Eastern Connecticut State University
Connecticut's Public Liberal Arts University

Eastern Connecticut State University
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Eastern Connecticut State University

CLIMATE ACTION PLAN

THE GREENING OF EASTERN

December 2009

CONTENTS

Preface

President Nuñez was one of the early signatories of the American College & University Presidents Climate Commitment (ACUPCC). Eastern's implementation date was September 15, 2007.

In 2007 Eastern selected the Green Campus Committee (GCC) as the campus group that is responsible for implementing the Climate Commitment and designated Nancy Tinker, director of Facilities Management and Planning and the chair of the GCC, to be the Implementation Liaison for the ACUPCC.

The first action taken by the GCC was to submit the Institutional Profile on November 16, 2007. In that document, the GCC indicated that Eastern had met the requirement for two tangible actions.

- Eastern had already constructed three LEED certified residence halls and was constructing the Science Center which was designed to qualify as a LEED Silver building. The State of Connecticut requires that all new state buildings be certified as LEED Silver.
- Eastern is in compliance with state policy that requires that all appliance purchases be ENERGY STAR certified products.

On September 18, 2008, the GCC submitted its 2008 Greenhouse Gas report to the ACUPCC. In that report, the GCC documented that the sum of its Scope 1, 2, and 3 emissions equaled 13,688 metric tons of CO2e for the fiscal year ending on June 30, 2008 (FY08). We also reported our estimate of Scope 3 emissions associated with commuting to equal 11,600 metric tons. Eastern's emissions, without the inclusion of the estimated commuting contribution, is equivalent to 2.7 metric tons per FTE student and 6.9 metric tons per 1000 gross square feet of campus building space.

The Presidents Climate Commitment required that by December 15, 2009 Eastern would develop an institutional action plan for becoming climate neutral. The ACUPCC required that the plan include the following components.

- A target date for achieving climate neutrality as soon as possible.
- Interim targets for goals and actions that will lead to climate neutrality.
- Actions to make climate neutrality and sustainability a part of the curriculum and other educational experiences for all students.
- Actions to expand research or other efforts necessary to achieve climate neutrality.
- Mechanisms for tracking progress on goals and actions.

The current document and its appendices describe Eastern Connecticut State University's climate neutrality goals and our plan for reaching these goals.

Goals

Current Status of Greenhouse Gas Emissions

Our current greenhouse gas emissions are associated with heating, electricity, solid waste disposal, and travel. The contributions from each of these sources are summarized in Table 1.

Table 1. Current Greenhouse Gas Emissions (FY 2009)

Electricity (Purchased)	9.3 thousand MT CO2e
Heating (Natural Gas and Heating Oil)	4.9 thousand MT CO2e
Travel (Gasoline and Diesel fuel)	0.3 thousand MT CO2e
Solid Waste Disposal	-1.5 thousand MT CO2e
Total	13.0 thousand MT CO2e

This table includes updated figures for fiscal year 2009. The units are metric tons of carbon dioxide or other gases expressed in terms of equivalent tons of CO2.

The **electricity** term in Table 1 is from all electricity use on campus, including lighting, air-conditioning, auxiliary equipment, computers, and appliances.

The **heating** term is associated with burning fossil fuel for space heating and water heating in residence halls, offices, and other campus buildings. Most (99%) of the heating emissions are from burning natural gas.

The **travel** shown here is official university travel by faculty and staff. We have **not** included greenhouse gas emission associated with commuting in this figure.

The credit for **solid waste disposal** arises because we recycle some of our solid waste and because the remainder of the solid waste is sent to a waste to energy (WTE) power plant by our solid waste management company, Willimantic Waste Paper.

The challenge for the university is to continue to provide needed services (heat, light, electric power, air-conditioning) and accommodate demand for improved facilities while reducing and eventually eliminating greenhouse gas emissions.

Target Date - 2050

The Goal of Eastern Connecticut State University is to achieve climate neutrality by 2050. This means that our greenhouse gas emission would be reduced to zero by this date. The GCC developed this date based on a careful assessment of institutional resources. Achieving this goal requires an average annual decrease in greenhouse gases equal to 325 MT CO2e. Eastern will achieve carbon neutrality goal by a combination of energy conservation, recycling, use of renewable energy, and purchase of carbon offsets.

Interim Targets

Table 2 defines Eastern Interim Carbon Reduction Targets.

Table 2. Interim Carbon Reduction Targets
(thousand metric tons carbon dioxide equivalent)

2010	13.0
2015	11.4
2020	9.8
2030	6.5
2040	3.2
2050	0.0

Education Plan

Through a combination of formal and informal programs, Eastern students will learn about and participate in activities to realize Eastern's climate action plan.

Research Plan

Eastern will encourage the further development of student and faculty research in sustainability, use of the campus as a learning tool, and joint projects with the Institute for Sustainable Energy.

Tracking Mechanism

The Green Campus Committee will serve as the tracking body and will inform the president and the campus community about Eastern's success in meeting these goals through an annual report and open forum.

Strategies

Introduction

Achieving our carbon neutrality target date and meeting each of the interim targets are goals that Eastern takes very seriously. We know that this task will be a challenge, but we believe these targets are realistic.

Table 1 demonstrates that four areas determine Eastern's carbon footprint: Electricity, Heating, Travel, and Solid Waste. We have developed different strategies for reducing carbon emission in each area.

Electricity

We estimate that lighting and electronics, ventilation, and cooling each consume about 1/3 of campus electricity. We can reduce the electricity consumed by lighting and electronics through more efficient technology and changes in resident behavior. Reduction in the other 2/3 of campus electricity consumption is related to building and HVAC system design and operation. New buildings that require much less energy to cool and ventilate can be designed and built, but most current campus buildings will still be operational in 2050. So, Eastern will have to replace chillers, fans, heat exchangers, and pumps with more efficient models, improve insulation, lower infiltration, and operate existing buildings more efficiently. We estimate that we will be able to reduce campus electricity demand by 50% of its present value by 2050; this is equivalent to reducing carbon emissions by 4.5 thousand MT.

Eastern also has the option of generating its own electricity using fuel cells, solar electricity, wind power, and combined heat and power. All of these technologies are practical and currently available, but require substantial capital investment and careful planning prior to implementation. We estimate that by 2050 the campus could generate more than 30% of the electricity that it currently consumes; this is equivalent to reducing carbon emissions by 2.8 thousand MT.

The combination of conservation, improved efficiency, and use of renewable energy technologies could reduce carbon emission associated with electricity consumption from 9.3 thousand MT to 1.9 thousand MT. This is equivalent to an annual reduction of 186 MT.

Heating

We estimate that 2/3 of heating energy is used for space heating and 1/3 is used for hot water heating. At least 70% of campus hot water heating energy could be economically supplied by solar hot water systems; this is equivalent to reducing carbon emissions by 1.1 thousand MT.

Space heating can be reduced by improved building design for new buildings, improvements in insulation and infiltration in existing buildings, more efficient heating equipment, better heating controls, deeper setbacks, geothermal heating, and combined heat and power. We estimate that we can reduce the energy used for space heating by 50%; this is equivalent to reducing carbon emissions by 1.6 thousand MT.

