



University of Massachusetts (UMass) Lowell Climate Action Plan



January 6, 2012

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APPENDICES

Appendix A – Climate Related Courses



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Martin T. Meehan
Chancellor

OFFICE OF THE CHANCELLOR

January 9, 2012

To the University of Massachusetts Lowell Campus Community:

The University of Massachusetts Lowell has a long standing commitment to sustainability and community as outlined in our University mission statement:

"..The University seeks to meet the needs of the Commonwealth today and into the future and supports the development of sustainable technologies and communities through its teaching, research, scholarship and engagement".

This climate action plan demonstrates the themes put forth in our mission statement and our "Learning with a Purpose" strategy to support our community by achieving greenhouse gas emissions reductions and the ultimate goal of climate neutrality. We take this goal very seriously and will strive to proactively implement greenhouse gas reduction strategies and projects. UMass Lowell has already made progress toward this goal in a number of areas including renewable energy, planning, efficiency and behavioral change and has numerous related curricular and research opportunities to apply this knowledge in productive ways.

We see the path to climate neutrality as a tremendous opportunity to engage our campus community in fulfilling a commitment endorsed by the entire University of Massachusetts System. We fully understand that as a comprehensive University we have a far reaching impact on our community of students, faculty, staff and University partners that transcends beyond the boundaries of our physical campus. By working together and leveraging our national reputation in science, engineering and technology, we can strive to be more sustainable, demonstrate responsible resource management, and move forward to find innovative solutions to climate neutrality.

I am grateful to the Climate Action Plan Approval Committee, Climate Change Initiative, Dean's Council and many other University Stakeholders for their dedication and leadership in developing this plan. We are working to foster a sustainable community who can collectively achieve change on campus and beyond.

Sincerely,

A handwritten signature in blue ink, appearing to read 'M. T. Meehan', written over a light blue horizontal line.

Martin T. Meehan, Chancellor
University of Massachusetts Lowell

ACKNOWLEDGEMENTS

There are several stakeholders that have been active with the development and leadership associated with the University of Massachusetts Lowell's Climate Action Plan. The committees, committee members, and others that participated in the development of this Climate Action Plan are acknowledged below.

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EXECUTIVE SUMMARY

I. Background

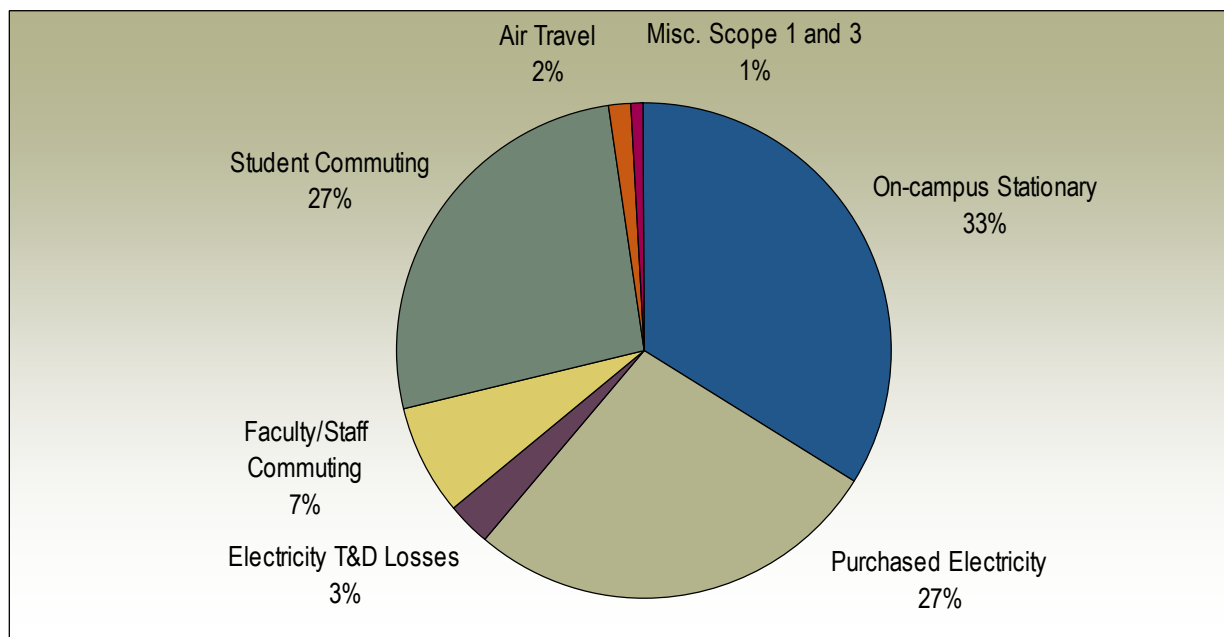
This Climate Action Plan (CAP) fulfills an important part of the University of Massachusetts Lowell's (UMass Lowell) obligation as a signatory of the American College & University Presidents' Climate Commitment (ACUPCC) and establishes a framework to achieve UMass Lowell's commitment to carbon neutrality. This CAP is intended to publically demonstrate UMass Lowell's dedication to reducing greenhouse gas (GHG) emissions through the execution of carbon mitigation projects and outreach to the larger campus community through curriculum and research activities. This CAP provides the following information:

- An inventory of UMass Lowell's Fiscal Year (FY) 2011 GHG emissions;
- Business-as-usual (BAU) projections for future GHG emissions;
- Previous accomplishments related to GHG emissions reductions;
- Carbon neutrality goals and interim milestones;
- GHG mitigation strategies to be implemented to achieve the goals identified; and
- Opportunities to continue and expand educational, research, and outreach activities to support the GHG emissions reductions.

This plan is intended to be dynamic in nature and continuously reviewed and updated as new GHG reduction strategies are developed. At a minimum the plan will be reviewed annually.

II. FY 2011 GHG Emissions and Business as Usual Projections

UMass Lowell's FY 2011 GHG emissions profile is presented below in **Figure ES-1**:



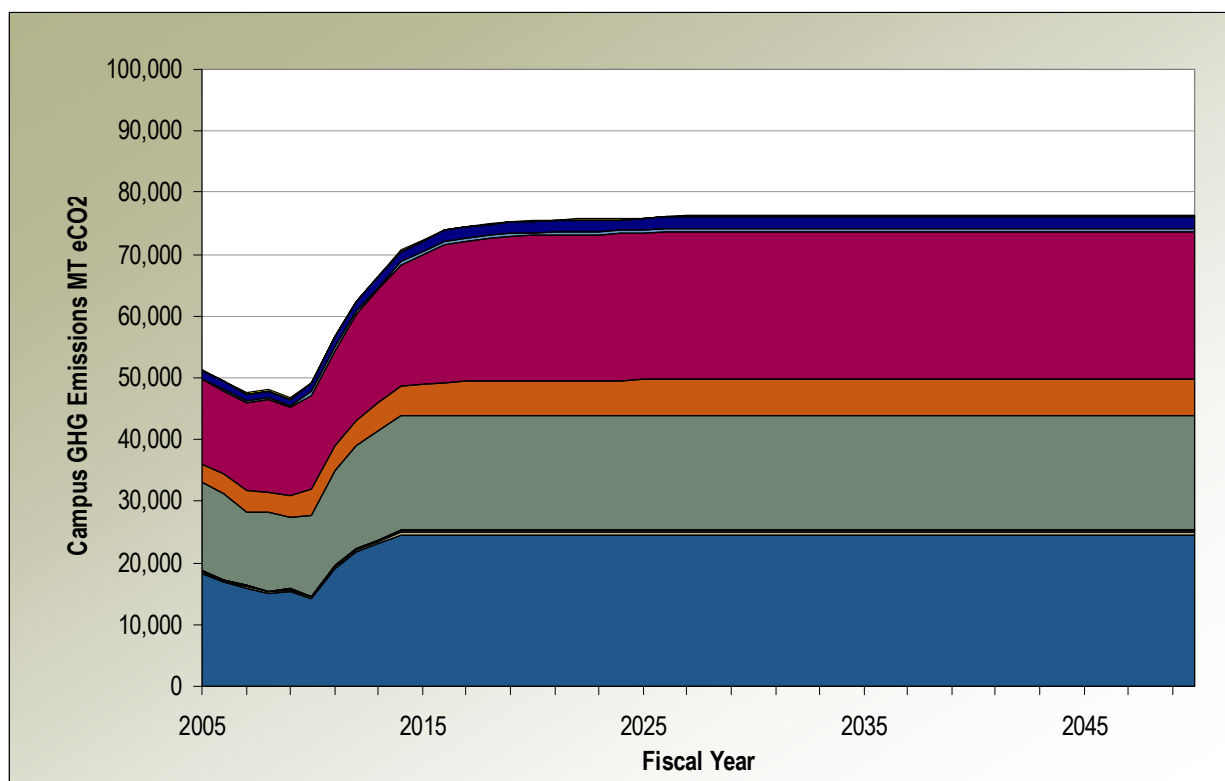
As is consistent with historic GHG emission inventories that have been completed for UMass Lowell, the top three GHG emission sources consist of:

1. on campus stationary sources such as natural gas, distillate oil, residual oil for boilers and emergency generators;
2. purchased electricity; and
3. student commuting.

Therefore, GHG mitigation strategies will predominantly focus on these three primary GHG emissions sources.

Prior to setting a long-term goal for achieving carbon neutrality and interim goals to foster progress along the way, it is important to understand how GHG emissions are expected to increase or decrease in the future under “business-as-usual” (BAU) conditions. Based on future plans for campus growth, UMass Lowell’s BAU trajectory is anticipated to consist of the following as projected out to FY 2050:

Figure ES-2: Business as Usual Trajectory to FY 2050



III. Previous GHG Emissions Reduction Successes

UMass Lowell has already implemented numerous projects and initiatives that have been successful in reducing GHG emissions and incorporating carbon neutrality concepts in the curriculum and research programs. The following are just a few of the many successful strategies that have been implemented:

- Conversion to natural gas as a primary heating fuel;

- Several energy efficiency projects such as the North Central Steam Plant Energy Efficiency Project and Steam Efficiency projects;
- Commitment to achieve at least LEED Silver Certification on all new buildings;
- Hiring of a dedicated Energy and Sustainability Manager for the University;
- Generation of on-campus renewable energy through solar photovoltaic power;
- Implementation of energy management programs involving energy procurement, building automation software and enterprise energy management software, and energy demand and load response programs;
- Commissioning of a transportation plan to address commuting issues and to identify alternate commuting options in addition to the already successful Shuttle Bus (UMass Lowell transportation bus/shuttle service), MassRIDES, Freewheelers Bike and Zipcar Car Sharing programs;
- Solid waste and zero sort recycling programs;
- A very active Climate Change Initiative that is charting the path to incorporate climate change themes into more aspects of curriculum and research with a focus on climate communication and community outreach;
- Over 70 climate-related courses that incorporate sustainability, environment, health, energy management, renewable energy, or climate change topics;
- A well-established on-line course program, reducing commuter trips to campus by students and faculty;
- Research opportunities into renewable energy and zero emissions vehicles; and
- An award winning Solar Energy Club.

These projects and initiatives have already contributed to GHG reductions on campus.

IV. GHG Reduction and Carbon Neutrality Goals

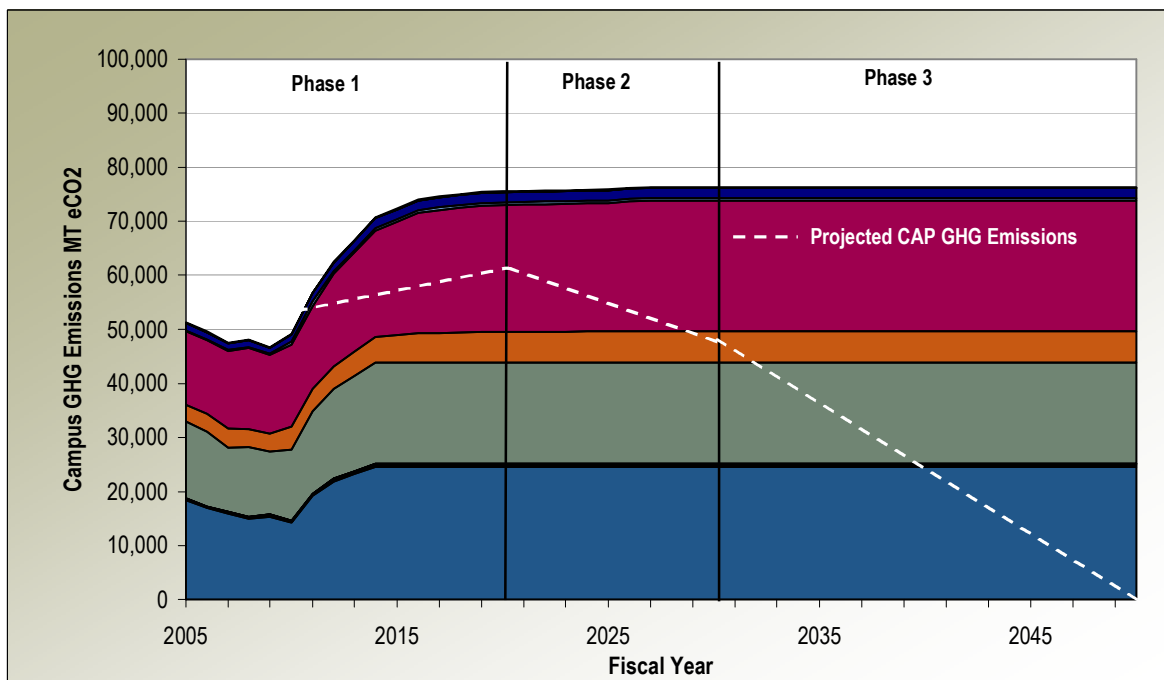
Based on the BAU projections, UMass Lowell has identified the year 2050 to achieve carbon neutrality. It has also identified two interim goals along the path to carbon neutrality. UMass Lowell's GHG reduction goals are provided in the following table:

Table ES-1: GHG Mitigation Phases and Interim Milestones

Phase	Time Frame	Scope 1 + 2 Performance Standard (MT eCO ₂ /1000 SF)	Scope 3 Performance Standard (MT eCO ₂ /FTE)	Goal Net GHG Emissions (MT eCO ₂)	Projected Net GHG Emissions per BAU (MT eCO ₂)	Cumulative Mitigation Required (MTeCO ₂)	Mitigation Required in Phase (MTeCO ₂)
Phase 1	FY2020	8.0	1.9	60,565	75,440	14,874	14,874
Phase 2	FY2030	6	1.5	47,100	76,231	29,131	14,256
Phase 3	2050	0	0	0	76,231	76,231	47,100

These goals as depicted with the BAU projections is outlined in **Figure ES-3** below:

Figure ES-3: BAU Projections as Compared to GHG Emission Reduction & Carbon neutrality Goals



V. Mitigation Strategies

Climate Action Planning will continue to be comprehensive and multifaceted, however, the following priorities have been identified as a means by which the UMass Lowell Climate Action Plan Implementation Committee will prioritize future GHG emissions reductions strategies:

- **Priority 1** - Examination of projects associated with on-campus stationary sources will continue to be reviewed and developed by the UMass Lowell Facilities Department. The Facilities Department has both the budget strategy and support to identify and implement GHG reduction projects associated with on-campus stationary sources.
- **Priority 2** – UMass Lowell has limited control or influence on the mixture of fuels used to generate electricity for the New England Region electrical grid system. However, UMass Lowell will investigate new purchasing approaches or opportunities to displace purchased energy with renewable energy that could reduce GHG emissions. UMass Lowell will continue to implement methods for reducing electrical power consumption through modernization of building electrical systems and upgrading to more efficient electrical equipment using electricity (i.e. lighting, motors, controllers, power management systems, Building Automation Systems (BAS), programmable logic controllers (PLC), microprocessors, pumps, chillers, HVAC equipment, etc.) and increasing energy conservation awareness on campus.
- **Priority 3** - Student, faculty and staff commuting options are currently being evaluated as part of the campus transportation plan that is in development. In addition to new initiatives identified in this plan, the existing rideshares and commuting programs identified will be continued and enhanced where feasible.

