The University of Connecticut Climate Action Plan:

Guiding the Path toward Carbon Neutrality

Storrs Campus
August 2009

Section 3:

Emissions Reduction Strategies

Section 3:

Emissions Reduction Strategies

Table of Contents

Cover Photo: University of Connecticut President, Michael Hogan, demonstrates the Connecticut Global Fuel Cell Center's fuel-cell powered go-kart during the University's 2009 Earth Day celebration.

Executive Summary

Emissions Reduction Strategy Evaluation & Selection

The University plans to reduce its greenhouse gas emissions through the implementation of strategies relating to energy (*i.e.,* generation, distribution and use), sustainable development (*i.e.,* building design and land management), and transportation (*i.e.,* campus fleet operation and off-campus travel). Reduction strategies selected for inclusion in the final Climate Action Plan were evaluated based upon four primary criteria:

- **Emissions Reductions** (*i.e.,* anticipated emissions reduction over the life of the project; reduction potential is estimated based upon current emission levels).
- **First Cost** *(i.e.,* initial investment required)
- **Return on Investment**, ROI (*i.e.,* payback period)
- **Time to Implement** (*i.e.,* time required to plan, design and begin implementing the strategy)

Specific parameters relating to the Emissions Reduction, First Cost and ROI criteria are described in Table 3.1. (The estimated time to implement each strategy is noted within the summary tables throughout this section.)

Table 3.1. Summary of Reduction Strategy Evaluation Criteria

	Emissions Reduction[1]	First Cost	ROI
Limiting	<1%	>$500,000	>10 Years
Good	1-5%	$50,000-$500,000	5-10 Years
Excellent	>5%	<$50,000	0-5 Years

The strategy summary tables provided in this section are meant to serve as tools to allow for easier comparison between proposed strategies. ***A rating of 'limited' for a given criteria is not meant to imply that the strategy should not be pursued.*** Rather, the ratings are intended to assist the decision making process, specifically the prioritization of initial CAP implementation. First cost, for example, will be large for certain strategies (*e.g.,* improving the efficiency of campus utility systems). However, these strategies may also have the greatest estimated emissions reduction impact. Conversely, a strategy with only a limited impact on overall emissions should be pursued regardless, in particular when the cost of doing so is negligible or there are additional secondary benefits. Ultimately, any emissions reduction will have a positive impact on the campus footprint and move the University closer to carbon neutrality.

Overview of Proposed Greenhouse Gas Emissions Reduction Strategies

Energy-Related Strategies

Energy-related strategies form the 'heart' of the University's Climate Action Plan. According to the 2007 UConn Storrs Campus greenhouse gas inventory, energy related emissions accounted for approximately

[1] Greenhouse gas emissions reduction potential of a proposed strategy is described in terms of the estimated percent reduction in current emission levels. Emissions reduction ratings noted in this version of the Climate Action Plan are based upon the potential of the proposed strategy to reduce 2007 emission levels. A strategy with an 'excellent' emissions reduction potential is estimated to avoid more than 10,630 MTeCO2. It is estimated that strategies rated 'Good' and 'Limiting' will reduce 2,126-10,630 and less than 2,126 MTeCO2, respectively.

80% of the University's greenhouse gas emissions. The majority of these emissions occurred in association with the operation of the University cogeneration facility (*i.e.,* electricity and steam generation). Other on-campus stationary sources (*e.g.,* emergency generators, large boilers and stand-alone chillers) and purchased electricity also contributed, to a lesser extent, to the campus emissions profile.

Given the significant proportion of the UConn Storrs Campus's emissions profile that is related to campus energy use, energy efficiency improvements will serve as the foundation of campus emissions reductions efforts, especially in the near future. In addition, since the cogeneration facility will serve as the primary energy source for the Storrs campus over the next 20-30 years, the University will strive to operate the facility at maximum efficiency and reliability. Energy conservation and the exploration of alternative fuels will also remain high priorities.

In general, the University's energy-related greenhouse gas emissions reduction plan relies upon five primary objectives:

1. Plan for the future (*i.e.,* future demand, future technology improvements, etc.).
2. Reduce demand.
3. Increase efficiency.
4. Substitute green technology for existing technologies.
5. Demonstrate alternative technologies.

The Energy portion of this section further elaborates upon the individual emissions reduction strategies identified to achieve the objectives above.

Sustainable Development-Related Strategies

Emissions due to campus energy use can also be indirectly addressed through sustainable development, notably through building design and construction. In addition, sustainable development related strategies can help reduce campus emissions associated with campus land use (*e.g.,* landscaping, agriculture, and forestry), water use (*i.e.,* pumping, distribution and treatment) and waste disposal.