The combination of conservation, improved efficiency, and use of solar hot water heating could reduce carbon emission associated with space heating and hot water heating from 4.9 thousand MT to 2.1 thousand MT. This is equivalent to an annual reduction of 69 MT.

Travel

Carbon emissions associated with official university travel is small, about 0.3 thousand MT. More than 85% of travel emissions are related to air travel. Although we can reduce ground travel carbon emission by using more efficient vehicles, by better trip planning, and by converting to electric vehicles, there is not much we can do to reduce air travel carbon emission, except flying less. We can raise funds to offset all official university air travel. We assumed that we will purchase carbon offsets for most of university air travel; so that, we reduce the carbon emission associated with travel from 0.3 thousand metric ton zero. This corresponds to an annual reduction of 7 MT.

Solid Waste

We estimate that Eastern produces 2440 tons of solid waste annually. Approximately 10% of this waste stream is recycled and the remainder is incinerated in a waste to energy (WTE) plant. The carbon emission value of this method of solid waste disposal is – 1.5 thousand MT CO2e. The minus sign means that this method of disposal produces a carbon credit because the WTE displaces fossil fuel energy and recycling reduces energy demand.

Our goal is to recycle 55% of campus waste. If we achieve this goal without changing the total volume of waste, the carbon emission value of our solid waste disposal process would equal -4.0 thousand MT. This corresponds to a total carbon emission reduction of 2.5 thousand MT or an annual reduction of 63 MT.

Other

We have examined other methods of carbon emission reduction, such as changes in use of the land owned by the university and the composting of food wastes, but have not found significant opportunities for emission reduction. We are also considering earning offset credits by helping the local community reduce its carbon emission through conservation and greater efficiency, but have not yet estimated the potential of this strategy.

Summary

Table 3. Carbon Emission Reduction Strategies (CO2e)

Electricity: conservation and renewable energy	186 MT/year
Heating: conservation and solar energy	69 MT/year
Travel: conservation and offsets	7 MT/year
Solid Waste: increased recycling	63 MT/year
Total	325 MT/year

Education and Research

To achieve the goal of making "climate neutrality and sustainability a part of the curriculum and other educational experiences for all students" the Green Campus Committee will form a Sustainable Education and Research subcommittee that will assess formal and informal sustainability educational activities and actively encourage broader participation in these activities. As a component of this educational effort, the Green Campus Committee will maintain a website that documents progress toward reaching the goals described in this action plan.

To achieve the goal of expanding "research or other efforts necessary to achieve climate neutrality", the Green Campus Committee will encourage greater faculty and student analysis of, and input into, decisions that determine campus sustainability. The Sustainable Education and Research subcommittee will help make campus energy consumption, solid waste disposal, and other relevant sustainability data accessible for faculty and student research projects. The Green Campus Committee will document staff, faculty, and student research and other activities related to sustainability on its website.

Conclusion

Eastern Connecticut State University has developed a plan to reach the goal of campus carbon neutrality by 2050. Our plan is a realistic mixture of energy conservation, energy efficiency, renewable energy, recycling, and offset credits. As we progress toward our climate neutrality goal, new technologies and new environmental pressures will inevitably require changes in the plans and may allow the university to meet this goal sooner. Nevertheless the target date, interim targets, and analysis presented in this document will serve to guide this ongoing effort.

The Appendices include data and analysis that support this climate action plan.

Climate Action Plan

Appendices

Appendix 1: Greenhouse Gas Inventory

Fred Loxsom

Environmental Earth Science

Background

President Nuñez signed the American College & University Presidents Climate Commitment (ACUPCC). Eastern's implementation date is September 15, 2007.

By September 15, 2008, we are scheduled to complete a comprehensive inventory of all greenhouse gas emissions (including emissions from electricity, heating, commuting, and air travel) and update the inventory every other year thereafter.

Eric Germain, Bill Leahy, and Fred Loxsom reviewed the inventory tools and decided to the use the Clean Air Cool Planet (CACP) Campus Carbon Calculator, version 5.0. This calculator is recommended by AASHE and Bill Leahy has used this calculator to do a preliminary carbon inventory for 2001-2006.

The Green Campus Committee has the responsibility to complete this inventory and Fred Loxsom agreed to direct the carbon inventory process. Several students, including Jacqueline Platt, Matthew Kosinski, and Alicia DeMaio, have worked on the carbon inventory and its subsequent updates.

Sources of Greenhouse Gases

The ACUPCC defines three "scopes" associated with the inventory:

- **Scope 1** refers to direct GHG emissions occurring from sources that are owned or controlled by the institution, including: on-campus stationary combustion of fossil fuels and mobile combustion of fossil fuels by institution owned/controlled vehicles.
- **Scope 2** refers to indirect emissions generated in the production of electricity.
- **Scope 3** refers to all other indirect emissions.

Eastern's sources of greenhouse gases can be divided into 4 categories:

- **Electricity Consumption:** Eastern uses electricity for lighting, ventilation, cooling, and for powering computers and other equipment. We purchase all of our electricity, except for a negligible amount of PV power.
- **Heating:** Eastern burns natural gas and distillate oil in its heating plants to provide space heating and domestic hot water for campus buildings.
- **Travel:** In this inventory, we only include official university travel that includes ground transportation on and off campus and air travel. We do not include greenhouse gas emissions associated with student or staff commuting.
- **Solid Waste Disposal:** Eastern's contracts for all of its solid waste disposal with Willimantic Waste Disposal Inc. Willimantic Waste recycles some of our waste and the remainder of the

waste is sent to Waste to Energy electricity plants. Because of this end use, solid waste disposal actually reduces our total greenhouse gas emission.

In this Appendix of the Climate Action Plan we describe the results of a detailed inventory of greenhouse gas emission from electricity consumption, heating, and travel. The next Appendix (Solid Waste and Recycling) documents greenhouse gas credits associated with Eastern's solid waste disposal process.

Electricity Consumption and Heating

We have compiled Eastern's consumption of natural gas, and heating oil from records kept by Susan Kennedy in Fiscal Affairs. This data is shown in Table 1. The data for fiscal years 2002-2007 were collected by students working for the Institute for Sustainable Energy and compiled in an internal report. The data for FY 2008 and FY 2009 were collected by students working with Fred Loxsom.

The electric data shown in Table 1 has a more complicated history. The data for fiscal years 2002-2007 were also collected by students working for the Institute for Sustainable Energy and compiled in an internal report. For FY 2008 and FY 2009, we used data available from the newly installed campus submetering system after we checked the accuracy of this method by comparison with electric utility bills.

Table 1. Primary Energy Consumption

FY	Electricity (kwh)	Natural Gas (CCF)	Fuel Oil (gal)
2002	16,605,602	679,742	41,275
2003	17,808,798	693,188	87,000
2004	18,307,348	712,294	28,896
2005	19,093,521	702,071	39,798
2006	19,972,124	859,069	29,594
2007	19,697,581	840,135	53,261
2008	19,971,203	879,669	4,116
2009	22,029,022	726,936	99,166

The sharp increase in electricity consumption between 2008 and 2009 is mostly due to the new science building that opened in August 2008. Equipment problems required the university to switch from burning natural gas to burning fuel oil during the winter of 2008-2009 and this shows up as a distinct shift from natural gas to fuel oil consumption during FY 2009 in Table 1.