With these guiding priorities, the following strategies have been identified to work toward achieving each of the interim Phase 1 and Phase 2 GHG emissions reduction goals and the Phase 3 carbon neutrality goal.

Phase 1

The first interim goal in the CAP is to achieve a campus GHG performance standard of 8.0 MT eCO₂/1000 SF for Scope 1 + 2 emissions and a performance standard of 1.9 MT eCO₂/FTE for Scope 3 emissions by FY 2020. This represents a reduction in annual GHG emissions by approximately 14,874 MT eCO₂ by FY 2020. The initial strategies to accomplish this goal consist of the following:

- Convene a Climate Action Plan Implementation Subcommittee to Identify and execute additional GHG reduction projects and/or accelerate the implementation of longer-term initiatives.
- Develop a written methodology for calculating annual GHG emissions from UMass Lowell so that consistency is maintained and progress toward goals can be accurately assessed.
- Focus on reduction of GHG emissions from sources that are significant contributors and within the control of UMass Lowell including GHG emissions from stationary sources burning fossil fuels and GHG emissions associated with the purchase of electricity to meet campus electrical demands.
- Focus on capturing more accurate data regarding student, faculty and staff commuting and implement measures to reduce commuting miles and measure progress in this area.
- Work with the CCI and other interested faculty to develop methods for continuing to include climate change and sustainability into UMass Lowell student curricula across a variety of disciplines and explore incentives for motivating faculty to complete research in these areas.
- Work with student groups and campus marketing to communicate UMass Lowell's commitment to reducing GHG emissions and promote the progress made along the way.

Specific projects that have already been identified to contribute to achieving the Phase 1 interim goal involve the continued identification and implementation of building HVAC and envelope improvements, opportunities to burn more natural gas in existing systems and retrofit existing oil-fired systems to allow for natural gas combustion, opportunities to generate renewable energy and cogeneration opportunities on campus. Preliminary feasibility studies are being planned to identify a larger scale renewable energy generation project for future implementation.

UMass Lowell is in the process of finalizing a Campus Transportation Plan that identifies options for reducing vehicle miles traveled through a variety of mechanisms. The Campus Transportation Plan shows that there is a good potential for alternative modes of transportation as many commuters live within walking distance (1 mile), biking distance (3 miles) or within a short walk of the Lowell Regional Transit Authority (LRTA) route to North campus or South Campus. During Phase 1, UMass Lowell will begin implementing the recommendations of the Campus Transportation Plan by promoting walking and biking, improving traffic infrastructure, considering transportation demand management, parking management, and other policy changes.

Phase 2

During Phase 2, UMass Lowell's goal is to achieve a campus GHG performance standard of 6.0 MT eCO₂/1000 SF for Scope 1 + 2 emissions and a performance standard of 1.5 MT eCO₂/FTE for Scope 3 emissions by FY 2030. This results in a net total of 47,100 MT eCO₂ by the year 2030. According to BAU projections, this represents a 29,131 decrease below projected FY 2030 emissions and an additional 14,256 MT eCO₂ mitigated upon Phase 1 projects. To achieve this goal, UMass Lowell will build upon the studies performed and data gathered during Phase 1. UMass Lowell has not yet identified the specific projects that it will implement to meet the Phase 2 goal, however these project details will be added to this CAP as decisions are made and data are available. Phase 2 project identification will include reviewing the latest incentives such as Massachusetts Alternative Energy Credits that pay for cogeneration, California's White Tags programs that place a value on efficiency, Organic Waste Programs or other emerging programs.

UMass Lowell anticipates that growth in student enrollment and campus building area will be much slower during Phase 2, compared to Phase 1, and that Phase 2 represents an excellent opportunity to focus on making existing campus energy systems as efficient as possible and to dedicate resources toward the selection, design and possible implementation of a larger renewable energy project. Student and faculty commuting will continue to represent a large portion of UMass Lowell's GHG emissions profile, however, during Phase 2, a greater percentage of students will be living in on-campus housing. Many of the recommendations described in the Campus Transportation Plan will have been implemented and UMass Lowell should have the systems in place to quantitatively assess the results of implementation.

Phase 3

During Phase 3, UMass Lowell's goal is to reduce net annual GHG emissions to become carbon neutral by the year 2050. According to BAU emission projections, this represents an additional annual reduction of 76,000 MT eCO₂ below projected FY 2050 levels. UMass Lowell does not anticipate that it will be possible, even in the future, to be considered carbon neutral without the help of a large scale renewable energy project or as a last resort, the purchase of RECs or offsets.

To achieve carbon neutrality, UMass Lowell may be able to implement larger on-campus or off-campus renewable energy projects. Some of these projects might include large wind, solar, biofuel, biogas or hydro components. While currently viewed as a last resort, Renewable Energy Credits (RECs) or carbon offsets may be considered as possible techniques to obtain necessary reductions that cannot be achieved through on-campus projects.

Summary

This CAP will serve as the guiding document to support the UMass Lowell community in its efforts to reduce GHG emissions. This CAP is intended to illustrate UMass Lowell's commitment improving its carbon footprint through the execution of carbon mitigation projects and outreach to the larger campus community through curriculum and research activities. The plan is a first step toward neutrality that will not only reduce campus GHG emissions but will also increase awareness, advance knowledge, and develop skills necessary for the next generation to address

complex environmental issues and build a more sustainable future. This plan will continue to evolve as our communities, technologies, opportunities and strategies change as we work toward our goal of carbon neutrality.

1. INTRODUCTION

The University of Massachusetts Lowell (UMass Lowell) is one of five universities within the University of Massachusetts System. All universities are signatories of the American College & University Presidents' Climate Commitment (ACUPCC), and each individually has a climate action plan (CAP) that outlines the path the University will take to achieve carbon neutrality. This CAP is intended to publically demonstrate UMass Lowell's commitment to reducing greenhouse gas (GHG) emissions through the execution of carbon mitigation projects and outreach to the larger campus community through curriculum and research activities. This CAP was developed collaboratively by campus stakeholders from across the University with the intent to chart a course toward achieving carbon neutrality. Development of this CAP and most recent GHG emissions inventory fulfills UMass Lowell's obligation under the ACUPCC. While a good faith effort was made to engage a variety of University stakeholders and capture completed and planned initiatives, there are important aspects of the University's campus operations that are not yet fully addressed by this CAP. As a result, UMass Lowell views this CAP as a dynamic, working document that will be continuously reviewed, revised and improved over time as new approaches, strategies and information become available.

1.1 CAMPUS DESCRIPTION

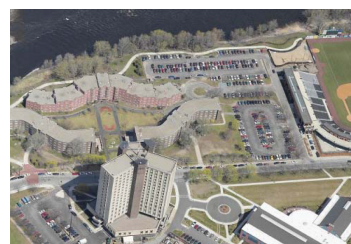
UMass Lowell is located on over 125 acres along the Merrimack River within the urban landscape of Lowell, Massachusetts. The University is divided into three campus clusters – North, South and East and is currently comprised of 3.4 million square feet of campus buildings. Much of the growth in the area has been the product of acquiring buildings from within the City of Lowell (e.g., ICC, Boathouse, Tsongas Center and Garage). University Crossing was purchased from an investment trust. The University offers 15,000 students bachelor's, master's and doctoral degrees in engineering, education, fine arts, health and environment, humanities, liberal arts, management, sciences and social sciences. There are more than 120 undergraduate, 32 masters and 20 doctoral degree programs in six colleges with more being added.



North Campus



South Campus



East Campus

1.2 A HISTORY OF ENERGY MANAGEMENT AND SUSTAINABILITY

UMass Lowell has a long standing commitment to sustainability, GHG reductions and energy management. This commitment has been demonstrated through the development of various programs, policies standards, organizational structure, and the implementation of carbon reduction projects that encompass different program areas and University stakeholders. A major engineering initiative on campus is the conversion to natural gas from No. 6 fuel oil, which has already been implemented in some areas and will continue to be implemented as other opportunities arise. This commitment to purchasing cleaner fuels will continue to result in GHG emissions reductions. A summary of some of the major organizational, energy efficiency, renewable energy, commuting, curriculum, research and community outreach accomplishments achieved to date are outlined below.

Organizational Achievements

Energy and Sustainability Manager Position - In the summer of 2011 UMass Lowell hired its first Energy and Sustainability Manager housed within the Facilities Department. One of the primary goals of this position was to develop and implement the University's CAP. This position has developed and will oversee the University's first Climate Action Plan Approval Committee that has been actively involved in the development of this plan.

Energy Procurement - In the past two years, UMass Lowell has replaced its contracts for natural gas and electricity procurement. These new contracts led to significant cost savings and reflect a reduction in energy use per square foot and the conversion to wider use of natural gas across campus.

Green Building Guidelines - The University is committed to improving the environmental performance of its facilities and has set a minimum standard of LEED Silver Certification for all academic buildings. Recently, all project managers involved in capital projects attended LEED training and certification programs. In addition, UMass Lowell has adopted Sustainability Initiatives and Green Design Guidelines to be considered for each construction or renovation project implemented.



Energy Star Procurement – Purchasing has been requiring Energy Star for all equipment that is covered by the Energy Star Program whenever possible.

Electric and Hybrid Motor Vehicles - The University is committed to enhancing its fleet with electric, hybrid and alternative vehicles when appropriate. Currently the University has eight electric cars and one Hybrid Ford Fusion vehicle for the Operations and Services department used for internal campus and offsite meeting transportation. Also included are electric transportation carts in O&S and three Segways for campus police.

Printing Solutions for Computer Labs, Academic and Central Administration Offices - Alternatives to printing have been implemented to allow printing and scan to e-mail as a standard on all multi-function devices throughout the University.

Solid Waste Recycling Improvements - In 2011, a total of 1,282 tons of solid waste was recycled representing 54.5% of the waste generated on campus. This compares to a 37.8% recycling rate in 2010. The University has a robust solid waste recycling program called Zero Sort (paper, cardboard, glass, plastic, metals) that provides for a co-mingled solid waste stream collected as one waste stream in common-bins in many convenient locations within UMass Lowell buildings. All areas of campus recycle solid waste and all students, faculty and staff are responsible for their own environmental footprint.

Online Classes - The Division of Online & Continuing Education offers several online programs. Since its inception in 1996, this program has grown dramatically (approximately 8-10% annually) and its popularity and use is expected to grow. In Fiscal Year (FY) 2011 there were over 18,500 enrollments (number of courses taken on-line) which translate into approximately 1,300 full-time equivalents (FTE). While some of these students are from other states and likely would not travel to UMass Lowell if on-line courses were not an option, for many



students this option eliminates regular travel to campus, thereby reducing GHG emissions from personal vehicle use. In addition, over 200 faculty involved in teaching on-line classes can conduct these classes remotely without needed to travel to campus.

Energy Efficiency Achievements

Utility Tracking Systems - UMass Lowell has implemented a web-based energy, water and sewer tracking system. The system, called Utility Tracker, tracks consumption and cost information for natural gas, fuel oil, electricity, water and sewer. It includes data for FY 2009 - 2012 in an easy to access online system. The system helps the University accurately measure and monitor energy, water and sewer use and identify areas where increases in efficiency or decreases in demand are possible.

Enterprise Energy Management Software (EEMS) - In April 2010, the Massachusetts Department of Energy Resources (DOER) recognized UMass Lowell for installation of a \$1.7 Million ARRA funded EEMS and sub-metering project. The installation of an EEMS aids in the determination of the root cause for energy consumption fluctuations. Energy profiling of the individual buildings in Energy Use Index (EUI) can be determined using real data with the EEMS where there is installed metering for electrical power, natural gas, steam and condensate flow for 45 buildings. EEMS will also be used to document power dips, failures, and other abnormalities and make real time equipment and scheduling adjustments. This system will allow UMass Lowell to provide measurement and verification before and after energy conservation and efficiency measures to quantify savings achieved. EEMS will be expanded as the campus increases its infrastructure for natural gas, electrical power and other utilities in the future (e.g., water and sewer).

Increase Breadth of Building Automation Software (BAS) - By increasing the utilization of BAS systems, UMass Lowell can better employ repeatable control of HVAC leading to reduced energy use associated with control drift and fluctuation as well as better awareness of control problems by computer alarming to the HVAC Department. The BAS allows for time scheduling of the HVAC systems for energy management control. Initial BAS projects have been completed at Durgin Hall, Pinanski Hall, Mahoney Building, Southwick Career Center, Recreation Center and Kitson Hall.

North Central Steam Plant Energy Efficiency Project (in progress) - This project involves the upgrade of a 1950's vintage steam plant that is both obsolete and inefficient to achieve full automation and also high energy efficiencies. The project includes the installation of two new boilers, a 400 and an 800 BHP Cleaver Brooks boiler, and modernizing the burner front and controls of existing Boiler No. 3. This project is expected to reduce the heat input energy by more than 17 percent. In addition, the new dual fuel boilers will use natural gas and No. 2 instead of No. 6 fuel oil for nearly 100% of the time. The project was initiated in 2010 and is scheduled for completion by end of FY 2012.

Steam Efficiency Projects - Steam efficiency projects include the repair and replacement of malfunctioning steam traps and are anticipated to reduce steam usage by 5-10% across campus. Steam efficiency projects were completed in FY 2011 for North Quad, Southwick, Kitson, Cumnock, and Mahoney.

Renewable Energy Achievements

Photovoltaic Power Generation

1. College of Engineering's Research and academic use photovoltaic arrays generate up to 13.1 kW on the roof of Ball Building.
2. UMass Lowell has installed photovoltaic energy generators on four buildings' roofs:
 - Costello Gym 336 panels for 59 kW
 - Dugan Hall 396 panels for 69 kW
 - Leitch Hall 220 panels for 38.4 kW
 - Bourgeois Hall 220 panels for 38.4 kW



These arrays generate up to 205 kW output of electricity and reduce GHG emissions by 115 MT eCO₂ per year.

Wind Turbines – Research and academic use wind turbines on Ball Building generate up to 4.7 kW.

Commuting Reduction Achievements

Shuttle Bus Program – UMass Lowell transports numerous students between all three campuses, off-campus residences, and satellite parking lots through its shuttle bus program. The shuttles are free to students. Despite operating in a challenging urban environment, the shuttles operate on 10 minutes headway and transports over 3,000 passengers on a typical weekday. Bus routes are routinely reviewed and modified as necessary to maximize ridership. When the Lowell Regional Transit Authority is not running, UMass Lowell Transportation provides on-call service to the Gallagher Train Station.