The design of the campus, in particular, how the University chooses to develop or conserve land in the future, has the potential to greatly influence the greenhouse gas inventory. It is therefore recommended that the University continue to abide by the responsible growth policies that have guided recent campus projects. In particular, the University should emphasize growth strategies and patterns that will:

- Opt for re-development of built parcels over the development of forest or other hydric or vegetated landscapes;
- Encourage mixed use development;
- Promote 'alternative' forms of transportation, including walking, bicycling, and public transportation, while discouraging single-occupancy-vehicle (SOV) trips; and
- Integrate green building and alternative energy design features whenever feasible.

Additional strategies that the University should pursue to reduce campus greenhouse gas emissions include:

1. Greening the campus building and renovation process;
2. Managing the campus forest to maximize carbon sequestration;
3. Refining campus agricultural practices to minimize fuel and chemical inputs, while maximizing sequestration;

4. Minimizing the carbon footprint of campus landscaping;
5. Embodying and implementing low impact development (LID) principles;
6. Maximizing water conservation and reuse; and
7. Increasing campus recycling and waste reduction rates.

The 'Sustainable Development' portion of this section provides additional details regarding these campus greenhouse gas reduction strategies.

Transportation-Related Strategies

The final piece of the University's greenhouse gas emissions profile is related to transportation, specifically emissions associated with operation of the on-campus vehicle fleet; faculty, staff and student commuting to and from campus; and off-campus travel (*e.g.,* rental cars, air travel). Therefore, in order to reduce greenhouse gas emissions associated with these transportation sources, the University will strive to achieve four main objectives:

1. Decrease annual vehicle fleet fuel use (*e.g.,* gasoline, diesel);
2. Increase the proportion of renewable fuel sources (*e.g.,* biodiesel) in annual fuel use;
3. Decrease annual commuter vehicle miles travelled to campus;
4. Minimize the impact of off-campus travel.

The 'Transportation' portion of this section provides additional details regarding campus greenhouse gas reduction strategies designed to achieve reductions in greenhouse gas emissions associated with campus transportation systems and university-related travel.

Conclusion

It will be the role of the Environmental Policy Advisory Council (EPAC) to prioritize implementation of the strategies proposed in this section. Evaluation criteria and ratings for each emissions reduction strategy are provided throughout this section to assist the EPAC with this task. The emissions reduction strategies and associated ratings are based upon the following assumptions about the University over the next 30-40 years:

1. There will be no significant changes in student enrollment.
2. The nature and delivery of education at the University will remain consistent.
3. The cogeneration facility will serve as the primary energy source for the campus.

However, circumstances change over time, and it is therefore recommended that the list of proposed emissions reduction strategies be reviewed on a regular basis (*e.g.,* 5-7 years) to provide an opportunity to revise the ratings, and, if applicable, to allow for inclusion of previously overlooked emissions reduction strategies.

Emissions Reduction Strategies:

Energy

Table 3.2. Energy-Related Emissions Reduction Strategies

E.1.	Plan for the Future	Emissions Reduction	First Cost	ROI	Time to Implement
E.1.1.	Develop a campus Utilities Master Plan.	n/a	n/a	n/a	n/a
E.1.2.	Ensure energy efficiency through the building design process.	n/a	n/a	n/a	n/a
E.1.3.	Commit to renewable energy goals for campus energy supply.	n/a	n/a	n/a	n/a
E.2.	**Reduce Demand**	**Emissions Reduction**	**First Cost**	**ROI**	**Time to Implement**
E.2.1.	Establish a program to continuously commission buildings.				0-2 years
E.2.2.	Adjust building temperature set points and occupancy schedules.				In Progress
E.2.3.	Establish a lighting update program (interior and exterior).				In Progress
E.2.4.	Reduce fume hood energy consumption.				In Progress
E.2.5.	Establish an energy-efficient computing policy.				2-5 years
E.2.6.	Implement a residence hall appliance policy.				0-2 years
E.2.7.	Minimize energy use associated with equipment and appliances.				2-5 years
E.2.8.	Identify and improve energy efficiencies associated with campus food service equipment and appliances.				2-5 years
E.3.	**Maximize efficiency**	**Emissions Reduction**	**First Cost**	**ROI**	**Time to Implement**
E.3.1.	Correct inefficiencies in campus utility distribution systems.				In Progress
E.3.2.	Expand and better integrate current energy monitoring efforts.				In Progress
E.3.3.	Promote continuous improvement of operational strategies at the cogeneration facility.				In Progress