Greenhouse Gas Emission

Using the data shown in Table 1, we calculated the greenhouse gas emission corresponding to the generation of electricity and the combustion of natural gas and heating oil. The results of this calculation are shown in Table 2. The factors used for this calculation were taken from the Clean Air - Cool Planet "Campus Carbon Calculator", version 6.4. The conversion factor for natural gas is 5.39 kg/ccf and for heating oil is 10.0 kg/gallon. For electricity the conversion factor (appropriate for the New England electric grid) was 0.4664 kg/kWh from 2002 to 2006 and 0.4226/kWh from 2007 to the present. In all

cases, the coefficients are expressed as equivalent kg of CO2, but they include greenhouse gases in addition to CO2.

Table 2. CO2e (MT)				
FY	Electricity	Natural Gas	Fuel Oil	Sum
2002	7,745	3,664	413	11,821
2003	8,306	3,736	870	12,912
2004	8,539	3,839	289	12,667
2005	8,905	3,784	398	13,087
2006	9,315	4,630	296	14,241
2007	8,324	4,528	533	13,385
2008	8,440	4,741	41	13,222
2009	9,309	3,918	992	14,219

The greenhouse gas emission increase between 2008 and 2009 represents the effect of the new science center and should not be viewed as a temporary increase.

Transportation

Staff/Faculty Travel. Based on Travel Authorization (TA) data for FY2008, we estimated ground and air travel for staff and faculty. Since the TA records only include expenses and destinations, the actual travel miles were estimated. We estimated the following ground and air distances:

Ground: 80,432 miles

Air: 1,308,697 miles

For ground travel we assumed the vehicle efficiency equaled 20 mpg and that gasoline releases 19.4 lb of CO2 per gallon. This is equivalent to 0.44 kg/mile. For air travel, we assumed 0.18 kg/passenger mile. The resultant GHG emission is shown below.

Ground: 35 MT

Air: 236 MT

Total: **271 MT**

Commuter Travel. We don't have any records of commuter travel; therefore, we will make an estimate based on a set of assumptions.

- 1200 part-time students who drive alone to campus twice each week for 30 weeks per year.
- 1500 full-time commuting student who drive alone to campus 5 times each week for 30 weeks per year.
- 293 Faculty who drive alone to campus 5 times each week for 30 weeks per year.
- 398 Staff who drive alone to campus 5 times each week for 50 weeks per year.
- The average round-trip commute is 60 miles.
- Carbon emission is 0.44 kg/mile

Based on these assumptions, we estimate total commuter travel as 26 million miles and computer GHG emissions as **11,600 MT**. This is a very uncertain number based on a set of questionable assumptions.

We show this estimate of carbon emissions associated with commuting for illustration only and we do not include emissions from commuter travel in our campus emission total.

Solid Waste Disposal

As documented in Appendix 2, our method of solid waste disposal gives Eastern credit for carbon dioxide reduction. So the carbon dioxide emission associated with solid waste disposal equals -1498 MT.

The credit arises because we recycle some of our waste and because the remainder of the waste is converted to energy in a waste to energy plant by our waste management company, Willimantic Waste Paper.

Summary

The components of Eastern's FY2009 greenhouse gas emission inventory are summarized below:

Electricity (Purchased)	9,309 MT CO2e
Heating (Natural Gas and Heating Oil)	4,910 MT CO2e
Travel (Official Travel only)	271 MT CO2e
Solid Waste Disposal	-1,498 MT CO2e
Total	12,992 MT CO2e

We have not included greenhouse gas emission associated with commuting in this total.

Appendix 2: Solid Waste and Recycling

Norma Vivar-Orum

Environmental Earth Science

Introduction

Eastern Connecticut State University enrolls an average of 5000 students each year. It is a small community within the town of Willimantic.

Campus Recycling and Waste Removal

We currently have a contract with Willimantic Wastepaper Company for waste removal. Our municipal solid waste, ("regular trash" or "MSW"), and much of our recyclable material is picked up by the contractor on a regular and scheduled basis. Recyclable materials included in our current contract are glass food and beverage containers, metal food and beverage containers, #1 and #2 plastics, mixed paper, and cardboard. Dumpsters for municipal solid waste, dumpsters for cardboard and labeled 90 gallon push carts for separated recyclables, are placed on campus grounds for waste removal. Hazardous waste and other recyclable materials are handled in accordance with other contracts and policies.

Facilities personnel provide custodial services for academic and administrative spaces as well as for all common public areas. Residents are required to remove trash and recyclables from their own residence hall rooms and suites as needed. 9o gallon pushcarts are labeled to indicate whether they are for "mixed paper" or "bottles and cans".

Why Recycle?

- It's the law.

In 1993, Connecticut's General Assembly passed legislation (Section 22a-220(f) of the Connecticut General Statutes), which, among other provisions, raised the state's recycling/source reduction goal to 40% by the year 2000. (http://www.ct.gov/dep/cwp/view.asp?A=2714&Q=324892)

- Recycling saves natural resources.
- Recycling reduces energy consumption in the manufacturing process as compared to manufacturing of products from virgin sources.
- Recycling extends the life of landfills.
- Recycling reduces green house gas emissions.
- Environmental stewardship is a core value

What We Have Done

Eastern has taken steps to increase recycling and decrease consumption through educational programs, events, and by distributing educational material. To date, those programs have included but are not limited to:

- The center for Sustainable Energy Science participates in the over-night freshmen Student Orientation and Registration program, (SOAR) by presenting a session to inform residents about the current recycling policy on campus.
- Recycling information posters that tell exactly what can be recycled in bins outside residence halls.
- "Create Your Own Recycling Bin" event to help provide students with bins for their rooms
- Pilot recycling and return program by students in residence halls to redeem cans for deposits. This was part of an effort to increase recycling rates by opening up recycling rooms and making the process easier.
- Inclusion of a representative from Willimantic Wastepaper Company in yearly Earth Day events.

Reducing Green House Gas Emissions through Recycling

The recycling program is included as part of Eastern's effort to reduce our carbon footprint and to employ sustainable practices. We want to discourage consumption while encouraging recycling. Our goals are to reduce over- all carbon emissions through recycling and to **increase recycling to 55%.**

To measure the impact of recycling on over-all carbon emissions, we used a web based calculator available at: http://epa.gov/climatechange/wycd/waste/calculators/Warm_Form.html.

The Impact of Recycling on our Carbon Footprint

The 2008 recycling report from Eastern indicates that we currently recycle 244 tons of mixed paper, cardboard, and bottles and cans, (or items considered "mixed recyclables") per year. We estimate that this represents 10 percent of the total waste stream hauled from the campus by our waste removal contractor.

In order to project possible reductions in green house gas emissions through recycling, we have made some basic assumptions. We estimate that:

1. The 244 tons of material currently recycled from Eastern represents 10% of the total waste stream.
2. 2440 tons of municipal solid waste and recyclable material is hauled from campus each year.
3. 2196 tons of material is hauled from dumpsters as municipal solid waste

4. About 50% of material placed in dumpsters could be recycled. (This is a conservative estimate)
5. Based on these assumptions, it is fair to estimate that 1342 tons of material generated on campus could be recycled.
6. Approximately 55% of our total waste stream is comprised of recyclable material

We have used these estimates to generate a projection for the impact of recycling on Eastern's carbon footprint.