Parking Policies - Since 2009, UMass Lowell has been charging for parking, a policy designed to encourage commuters to shift to carpooling or other modes of transit. The University also prohibits resident students from driving between campuses during the day by restricting student parking to a single, assigned lot.

MassRIDES Commuter Travel - The University partners with MassRIDES to offer a benefit to those who carpool called NuRide. NuRide is a free online service where students, faculty, and staff can earn rewards when they commute by public transportation, biking, walking, telecommuting, carpooling or vanpooling.

UMass Lowell Freewheelers Bike Share Program - In order to help build a sustainable and healthy campus community, UMass Lowell launched a pilot bike share program in the Fall 2011. The program allows members to use a bike lock key as their membership tool. The key can be used in any of the u-locks within the Bike Share fleet located throughout the campuses and returned to a designated rack on any other campus. The UMass Lowell Bike Share is open to all students, faculty, and staff.

Pedestrian and Cycling Maps - In order to promote more walking and bicycling between campuses, the University released a walk/bike map that was initially distributed in Fall 2011. The map shows primary and secondary walking routes between all campuses, downtown Lowell, and the Gallagher MBTA transit stop, as well as major destinations in Lowell. The map is distributed to freshmen at orientation and made available at map kiosks throughout campus during the year.

Zipcar Car Sharing Program - The University received its first fleet of Zipcars on campus in the Fall 2011. With Zipcar, anyone can sign up for a membership and rent a car by the hour for a flat rate that includes gas and insurance. The options of a short-term car rental makes car-free living a more convenient and feasible option for anyone at the University, be they students living on campus without a car or people arriving via public transit who would like the option to run errands during the day.

Curriculum, Research and Community Outreach

A core requirement of the ACUPCC is to develop and implement strong research, education, and outreach programs to educate students, faculty, their broader communities, our elected officials, and other stakeholders about climate change mitigation and adaptation. Curriculum, research and community outreach efforts already in place at UMass Lowell are summarized in the following sections.

Curriculum

UMass Lowell offers 120 fully-accredited academic programs in six colleges including: the Graduate School of Education, the College of Engineering, the College of Fine Arts, Humanities & Social Sciences, the School of Health & Environment, the Manning School of Business and the College of Sciences. The University currently offers over 70 climate-related courses that incorporate sustainability, environment, health, energy management, renewable energy, or climate change topics. The University also offers the following climate-related degree programs:

College of Engineering, M.S & Ph.D. Energy Engineering – The Mechanical Engineering department offers a multidisciplinary graduate program in Energy Engineering that prepares students to perform state-of-the-art engineering work on energy systems. The objective of the doctoral program in renewable energy engineering is to prepare engineers for leadership positions in industry, academia, and government to provide society with sustainable energy systems. As part of this program, the University operates four experimental wind turbines, a roof top solar PV, fuel cell hydrogen generator, and a Central Power Integration room to convert all of these energy systems into electrical energy with a potential to generate 19 kW.

College of Engineering, Graduate Certificate Energy Conversion – The Electrical and Computer Engineering Department offers a Graduate Certificate program in Energy Conversion. The certificate program focuses on applying practical applications in the housing industry to supply houses with clean sources of energy in order to meet electrical, heating and cooling needs.

College of Sciences B.S. & M.S. Environment, Earth & Atmospheric Science, Environmental Studies Concentration - This concentration blends a strong science core with focused areas in the humanities/social sciences leading to a program of study that is compatible with the student's strengths and goals. The science focus

can be in either biology or chemistry. This concentration prepares students for employment in the private and government sectors where knowledge is required in management and protection of the environment, environmental laws and regulations, natural resources and environmental economics.

College of Sciences, B.S. & M.S. Environment, Earth & Atmospheric Science, Atmospheric Science Concentration - The Atmospheric Science Concentration focuses on the study of the various facets of weather, climate and air pollution control. Meteorologists study the physical causes of weather and climate and apply this knowledge to forecasting, as well as to analyzing the influence of weather and climate on public health, agriculture, engineering, industry, commerce, national defense and other facets of society.

College of Sciences, B.S. Ecology – The Ecology degree program offers students a strong foundation in the basic sciences of biology, chemistry, and physics, as well as advanced courses in Ecology and Environmental Biology. Principles of Ecology, Biology of Global Change, and Environmental Microbiology are part of the core requirements in Biological Sciences. Students may choose from advanced courses in biology, including Population Genetics and Evolution, Botany, Invertebrate Zoology, Wetlands Ecology, Limnology, and Recombinant DNA Techniques. Electives are also available in several interdisciplinary fields, including Environmental Chemistry, Analytical Chemistry, Environmental Economics, Environmental Law, Geographic Information Systems, Hydrogeology, and Environmental Geochemistry.

School of Health & Environment, B.S. & M.S. Work Environment Policy - The fields of occupational and environmental health are integrated by the practical focus on actual workplace conditions: policy is based on the science; engineering and political economy provide the solutions. The Work Environment Policy concentration accepts students from a wide variety of backgrounds, including physicians and lawyers, as well as those with training in the social sciences who wish to be policy analysts in academia, government agencies and organizations concerned with affecting environmental health and worker safety and health.

School of Health & Environment, B.S. Environmental Health – UMass Lowell is the only University in the Northeast that offers a B.S. program in Environmental Health. While the practice of environmental health has a long history in sanitation, water quality and food safety, the field is rapidly evolving and expanding as scientists better understand the complex links between exposures to chemicals, radiation, pathogens, climate change and ecosystem damage and human health.

School of Health & Environment, M.S. & Ph.D. Cleaner Production & Pollution Prevention - The Department of Work Environment offers a master's degree and a doctoral degree in Cleaner Production and Pollution Prevention. Cleaner Production and Pollution Prevention offer new directions for reducing environmental and occupational health risks by redesigning production systems or reformulating commercial products with the objective of prevention or minimization of short and long term risks to humans and the environment. Cleaner production applies to both products and processes. Cleaner products are those designed to reduce impacts throughout their entire life cycle, from raw material extraction to ultimate disposal of the product and packaging. Cleaner production processes conserve raw material and energy, eliminate toxic materials and reduce the generation of wastes and emissions.

College of Fine Arts, Humanities & Social Sciences, Concentration in Environment and Society – UMass Lowell offers a B.A. program with a concentration in Environment and Society which allows students who have an interest in environmental issues to explore the ways that these issues can be addressed through a variety of disciplinary perspectives, including political science, history, sociology, legal studies, English, art history, and philosophy. Courses in these disciplinary areas invite students to consider how attitudes toward nature and the built environment have changed over time; how public policies affect the relationship that people have with the environment and may influence choices about preservation of open space and natural resources; how writers and artists have interpreted and represented the natural world and the built environment, including the tensions that exist

between the two; how issues such as health, sustainable development, the history of industrialization, and the expansion of technologies are related to and/or affect the environment.

Research

Examples of the various research opportunities and non-curricular community outreach activities available at UMass Lowell are described below. Several of these programs are award-winning and are charting the course in research into renewable energy and zero emissions vehicles. Opportunities to incorporate sustainability, environmental, energy management, renewable energy, and climate change concepts into research activities are continually being developed and expanded.

Atmospheric Research - Founded with the goal of conducting experimental and analytical research in the atmospheric and space sciences, to provide research opportunities for graduate and undergraduate students, and to demonstrate how research and development tie to solving real world problems.

Electric Car and Energy Conversion - The primary focus is the application of renewable energy in roof-top residential, industrial, and utility-interactive environments.

Center for Health Promotion and Research (CHPR) - CHPR focuses on public health, which is an important component of UMass Lowell's commitment to sustainable development.

Industrial Competitiveness - Conducts research on topics such as globalization, innovation, industrial transformations, workforce and training, and organizations and regions.

Lowell Center for Sustainable Production - Helps to build healthy work environments, thriving communities, and viable businesses that support a more sustainable world.

Public Opinion Center - The Center for Public Opinion seeks to further UMass Lowell's academic and strategic objectives through cross-disciplinary research related to political and public opinion trends and behaviors, as well as through distinctive, revealing public opinion polling, and provides students, faculty and visiting scholars access to public opinion research. Subjects of study are multi-disciplinary, covering political, social, economic and cultural issues.

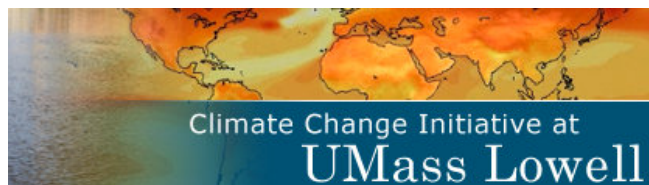
Center for Sustainable Energy - Develops systems to provide energy for various end uses in an environmentally and economically sustainable manner.

Toxics Use Reduction Institute (TURI) - TURI provides training, services and grant programs to reduce toxic chemical use and advance energy and water efficiency while enhancing the economic competitiveness of local businesses.

Wind Energy Research Group (ERG) – ERG unique expertise and capabilities to conduct research in the advancement of wind turbine science and systems. The group consists of thirteen interdisciplinary faculty members whose research focuses on wind turbine manufacturing, reliability, energy storage, and design.

Community Outreach

UMass Lowell's own Climate Change Initiative (CCI), established in 2009, has already made great strides with regard to community outreach efforts. CCI's goal is to address climate change through education, research, and developing solutions to transition to a more sustainable and resilient society. The philosophy of the initiative is that scientific research must be the foundation for informing society about ongoing climate change and its potential future impacts. The CCI is committed to examining the physical, ecological, environmental, social, economic, historical, and political



facets of climate change impact, mitigation, and adaptation. The CCI is composed of: academic programs at the undergraduate and graduate levels; research in diverse fields, ranging from modeling climate change to ecological impacts, clean energy, sustainability, education, and others; campus events on climate change; and outreach to the broader

community to increase public understanding of climate change. While still growing, the CCI currently includes a Steering Committee and Advisory Board drawn from faculty members of twelve academic departments and all six UMass Lowell Colleges and Schools, as well as the two UMass System-wide intercampus programs: the School of Marine Sciences and the Biomedical and Biotechnology Engineering program. While still in its early stages, the CCI has already demonstrated its ability to obtain external funding, develop new academic courses and programs, and to engage the public beyond UMass Lowell.

The CCI was instrumental in obtaining a grant from NASA to develop and use tools of student media production to engage and empower students in climate change education. The first year of the project, CCE Media, has included: the development of several new programs and a cross-disciplinary approach to climate change education including the development and execution of climate change courses at the undergraduate and graduate levels, high school summer program, integration of media production and climate change science education, several public student video screening and discussion events (with a total of ~360 attendees across all events), and a widely attended Climate Change Teach-In (~230 attendees).

UMass Lowell also recently hosted "Carbon Smarts: Learning Science on the Go", a national conference that brings diverse communities together to examine the potential of Out of Home Media to foster informal science learning among the commuting adult population. Experts representing marketing, communication, risk analysis, science education, mass transit, informal learning, and atmospheric research share experiences and ideas on how to improve the public's understanding of climate change science with special attention given to new digital tools. The conference focuses on developing discourse between academic and industry personnel with a goal of laying a foundation for more collaborative and effective initiatives.

1.3 CLIMATE CHANGE COMMITMENTS

There are several climate change commitments that have been endorsed by or are applicable to UMass Lowell. Some of these commitments are campus focused, while others apply to the system in its entirety. A summary of the major climate change commitments that UMass Lowell adheres to are described below.

Commonwealth of Massachusetts Executive Order 484 Leading by Example Program

The Leading by Example Program applies to all higher education operations in the Commonwealth of Massachusetts and is a requirement of Governor Patrick's Executive Order 484: Leading by Example (LBE) – Clean Energy and Efficient Buildings. This program sets GHG and energy reduction targets and renewable energy goals. It also requires stakeholders, such as UMass Lowell to submit data annually on energy use, solid waste and recycling.

The goals set forth in the Executive Order 484 are applicable to the Commonwealth as a whole, but are encouraged to be applied individually to the greatest extent feasible. Per the Order, higher education institutions within the Commonwealth are required to collectively meet certain GHG and water resource reduction goals. Also, LBE orders that all new construction and major renovation over 20,000 square feet must meet MassLEED Plus requirements. All new construction less than 20,000 square feet must meet MassLEED Plus, achieve 20% above the Mass Energy Code, or meet the Advanced Buildings energy criteria.

The Division of Capital Asset Management (DCAM) is actively implementing projects, several of which have been implemented at UMass Lowell, to work toward achieving these goals. DCAM is also working on other energy efficiency projects, building retro-commissioning, energy performance initiatives, maintenance programs, training and energy information systems to support the goals of the Order.

The Energy and Sustainability Manager is planning to align with DCAM on financing energy conservation projects in the future.

U.S. Conference of Mayors Climate Protection Agreement

The City of Lowell has signed the Mayors Climate Protection Agreement in which participating cities agree to help reduce global warming pollution by taking the following actions:

- Strive to meet or beat the Kyoto Protocol targets in their own communities, through actions ranging from anti-sprawl land-use policies to urban forest restoration projects to public information campaigns;
- Urge their state governments, and the federal government, to enact policies and programs to meet or beat the GHG emission reduction target suggested for the United States in the Kyoto Protocol -- 7% reduction from 1990 levels by 2012; and
- Urge the U.S. Congress to pass the bipartisan GHG reduction legislation, which would establish a national emission trading system.

American College & University Presidents' Climate Commitment

Through the development and implementation of this CAP, UMass Lowell has chartered a course to achieving the carbon neutrality goal of the American College & University Presidents' Climate Commitment. UMass Lowell along with the other four institutions representing the UMass System are all signatories with each operating under individual goals set forth in University specific climate action plans. The carbon neutrality target set forth in UMass Lowell's CAP is generally consistent with those of the other universities in the system. The process used to develop this CAP is summarized in the following section.

1.4 DEVELOPMENT OF CLIMATE ACTION PLAN

This CAP was developed with input and guidance provided by UMass Lowell's Climate Action Plan Approval Committee with support from its consultant, Woodard & Curran. The Climate Action Plan Approval Committee is chaired by the newly created Energy and Sustainability Manager housed within the Facilities Management Department. The Committee members represent a cross section of University stakeholders with members from the facilities, environmental health and safety, transportation, residential life, and finance departments, senior administration, faculty and students as identified in the acknowledgements presented at the beginning of this plan. This plan was also reviewed and supported by the Chancellor's Office, Climate Change Initiative and representatives of the Dean's Council.

1.5 IMPLEMENTATION OF CLIMATE ACTION PLAN

The following sections describe UMass Lowell's approach for the implementation of this CAP and related activities to be performed to monitor the progress toward meeting interim goals and achieving carbon neutrality.

Implementation Structure

UMass Lowell's Climate Action Plan Approval Committee was initially formed with the primary objective of completing this CAP. With the submission of this plan, the Climate Action Plan Approval Committee will be formally transitioned to the Climate Action Plan Implementation Committee and will have regular meetings to review and continually develop new strategies to implement this plan. The Committee will be coordinated by the Facilities Management department with reporting to the Vice Chancellor, Finance and Operations and the Associate Vice Chancellor, Facilities Management. The Climate Action Plan Implementation Committee will work closely with the Climate Change Initiative and other related organizations.