E.3.	Maximize efficiency (Continued)	Emissions Reduction	First Cost	ROI	Time to Implement
E.3.4.	Centralize utility systems as much as possible and examine opportunities to integrate building projects to maximize utility system efficiency.				In Progress
E.3.5.	Improve the efficiency of building HVAC systems through heat zoning and high-efficiency filters.				2-5 years
E.3.6.	Develop and initiate a boiler efficiency and emissions reductions program.				0-2 years
E.3.7.	Equipment energy efficiency purchasing policy.				0-2 years
E.4.	**Substitute green technologies for existing technologies**	**Emissions Reduction**	**First Cost**	**ROI**	**Time to Implement**
E.4.1.	Seek to incorporate alternative energy sources into new constructions and retrofit existing buildings were appropriate and feasible.				2-5 years
E.4.2.	Maximize efficiency of laboratory airflow through new technologies.				2-5 years
E.4.3.	Identify and evaluate additional applications for variable-frequency drives (VFDs).				2-5 years
E.4.4.	Evaluate the feasibility and appropriateness of developing a carbon neutral power plant.				>5 years
E.5.	**Demonstrate alternative technologies**	**Emissions Reduction**	**First Cost**	**ROI**	**Time to Implement**
E.5.1.	Develop an alternative/renewable energy strategic plan and implement demonstration projects.				2-5 years

Strategy E.1: Plan for the Future

E.1.1 Develop a campus Utilities Master Plan.

The University has outlined a scope of work for a campus utilities master plan study. The plan will result in a practical, cost effective, efficient, reliable, and robust strategy for utilities infrastructure, meeting the University's current and future needs. Systematic development of the utilities capacity and distribution master plan will assist the University in prioritizing projects in the campus master plan, while supporting resource conservation and the long term value of systems.

Figure 3.1. The UConn cogeneration facility. The facility went online in mid-2006 and will serve as the primary energy source for the next 30-40 years.

Under the proposed scope, a consultant will be contracted to develop a comprehensive Utilities Master Plan, provide engineering and economic analysis of existing systems, planned construction and renovation activities, and envisioned improvements through the year 2030. Integration of these efforts will maximize resources and overall efficiency. Next steps include final scoping and appropriate funding to initiate this Plan.

E.1.2 Ensure energy efficiency through the building design process.

The majority of energy generated and used on campus is directed towards campus buildings. Heating, cooling, and electrical demands of buildings can be reduced through proper attention to initial building design. Energy-efficiency is required in laboratory design criteria (e.g., EPA's Labs21 Environmental Performance Criteria's 'energy & atmosphere' credits) when designing buildings with laboratory or research space. Similarly, energy and water conservation related points should be given priority when seeking LEED certification for a building. (Refer to Chapter 4: Sustainable Development for more information regarding green building and LEED certification.)

E.1.3 Commit to renewable energy goals for campus energy supply.

The University presently produces the majority of its energy needs through the operation of the cogeneration facility. However, a significant amount of electricity is purchased to serve the needs of those areas of the campus not currently tied into the cogeneration facility. The University should, at a minimum, commit to replacing a portion of purchased energy with renewable energy from on-site demonstration projects. Given plans for future growth and development of the Depot campus, in particular, on-site renewable energy generation may be a viable solution to meet future growth in energy demands. To further stimulate on-campus alternative fuel research and development, the University should make a formal commitment to a renewable energy goal, such as 20% by 2020.

Strategy E.2: Reduce Demand

E.2.1 Establish a program to continuously commission buildings.

It is estimated that retrocommissioning campus buildings can have an immediate impact of 10% or more on campus energy use (EH&E 2009). Furthermore, retrocommissioning doesn't require an investment in capital equipment. Therefore, the University should identify campus 'energy hogs' and develop action plans to reduce building energy demand.

a. Establish a building HVAC retrocommissioning program, which includes:
   - Conducting complete energy audits on buildings;
   - Prioritizing audits by current building energy usage or by other economic means;
   - Reviewing maintenance and submetering records to identify unanticipated sources of high energy use, unexplained utility usage fluctuations or increases in maintenance calls; and
   - Developing action plans and implementing corrective actions.

b. Identify energy efficiency improvement opportunities associated with building maintenance and renovation. To minimize energy consumption, evaluate building envelopes (e.g. windows, insulation) and strive to maintain and upgrade where needed by:
   - Upgrading roof and wall insulation to current energy code levels;
   - Minimizing water and wind infiltration; and
   - Maximizing serviceability.

E.2.2 Adjust building temperature set points and occupancy schedules.