The model we used,

(WARM http://epa.gov/climatechange/wycd/waste/calculators/Warm_Form.html.), makes it possible for us to factor the way our municipal solid waste, (MSW) is combusted. We get carbon reduction credit due to the fact that our MSW is used as fuel in "trash to energy" power plants and thus is considered a bio-fuel.

In our baseline waste management case, we input the assumed values as we currently operate. This is our "business as usual" scenario. The results of this first analysis indicate that our current practices result in a "metric tons of carbon dioxide equivalent", (MTCO2E) of -1,498.

In our second scenario, we assume that half of what is in the dumpsters can be recycled. We ran a "what if" scenario to show what impact an increase in recycling might have on our carbon footprint. We took half the weight from the dumpsters and added it to the weight of recycled material. The change in MTCO2E equates to a difference of -2,514, suggesting a significant impact on our carbon footprint is possible through increased recycling.

GHG Emissions Analysis -- Summary Report

(Version 9.01, 3/09)

Analysis of GHG Emissions from Waste Management

GHG Emissions from Baseline Waste Management (MTCO2E): -1,498

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E
Mixed Recyclables	244	0	1,098	N/A	-1,358
Mixed MSW	N/A	0	1,098	N/A	-140

GHG Emissions from Alternative Waste Management Scenario (MTCO2E): -4,012

Material	Tons Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E

Mixed Recyclables	N/A	1,342	0	0	N/A	-3,872
Mixed MSW	N/A	N/A	0	1,098	N/A	-140

Total Change in GHG Emissions: -2,514 MTCO2E

Our Maximum Capacity for Waste Removal on a Regular Weekly Basis

Under current conditions, the maximum amount of municipal solid waste that can be removed from Eastern's campus is 823 cubic yards per week. An accepted volume to weight conversion is an average 225 pounds per cubic yard of waste. This means 106 tons of MSW can be removed from campus per week, (5516 tons per year), based on our current facilities and contract. We could do another run of the WARM model using these numbers; however the validity of the results would be less reliable since it is much less likely that dumpsters are completely full every week, (especially since students are not living on campus during the summer and winter breaks).

Our Goal Is To Increase Recycling On Campus To 55%

Several steps will help us achieve our goals.

Specific strategies include:

Adoption of a Single Stream Recycling Program:

The University will adopt the single stream recycling service provided through the contracted hauler. The convenience of single stream recycling is expected to garner greater participation.

Container availability:

The Green Campus Committee will collaborate with student groups to regularly check that recycling bins located near trash dumpsters are correctly placed and available. Care should be taken to evaluate whether bins are strategically well placed.

Programming:

The University will continue educational programming for incoming freshmen with regard to recycling and sustainable practices. The current programming is limited to participation in the SOAR program, which is conducted by the Student Activities Office, and small group programs which are conducted in the resident halls upon request. We recommend the expansion of this educational programming to include more students. All first year students should be exposed to educational programming with regard to recycling and sustainability.

Information:

Recycling information will be distributed and/or available to all community members and will be placed on and around appropriate containers.

Appendix 3: Sustainable Buildings

Nancy Tinker

Facilities Planning and Management

Introduction

Eastern has a long-standing history of energy efficient building, renovation and operation practices.

Recent Energy Efficiency Improvements

Recently three 250 bed residence halls were built and all three are LEED certified.

The recently opened Science Building was designed to meet LEED silver standards and will begin the review process once commissioning is complete. All new buildings are designed to meet LEED certification as a minimum.

Eastern replaced baseboard electric heating in a high-rise residence hall with a geothermal system that provides both heating and cooling.

Solar lights are used on the exterior of two buildings, at dumpster and other remote locations as well as bus stops. Additional solar lights are added to the campus as appropriate when funds are available.

The Facilities Department has installed a real time electrical monitoring system that tracks and displays energy use in all the buildings. This system also tracks greenhouse gas emissions and will be used to help us track our progress. The system is used to identify areas that should be focused on with respect to reduction of greenhouse gases through conservation projects.

The majority of Eastern's buildings are controlled and monitored by a Building Automation System. This system is programmed to systematically cut back on electric usage when we approach peak demand. This automatic load shedding not only saves money in the present time but helps reduce costs all year.

Eastern has partnered with the Connecticut Light and Power Company in a pilot retro-commissioning project that identifies energy saving measures we can take in buildings that have a Building controls system. Several projects have been implemented including Library lighting controls; Webb Hall air handler control upgrade, Mead and Niejadlik hallway lighting occupancy sensors, sports center gymnasium lighting and the North Residential Village chiller optimization project.

Eastern uses green chemicals for cleaning and only specifies Energy Star appliances.

Planned Energy Efficiency Improvements

Additional Facilities Management mitigation measures that will be undertaken to lower the greenhouse gas emissions include:

- Adjusting the temperatures up in the summer and down in the winter through the use of the building automation system; ensuring that temperatures are lowered or raised when the building s are not occupied during breaks.
- Implementing additional lighting controls and efficiencies through advanced technology such as Encelium

- All future building renovations will include building automation systems and a minimum of LEED certification
- Eastern is working towards installation of a fuel cell that will greatly reduce our electric consumption and help with the heat plant function as well.
- Our Master plan has identified several buildings that will be demolished; some will be replaced with new more efficient buildings
- The university will continue its exploration and implementation of new technologies; during the timeframe of our plan there are most likely technologies that will be developed that we cannot imagine yet.

Planned Major Projects

The table on the following page shows the estimated impact of future Facilities Management and Planning projects.

Project	FY	+/-	CO2 Increase/Decrease (MT)
Library Lighting Controls	2009	-	-6.22
Webb Hall Air Handler Upgrade	2009	-	-1.0
Mead Hall Lighting Occupancy	2009	_	-2.03
Niejadlik Hall Lighting Occupancy	2009	-	-1.37
Sports Center Gymnasium Lighting	2009	-	-2.61
Mead /Niejadlik chiller controls	2010	-	-12.9
Lighting Improvements (encellium)	2010	-	-24.5
Fuel Cell	2011	-	-4499.5
Warehouse construction	2011	+	+13.5
Athletic Support Building Construction	2012	+	15
Lighting Improvements (LED)	2012	-	-5.5
Burr Hall Renovation	2012	-	-2.2
Fine Arts Construction	2013	+	+160
Eastern Hall Demolition	2014	-	-81.42
Media Goddard Renovation Phase I	2014	-	-1.0
Shafer Hall Renovation	2015	-	-1.0
South Campus Parking Garage	2015	+	20
Hurley Hall Renovation	2016	+	-15.5
New Residence Hall	2017	+	20
Demolish Low Rise	2018	-	-76.56
New Residence Hall II	2018	+	20
Sports Center Renovation/Addition	2019	-	40
Boiler Plant Expansion	2020	+	20
Facilities Addition/Renovation	2021	-	10
Replace Burnap/Crandall	2021	+	
Media/Goddard Phase II	2022	-	-5
New Health Center	2022	+	+15
Demolish old Health Center	2022	-	-15
Technology/Classroom Building	2023	+	20

Appendix 4: Transportation

Bill Leahy

Institute for Sustainable Energy

Introduction

As a signatory of the American College and University Presidents' Climate Commitment (PCC), Eastern Connecticut State University is taking steps to combat global climate change by reducing the emissions of green house gases associated with activities on campus, including emissions associated with transportation. Transportation improvements play an important part of the plan because transportation emissions make up a large portion of Eastern's carbon footprint. According to Eastern's 2008 PCC report on carbon emissions, the transportation sector produces approximately 12,164 MT of carbon each year. This includes: exhaust emissions produced by Eastern's on-campus fleet of shuttle buses, vans and maintenance vehicles; university business and athletics travel utilizing private vehicles and commercial carriers; and the approximated emissions produced by commuting activities of the staff, faculty and students. Included in this report are steps and a timeline for making Eastern's transportation sector carbon neutral by 2050. This includes purchasing more efficient vehicles, utilizing alternative fuels, changing guidelines for university travel, and creating a pedestrian friendly campus. Emissions that can not be reduced will be offset by purchasing carbon credits or through carbon sequestration. This is a 40 year plan that leaves room for the inclusion of emerging technologies and developments not currently commercialized, affordable or viable. The steps of this plan are described in detail in the following sections.