It is anticipated that the Climate Action Plan Implementation Committee will form subcommittees in the future. The purpose of these subcommittees will be to work on implementation of specific parts of this plan, establish and improve current data collection efforts, and to establish a greater presence within the University.

Communication and Outreach

It will be the responsibility of the Climate Action Plan Implementation Committee to coordinate and implement communication and outreach associated with climate action goals, strategies, and implementation. One of the first tasks of the Climate Action Plan Implementation Committee will be to develop a communication plan regarding carbon neutrality for UMass Lowell. It is anticipated that existing communication vehicles such as campus publications and focused seminars will continue to be utilized and adapted for this purpose. The Committee also will examine other avenues for outreach and engagement including social media, a CAP website, and visible postings in campus facilities.

In addition to the communications discussed above which will target the wider UMass Lowell community, the Energy and Sustainability Manager will also be responsible for providing regular briefings to senior management within the facilities department, the Dean's Council, the Chancellor's Office and the Climate Change Initiative.

Ongoing Monitoring and Tracking Progress

The Climate Action Plan Approval Committee recognizes the critical importance of measuring the GHG emissions reductions from each project implemented so that progress toward the goals outlined in this plan can be measured. Currently, there are several systems in place to support ongoing monitoring such as the Enterprise Energy Management Software and the Building Automation Systems. In addition, the Energy and Sustainability Manager gathers data on carbon reductions for the University's annual Energy and Sustainability Report. The Climate Action Plan Implementation Committee will develop specific policies and procedures to formalize its plans for ongoing monitoring and progress tracking.

Periodic Plan Review and Updating

UMass Lowell views this first CAP as a work in progress representing a specific snapshot in time. This plan is intended to be a dynamic document with future updates to continually incorporate new mitigation strategies based on University initiatives, emerging technologies, and the nature of the energy market. On at least an annual basis, the Climate Action Plan Implementation Committee will determine the potential necessity to update this CAP. Updates will be issued as needed.

Reporting and Recordkeeping

It will be the responsibility of the Climate Action Plan Implementation Committee to maintain and assemble the records associated with CAP implementation and ongoing monitoring. Minutes of the Climate Action Plan Implementation Committee and associated subcommittees will be maintained and summarize the findings and progress toward achieving carbon neutrality. On at least an annual basis, the Climate Action Plan Implementation Committee will complete a comprehensive review of the CAP and progress made toward its goals.

1.6 STRUCTURE OF THE CLIMATE ACTION PLAN

The remainder of this CAP is organized into the following sections:

- Section 2 – Presents UMass Lowell's 2011 GHG emissions inventory and compares it with previous inventories completed. It outlines the University's business as usual trajectory and emissions projections.
- Section 3 – Identifies UMass Lowell's target date to achieve carbon neutrality and interim goals to meet this date. Mitigation strategies and projects planned to meet these goals will be presented.
- Section 4 – Outlines future plans to continue to incorporate CAP concepts into the University's educational experience and research opportunities and how it will continually engage the campus community in these activities.
- Section 5 – Provides concluding thoughts and next steps to continue to execute this CAP

2. CAMPUS GHG EMISSIONS

Concern over climate change has grown in recent years, as more and more scientific evidence implicates human activities in the rise of atmospheric GHG emissions¹. Increasing concentrations of GHG emissions traps heat in the upper atmosphere, which in turn, is predicted to have severe impacts both on the natural environment (melting ice caps, raising sea levels, altering seasons) and society (disrupting food supply, increasing vector-borne disease, displacing coastal populations, among other impacts).²

UMass Lowell completed its first GHG inventory for FY 2008 in accordance with the ACUPCC requirement to complete a GHG inventory and publicly report on GHG emissions within one year of becoming a signatory. The FY 2008 inventory was completed by Sightlines, a third-party preparer of GHG emission inventories, who also retroactively prepared GHG emission inventories for FY 2005, 2006, and 2007. Sightlines also prepared GHG emission inventories for FY 2009 and 2010. The current, FY 2011, GHG inventory was prepared by Woodard & Curran, Inc. The FY 2005 – 2011 GHG inventories all utilize the Clean Air Cool Planet (CACP) Campus Carbon Calculator v6 which uses GHG emission estimation methodologies that are consistent with the standards of the GHG Protocol of the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI). The GHG Protocol is the most widely used international GHG emission accounting tool and it provides organizations with a standard methodology to understand, quantify, and manage GHG emissions.³

To help delineate direct and indirect emission sources, improve transparency, facilitate fair comparisons and prevent double-counting and double-crediting, the GHG Protocol defines three “scopes” for GHG emission accounting and reporting purposes.

- Scope 1 includes all direct sources of GHG emissions (such as stationary combustion sources, vehicle fleets, and refrigerant releases) from sources that are owned or controlled by UMass Lowell.
- Scope 2 includes GHG emissions from purchased electricity, heat or steam which are generally associated with the generation of these imported sources of energy.
- Scope 3 includes all other indirect sources of GHG emissions that may result from the activities of UMass Lowell but occur from sources owned or controlled by another company or individual, such as commuting.

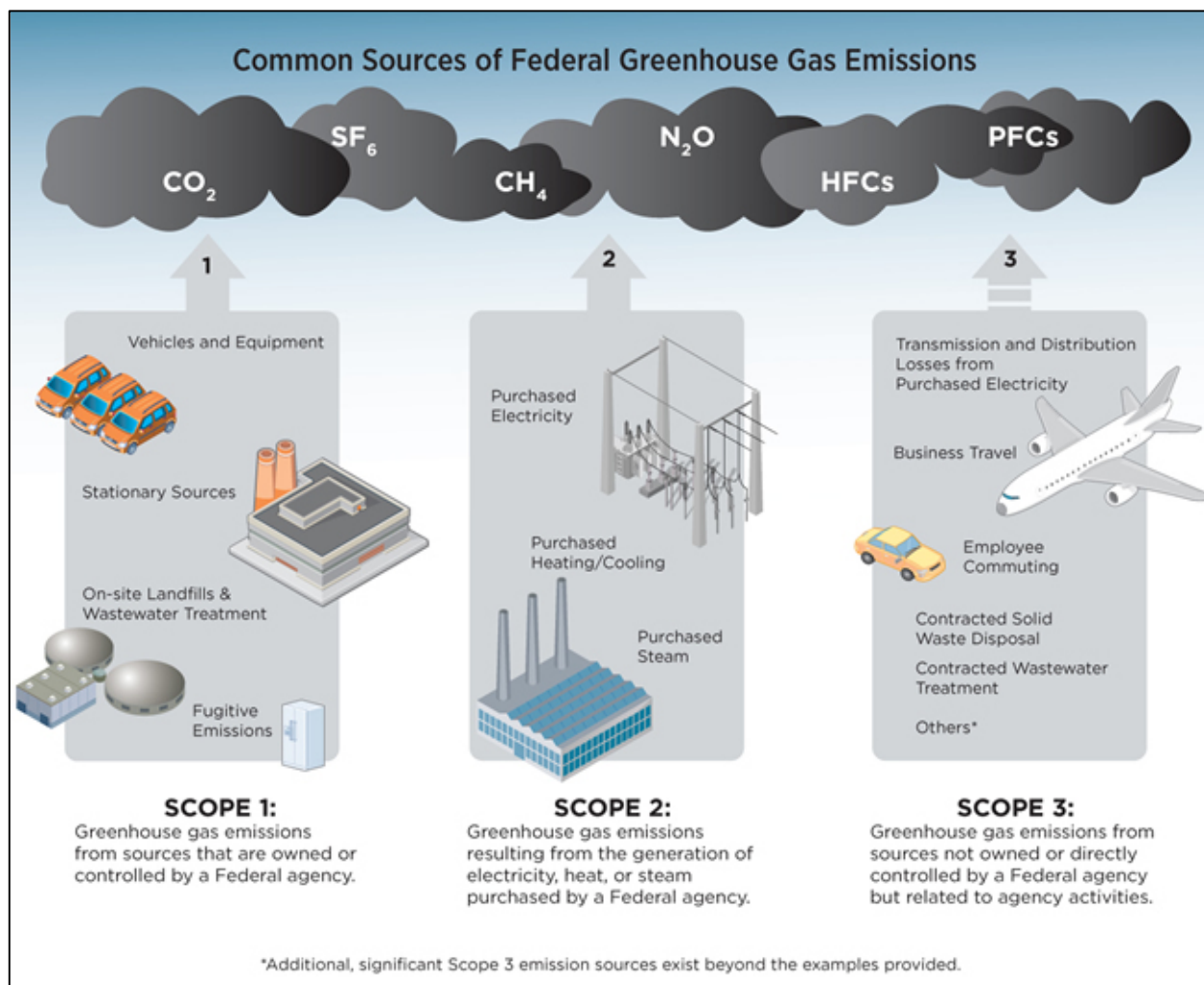
¹ Intergovernmental Panel on Climate Change. (2008) *Climate Change 2007, The IPCC Fourth Assessment Report*.

² Pew Center on Global Climate Change. (2006) *Climate Change 101: The Science and Impacts*.

³ <http://www.ghgprotocol.org/>

Figure 2-1 depicts the types of emission sources commonly contributing to each scope.

Figure 2-1: GHG Emissions by Scope



EPA's Greenhouse Gas Emission Reductions. 2011 Aug 16. (Environmental Protection Agency (EPA). 2011 Dec 9. <http://www.epa.gov/greeningepa/ghg/>)

As an ACUPCC signatory, UMass Lowell has agreed to account for and report on emissions from Scopes 1 and 2, and in addition, some Scope 3 emissions specifically associated with faculty, staff and student commuting, and directly financed air travel. Emission sources that contribute to less than 5% of the facility's total emissions are considered "de minimus" and their quantification is not required by the GHG Protocol.

While UMass Lowell's emission inventories have been prepared by multiple third-parties, care has been taken to document data sources and maintain consistency across inventories with regard to assumptions and methodologies used. It is UMass Lowell's policy to determine GHG emissions from one year to the next using consistent methods until another method has been demonstrated to provide a more accurate assessment of emissions from that source. **Table 2-1** lists the sources of GHG emissions included in each Scope in UMass Lowell's most current year, FY 2011, inventory.

Table 2-1: Sources of GHG Emissions Included in Each Scope at UMass Lowell

Scope	FY 2011
Scope 1	<ul style="list-style-type: none"> • On-Campus Stationary Sources (i.e. natural gas, distillate oil, residual oil for boilers and emergency generators) • Motor Vehicle Fleet • Fertilizer Application • Refrigerant Releases
Scope 2	<ul style="list-style-type: none"> • Purchased Electricity
Scope 3	<ul style="list-style-type: none"> • Faculty and Staff Commuting • Student Commuting • Study Abroad Air Travel • Wastewater Processing • Paper Purchasing • Electricity Transmission and Distribution Losses

2.1 FY 2011 GHG EMISSIONS INVENTORY

The FY 2011 emissions inventory was compiled by UMass Lowell's consultant, Woodard & Curran, with data assembled and provided by UMass Lowell's Climate Action Plan Approval Committee. UMass Lowell's GHG emissions inventory is expressed in the units specified by the GHG Protocol of metric tonnes of carbon dioxide equivalents (MT eCO₂).

Figure 2-2 and Table 2-2 provides the GHG inventory for FY 2011 organized by GHG emissions source. The Miscellaneous Scope 1 and 3 category includes emissions from: the campus vehicle fleet, fertilizer use, refrigerant releases, wastewater processing and paper purchasing. These sources have been combined into one category as collectively they represent only 1% of UMass Lowell's annual GHG emissions. While these emissions are collectively de minimus, UMass Lowell has elected to continue tracking emissions associated with these sources.

Figure 2-2: FY 2011 Gross GHG Emissions by Source

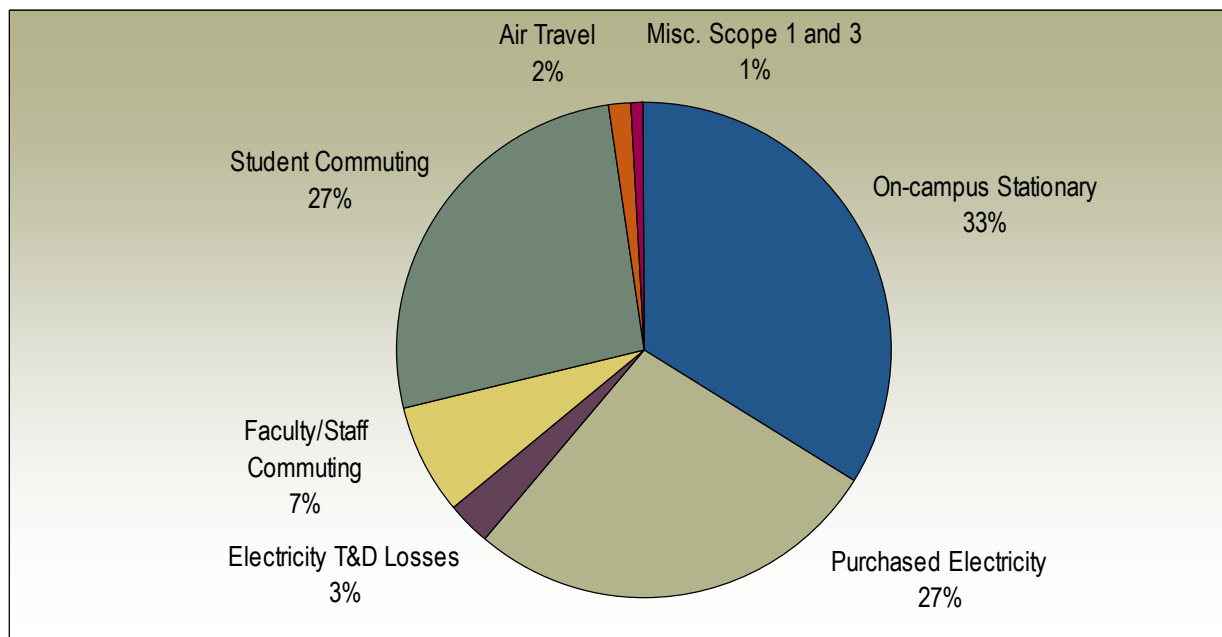


Table 2-2: FY 2011 GHG Emissions by Source Data

GHG Source	FY 2011 (MT eCO ₂)	% of Total
On-campus Stationary	19,187	33.8%
Purchased Electricity	15,370	27.1%
Electricity T&D Losses	1,520	2.7%
Faculty/Staff Commuting	4,090	7.2%
Student Commuting	15,314	27.0%
Air Travel	879	1.5%
Misc. Scope 1 and 3		
Vehicle Fleet	223	<0.5%
Refrigerants	139	<0.5%
Agriculture	< 1	< 0.1%
Wastewater	< 1	< 0.1%
Paper Purchasing	NA,	< 0.1%
Gross Annual GHG Emissions	56,686	

Figure 2-3 provides the GHG inventory for FY 2011 organized by GHG emissions scope. Scope 3 emissions contribute the greatest to UMass Lowell's GHG emissions inventory; however, those are also the emissions over which the University has the least control. Scope 1 emissions from stationary sources of fuel combustion are also significant as well as Scope 2 emissions from purchased electricity.

