by six district cooling systems with clusters of refrigeration units and distribution piping extended to the connected buildings. RMF notes that this efficient and effective, utilizes the most efficient chiller technology, minimizes maintenance and reduces installed capacity while ensuring reliability. As with all systems, capital renewal of equipment is ongoing with 28% of chillers over 20 years old and requiring planned replacement within the next 10 years. A significant portion of the systems are over 10 years of age and could benefit from current reliability is consistent with centralized utility systems for the majority of large education and research campuses.

industry technology that would improve system efficiencies by 20% to 30%.

In addition to the new buildings added to campus, the renovation of existing, non-air conditioned facilities to include new air conditioning systems will increase the campus cooling demand by approximately 60% by 2022. RMF recommends maintaining and expanding existing district cooling systems to incorporate existing buildings as renovations occur. To optimize operation of the cogeneration system, the campus has several steam absorption chillers that rely on steam supply during the summer months to generate chilled water. RMF recommends that UMass install absorption chillers only in district cooling plants and not in individual buildings, in order to facilitate load management based upon varying factors. RMF reviewed various types of thermal storage systems but found that they do not pose an economic advantage; however as each district cooling system is updated or expanded, thermal storage should be evaluated as utility rates and structures change in the future.

## C. ELECTRICITY

Over 90% of existing campus buildings are connected to a central electric distribution system owned by UMass and supplied through two switch stations – West station within the CHP and East station adjacent to the Field house. RMF evaluated the firm capacity of each switch station and found that under a feeder outage scenario the existing system has adequate capacity to serve the existing peak electric load with only 5% spare capacity. As future load is added in the short term, the

current system will not have adequate reliable capacity; the university is currently in design of a new high voltage substation that will allow two existing switch stations to transfer loads to one another and increase feeder capacity.

With the addition of the future loads through year 2022, two of the existing 10 feeder systems will be loaded beyond their firm capacity and three will be beyond 80% firm capacity. Replacing the existing feeders with larger capacity lines is limited by the existing conduit sizes, therefore RMF recommends the addition of a third switch station and associated ductbank routing located in the north area of campus.

#### D. BUILDING SYSTEMS

85% of the campus energy use is directly attributed to building operations, therefore RMF conducted a general evaluation of building energy use to identify potential savings and prioritize buildings for further analysis. All building load profiles were reviewed base on the following: unitary base load comparison, heating and electric loads during non-occupied periods, winter cooling loads when water and air-side economizers could be used, and system control / possible calibration issues. As a result

of the comparison RMF noted several buildings that present anomalies and estimated potential opportunities for energy improvements and conservation projects that could result in a load reduction of approximately 8%.

#### E. ALTERNATIVE ENERGY PROJECTS

The University is continuously considering alternative energy projects to support regional energy conservation and sustainable design principles. Following is a summary review by RMF of the potential energy savings associated with implementing alternative technologies, which were noted as most applicable on a small scale building system basis.

The life cycle economics of the majority of the options do not result in significant, if any, cost advantage. However, other qualitative factors such as carbon reduction, renewable energy goals and support for sustainability initiatives could provide adequate justification for implementing various systems. For example, RMF found that the anaerobic digester system is not recommended based on economics, but it may proceed based upon complying with regulatory requirements. The wind turbine application is not recommended for the Amherst campus, but the solar and geothermal

<i>Technology</i>	<i>Size</i>	<i>Energy Reduction (MMBtu/yr)</i>	<i>Energy Reduction as a % of Total Campus Energy</i>
<i>Solar</i>	<i>7.8 MW</i>	<i>29,200</i>	<i>1.2%</i>
<i>Geothermal</i>	<i>500 tons</i>	<i>18,000</i>	<i>1.8%</i>
<i>Wind</i>	<i>100 kW</i>	<i>84</i>	<i>&lt;0.01%</i>
<i>Anaerobic Digester</i>	<i>1,000 kW</i>	<i>27,000</i>	<i>1.1%</i>

Table 11: Alternative Energy Projects



technologies may have opportunities for application on the campus that could reduce energy use 1 – 2%.