Recommendations

Scope 1 Emissions: All direct emissions from sources owned or controlled by the institution.
The FY2008 receipts for on campus gasoline use showed 33,272 gallons of gasoline purchased for the entire campus fleet of vehicles. Eastern's Scope 1 transportation emissions for FY2008 came to 293 MT of carbon dioxide emissions. Eastern also owns diesel-powered vehicles that were not included in these calculations.

Below are recommendations for lowering Eastern's Scope 1 transportation carbon emissions.

- Purchase high efficiency vehicles and implement efficiency requirements for all newly purchased vehicles, using EPA fuel economy standards.
- Reduce the use of pickup trucks and vans for on campus maintenance by replacing most vehicles in the fleet vehicles with plug-in hybrid electric vehicles (HEVs) and plug-in electric cars. These can also be used for providing campus tours.
- Create a policy to have smaller, more efficient vehicles available for use, encouraging "right sized" transportation for teams, clubs, and for field trips rather than having only large vans and buses available for these functions. Often large vans and buses are used to transport only a few students, which wastes gasoline and increases campus carbon emissions.

- When the current shuttle buses need replacing, the university should switch from gasoline-powered buses to the most cost effective alternative. Currently, that would be diesel-powered buses. Diesel buses get better fuel mileage and can be run on cleaner B5 biodiesel fuel through their warranty period. After the new vehicle warranties have expired, the buses can be run on a mix of B20, (20% Biofuel/80% Diesel) which reduces CO_2 significantly, and B100 in warmer weather. When the diesel vehicles need to be replaced, hybrid electric gasoline (HEVs) and diesel buses should be more cost competitive and should be purchased as replacements. The diesel hybrid vehicles can also run part-time on biodiesel, and on B100 in warm weather. In the 2030 time period, advancements in fuel cell technology may make fuel cell buses available which operate on pollution-free fuel cells. This would be the final step in transforming Eastern's bus fleet to operating with zero carbon emissions.
- Eastern should initiate the production of biodiesel on campus, using waste vegetable oil from the dining hall and area restaurants. This manufacturing process will create educational opportunities for students.
- Implement policies that reduce fuel use in vehicles, including a no idling policy for students, staff and faculty, especially those waiting for parking spaces during the day. Increasing the availability of on-campus parking garages, effective loop transportation from outlying lots, and removing parking lots in the center of campus will reduce this issue.
- Purchase alternative vehicles for police patrol, such as Segways or bicycles. These would provide effective and visible coverage campus-wide, without carbon emissions.
- Build a gondola connecting the main campus to the sports complex over Route 6 to transport students to and from the athletic facilities and remote parking to campus. Power the system using renewable energy, such as solar, wind or a biofuel powered generator.

Scope 2 Emissions: all other indirect transportation emissions associated with the university. This area includes faculty and student commuting, university official business mileage and University-related air travel. For FY2008 university business travel included 80,432 ground miles and 1,308,796 air miles estimated to produce 271 MT of carbon emissions. Commuter travel by students, staff and faculty was estimated since detailed commuter mileage records do not currently exist. The 26 million estimated commuter miles, produced 11,600 MT of carbon emissions. Total Scope 2 Emissions for Eastern's transportation sector for FY2008 came to 11,871 MT.

Recommendations for reducing Eastern's Scope 2 transportation carbon emissions are listed below.

- Improve the layout and traffic circulation of the campus to make it more pedestrian and bike friendly. Create more green space, walking paths, bike lanes and parking garages as buildings are renovated, removed and new ones built.
- Utilize natural landscaping and indigenous plantings, rain gardens to replace turf lawns to reduce fuel used for mowing and turf maintenance. By 2040, lawn mowers and other landscaping power tools will likely be plug-in electric or other sustainable technologies. Also, using native species in campus landscaping would reduce the need for watering, mowing, fertilizers and other maintenance.
- Remove roads from the interior of the campus, creating more green space and develop a loop road around campus. Build more parking garages on the loop road.

- Build special lanes for bicycle users, so they can move around campus and to the athletic facility or to Main Street, Willimantic more easily.
- Place more bike racks on campus, including adding racks on the front of all university buses.
- Start a bike share program. Bike share programs provide transportation for students and faculty, while providing them exercise and reducing carbon emissions. These programs are getting more popular on college campuses.
- Create an online rideshare database (people with cars seeking passengers, people seeking drivers, or shared responsibilities). Provide incentives for people to carpool or drive Low Emission Vehicles (LEV) such as hybrids. Incentives may include free parking permits (a fee would have to be implemented for non-carpoolers) or parking spaces in more convenient lots.
- Encourage students to live on campus or close (walking or bike distance) to campus. This could include financial incentive or assistance provided the student adheres to certain conditions like not having a parking permit.
- Provide incentives for keeping students on campus on the weekend rather than having them drive home. This might include sponsoring activities like providing movies, mini arcade, dance parties, live entertainment, etc. Activities like these are already happening, but the general opinion among students is that they are not appealing to all or do not happen frequently enough to have a real impact on students leaving campus. This could also include bus trips to regional attractions.
- Provide incentives and reduced cost for using Windham Region Transit District (WRTD) bus transit for students and employees living near the routes or traveling to sites on WRTD routes. This would enhance the school-town connection and support local businesses and a network of available public transit.
- Offer a greater variety of on-line classes and distance learning opportunities. This will reduce commuter mileage and subsequently reduce greenhouse gas emissions.
- Introduce curriculum or awareness programs concerning transportation issues and carbon emissions through the First Year Program, student orientation, and other appropriate academic avenues.
- Encourage bike riding around the community. In cooperation with the town, locate bike racks strategically in town to offer safe places to park bikes.
- Help local business development in downtown Willimantic by encouraging students to patronize businesses within walking or biking distance of the campus. Also, promote awareness among the student body of current businesses in Willimantic. This would provide an alternative to driving long distances for shopping. For example, there is a local food co-op, artisan co-op, and new coffee shop located within walking distance from campus, of which many students are not aware. Extending shuttle bus runs could reduce personal vehicle use by providing transportation for food shopping and entertainment.
- Start a car-sharing program, such as Zipcar. This is a program where multiple users share a vehicle to get around campus and the community. This would not only reduce greenhouse gas emissions, but it would reduce the amount of parking spaces needed on campus.
- University should implement carbon reduction policies for university travel. When traveling greater distances in the northeast corridor for University business, travelers should use the bus

or train instead of flying. Air miles account for 236MT of Eastern's carbon emissions. Air travel is very carbon intensive and should be avoided when possible. When flying is necessary, carbon credits for the flights should be offset with the price included in the ticket from the travel agent.