Figure 2-3: FY 2011 Gross GHG Emissions by Scope

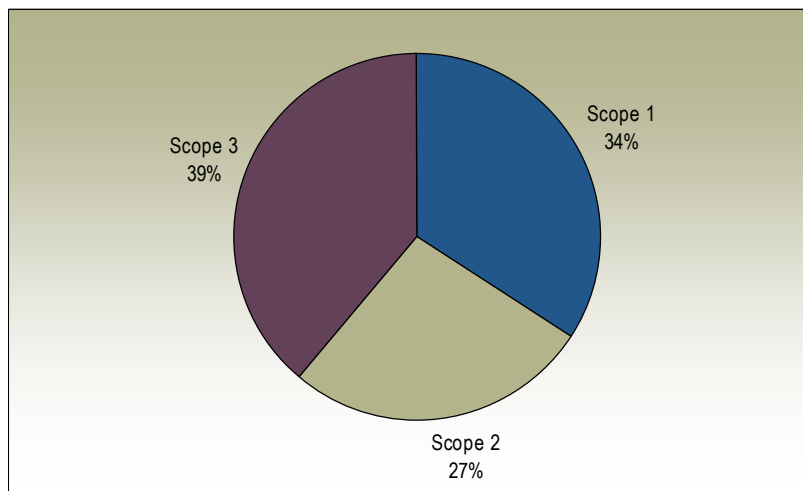
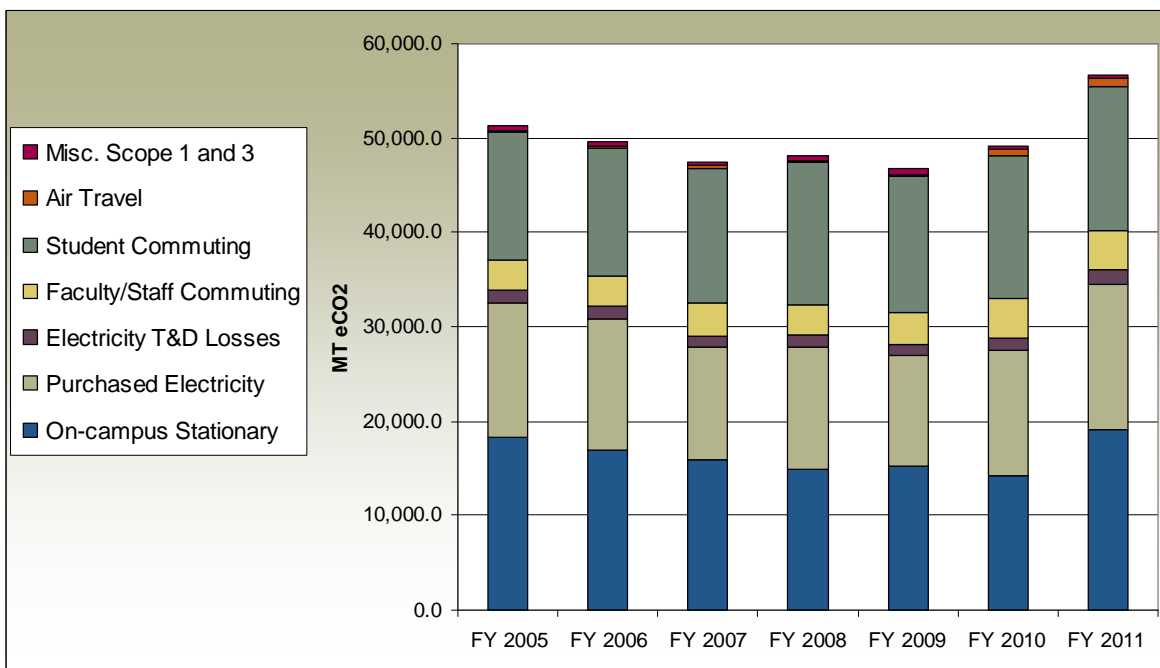


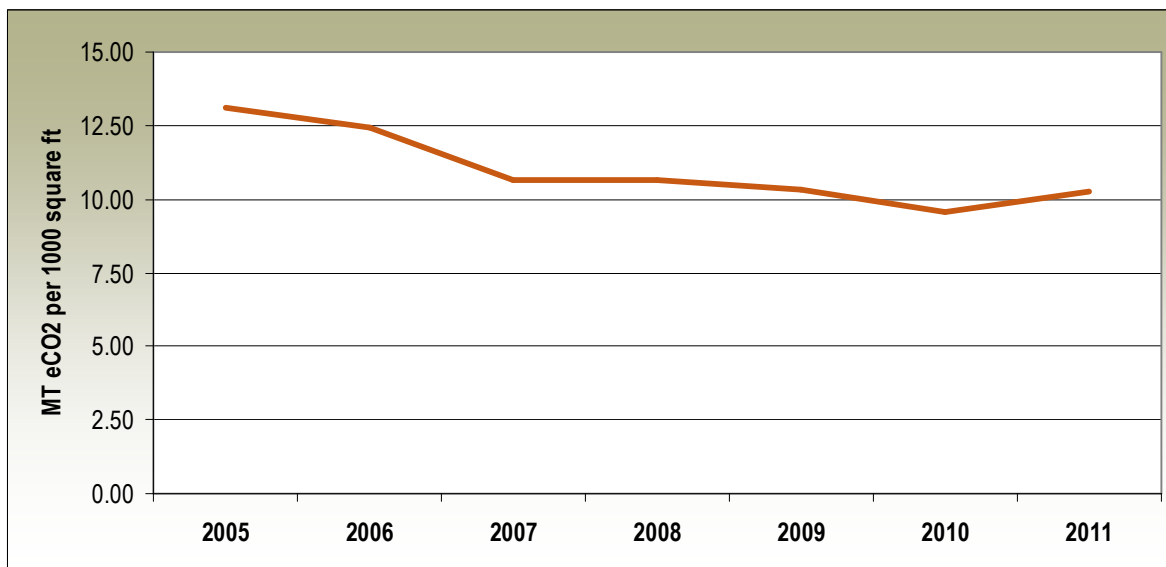
Figure 2-4 provides annual GHG emissions by source for each fiscal year from FY 2005 through FY 2011. As expected, GHG emissions from campus owned stationary sources and from purchased electricity represent the majority of UMass Lowell's historic GHG emissions with significant emissions resulting from student and faculty/staff commuting. Generally, gross GHG emissions from the University were decreasing until FY 2010 and FY 2011 when the University began acquiring more energy-intensive buildings.

Figure 2-4: FY 2005 through FY 2011 Gross GHG Emissions by Source



Despite UMass Lowell's growing GHG inventory, the University has made significant strides to become more energy efficient and gross GHG emissions do not tell the complete story. Figure 2-5 below depicts annual GHG emissions normalized for gross building area from FY 2005 through FY 2011 which has decreased as a result of energy efficiency projects and moving to burning cleaner fuels such as natural gas.

Figure 2-5: FY 2005-2011 GHG Emissions per Gross Square Foot of Building Area



2.2 BUSINESS-AS-USUAL EMISSIONS TRAJECTORY

Prior to setting a long-term goal for achieving carbon neutrality and interim goals to foster progress along the way, it is vital that an institution understand how GHG emissions are expected to increase or decrease in the future under business-as-usual (BAU) conditions. To arrive at this understanding, UMass Lowell made two major considerations: 1) how the UMass Lowell campus is expected to change over time; and 2) how major sources of GHG emissions are expected to change over time and with various campus conditions of growth in area and enrollment.

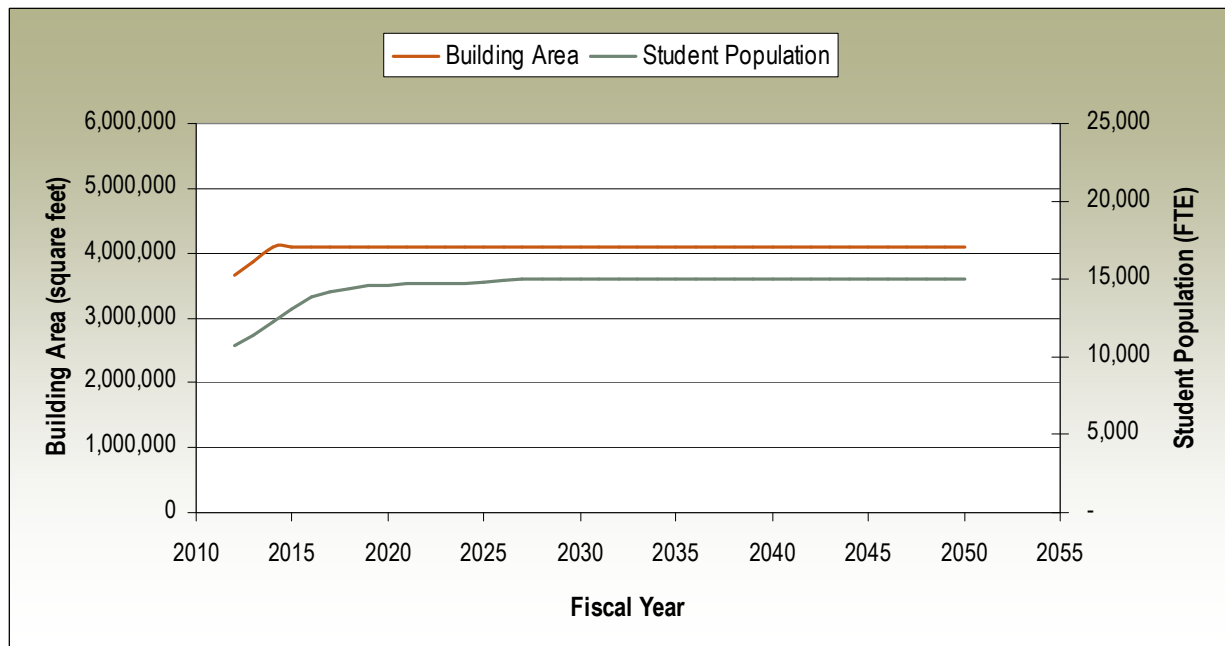
Campus Growth Projection: Student Population and Building Area

UMass Lowell has developed the 2020 Strategic Plan which provides the basis for estimating future growth and expansion at UMass Lowell. In developing BAU emissions projections, these plans were reviewed in consultation with the Controller's Office and Facilities Department to determine how student population (expressed as full-time equivalents (FTEs)) and building area (gross square feet) are expected to change due to future strategic initiatives and campus acquisition, construction, renovation and demolition plans. Figure 2-6 below shows the projected growth in campus population and in building footprint from FY 2012 through 2050.

Campus population is expected to grow quickly from 2012 through 2016 at a five to six percent increase in both graduate and undergraduate FTEs. From 2017 forward, student population (and proportional faculty) growth is expected to slow to 0.5-2% per year until a total student population of 15,000 FTE is achieved. UMass Lowell does not currently believe it will exceed a student population of 15,000 FTE. The campus building area is also expected to

grow quickly from 2012 through 2014 reaching a gross building area of 4.1 million square feet. UMass Lowell does not anticipate further growth in building area beyond 2014.

Figure 2-6: Student Population and Building Area Projected to FY 2050



GHG Emission Trends by Source

According to UMass Lowell's GHG emission inventories from FY 2005-2011, the major sources of GHG emissions include on-campus stationary sources (primarily natural gas and fuel oil used for steam, domestic hot water, comfort heating and emergency electrical generation), purchased electricity and student commuting. Combined, these sources represent 87% of UMass Lowell's GHG emission in FY 2011.

Upon identifying its major sources of GHG emissions, UMass Lowell explored how GHG emissions from these sources fluctuated due to increases or decreases in student population and campus building area. Generally, historic GHG emissions from stationary sources (Scope 1) and purchased electricity (Scope 2) tended to fluctuate with building area while GHG emissions from commuting (Scope 3) fluctuate with the student population. Using the campus growth projections described in the previous Section for student population and building area, BAU projections were established for each emissions source in the inventory by projecting the annual variable growth rate for either the student population or building area projections onto the particular emissions source. A summary of each method used to project future GHG emissions is included in **Table 2-3** below.

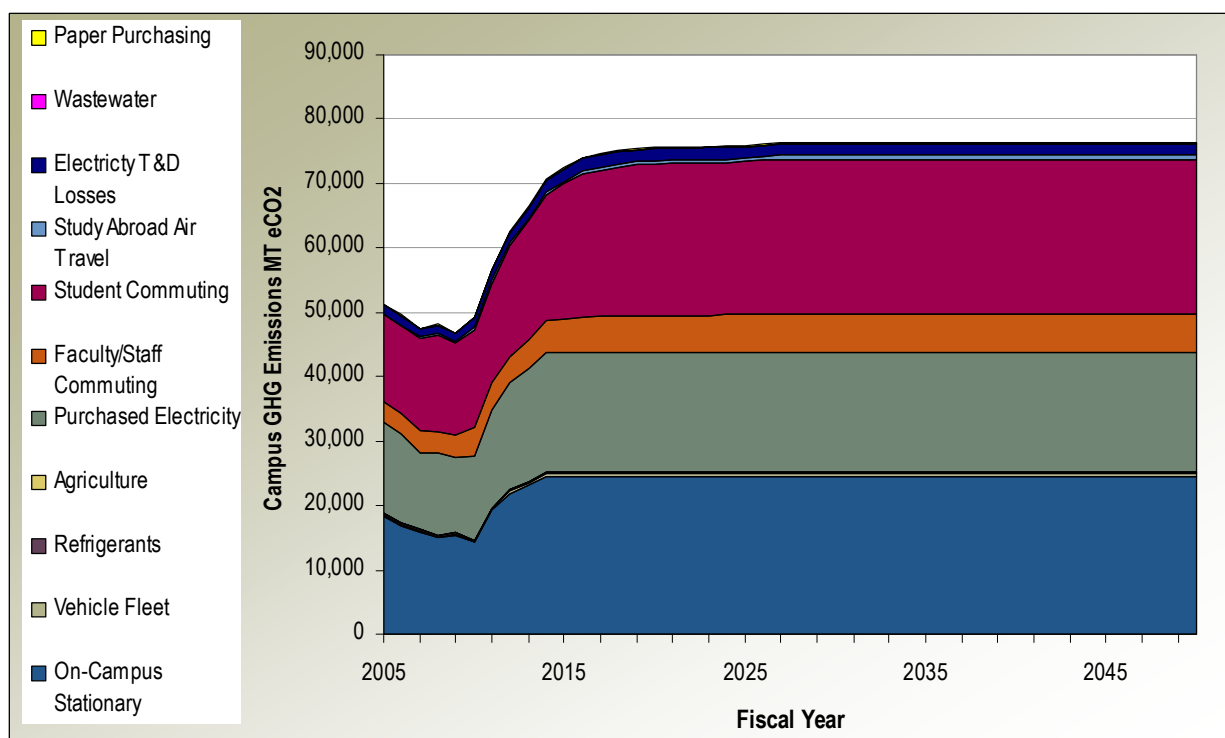
Table 2-3: GHG Emission Projection Method for Each Source

	GHG Emission Source	Projection Method	Reasoning/Improvements
Scope 1	On-Campus Stationary Sources	Gross Building Area Based	Multiple data points available and trends show on-campus stationary source fuel consumption increasing with gross building area.
	Motor Vehicle Fleet: Gasoline and Diesel	Gross Building Area Based	Multiple data points available and trends show motor vehicle fuel consumption increasing with gross building area as the campus facilities group travels to newly acquired/built locations.
	Refrigerants	Gross Building Area Based	Based on gross building area as refrigeration units expected to increase as campus area increases.
	Fertilizer Use and Weighted Avg. % Nitrogen	Gross Building Area Based	Based on gross building area as fertilizer use is expected to increase as campus area increases.
Scope 2	Purchased Electricity	Gross Building Area Based	Multiple data points available and trends show purchased electricity consumption increasing with gross building area.
Scope 3	Student Commuting: Automobile and Bus	Student Population Based	Multiple data points available and trends show commuter miles increasing with student population. This population increase is to be partially offset by the building of more residence halls for students, reducing commuting.
	Faculty-Staff Commuting: Automobile	Student Population Based	Multiple data points available and trends show commuter miles increasing with student population.
	Study Abroad Travel	Student Population Based	Study abroad travel is expected to increase as student population increases.
	Electricity T&D Losses	Based on Purchased Electricity	See Purchased Electricity.
	Wastewater	Gross Building Area Based	Based on gross building area as water use is expected to increase as campus area and population increases.
	Paper Purchases	Student Population Based	Based on student population as paper use is expected to increase as campus population increases.