In general, estimates suggest a 1-2% savings of total utility costs for each degree that the temperature is raised or lowered (during summer and winter, respectively). The University should therefore implement a campus policy regarding temperature set points and occupancy schedules. The policy should include the following elements:

- Building temperature ranges or set points tied to the ASHRAE 66-2004 or other appropriate industry standard.
- Established hours of building operation and building occupancy schedules.
- Identification of occupant responsibilities related to turning off lights, office equipment, closing fume hoods, etc.
- Identification of specialized areas – such as animal facilities, collections, data center, galleries, etc. – that would be exempt from the guidelines.
- A process to seek a deviation from operating hours via an appropriately identified University approving authority.
- Identification of Energy Management Systems (EMS) role in the process.

To ensure effectiveness and continuous improvement:

- Develop a list of the most energy efficient buildings and prioritize scheduling accordingly.
- Conduct annual reviews of operational schedules and monitor for undocumented or unapproved modifications throughout the year.
- Update occupancy schedules as needed to remain current with changes in building utilization and department needs.

E.2.3 Establish a lighting update program (interior and exterior).

Perform lighting audits and maintain a continuous lamp update program. Consider green technologies and the latest technological advances when making decisions.

Minimize energy requirements of interior and exterior lighting by:

- Installing occupancy sensors to allow for control of lighting in areas with variable occupancy frequencies (e.g. laboratories, common areas, bathrooms, hallways);
- Installing photosensors in areas suitable for daylighting;
- Installing motion sensors with dimming technologies, where appropriate, to maximize safety while minimizing energy use associated with lighting hallways and pathways; and
- Considering solar energy or other alternatives to power exterior lighting at bus stops, along roadways, sidewalks, parking lots, and paths (e.g. not building associated) and for small uplighting projects.

E.2.4 Reduce fume hood energy consumption.

During fall 2009, the University will outfit all campus fume hoods with “Shut the Sash” reminder stickers (Figure 3.2). To complement this effort, it is recommended that the University:

- Develop and implement a fume hood 'responsible use' policy that includes mandatory training for applicable faculty, staff and students.
- Evaluate departmental fume hood need and use; temporarily turn off fume hoods that are not currently in use.

Figure 3.2. UConn fume hood reminder sticker. Reminder stickers were placed on all campus fume hoods during the 2008-2009 academic year to encourage energy conservation.

E.2.5 Establish an energy-efficient computing policy.

Over ten thousand computers are located on the UConn Storrs campus. The U.S. EPA reports that enabling computer power management settings can save as much as $25-$75 per computer annually (USDOE 2009). Similarly, data center energy demand is expected to nearly double in the next five years (USDOE 2009). Therefore, the University should adopt a comprehensive energy-efficient approach to managing campus computers, servers, and related equipment could generate significant energy and cost savings. (Exceptions may be necessary for research or operational requirements.) Goals of the policy should include:

- Identify and implement mechanisms to reduce data center energy consumption and improve energy efficiency, such as:
    - conducting energy use assessments;
    - consolidating campus servers and data centers;
    - identifying opportunities to increase cooling equipment energy efficiency;

    - exploring virtualization tools, optical networks, and thin-client computing; and
    - evaluating potential data center design changes.
- Establish computer use expectations, including:
    - enabling power management settings on computing resources; and
    - shutting down computers and affiliated equipment when not in use.

E.2.6 Implement a residence hall appliance policy.

Develop a policy to address common, energy-intensive appliances used in the residence halls, such as refrigerators, microwaves, televisions, and/or lights.

Components of the policy might include:

- Limit the number of each appliance type (e.g. refrigerator, microwave) allowed per room, and require ENERGY STAR certified appliances when available.
- Restrict the use of personal appliances in the residence halls; provide University-owned energy efficient appliances and collect a student deposit to cover losses due to theft or damage.

Work with the UConn Co-op to ensure ENERGY STAR model appliances are regularly stocked and competitively priced; encourage students and their families to purchase appliances for residence halls from the Co-op.

E.2.7 Minimize energy use associated with equipment and appliances.

a. **Minimize phantom loads associated with office appliances**. Identify a team to evaluate campus phantom loads and develop a reduction strategy to minimize unnecessary electricity use. Office and residential equipment and appliances draw a significant amount of energy from the campus grid even when not in use (i.e. the 'phantom load). Simple solutions, such as the distribution and use of power strips or education to encourage campus members to unplug appliances when not in use, can help reduce the campus phantom load.

b. **Eliminate use of window air conditioning units wherever possible**.
Develop an official policy banning the use of personal air conditions in campus buildings, unless University approved for health or other qualifying reasons. All approved AC units must be covered during the winter months to prevent heating loss.

c. **Discontinue the use of small individual space heaters through increased enforcement of the University's space heater policy**. The current policy is available at http://policy.uconn.edu/pages/findPolicy.cfm?PolicyID=223

E.2.8 Identify and improve energy efficiencies associated with campus food service equipment and appliances.