- Teleconference or videoconference instead of commuting to conferences. This allows the university to include more participants in meetings than could be released for time away from campus. It is also an area of opportunity to provide high-tech meeting spaces on campus that enhance the university image.

Implementation Timeline

2010 - 2015

- Implement efficiency requirements for all newly purchased vehicles, using EPA fuel economy standards.
- Replace campus shuttle buses, police and maintenance vehicles.
- Provide incentives for living close to campus and help students find housing close to campus.
- Start a car sharing program such as Zipcar.
- Start a bike share program.
- Create a database of people seeking carpools.
- Provide incentives for keeping students on campus during weekends rather than driving home.
- Provide incentives/reduced cost for WRTD bus transit for students/employees living near the routes.
- Introduce curriculum concerning transportation and carbon emissions into freshman orientation.
- Help local business development in downtown Willimantic, to provide a wider variety of places for students to go that are within walking or biking distance.
- When travelling great distances for University business avoid air travel.
- Teleconference instead of commuting to conferences.
- Offer a greater variety of online classes.
- Install bike racks on University shuttles.
- Implement policies that reduce fuel use in vehicles, and implement a no idling policy.

2015 -2020

- Continue to upgrade the University fleet. This includes the continued purchase of efficient vehicles as well as the conversion of diesel vehicles from diesel B5 to B20.
- Start the production of biodiesel on campus, using waste vegetable oil from the dining hall and area restaurants.
- Build a special lane for the bicycle users.

- Create incentives for carpooling.

2020-2025

- Continue upgrading fleet vehicles, including converting university busses from diesel electric hybrid to B5 hybrid.
- Continue upgrading fleet vehicles, including the purchase of hybrid electric diesel busses.
- Purchase Segways or bikes for the campus police.
- Build gondola connecting the main campus to the sport complex, and power the system on renewable energy like solar or wind.

2025-2030

- Continue upgrading fleet vehicles, including converting university busses from B5 electric hybrid to B20 hybrid.
- Start purchasing plug-in HEV's or electric vehicles for police campus and maintenance.
- Change the campus layout making it more pedestrian and bike friendly.

2030-2035

- Continue upgrading fleet vehicles, including converting university busses from B20 electric hybrid to B100 hybrid.
- Replace landscaping and maintenance equipment, such as mowers, with electric equipment.

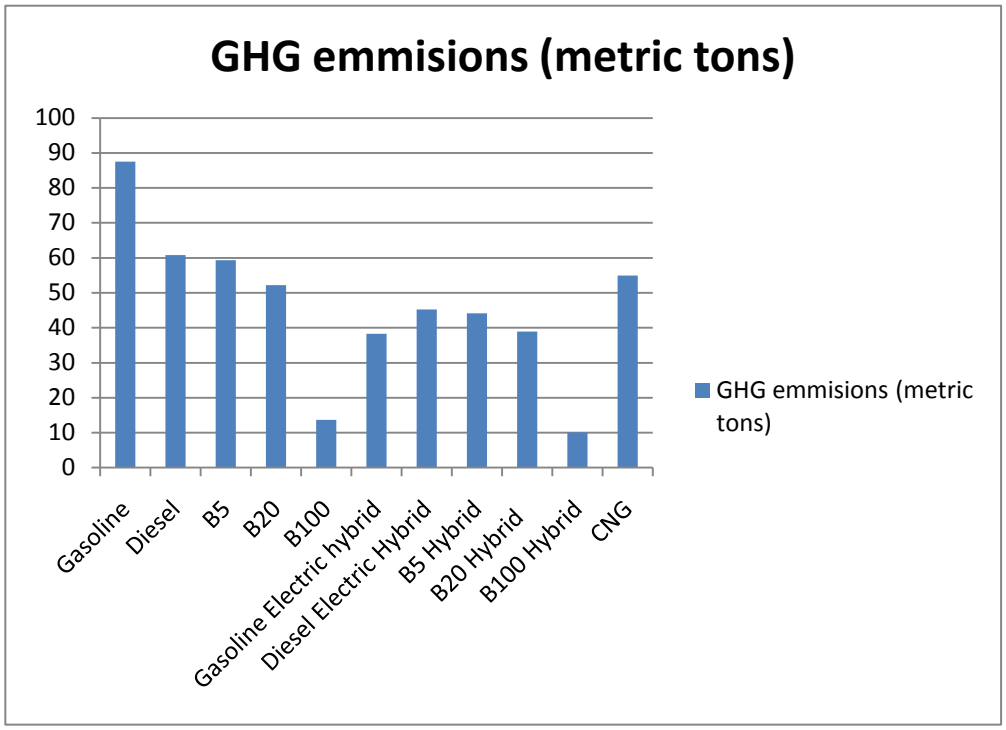
2040-2050

- By 2050, all campus vehicles should be using plug-in electric vehicle or fuel cell technology.
- Any emissions that remain from commuter and business travel will be offset.

Table Data for Shuttle Bus Analysis. Data in the table below shows the calculation of annual carbon emission for various options for university shuttle bus.