Business-As-Usual Emission Projections

Based on the projected campus growth and the GHG emission projection method applied to each source (Table 2-4), UMass Lowell developed its projection of BAU emissions from FY 2012 through FY 2050 using the CA-CP Campus Carbon Calculator v6.7. BAU emissions are expected to increase quickly in the near term due to the campus plans for student population growth and building area development. Following this initial stage of high growth, UMass Lowell GHG emissions are expected to increase at a slower rate. These projections result in slightly over 76,000 MT eCO₂ by 2050. For planning purposes, 76,000 MT eCO₂ are the projected emissions that will need to be offset through UMass Lowell action. **Figure 2-7** depicts the projection of GHG emissions through this time period.

Figure 2-7: GHG Emission Projection by Source from FY 2012 through 2050



3. MITIGATION STRATEGIES

3.1 GOAL FOR CARBON NEUTRALITY

The purpose of this CAP is to provide a path for UMass Lowell to achieve carbon neutrality. The CAP is required to include a target date to achieve carbon neutrality and interim milestones to achieve along the way. UMass Lowell has set a target date for carbon neutrality of FY 2050. This date and interim milestone dates were selected based on the following reasons:

- To maintain consistency with three of the other four institutions in the University of Massachusetts System;
- To follow the mandate of the Commonwealth of Massachusetts Executive Order 484 Leading by Example Program;
- Based on UMass Lowell’s BAU GHG emission projections and GHG emission reduction projects that are planned for future implementation;
- In order to drive UMass Lowell to proactively monitor and adopt new technologies, sustainable practices, renewable energy and participate in the energy market to allow the University to achieve reductions that are not presently feasible; and
- To engage the broader campus community to work together to achieve carbon neutrality within a large, urban setting.

To assist in the achievement of the goal for carbon neutrality, UMass Lowell has identified three mitigation strategy phases and set two interim milestones which are based on Campus Performance, specifically, Scope 1 + Scope 2 emissions in MT eCO₂ per 1000 SF and Scope 3 emissions in MT eCO₂ per FTE. This basis allows UMass Lowell to continue its plans for high growth in the short term and recognizes that while total campus emissions may increase, normalized emissions (i.e. MT eCO₂ per 1000 SF and or FTE) will decrease. Rather than setting a campus performance standard for total GHG emissions, a separate campus performance standard was developed for Scope 3 emissions since these consist largely of commuting which is more dependent on student population than campus building area.

Performance standards for Scope 1 + 2 and Scope 3 emissions were selected based on UMass Lowell’s FY 2011 level of performance, and the level of performance of other doctorate level and masters level universities that have reported to the ACUPCC. A comparison of campus performance is provided in **Table 3-1** below:

Table 3-1: UMass Lowell Campus Greenhouse Gas Performance

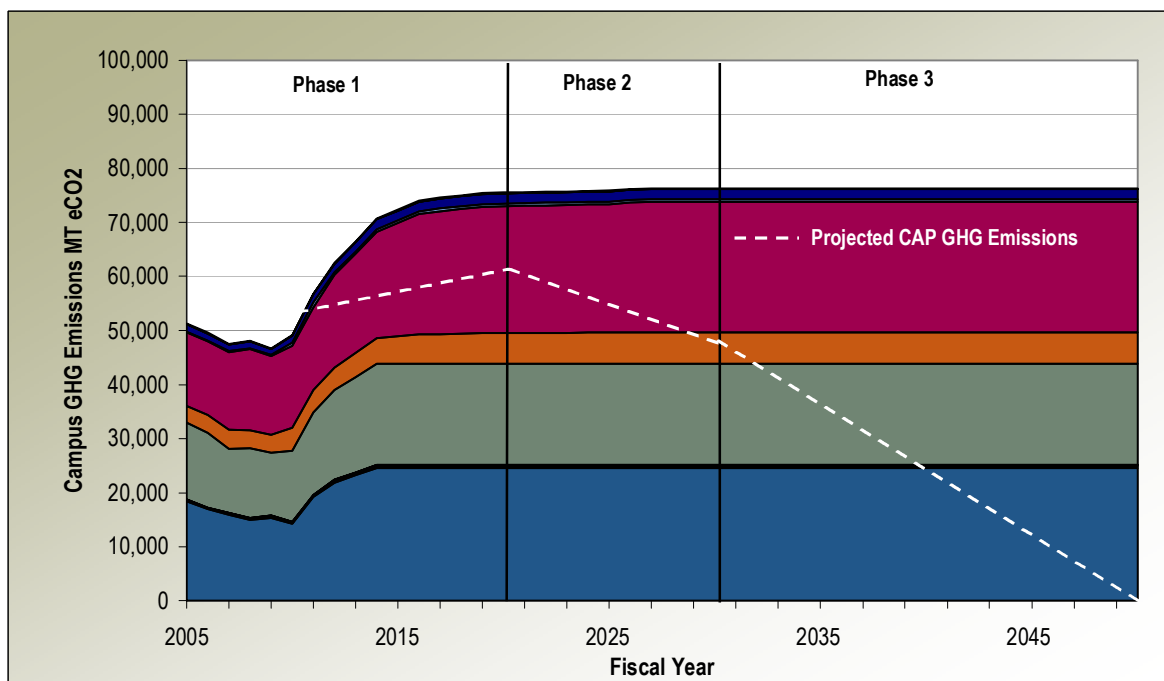
	UMass Lowell FY 2011	ACUPCC Doctorate University Average	ACUPCC Masters Level University Average
Scope 1+ Scope 2 (MT eCO₂/ 1000 SF)	10.22	14.51	10.25
Scope 3 (MT eCO₂/ FTE)	2.14	1.77	1.51

Table 3-2 describes the three phases and interim milestones associated with each phase and Figure 3-1 depicts the GHG mitigation phases graphically.

Table 3-2: GHG Mitigation Phases and Interim Milestones

Phase	Time Frame	Scope 1 + 2 Performance Standard (MT eCO ₂ /1000 SF)	Scope 3 Performance Standard (MT eCO ₂ /FTE)	Goal Net GHG Emissions (MT eCO ₂)	Projected Net GHG Emissions per BAU (MT eCO ₂)	Cumulative Mitigation Required (MTeCO ₂)	Mitigation Required in Phase (MTeCO ₂)
Phase 1	FY2020	8.0	1.9	60,565	75,440	14,874	14,874
Phase 2	FY2030	6	1.5	47,100	76,231	29,131	14,256
Phase 3	2050	0	0	0	76,231	76,231	47,100

Figure 3-1: GHG Mitigation Phases



3.2 PRIORITIZATION OF GHG EMISSION REDUCTION PROJECTS

As outlined in Section 2, the primary contributors to UMass Lowell GHG emissions are on-campus stationary sources, purchased electricity and student, faculty and staff commuting. While efforts will continuously be made to reduce emissions in each of these areas, the priority will be as follows:

Table 3-2: GHG Emission Reduction Priorities

Priority	Category
Priority 1	On-Campus Stationary Sources
Priority 2	Purchased Electricity
Priority 3	Student, Faculty, and Staff Commuting

This selection of priorities was based on the areas UMass Lowell feels it has the greatest opportunity to influence and has fully developed procedures to support in order to make the most immediate impact.

- Priority 1 - Examination of projects associated with on-campus stationary sources is continuously being reviewed and developed by the UMass Lowell Facilities Department. The Facilities Department has both the budget strategy and support to identify and implement GHG reduction projects associated with on-campus stationary sources.
- Priority 2 – UMass Lowell has little control or influence on the mixture of fuels used to generate electricity for the New England Region electrical grid system. However, UMass Lowell will investigate new purchasing approaches or displace purchased energy with renewable energy that could minimize GHGs. UMass Lowell will continue to implement methods for reducing electricity consumption through modernization of building electrical systems and upgrading to more efficient electrical equipment (i.e. lighting, computers, pumps).
- Priority 3 - Student, faculty and staff commuting options are currently being evaluated as part of the campus transportation plan. In addition to new initiatives identified in this plan, the existing rideshare and commuting programs identified in Section 1 will be continued and enhanced where feasible.

Within each of these priorities, projects will be reviewed and evaluated against numerous factors including GHG reduction potential, ease of implementation, cost, project funding options, and the opportunity for integration into the campus curriculum, research and community outreach activities. The Climate Action Plan Implementation Committee will make recommendations to the appropriate stakeholders regarding projects that will best support the goals put forth in this plan.

Funding of GHG Emission Reduction Projects

There are a variety of funding mechanisms that are currently available to implement GHG emissions reduction projects as identified below:

- Annual Capital Projects Budget – UMass Lowell utilizes a portion of its annual budget for capital projects to fund energy and GHG reduction projects. This budget applies only to academic facilities or other UMass system related initiatives.
- Energy Project Budget – This budget is dedicated to completing energy related projects only. These projects typically consist of engineering related energy efficiency and conservation projects, energy contracting, and electronic energy use monitoring.
- Deferred Maintenance Budget – The deferred maintenance budget is used to maintain the capacity and reliability of existing infrastructure. Projects funded under this budget include typical ‘wear and tear’ improvements such as upgrades, replacements and renovations.

- Residential Life Budget – Projects associated with residence halls are funded under the Residential Life budget. These projects may consist of regular maintenance, renewal, or improvements to existing residential buildings, including energy efficiency.
- MA State Funds – As discussed in Section 1, DCAM (Division of Capital Asset Management) is state funded and charged with implementing the Lead By Example Program and will implement projects at State facilities to support its renewable energy and GHG reduction goals. DCAM was most recently responsible for funding the solar PV projects at UMass Lowell.
- University of Massachusetts Building Authority (UMBA) Loan Program – For larger projects on the order of at least \$1M, UMass Lowell can bond energy projects and finance larger reconstruction and improvement projects. Currently the North Campus Boiler Plant project is being completed via a UMBA bond.

In addition to these funding mechanisms, UMass Lowell will continue to explore alternative options to fund GHG mitigation projects. For example, a revolving fund that uses monies from savings achieved from energy efficiency projects to complete new projects current is not in place at UMass Lowell. This is one of several types of alternative funding mechanisms that will be examined by one of the Climate Action Plan Implementation subcommittees.

The University will also explore opportunities for GHG Emission Reduction through applying for Grants, Energy Rebates program, Education/Awareness Programs, and other such opportunities that support overall GHG Emission reduction.

3.3 MITIGATION GOALS AND STRATEGIES

The following sections outline specific strategies that will be implemented to achieve each of the goals outlined in this CAP. At this point, the short term strategies are better understood than longer-term strategies, however the intent is to continually develop additional strategies and update this plan accordingly.

Phase 1 Strategy

The first interim goal in the CAP is to achieve a campus GHG performance standard of 8.0 MT eCO₂/ 1000 SF for Scope 1 + 2 emissions and a performance standard of 1.9 MT eCO₂/FTE for Scope 3 emissions by FY 2020. This represents a reduction in annual GHG emissions by approximately 14,874 MT eCO₂ by FY 2020. The initial strategies to accomplish this goal consist of the following:

- Focus on reduction of GHG emissions from sources that are significant contributors and within the control of UMass Lowell including GHG emissions from stationary sources burning fossil fuels and GHG emissions associated with the purchase of electricity to meet campus electrical demands.
- Focus on capturing more accurate data regarding student, faculty and staff commuting and implement measures to reduce commuting miles and measure progress in this area.
- Work with the CCI and other interested faculty to develop methods for continuing to include climate change and sustainability into UMass Lowell student curricula across a variety of disciplines and explore incentives for motivating faculty to complete research in these areas.
- Work with student groups and the University Public Affairs Department to communicate UMass Lowell's commitment to reducing GHG emissions and promote the progress made along the way.

- Develop a written methodology for calculating annual GHG emissions from UMass Lowell so that consistency is maintained and progress toward goals can be accurately assessed.
- Convene a Climate Action Plan Implementation subcommittee to identify and support execution of additional GHG reduction projects and/or accelerate the implementation of longer-term projects.

Phase 1 Mitigation Projects

As described in Section 2, 33% of the University's GHG emissions are from on-campus fuel burning equipment used for heating and hot water generated and 27% is from purchased electricity. Together, stationary combustion sources and purchased electricity comprise 60% of the University's carbon footprint. During Phase 1, UMass Lowell will continue to identify and implement building HVAC and envelope improvements and create and implement specifications for building performance and materials used in renovation and construction projects. UMass Lowell will pursue opportunities to burn more natural gas in existing systems and retrofit existing oil-fired systems to allow for natural gas combustion as well. UMass Lowell will also continue to look for opportunities to generate small pilot scale and larger scale renewable energy projects and cogeneration opportunities on campus. UMass Lowell does not expect to implement a larger scale project during Phase 1, however, potential options will be identified and the preliminary feasibility studies will be initiated. UMass still needs to weigh the potentially higher up-front costs of LEED high efficiency construction against long range impacts to the environment and reduction of GHG as part of their project prioritizing process. However, impact to the Climate Action Plan will be weighed more heavily than ever before in decision-making process as a poor GHG mitigation decision early on will be very costly to resolve after the building is built. At the planning stage if GHG mitigation is planned it will have a much lower cost impact to the future of the CAP than if we base our decision on first cost.

A summary of the Phase 1 mitigation projects scheduled beginning in FY 2012 are summarized in **Table 3-3**.