Food service vendors, both University-owned and private, are located throughout campus. Additional improvements to food service energy efficiency can be made by:

- Evaluating university-owned refrigerators, freezers and dishwashers in order to identify and replace inefficient and/or older models;
- Requiring the replacement of open display refrigerators or freezers with closed door units;
- Consolidating campus food vendor equipment based upon need and frequency of use;
- Working with vendors to ensure they are using the most efficient units possible; and

- Installing vending machine misers on all equipment (e.g. soda and snack machines, food displays).

Strategy E.3: Maximize efficiency

E.3.1 Correct inefficiencies in the utility distribution systems.

An engineering consulting firm, Fuss & O'Neill, have been contracted to survey the existing steam and condensate infrastructure. A computer model will be developed enabling Facilities Operations to optimize operation, isolate sections for replacement with minimal interruptions to the customer base, and balance flows to reduce systems stresses. The first $2.6M replacement projects are expected to be included in the 2011 (fiscal year) deferred maintenance program. Similar expenditures will be required on an ongoing basis to stabilize degradation and commence upgrading the systems.

The Chilled Water system controls are currently being upgraded under the FY09 Deferred Maintenance Program. This upgrade will properly integrate the operation of the 1999 electric and gas driven chillers with 2006 steam chillers. Increased efficiency will result from being able to effectively run and balance loading using the most economical sequence of chiller operation.

E.3.2 Expand and better integrate current energy monitoring efforts.

Complete the on-going meter installation program and verify proper functioning. Expand the Energy Management System (Andover) to include areas not currently monitored. Develop a University protocol for monitoring, tracking and trending meter data, including integration with outreach efforts. For example, place Energy Kiosks at highly visible locations to display the metering data with recommended actions to reduce use. Based upon data collected identify campus 'energy hogs' and target these buildings for retrofitting to reduce energy usage.

The third phase of a four-phase meter installation program is in progress. Phase I focused on surveying the existing infrastructure and installing metering on the largest or externally billable users. Phase II focused on installing metering on the grant funded buildings and completing connection of all installed metering to the data historian. Phase III will begin integration of the data collection into analysis tools, developing a billing structure with cost estimates, and developing the evergreen principles necessary to maintain and repair the metering network components.

The outdated FASER 6.0 Energy management software should be updated to take advantage of the current generation of analysis tools. Increased national awareness of energy consumption and the need for conservation has driven the software manufacturers to broaden the abilities and lower costs associated with energy management software. Greater flexibility in determining energy improvement targets exist in current versions. This software serves as the central gathering point of external and internal energy consumption and billing data. Selection of this software should be an enterprise level effort to incorporate the needs of stakeholders such as Accounts Payable, Accounts Receivable, and Facilities Operation. The ability to accurately bill energy users and maintain all the required sub metering is dependent upon this software working correctly.

E.3.3 Promote continuous improvement of operational strategies at the cogeneration facility.

Identify and implement power plant efficiency improvement measures. Presently the power plant operates at approximately 60% efficiency and opportunities remain to further improve this efficiency.

E.3.4 Centralize utility systems as much as possible and examine opportunities to integrate building projects to maximize utility system efficiency.

All UConn buildings located on the campus, that still are on Connecticut Light and Power meters should be removed from the meters, and instead be rewired to the UConn campus grid. The cogeneration plant has the capacity to support this additional load. This will eliminate large quantities of electric charges and allows us to use our energy efficient cogeneration plant at near full capacity. This work will be need to be conducted in balance with increasing the steam usage on campus to effectively leverage the cogeneration effect.

Audit all campus transformers and downsize or consolidate where possible.

E.3.5 Improve the efficiency of building HVAC systems.

a. Install occupancy sensors to allow for control of HVAC in areas with variable occupancy frequencies (e.g. laboratories, common areas, bathrooms, hallways). Make this a UConn standard for all new construction and renovations.

b. Switch to heat zoning to address areas of buildings that require deviation from the established set point. Heat zoning allows the University to address certain areas of buildings based upon occupancy, equipment or functions, which require deviation from the established set point.

c. Require the use of high-efficiency filters for all HVAC systems to reduce drag. High quality filters should be used in all University HVAC systems. In addition, the University should require annual cleaning of all campus building heating/cooling HVAC coils and Air Handling Units (AHUs).