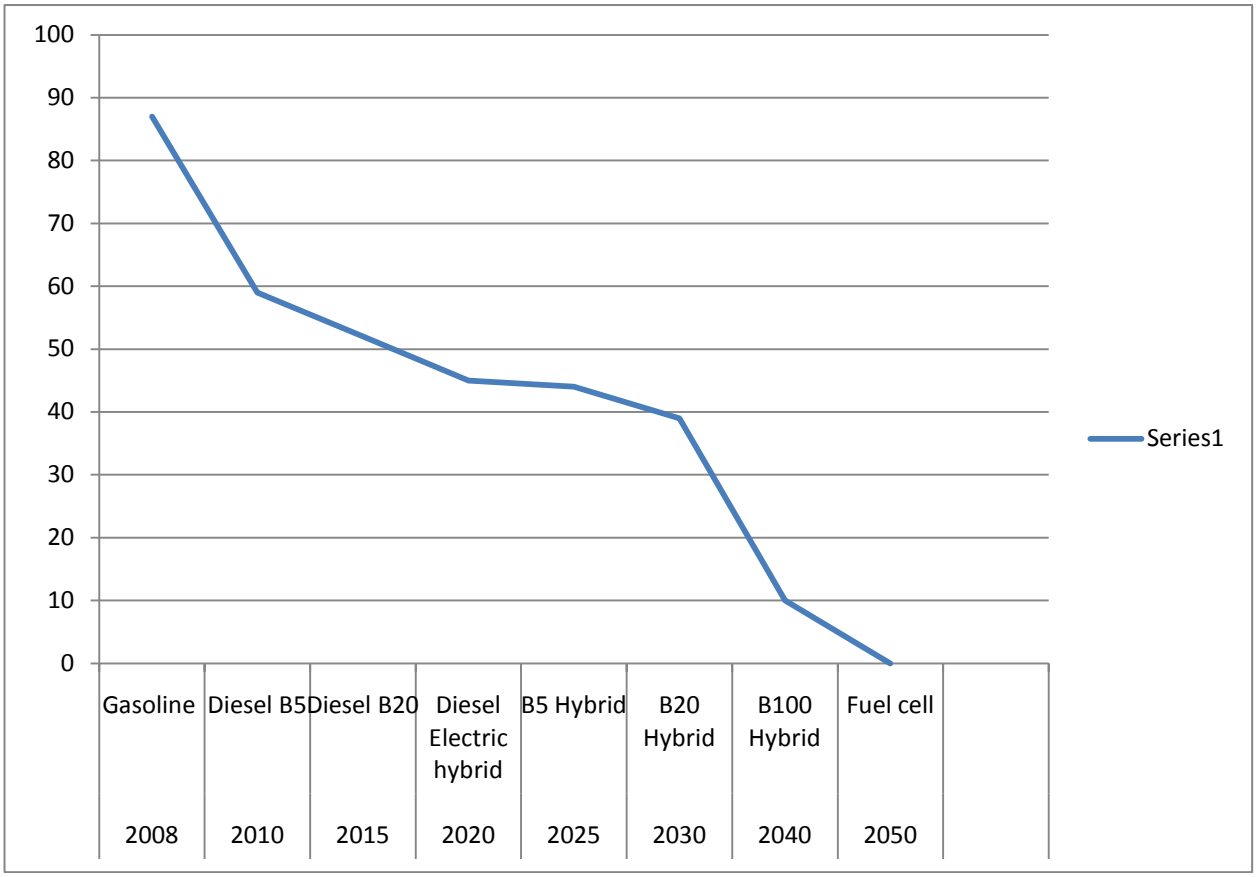
Fuel type	mpg	miles per year	Gallons use per year (52,692 miles)	lbs of CO2 release per year	metric tons	lbs CO2 per gallon
Gasoline	5.3	52,692	9,942	192,873	87.49	19.4
Diesel	9.0	52,692	5,855	134,130	60.84	22.91
B5	8.9	52,692	5,947	130,771	59.32	21.99
B20	8.8	52,692	5,986	115,178	52.24	19.24
B100	8.0	52,692	6,578	30,142	13.67	4.582
Gasoline Electric hybrid	12.1	52,692	4,355	84,481	38.32	19.4
Diesel Electric Hybrid	12.1	52,692	4,355	99,766	45.25	22.9
B5 Hybrid	11.9	52,692	4,428	97,370	44.17	21.98
B20 Hybrid	11.8	52,692	4,465	85,915	38.97	19.24
B100 Hybrid	10.8	52,692	4,879	22,355	10.14	4.581
Hydrogen	7.0	?	?	0	0	0

Data and Analysis for Shuttle Bus



Graph and Analysis for Shuttle Bus

The graph below shows the carbon emissions reductions as university busses are converted to new technologies.



Conclusions

Transportation contributes a large portion of greenhouse gas emissions on campus. The recommendations in this report should be helpful in reducing these emissions. As new emerging technology advances and becomes commercially available and additional financial incentives are made available to support Eastern's transportation transition, these ideas should be added to the report. The transition to lower emission vehicles and an overall reduction in vehicle usage will not only reduce carbon emissions, it will also create a healthier environment for the campus population, save the university money and increase educational opportunities to teach about a more sustainable community and world.

Appendix 5: Renewable Energy

Fred Loxsom

Environmental Earth Science

Introduction

Eastern will use renewable energy systems to supply some of the campus demand for domestic hot water, space heating, air-conditioning, and electricity. Five renewable energy technologies offer the substantial opportunities for satisfying a large fraction of the demand: Passive Design, Geothermal, Fuel Cells, Solar Electric, and Solar Thermal. These technologies will be employed after demand has been substantially reduced by greater energy efficiency and energy conservation strategies.

Passive Design

Building design can reduce building energy demand by proper building orientation, super-insulation, efficient heat-exchangers for ventilation, day-lighting, natural ventilation, green roofs, earth berms, passive shading, and lighting controls. New buildings can be designed to use the half the energy per square foot as traditional buildings.

Geothermal Heating and Cooling

Geothermal system use energy stored underground to help heat and cool buildings. These systems use energy more efficiently and use electricity rather than natural gas for heating. Because grid electricity is primarily generated by a combination of natural gas, nuclear power, and hydroelectricity in New England, geothermal systems heat and cool with substantially less emission of greenhouse gases than conventional HVAC systems. Eastern can install these systems on new buildings or retrofit older buildings in a similar way that we retrofitted the High Rise Apartments.

Fuel Cells

With fuel cell systems, we can generate our own electricity using natural gas as the fuel for a highly efficient fuel cell. If the fuel cell is used as the center of a combined heat and power (CHP) system, then reduction in CO2 emission can be achieved. Waste heat from the fuel cell can be used for space heating or domestic hot water systems.

Solar Thermal

Solar thermal systems use solar collectors to heat water for hand-washing, showers, dish-washing, and other domestic uses on campus. Solar heated water can also be used for space heating. Solar thermal collectors are very efficient and we have ample roof space to install these systems.

Solar Electric

Solar electric (PV) systems convert sunlight directly in to electricity that can be used to power lighting, appliances, ventilation equipment, and computers. PV systems are only about 15% efficient and are expensive, but costs are decreasing and efficiency is improving. PV arrays can be mounted on south-facing roofs or mounted on racks. Newer technologies will allow PV power systems to be incorporated into roofing or siding materials. Since the PV arrays are modular, new arrays and old arrays can be incorporated into the same system; so, the campus can move gradually into generating an increasing fraction of its own electric energy.

Appendix 6: Carbon Sinks

Adam Lambert

Department of Biology

Introduction

Carbon sinks are ecosystems components (water, soil, plants) that function as short- and long-term storage sites for carbon compounds following the incorporation of elemental carbon into living tissues, primarily through photosynthesis, or into soils through decomposition of plant and animal tissue. In terrestrial ecosystems, soils function as the major carbon sink and sequester more organic carbon than plants and the atmosphere combined (Swift 2001). The ability of soils to sequester and maintain carbon stores is primarily a function of soil stability and turnover rates, and to a lesser extent, the chemical makeup of the soil.

Offsets

These sinks are often used as a way to mitigate or offset atmospheric carbon loading caused by human activities. However, it is often difficult to quantify the potential of any habitat to function as a sink or source of carbon dioxide, especially over a short temporal scale (<20 years), due to abiotic and biotic fluctuations (temperature, precipitation, disease, diversity of microbial decomposers, etc.) that increase the stochasticity in systems and impede accurate measurement of an ecosystems potential to function as a carbon reservoir (The Royal Society 2001). Carbon sinks have limited viability as carbon offsets because they do not compensate for carbon emissions from fossil fuel combustion because fossil fuel deposits are not naturally part of the carbon cycle (SinkWatch 2009). Most deposits are buried deep underground where they are isolated from the active carbon cycle.

We describe below university-owned lands that can potentially function as carbon sinks, and when maintained in their current state, will offset a portion of atmospheric carbon dioxide produced through University operations. However, it must be noted that for these areas to act as long-term carbon stores, quantitative measures of carbon fluxes are necessary to determine the extent to which these lands sequester carbon, and further, they must be maintained in their current state and protected from disturbance or urban development (Luyssaert et al. 2008).