## F. ENERGY MANAGEMENT

The current hourly cost for campus energy use varies significantly depending upon the fuel used, load profile, operating equipment and utility rates. With the transition of absorption cooling from buildings to district cooling plants, the University is positioning its energy system to be managed on an hourly basis with equipment deployment in response to fuel costs and load profiles. RMF recommended additional metering at strategic locations within the DHP and at each district cooling plant in order to optimize the system operation.

The benefits of energy management include: i) maximizing on opportunity to shift energy use as rates change by managing hourly fuel and electric use and purchasing power at intervals that are more market based; ii) providing comprehensive campus load profiles and more accurate savings estimates, as for example when reducing steam use generated by auxiliary boilers that use secondary - and more costly – fuels. In addition, the integration of renewable energy sources into the campus load profile will need to occur through careful consideration of existing assets to prevent equipment tripping offline.

## G. SUSTAINABILITY

RMF found that the approach, intent and efforts of UMass Amherst are consistent with Executive Order 484 guidelines. The

recommendations developed for the steam, chilled water and electric systems will result in some reductions in both energy use and carbon emissions. The options proposed will also result in lower life cycle costs compared to the base options evaluated. To further reduce energy use and carbon emissions, beyond the proposed utility recommendations, will require spending additional capital funds that do not have or are beyond a reasonable payback period. Table 12 summarizes potential energy reductions available to UMass based upon upgrading to renewable energy production recommended by this study by 2020.

The EO 484 energy accounting is not favorable for the unique conditions associated with the UMass Amherst campus, particularly in the following three areas:

- Energy reduction targets are based upon total energy use and do not include consideration for the regional energy savings associated with cogeneration at an efficiency greater than fossil fuel plants
- Space use on not considered. A disproportionate area of future growth has been identified for energy intense laboratory and research facilities which will drive the aggregate energy use upward
- Carbon reductions are based upon total emissions and do not account for campus growth

Over the past 10 years UMass has transformed the campus from a coal-fired heating system to an efficient natural gas cogeneration facility with over 27% less energy use at the buildings. Short term plans include a campus-wide solar powered system, expansion of district cooling

and a potential increase in cogeneration capacity, all of which are consistent with EO 484 goals to reduce energy and carbon emissions.

RMF recommended that prior to allocating additional funds to specifically reduce energy and carbon emissions to comply with the targets identified in EO 484, UMass ought to undertake a comprehensive review of the compliance requirements and justification for spending. More specifically, RMF recommends an Energy and Carbon Management plan that addresses compliance with EO484 in addition to accomplishing the following:

- Establish specific goals for the UMass Amherst campus through review and coordination with the appropriate state agencies
- Quantify the cost of non-compliance as well as the overall cost to the UMass system for the Amherst campus to meet the specific goals
- Develop an approach to prioritize projects based upon a “triple bottom line” evaluation of economics, energy use and carbon reductions.

## 6. SLOW THE FLOW/ EPA CAMPUS RAINWORKS CHALLENGE 2014

In 2014 Prof. Mark Lindhult, FASLA of Landscape Architecture and Regional Planning and Dr. Robert Smith of Department of Environmental Conservation engaged a group of seven graduate students in developing a competition entry for the EPA Campus Rainworks Challenge. The team partnered with a local environmental consultant and staff from Campus Planning and Design & Construction on a proposed Green Infrastructure Master Plan for UMass Amherst that aims to dramatically reduce the peak runoff volume during a storm event by strategically implementing district storm water management solutions. Titled “Slow the Flow”, the team proposal included a series of small green infrastructure projects along the path of Tan Brook that collectively propose to reveal and integrate historic, cultural and natural rainwater systems throughout the campus and particularly at the Campus Pond; to filter water, enhance habitat and biodiversity, increase the campus aesthetic value and provide educational opportunities for the campus community (see Figures 20 and 21).