E.3.6 Develop and initiate a boiler efficiency and emissions reductions program.

The University should track small boilers and determine the associated efficiencies. An annual boiler maintenance plan should also be developed and implemented on a rotating basis.

E.3.7 Develop and implement an equipment energy efficiency purchasing policy.

EPA and DOE continually develop new ENERGY STAR specifications to expand the program to new products. Energy Star models are now available for commercial appliances, commercial heating & cooling, consumer electronics, residential appliances, residential lighting, commercial food service, construction products, office products, and residential heating & cooling products. A complete product specifications and updated lists of qualifying products is available at: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.

Recommended components of the university equipment energy efficiency purchasing policy include:

- Require that University vendors provide products that earn the Energy Star and meet the Energy Star specifications for energy efficiency when available.

- Require departments to purchase Energy Star products when offered by campus vendors. Require written justification to purchase non-efficient products for which a more energy efficient model is available.

Strategy E.4: Substitute Green Technologies for Existing Technologies

E.4.1 Seek to incorporate alternative energy sources into new constructions and retrofit existing buildings were appropriate and feasible.

The University should make it standard practice to consider on-site renewable energy sources with new construction and renovation projects. When determining feasibility the upfront costs of the project should be compared to upfront costs of conventional designs as well as the difference in energy expenditures over the life of the building. Specific opportunities might include:

- *Incorporate solar thermal and solar photovoltaics (PV) into building designs.*
  Solar water heaters have been demonstrated to reduce conventional water heating needs by approximately 66% (USDOE 2006). Solar PVs not only generate energy but also have excellent PR value, serving as a highly visible 'announcement' of the University of Connecticut's commitment to sustainability.
- *Install geothermal heating or cooling systems.*
  According to the EPA, geothermal heat pumps can reduce energy consumption—and corresponding emissions—up to 44% compared to air-source heat pumps and up to 72% compared to electric resistance heating with standard air-conditioning equipment. (USDOE 2008).

E.4.2 Maximize efficiency of laboratory airflow through new technologies.

Replace constant volume hoods on campus with the most efficient available hood type (e.g. variable air volume hood) for the intended purpose. Install Usage Based Controls (UBC) which modulate hood flows based on the presence or absence of a fume hood operator, Phoenix controls, or a comparable option, on all campus fume hoods. Install alarms to indicate to Facilities and Environmental Health & Safety when sashes are left open. Generate corresponding reports and send to department heads for action.

E.4.3 Identify and evaluate applications for variable-frequency drives (VFDs).

Variable frequency devices (VFDs) control the rotational speed of an alternating current electric motor by controlling the frequency of the electrical power supplied to the motor. The majority of the University's chillers currently are equipped with variable frequency devices (VFDs). Additional on-campus applications of VFDs can save the University energy and money. (For example, Harvard University has successfully implemented VFDs to control kitchen exhaust hoods while Ball State University uses VFDs in association with campus distribution pumps.)

E.4.4 Evaluate the feasibility and appropriateness of developing a carbon-neutral power plant.

The cogeneration facility has approximately a 40-year design life. As our 2050 carbon neutrality goal approaches, it is likely that the University will still have emissions requiring neutralization. Therefore, it is recommended that the University plan to evaluate in the long-term, the feasibility of replacing the cogeneration facility with a carbon neutral power supply such as a fuel cell reactor.

Strategy E.5: Demonstrate Alternative Technologies

The University of Connecticut Storrs campus is already involved in an impressive array of alternative and renewable energy technologies. Faculty from across the University conduct research and outreach involving solar photovoltaics, fuel cells, geothermal energy, and biofuels. UConn Biodiesel Consortium has been involved with small-scale biodiesel testing and production since 2006 and has plans for extensive growth in the upcoming years. The Center for Clean Energy Engineering (C2E2), a leader in emerging fuel cell technologies, is located on the Depot campus. Building upon this tradition, members of the University are working together to make the Depot campus the first self-sustaining green campus in the nation. These recommendations will not only meet the campus energy demand in a carbon-neutral manner, but also increase the University's prestige in sustainable energy both nationally and globally.

E.5.1 Develop an alternative/renewable energy strategic plan and implement demonstration projects.

Campus renewable energy demonstration projects serve several purposes. Successful projects will not only generate energy but may also test new technology. Of equal importance, campus demonstration projects serve as highly visible reminders and examples of the University's commitment to sustainability.