Table 3-3: Phase 1 Mitigation Projects Scheduled to begin in FY 2012

Building(s)	Project Name	Estimated Savings GHG (MTE/yr)
North Central Power Plant	North Central Steam Plant Energy Efficiency Project	4,750
O'Leary, Durgin & Weed	Replace obsolete chillers with new magnetic levitation centrifugal chillers	2,885
Weed, Donahue, Sheehy & Concordia	Replace pneumatic controls with automated logic Building Automation System (BAS) for energy conservation	1,122
Durgin, Coburn, Pasteur, Kitson, Lydon, Cumnock, MacGauvran & Alumni	Lighting Efficiency Audits and Improvements	550
All Campuses; Various buildings	Survey steam traps for leaking steam and replace with energy efficient traps.	468

Building(s)	Project Name	Estimated Savings GHG (MTE/yr)
Dugan), Costello Gym , Leitch Hall & Bourgeois Hall	Photovoltaic roof installation 205 KW output will save 274,000kWh per annum. This was constructed in FY2011and turned over to Operations in FY 2012, August 2011	115
Olney	Replaced Olney 150 HVAC	136
Various	Monitoring Based Commissioning	136
ICC	Replace terminal units, install BAS for common areas and large dining & banquet halls - save 491MWh/year	192
Tsongas Center	Install PLC controls and efficient compressors and VFD's on circulating glycol and condenser water pumps and cooling tower fan to reduce energy.	112
	TOTAL	10,466

Additional details on selected mitigation projects are included below:

- The North Campus steam plant efficiency project is expected to result in the greatest Phase 1 reduction in GHG emissions. This project involves replacing two 1950's vintage No. 6 oil fired boilers with two new fully automated natural gas fired boilers (with oil backup). The new boilers operate at over 80% efficiency. This project will reduce the required energy input (fuel consumption) at the North Campus plant by more than 17%. The project began in 2010 and is expected to be completed by the end of 2012.
- Another large GHG reduction project is expected to result from the replacement of several obsolete chillers with new magnetic levitation centrifugal chillers on the South Campus.
- Replacing the current pneumatic controls in Weed, Concordia, Sheehy and Donohue with a Building Automation Systems (BAS) will conserve energy and better control of HVAC systems.
- Lighting efficiency audits have been completed on Kitson and Pasteur and these buildings will be upgraded with high efficiency lighting by the end of January 2012. A series of similar projects are planned for Cumnock, MacGauvran, Durgin, O'Leary, Alumni, Coburn, and Lydon.
- Replacing and repairing leaking steam traps is expected to reduce steam usage by 5 to 10%. The University is planning a major steam trap survey of all traps on the North and South Campuses in FY 2012. This project is co-funded by National Grid with the caveat that the utility will pay 100% of the survey and 50% of all labor and materials.
- Photovoltaic roof installations, potential small scale cogeneration; window replacement projects, and monitoring-based commissioning will also contribute to Phase 1 GHG reductions.



- Energy audits of the campus buildings are required to update us on the state of systems on campus and the potential reductions with benefit:-cost ratios so that priorities can be established.
- Alternative financing to be pursued to enable further GHG mitigation projects to be realized.

Student and Faculty/Staff Commuting

UMass Lowell is currently a predominantly commuter school with approximately 65% of its undergraduate students living off-campus in the surrounding towns and cities. According to the methodology used in the FY 2011 GHG



emissions inventory, the average one-way trip traveled by a commuter student is estimated to be 13 miles. GHG emissions associated with student commuting represent over 26% of UMass Lowell's GHG footprint and student and faculty/staff commuting collectively contribute to over 30% of the GHG footprint. The 2020 Strategic Plan calls for an increase in the number of students living on campus from 35% in FY 2011 to approximately 50% by 2020. This initiative will reduce the number of commuting miles travelled, however, there will be associated gains with stationary source and electricity emissions due to the increase in conditioned building space required to house more students in residence halls.

UMass Lowell is in the process of finalizing a Campus Transportation Plan and has worked with BHB Engineering to identify options for reducing commuting miles traveled through a variety of mechanisms. The Plan shows that there is a good potential for alternative modes of transportation as many commuters live within walking distance (1 mile), biking distance (3 miles) or within a short walk of the Lowell Regional Transit Authority (LRTA) route to North campus or South Campus. During Phase 1, UMass Lowell is going to make progress toward implementing the recommendations of the Campus Transportation Plan which focus on the following areas:

- Infrastructure – UMass Lowell will take advantage of its urban campus setting and promote walking and biking and improve traffic management. UMass Lowell plans to explore the concept of a “Boulevard” on Pawtucket Street connecting South and East campuses which will make the campus friendlier to walkers and cyclists. In addition, traffic signal and safety improvements will be pursued along with a “Main Streets” concept which will combine pedestrian safety with attractive design. Main Streets being considered include Broadway on South Campus, Pawtucket Street on East Campus, and University Avenue on North Campus.
- Transportation Demand Management (TDM) – The UMass Lowell Campus Transportation Plan recommended the hiring of a TDM coordinator (or assigning those duties to existing staff) to oversee the various transportation alternatives available to students, faculty and staff. The TDM coordinator will encourage carpooling, public transportation, walking and cycling through outreach, information and incentive programs.
- Parking Management – UMass Lowell will continue to analyze on-campus parking (which is currently at a minimum) to determine if new parking spaces are needed and the pros and cons (i.e. development on potential green space, athletic areas) of new parking structures/lots. The University will begin to implement preferred parking for carpools and fuel efficient vehicles.

- Policy – UMass Lowell will explore current campus policies that influence commuting such as class scheduling to determine if changes can be made to encourage carpooling. In addition, new policies will be explored such as the “Park Once” concept that allows commuters to park in a single location during the day and requires them to walk or take on-campus or public transportation to all campus or downtown Lowell locations once they have arrived.

In addition to the initiatives described in the focus areas above, UMass Lowell also plans to explore the following as recommended by the Campus Transportation Plan:

- Expand weekend “entertainment” shuttles.
- Study improved services for mobility limited individuals.
- Investigate the feasibility of pre-tax payment for transit passes for those riding public transportation.
- Advocate with LRTA for improved coordination.
- Coordinate with National Park Service and the City of Lowell on the expansion of the trolley line.
- Introduce automatic vehicle location services for shuttles.
- Install bike racks on buses.
- Investigate flexwork/telework programs.
- Work with Zipcar to expand the car sharing program.

In addition to implementing the recommendations in the Campus Transportation Plan, UMass Lowell recognizes that previously collected data describing and quantifying commuting habits is insufficient to accurately assess and measure progress toward the Campus Transportation Plan goals and GHG emission reductions. The University will identify and implement better methods of data collection (i.e. commuting surveys, info required to receive parking permit) and assessment to more accurately determine commuter miles traveled and subsequent GHG emissions.

UMass Lowell will also continue to offer more online classes through the Division of Online & Continuing Education.

Phase 2 Strategy

During Phase 2, UMass Lowell’s goal is to achieve a campus GHG performance standard of 6.0 MT eCO₂/ 1000 SF for Scope 1 + 2 emissions and a performance standard of 1.5 MT eCO₂/FTE for Scope 3 emissions by FY 2030. This results in a net total of 47,100 MTeCO₂ by the year 2030. According to BAU projections, this represents a 29,131 decrease below projected FY 2030 emissions and an additional 14,256 MT eCO₂ mitigated upon Phase 1 projects. To achieve this goal, UMass Lowell will build upon the studies performed and data gathered during Phase 1. UMass Lowell has not yet identified the specific projects that it will implement to meet the Phase 2 goal, however these project details will be added to this CAP as decisions are made and data are available. Phase 2 project identification will include reviewing the latest incentives such as Massachusetts Alternative Energy Credits that pay for cogeneration, California’s White Tags programs that place a value on efficiency, Organic Waste Programs or other emerging programs.

UMass Lowell anticipates that growth in student enrollment and campus building area will be much slower during Phase 2, compared to Phase 1, and that Phase 2 represents an excellent opportunity to focus on making existing campus energy systems as efficient as possible and to dedicate resources toward the selection, design and possible

implementation of a larger renewable energy project. Student and faculty commuting will continue to represent a large portion of UMass Lowell's GHG emissions profile, however, during Phase 2, a greater percentage of students will be living in on-campus housing. Many of the recommendations described in the Campus Transportation Plan will have been implemented and UMass Lowell should have the systems in place to quantitatively assess the results of implementation.

Phase 3 Strategy

During Phase 3, UMass Lowell's goal is to reduce net annual GHG emissions to become carbon neutral by the year 2050. According to BAU emission projections, this represents an additional annual reduction of 76,000 MT eCO₂ over FY 2011 levels. UMass Lowell does not anticipate that it will be possible, even in the future, to be considered carbon neutral without the help of a large scale renewable energy project or as a last resort, the purchase of RECs or offsets. To achieve carbon neutrality, UMass Lowell plans to implement larger on-campus or off-campus renewable energy projects. Some of these projects might include large wind, solar, biogas or hydro components. This section provides a brief summary and analysis of renewable energy projects that UMass Lowell plans to consider.

While currently viewed as a last resort, Renewable Energy Credits (RECs) or carbon offsets may be considered as possible techniques to obtain necessary reductions that cannot be achieved through on-campus projects. RECs are not the same as carbon offsets. A REC is proof that one MWh of electricity has been generated from a renewable source. In order to take "credit" for the reduction in GHG emissions from purchasing renewable power, the RECs associated with that power must also be purchased. A carbon offset represents the act of reducing, avoiding, destroying or sequestering one ton of carbon dioxide equivalents to "offset" an emission taking place elsewhere. Offsets must be real, permanent, verifiable, and most importantly "additional" to a business-as-usual scenario (i.e. the reduction would not have happened otherwise).

Wind

UMass Lowell will review the feasibility of conducting a wind metering analysis for feasibility determination at the South Field along the perimeter boundary with open exposure to the prevalent Merrimack River's wind stream.

Given UMass Lowell's limited wind resource, neighborhood, and space constraints it is unlikely that a large scale on-campus wind energy project could be developed. That said, UMass Lowell might enter into a contract with a third party to purchase power and environmental attributes generated from an off-campus wind energy project for a tens of megawatt project. Given UMass Lowell's credit worthiness, long term energy needs and long term stability, the University's commitment to a project would be significant and financeable.

Solar

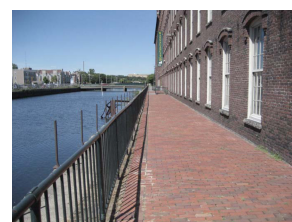
UMass Lowell's current campus comprises approximately 150 acres within an urban landscape. Based on current technology and emission reduction requirements, a solar array in the magnitude of several hundred acres would be

required to offset enough emissions to achieve carbon neutrality. That approach may not be practical on campus but supporting large solar developments off-campus with a commitment to buy power and environmental attributes might be a solution for carbon neutrality. Several large solar arrays are currently under development in the region and require investment grade purchasers for power. UMass Lowell could be instrumental in moving these projects forward and directly responsible for promoting renewable energy construction in the region.



Hydropower

The UMass Lowell campus and greater Lowell community embody a rich history of hydropower as a source of energy in various hydro-electric and mechanical applications. This energy was harvested to empower the development of the City and in many ways embodies intelligent use of resources. That said, hydropower application for power generation has become limited due to environmental conditions created as part of impeding water flows. The campus might consider some designs to generate renewable energy but a larger scale project in the tens of megawatts range would not be viable. As highlighted above, UMass Lowell might consider receiving power from a project and enabling development through a long term financial commitment.



Landfill Gas

The Westford Street Landfill located within the City of Lowell is currently producing electricity from the landfill gas (LFG) generated. The energy generation operation is currently run by MM Lowell Energy LLC. UMass Lowell might explore the use of this LFG on campus but it is believed that the bulk of the gas generated by the landfill is being used by MM Lowell Energy LLC to produce electrical energy that is distributed into the grid. UMass Lowell might explore alternative uses of this gas but it is unlikely to be a viable option since the gas is already utilized. In the future, if additional gas becomes available this would likely be a very cost effective project.

Others

Given the long term nature of Climate Action Planning, other technologies may be developed or become economical as the plan matures. In addition, new incentives may arise like Massachusetts Alternative Energy Credits that make systems such as cogeneration more economically viable. By developing this plan and supporting committees, UMass Lowell will continue to evaluate options for energy production such as cogeneration or new emerging technologies that may not be available now.

These are a few of the larger projects that might be deployed to reach carbon neutrality. Each of these cases will have positive and negative attributes. The most important consideration in this plan is to understand the options available to the community and continuously review opportunities that might arise due to new technologies, grants or economic conditions. A subcommittee of the Climate Action Plan Implementation Committee will be formed to monitor new programs and technologies. UMass Lowell will continuously implement opportunities as they arise on

campus and monitor for larger projects that may not be on-campus but could be directly attributable to UMass Lowell's actions.

4. EDUCATION, RESEARCH AND COMMUNITY OUTREACH

UMass Lowell's mission is to "enhance the intellectual, personal, and cultural development of its students through excellent, affordable educational programs. The University seeks to meet the needs of the Commonwealth today and into the future and supports the development of sustainable technologies and communities through its teaching, research, scholarship and engagement." The University's mission is directly in line with a core requirement of the ACUPCC: to develop and implement strong research, education, and outreach programs to educate students, faculty, their broader communities, our elected officials, and other stakeholders about climate change mitigation and adaptation. This requirement is also directly aligned with the nine overarching goals of the UMass Lowell 2020 Strategic Plan as follows:

1. improve the quality of academic programs on the undergraduate and graduate level;
2. ensure that diversity and pluralism is addressed in all aspects of the strategic plan;
3. improve the entire learning experience for students;
4. increase research and scholarship;
5. strengthen corporate and community partnerships;
6. strengthen revenue sources;
7. ensure that environmental sustainability is addressed in all aspects of the strategic plan;
8. maximize infrastructure: physical plant, technology, budget systems, and human resource review to support all goals; and
9. achieve recognition for the quality of academic programs, student learning, research, and partnerships.

Education, research and outreach are critical to UMass Lowell's CAP for many reasons, including:

- The majority of UMass Lowell GHG emissions are generated by commuting and electricity consumption. As such, a major component of UMass Lowell's climate commitment is linked to 'mindset shifts' and behavior change among students, faculty, and staff;
- As a public institution committed to carbon neutrality by 2050, UMass Lowell can serve as a regional and national model to catalyze change in other institutions and organizations. However, without education and outreach efforts to demonstrate and publicize its successes, this opportunity will be lost; and
- Energy and environmental policies on the federal and state level have a direct impact on future campus efforts required to meet our goal of carbon neutrality. For example, climate-neutral electricity is currently more expensive in Massachusetts than electricity from coal-fired plants, creating a disincentive and barrier for meeting neutrality. Removal of such disincentives requires broader societal change, which is only possible by building public support through education and outreach.

As described in Section 1, the UMass Lowell CCI is uniquely positioned to address these issues and has already demonstrated its ability to obtain external funding, develop new academic courses and programs and engage the public beyond UMass Lowell. It is anticipated that the Climate Action Plan Implementation Committee will work very closely with the CCI to implement the education, research and outreach portions of this plan and develop additional measures and metrics for monitoring progress.