Figure 20: Slow the Flow concept





Green Infrastructure Master Plan



Figure 21: Green Infrastructure Master Plan



During large rain events high water levels in the Mill River have caused pipes to surcharge on campus, flooding a major parking lot and a gymnasium. Water quality in the Tan Brook and pond suffer from sediment accumulation and contamination of nitrates, phosphates, and heavy metals from roads and parking lots. The pond also rarely freezes, making it suitable for geese who contribute nitrates into the surrounding soil and water. The team chose four prototypical areas on campus that show different storm-water issues that must be addressed on campus and one key location in downtown Amherst which is the biggest contributor of suspended solids. The green infrastructure plan as a whole aimed to increase infiltration, increase the time of concentration, reduce peak flows of runoff, filter pollutants and sediment, allow for the removal of catch basins and pipes, reduce pavement and add vegetation.

## 7. FOOD SYSTEM INITIATIVES

In 2013, Chancellor Kumble Subbaswamy signed on to the Real Food Campus Commitment. As a result, UMass has the distinction of being the largest campus



Figure 22: UMass Amherst Chancellor signs Real Food Pledge

foodservice provider in the country to honor the challenge. Real food is defined as local and community based, ecologically sound, fair, and humane. It is a student-led initiative working alongside Dining Services to source 20% Real Food by 2020. Students are responsible to run an audit of Dining Services' invoices each semester to measure progress and help dining staff set real food targets. These data give the University a place to grow the conversation surrounding continued progress towards ever-improving sustainable practices in our campus food system.

In 2014, UMass Dining was awarded a \$485,000 grant from the Kendall Foundation to launch the "UMass Healthy and Sustainable Food System." This 2-year project will continue to take UMass towards campus goals for sustainability and allow us to continue to act as a leader for other colleges and universities, making strides in support of healthy, sustainable and local food production. Over the next two years UMass will convert Hampshire Dining Commons into a premier campus eatery dedicated to sustainability, health, and wellness. The program will shift the food and beverage budget to New England farms and businesses. It will fund the development of a "How-To" Guide as well as provide resources to teach our campus model so that we might extend our positive impact to others. The grant also supports menu items cooked from scratch using healthy proteins such as fish, poultry, beans and nuts, as well as reduced offerings of processed ingredients such as sugary sodas. An improved seasonal menu design will increase the volume of locally sourced produce used. In addition, Hampshire Dining

Commons will be introducing new menu items served with New England-raised beef, chicken, pork and fish. To stay true to educational goals, the Dining Commons will also host monthly events to highlight local food.

## **8. WASTE SYSTEM INITIATIVES**

The Physical Plant is developing a mandatory recycling policy that will provide a vehicle for an educational campaign to increase the campus recycling rate, which is currently edging toward 60%. Academic interns will help design the outreach campaign and will conduct a project to model the waste system and calculate the Scope III GHG emissions associated with waste management.

## IV. NEXT STEPS

The Master Plan Sustainability Committee conducted a visioning session at the end of 2014 during which it developed the following list of actions that sustainability advocates within the Chancellor's Sustainability Committee could undertake in order to support the implementation of the Campus Master Plan in a sustainable manner.

- Engage in public outreach and community engagement both on campus and with the Town of Amherst that supports a culture of planning for sustainability
- Work with Physical Plant to develop guidelines for sustainable landscape management practices
- Support the Bicycle Advisory Committee in their implementation of the recommendations of the Bicycle Friendly Campus report and develop guidelines for optimal bicycle storage solutions on campus
- Support Campus Planning in implementing smart growth strategies associated with pedestrian corridors in the campus core and concentration of community services within a walkable campus
- Assist the Chancellor's Sustainability Committee in developing metrics for academic and physical planning for sustainability
- Provide a forum for review of building design and landscape guidelines
- Continue to support pilot projects on renewable energy generation,

optimization of transit system, increasing solid waste recycling and optimizing the campus waste system, evaluating porous paving alternatives and other green infrastructure research projects that support operations efficiency

- Assist the campus and the Town of Amherst in planning to meet the requirements of the EPA Municipal Separate Storm and Sewer (MS4) program
- Join efforts with the Green Building committee in developing green facility planning and programming requirements that ensure the building of a green campus and support multiple uses for existing campus landscapes and buildings.