The Climate Action Task Force therefore recommends that the University work with campus experts to develop a master plan, which would evaluate the suitability of wind, solar (PV and thermal), geothermal, biofuels, fuel cells, hydroelectric and any other appropriate renewable energy technology on the campus. The plan would seek to identify target locations for renewable energy expansion and new use, emphasizing high visibility pilot projects related to the University's research endeavors.

Given the presence of the C2E2 and a proposal to develop an expanded campus biofuels facility, the Depot Campus may prove a valuable beta testing ground for these projects and technologies. Similarly, the UConn Dairy Bar attracts large numbers of campus members and visitors year-round and would serve as an excellent location to highlight renewable energy technologies, such as a fuel cell or a solar PV display, while 'offsetting' the greenhouse gas emissions associated with the livestock used to create the dairy products.

Where appropriate, consideration should be given to private and public partnerships to help defray costs.

Emissions Reduction Strategies:
Sustainable Development

Table 3.3. Sustainable Development-Related Emissions Reduction Strategies

SD.1.	**Green the campus building and renovation process**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
SD.1.1.	Revise the Sustainable Design and Construction Policy.				0-2 Years
SD.1.2.	Update the Sustainable Design Guidelines and mandate their use for projects not required to meet LEED standards.				0-2 Years
SD.1.3.	Develop a construction materials selection, recycling and reuse guide.				0-2 Years
SD.1.4.	Seek to achieve zero-carbon buildings.				>5 years
SD.2.	**Manage the campus forest to maximize carbon sequestration**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
SD.2.1.	Establish a permanent position to oversee the management of the University's forest holdings.				2-5 years
SD.2.2.	Inventory the University's forest holdings and establish a plan to maximize carbon sequestration.				2-5 years
SD.2.3.	Develop and implement a management plan to improve and expand the urban forest.				2-5 years
SD.2.4.	Establish general forest acquisition goals and a 'no net loss' policy.				>5 years
SD.3.	**Refine campus agricultural practices to minimize fuel and chemical inputs, while maximizing sequestration**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
SD.3.1.	Develop an agricultural and landscaping waste composting system.				In Progress
SD.3.2.	Identify opportunities to use agricultural wastes to generate new products.				2-5 years
SD.3.3.	Maximize the use of organic, conservation-till agriculture on campus.				2-5 years
SD.3.4.	Manage herds to minimize associated emissions.				2-5 years

SD.4.	**Minimize the carbon footprint of campus landscaping**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
SD.4.1.	Develop a campus landscaping master plan designed to minimize chemical, energy, and water use.				In Progress
SD.4.2.	Improve turf quality on campus.				2-5 years
SD.4.3.	Maximize recycling of landscaping organic waste.				0-2 years
SD.5.	**Embody and implement low impact development (LID) principles**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
SD.5.1.	Require the use of the LEED for Neighborhood Development Rating System to guide future development decisions.				>5 years
SD.5.2.	Establish a cap on impervious surface.				>5 years
SD.5.3.	Select surface materials that are characterized by a high albedo, high emissivity, and low heat capacity, instead of traditional impervious surface materials.				2-5 years
SD.5.4.	Require integration of green roofs into all new building designs; retrofit existing buildings where possible.				2-5 years
SD.6.	**Maximize water conservation and reuse**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
SD.6.1.	Correct inefficiencies in steam utility systems.				In Progress
SD.6.2.	Upgrade water fixtures in campus buildings to maximize efficiency.				In Progress
SD.6.3.	Construct a water reclamation facility.				In Progress
SD.7.	**Increase campus recycling and waste reduction rates**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
S.D.7.1.	Increase campus food waste recycling.				2-5 years
S.D.7.2.	Establish a green purchasing policy to minimize packaging and other waste associated with campus purchases.				0-2 years

Strategy SD.1: Green the campus building and renovation process.

Figure 3.3. The UConn Burton Family Football Complex and Shenkman Training Center. The facilities were built to LEED-Silver green building standards, making them the first LEED-Silver certified NCAA athletic facilities in the nation.

The University recognizes the environmental, health and productivity benefits, as well as long-term cost savings, inherent in sustainable design and construction practices. In 2004, the University developed *Sustainable Design Guidelines* (SDGs) to augment Leadership in Energy & Environmental Design (LEED) as a sustainability benchmark. These guidelines have since been updated through the adoption of the *Sustainable Design and Construction Policy* in March 2007 (Appendix D). This policy requires that the University shall establish LEED Silver as a minimum performance rating for any building construction project entering the pre-design planning phase (for which the estimated total project cost exceeds $6M, excluding the cost of equipment other than building systems). Finally, current state legislation (PA 07-242) requires LEED Silver certification for renovations costing $2M or more beginning January 1, 2010 (as well as construction projects exceeding $6M in costs starting January 1, 2009). The act also specifies that these facilities must exceed the current building code energy efficiency standards by at least 20%. Discussions are underway to update the University's policy to reflect this legislation.