Eastern's Land Resources

Eastern Connecticut State University is located in Willimantic, CT which is a temperate forest bioregion. Northern temperate forests sequester approximately 1.3+0.8 PgC y^{-1} – this figure takes into account land use changes and forest loss that is occurring in this region (The Royal Society 2001; Figure 1). Eastern's land holdings include undisturbed tracts of deciduous forest, wetlands, urbanized/developed land, and properties with mixed land use.

Eastern Connecticut State University Arboretum. The ECSU Arboretum is a 12 hectare natural area on the northwest side of the campus in Willimantic, CT. Deciduous forest comprises the greatest land area (80%) with predominately hardwood tree species including, white oak, red oak, hickory, beech, and

white ash. Approximately 2.4 hectares are wetland habitat consisting of a permanent stream, a catchment pond, and a freshwater marsh.

Church Farm. The Church Farm property consists of two parcels of land totaling 45.2 hectares located in Ashford, CT. This property is owned by the ECSU Foundation. The purpose of the property is to facilitate scientific and cultural activities associated with classes. The mission of the landscape as a teaching facility ensures the long-term stability of these natural areas. The vast majority of the landscape (73%; 33 hectares) is mixed deciduous/conifer forest with diverse plant communities throughout. This land area comprises the most substantial carbon sequestration/sink potential the University possesses. Meadow and grassland habitats comprise 26% (~12 hectares) of the land area at Church Farm. In the past, the rate of carbon sequestration by grassland habitats has been grossly underestimated and only recently has the importance of grasslands as carbon sinks been recognized (Scurlock and Hall 1998). We currently manage these areas to maintain grassland habitat and prevent these former agricultural fields from reverting back to deciduous forest. Wetlands comprise only a minor portion of the Church Farm property and are not expected to contribute substantially to the potential of this property as a carbon sink.

ECSU Sports Complex. The ECSU Sports Complex (29.5 hectares), located in Mansfield, CT, houses several athletic fields and a track. This property has substantial wooded areas dominated by deciduous trees and a 3.5 hectare wetland with large-statured grasses. The wetland has significant value as a carbon sink due to the high productivity of the wetland vegetation and high yearly turnover rate.

Green Space Initiative

A key initiative of Eastern's recently approved strategic plan (2007) is to increase the amount of 'green space' throughout the 74 hectare campus. We do not yet know how the anticipated expansion of green space will impact any potential as a carbon sink, but we expect that it will increase the carbon storage capacity of the University's natural areas.

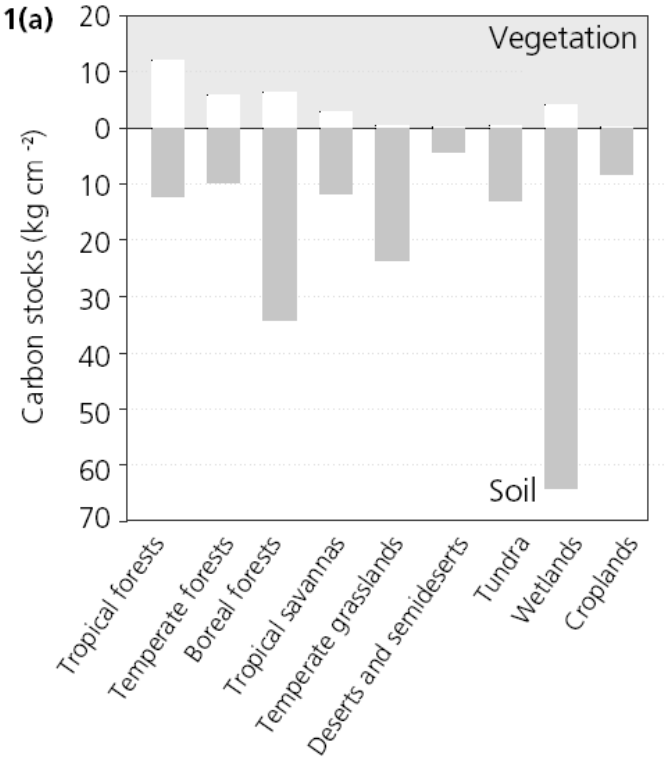


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Figure 1. Carbon stocks in soil and vegetation. Mass of carbon stored in soils and vegetation per meter square for different terrestrial systems (kg C m^{-2}). Source: The Royal Society 2001

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Appendix 7: Purchasing Green Initiatives

Cindy Hodis

Purchasing Department

1. Adopt a Sustainability and Green Campus Initiative to include in quotations and proposals as follows:

   In the interest of supporting ECSU's initiative to reduce waste and extraneous use of natural resources, ECSU is requesting the following.

   - All proposals should be submitted on two-sided recycled paper where possible.
   - Proposers should refrain from using excessive and unnecessary packaging when shipping or mailing their responses.
   - Proposers should refrain from using superfluous binders where possible, especially for the copies being requested.
   - Proposers should consider presenting peripheral information (i.e. company and product brochures) on CD or DVD where possible or practical.

2. Reduce delivery of office supplies from five to two days per week.

3. Purchase only energy star appliances or electronics.

4. Currently use 26,000 reams of paper per year, would like to initiate double-sided copying to reduce current usage.

5. Current laundry vendor is to purchase carbon offsets on behalf of ECSU.

Appendix 8: Education and Research

- We currently offer an interdisciplinary minor in Sustainable Energy Studies and plan to offer a Sustainable Energy Science track within the Environmental Earth Science major beginning this Spring Semester. Included in the courses for these programs are two general education courses that describe the science of global climate change, the effects of climate change, and methods for moving toward climate neutrality and sustainability. A committee is developing an interdisciplinary Sustainability major.
- We offer informal educational opportunities for students. These opportunities include Earth Day activities, orientation for first year residential students (SOAR), residence hall activities, lectures, and a student organization with an environmental theme. So, there are educational opportunities available to all students, but there are no mandatory educational experiences for all students.
- We could consider including sustainability education in the first year program or in the liberal arts curriculum.
- Sustainable energy courses include study of campus facilities such as the geothermal plant and campus PV installations.
- We are currently developing a service-learning project in Jamaica. This project emphasizes sustainable development and is open to all Eastern students. We are planning additional service-learning projects in the local community and related to sustainability through the Center for Community Engagement.
- Students have an opportunity to work at the Institute for Sustainable Energy.

Appendix 9: Achieving Carbon Neutrality

Fred Loxsom

Environmental Earth Science

The table below shows the projected CO2 equivalent emission between 2010 and 2050. This projection model assumes that the combined effect of the greenhouse gas reduction strategies reduces greenhouse gas emission by 325 MT per year.

Table 1. CO2e (1000 MT)

FY	Electricity	Heating	Travel	Solid Waste	Total
2010	9.3	4.9	0.3	-1.5	13.0
2015	8.4	4.6	0.3	-1.8	11.4
2020	7.4	4.2	0.2	-2.1	9.7
2030	5.6	3.5	0.2	-2.8	6.5
2040	3.7	2.8	0.1	-3.4	3.2
2050	1.9	2.1	0.0	-4.0	0.0