4.1 EDUCATION

A core requirement of the American College and University Presidents' Climate Commitment (ACUPCC) is to develop and implement strong research, education, and outreach programs to educate students, faculty, their broader communities, our elected officials, and other stakeholders about climate change mitigation and adaptation. In the UMass Lowell Climate Change Initiative (CCI), our University already has a cross-disciplinary organization that was established in 2009 and is committed to these goals. While still growing, the CCI currently includes a Steering Committee and Advisory Board drawn from faculty members of twelve academic departments and five UMass Lowell Colleges and Schools, as well as the two UMass System-Wide intercampus programs, the School of Marine Sciences and the Biomedical and Biotechnology Engineering program. While still in its early stages, the CCI has already demonstrated its ability to obtain external funding, develop new academic courses and programs, and to engage the public beyond UMass Lowell.

Education and outreach are critical to UMass Lowell's Climate Action Plan (CAP) for many reasons, including:

- With 34% of UMass Lowell greenhouse gas emissions coming from commuting and a large percentage of targeted emissions reductions coming from reduced energy use, a major component of UMass Lowell's CAP commitments are linked to 'mindset shifts' and behavior change among students, faculty, and staff. The CCI is poised to meet that need;
- As a public institution committed to becoming climate-neutral by 2050, we can serve as a regional and national model to catalyze change in other institutions and organizations. However, without education and outreach efforts to demonstrate and publicize our successes, this opportunity will be lost; and
- Meeting our goals would be greatly facilitated by policy changes beyond our campus – for example, climate-neutral electricity is currently more expensive in Massachusetts than electricity from Fossil-fuel plants, creating a disincentive and barrier for meeting our CAP commitments. Removal of such disincentives requires broader societal change, which is only possible by building public support through education and outreach, once again, core activities of the CCI.

To our knowledge, there are no existing climate action plans which focus on the strength of a regionally-populated and high-retention living institution by using community projects/service learning/living laboratory techniques. UMass Lowell has a unique opportunity to fulfill one of the core goals of the ACUPCC – the lasting and effective integration of sustainability education into the core curriculum (meaning the foundational principles of teaching, but not necessarily isolated into a 'core requirement') in order to prepare students, as citizens, to lead effective change in their communities.

As described in Section 1, UMass Lowell offers over 70 climate and environment-related courses and several undergraduate and graduate degree programs. The University is committed to expanding existing efforts to further integrate sustainability education into the core curriculum in order to prepare students, as citizens, to lead effective change in their communities. As part of this effort, new course offerings and degree programs are continually being developed. As one example, the College of Engineering is in the process of proposing a new minor in Energy Engineering for undergraduate degree programs. As part of the rationale for developing this minor, the College of Engineering recognizes that issues related to energy are, and will likely continue to be, of great interest to UMass Lowell stakeholders including students, industry, and government. The objective of the Energy Engineering Minor is to provide students training and education regarding energy generation, storage, and usage. Possible courses may include: alternative energy systems, green energy engineering, electric vehicle technology, green and sustainable civil engineering, solar energy engineering, and aero/wind engineering. This minor is targeted to reach more of the undergraduate population. In order to fully develop this minor and offer new opportunities in this area, the College of Engineering has future plans to add faculty to develop and teach these new courses.

In order to more formally and systematically expand climate education and outreach efforts throughout the University has drafted the following Climate Action Education & Outreach Goals. These goals have been approved by both the CAP Implementation Committee and the 2020 Strategic Committee on Facilities Renewal and Campus Master Planning, but have not yet been reviewed or approved by the Dean's Council, the Provost's Office, the Faculty Senate, or the Development Office.

Potential Climate Action Education & Outreach Goals – Currently Under Review

1. **Goal:** Explore climate change education as a recognized and emphasized theme across the University curriculum.
2. **Goal:** Develop faculty capacity for climate change education and research that can become known for its excellence.
3. **Goal:** Integrate UMass Lowell Climate Change academic and research activities with those of the UMass system and with the regional needs.
4. **Goal:** Promote these academic and research components of the UMass Lowell Climate Action Plan to raise external funding.

4.2 RESEARCH

Research at UMass Lowell aims to develop innovative solutions and technologies to tackle the world's toughest challenges. From focusing on today's demands for clean, sustainable energy to fueling major medical breakthroughs, the University's research happens through creative collaborations in academic departments, through 37 interdisciplinary research groups, by graduate and undergraduate students, and with corporate sponsorship and leading national research institutes. Cutting-edge research is taking place every day in UMass Lowell labs and research centers as described in Section 1. The University will continue to identify new research opportunities and initiatives. It is anticipated that the Climate Action Plan Implementation Committee will form a specific subcommittee focused on research and will work with University research centers to more formally track climate-related research expenditures and set measurable goals to increase climate research. New research opportunities may be identified by expanding upon existing projects and partnerships, fostering collaboration among University researchers, campus experts, centers and institutes, and improving communication to disseminate research results both on and off campus.

4.3 COMMUNITY OUTREACH

The CCI's proposed Climate Action Education & Outreach Goals described above include specific actions UMass Lowell can take to increase awareness of climate change in the local community as well as at the regional and national levels, engage external stakeholders, and leverage partnerships to advance efforts, catalyze action in the broader community and offer students a way to put studies into practice. It is anticipated that the Climate Action Plan Implementation Committee will form a specific subcommittee to work with CCI to more formally coordinate and track community-outreach efforts so that progress can be monitored.

The CCI is currently working on several community outreach initiatives including an upcoming climate change series to be developed in partnership with the Lowell Telecommunications Corporation (LTC), the local public broadcasting station. Some of the topics under consideration for the future series include: the October 2011 CCI Teach-In, UMass Lowell's climate action planning efforts and specific mitigation projects, climate change evidence based on data collected by Thoreau, green design features of the new ETIC building, as well as interviews of future guest speakers on climate issues. The recordings will not only air on local television but can also be uploaded to the CCI website.

CCI has identified faculty that will spearhead and coordinate the climate change series effort. CCI is also planning to host regular events with a possible target of at least four events per year.

The Student Environmental Alliance (SEA) will also be launching a media campaign in the Spring of 2012 to raise awareness of environmental issues with a focus on climate change and increasing student involvement. The UMass Lowell Center for Industrial Competitiveness hosts an ongoing speaker series and has selected climate change as the topic for the Fall 2012 event.

In addition to the outreach goals proposed by CCI, future outreach activities could also include energy use competitions between dorms, continued collaboration with the City of Lowell on sustainability issues including expanding public transportation options and improving routes to increase ridership, an energy awareness campaign, use of TV monitors and bulletin boards across campus to promote events and share information, and exploring the possibility of increasing visibility of climate-related information on the UMass Lowell main web page.

5. SUMMARY AND NEXT STEPS

With the submission of this CAP, UMass Lowell has fulfilled an important aspect of its commitment as a signatory to the ACUPCC. This CAP will serve as a roadmap for UMass Lowell to continue to make progress toward achieving carbon neutrality. This plan is intended to be a dynamic plan and will be continually updated as new strategies are developed.

The Climate Action Plan Approval Committee has served as the primary group of stakeholders involved in the development and approval of this plan. This committee will now transition its efforts to implementing this plan and will become the Climate Action Plan Implementation Committee. The Climate Action Plan Implementation Committee will convene for its first meeting in February 2012 and discuss implementation strategies. Some of the first actions of the Climate Action Plan Implementation Committee will consist of the following:

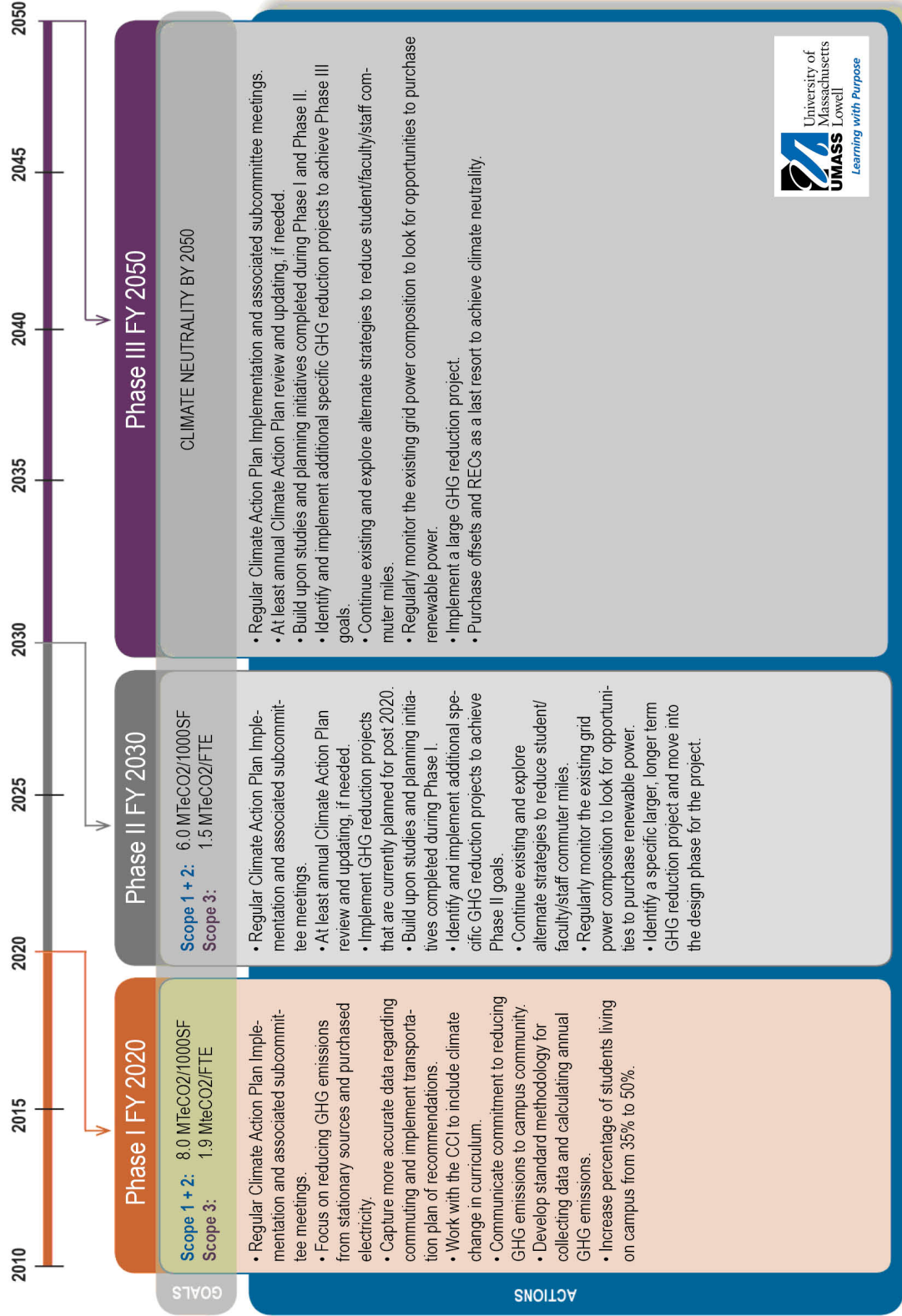
- Appoint organizational roles, such as a Chair, Assistant Chair and Meeting Minute Taker, for the Committee, determine the level of effort or involvement for each role, define expectations moving forward and identify meeting frequencies.
- Assess the existing committee membership and identify areas which may not be currently represented. In this case, identify potential representatives to include on the Climate Action Plan Implementation Committee.
- Develop the organizational structure of the Committee and point people to report out to senior management and interface with other key organizations such as the Dean's Council, Climate Change Initiative, Student Government and the Student Environmental Alliance.
- Identify functional areas to be addressed and develop subcommittees to work on implementing specific aspects of the plan (example subcommittees may include renewable energy, commuting, education and research, community outreach and long-term strategic initiatives).
- Identify protocols to be developed or implemented and the responsible parties involved. Some examples that have already been discussed during the development of this plan consist of data collection and analysis of GHG emissions and means and methods to identify progress toward the goals put forward in this plan.
- Consider strategies to educate the larger campus community on the work being completed by the Climate Action Implementation Committee.
- Identify other entities, organizations and individuals that have resources or skills that can support the implementation of this CAP. Identify how to most effectively engage these resources to support the goals of this plan.
- Develop, and review the methodology for accurately and consistently capturing data on energy savings and GHG reduction efforts achieved by each project. Implement measurement and verification process to accurately prove energy reductions and process accurate real-time savings for large mitigation projects.

By developing a functional, multi-disciplinary organizational structure fully endorsed by the University administration and executing the actions identified above, UMass Lowell is demonstrating a focused and serious effort to achieving the goals outlined in this CAP and to its commitment as a signatory of the ACUPCC. The Climate Action Plan Implementation Committee recognizes the work ahead is significant and is fully committed to progressing toward carbon neutrality. The University has made considerable progress to date and intends to accelerate its progress by bringing together talent within and beyond the campus community to work on this important initiative.

Figure 5-1 summarizes the climate action goals and mitigation strategies of this plan:

Figure 5-1: Summary of Climate Action Goals and Mitigation Strategies

FIGURE 5-1: SUMMARY OF CLIMATE ACTION GOALS AND MITIGATION STRATEGIES



APPENDIX A: CLIMATE RELATED COURSES

Undergraduate

*New or newer courses, Spring 2012

- Air Pollution
- Alternative Energy Sources
- Advanced Atmospheric Dynamics I
- Advanced Atmospheric Dynamics II
- American Environmental History
- Atmospheric Dynamics
- Biology of Global Change
- Climate Change: Science, Communication and Solutions*
- Community Health and Environment
- Designing the Future World
- Earth and Environmental Systems I
- Earth and Environmental Systems Laboratory
- Earth and Environmental Systems II
- Electric Vehicle Technology
- Environmental Engineering
- Environmental Geochemistry
- Environmental Health Seminar
- Environmental Law
- Environmental Microbiology
- Environmental Philosophy
- Environmental Problems Seminar
- Environmental Radiation and Nuclear Site Criteria
- Environmental Studies Practicum
- Global Environmental Policy
- Human Ecology
- Introduction to Environmental Economics
- Introduction to Environmental Studies
- Physical Climatology
- Physical Meteorology
- Principles of Ecology
- Principles of Ecology Laboratory
- Principles of Environmental Health
- Public Transit Plan and Design
- Regional Health and Environment
- Sociological Approaches to the Environment
- Sustainable Development
- Sustainable Housing Development and Land Use: Policy and Practice
- Thoreau in Our Time*

- Weather and Climate
- Weather and Climate Laboratory

Graduate

- Air Pollution Control
- Air Pollution Phenomenology
- Alternate Energy Sources
- Atmospheric Structure and Dynamics
- Biology of Global Change
- The Climate System
- Comparative Environmental Studies
- Economic Analysis
- Electric Vehicle Technology
- Energy and Environment
- Energy Engineering Workshop
- Environmental Aquatic Chemistry
- Environmental Fate and Transport
- Environmental Chemistry
- Environmental Law
- Environmental Law and Policy
- Environmental Microbiology
- Environmental Radiation and Nuclear Site Criteria
- Evolution in Context for Teachers
- Green and Sustainable Civil Engineering
- Politics and Economics of Public Policy
- Remote Sensing of the Atmosphere
- Simple Atmospheric Models
- Solar Engineering Fundamentals
- Solar Systems Engineering
- Sustainable Housing Development and Land Use: Policy and Practice
- Sustainable Water Infrastructure
- Teaching General Science and Seminar
- Teaching Biology and Seminar
- Teaching Earth Science and Seminar