The University's commitment to green building is impressive; however, in order to achieve the maximum emissions reductions benefits from the University's green building and renovation efforts, the Climate Action Task Force recommends the following strategies:

SD.1.1. Revise the Sustainable Design and Construction Policy.

Green building is a rapidly expanding field, and the University of Connecticut policy needs to be routinely reevaluated to ensure that the policy remains current and at the forefront of the green building field. LEED certification provides assurance that a building's design utilizes energy and water efficiently and provides a healthy working environment for the building's occupants. As noted above, state law requires LEED-Silver certification for projects exceeding a certain fixed cost. However, the LEED Silver building of today may become a relic in ten years. Therefore, the University should alter the existing policy to:

- Require evaluation of LEED certification potential for all new construction and renovation projects. The evaluation should be based on the anticipated life of the building to adequately capture the potential long-term savings (i.e. life cycle cost analysis or LCCA), rather than analysis of upfront costs alone.
- Encourage the University to achieve the highest LEED certification possible for all new construction and renovation projects.

- Ensure that LEED certification points are pursued first through energy and water conservation related points. Achieving energy conservation points, in particular, will help maximize the greenhouse gas emissions reduction benefits of the LEED certification.
- If the costs of obtaining LEED certification is determined to be unreasonably burdensome (through a demonstrated lifecycle analysis as described above), allow substitution of the University's Sustainable Design Guidelines in lieu of LEED certification.
- Promote involvement of all stakeholders during the approval of building schematics by requiring at least one ecocharrette ('green meeting') during the schematic phase of building approval. Involve the facilities personnel, who will be responsible for building operation and maintenance, as well as the anticipated building occupants, in design discussions.

SD.1.2. Update the Sustainable Design Guidelines and mandate their use for projects not required to meet LEED standards.

The present Sustainable Design Guidelines (SDGs) were developed in 2004 and need to be updated to reflect improvements in design standards since the guidelines first release. The following are specific recommendations for updating the SDGs:

- ***Include a clear statement of design standards and specific building performance targets****.* Include resource use intensity targets, carbon or other environmental footprint targets, as well as performance goals relative to code baselines. Language regarding preferred, accepted, or rejected technologies and environmental priorities is needed.
- ***Assign numerical benchmarks to each goal within the guidelines***. A scoring matrix can then be used to assess whether new construction or renovation projects meet the University Sustainable Design Guidelines. As is recommended for the Design and Construction Policy, an emphasis should be placed on earning points through energy and water conservation measures.

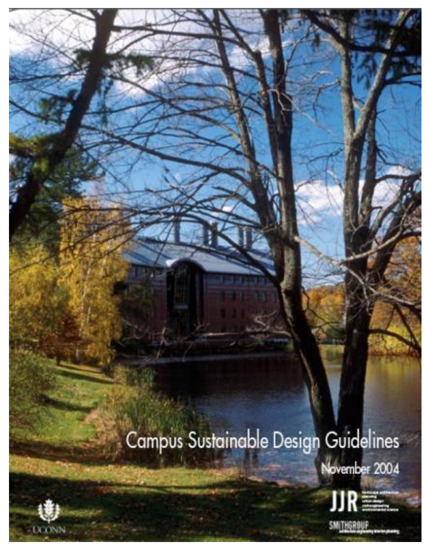

Figure 3.4. The University's 2004 Campus Sustainable Design Guidelines.

- ***Encourage the incorporation of 'natural' features into building designs, to maximize building efficiency, aesthetics, and safety while minimizing environmental impacts****.* Incorporating plants into the building design (*e.g.,* shade trees and windbreaks, green roofs) not only can lead to a more attractive and inviting building, but can help increase heating and cooling efficiency while improving indoor air quality, and be an important component of stormwater management. Emphasize site selection and buildings designs which maximize use of passive solar energy and natural ventilation. Public safety concerns should be considered when considering available options.

SD.1.3. Develop a construction materials selection, recycling and reuse guide.

The proposed construction materials guide should outline targets for the materials selected for new construction and renovation projects. Emphasis should be placed on materials that are locally produced, have a high recycled content, are rapidly renewable, and/or are low in toxicity and emissions. In addition, the guide should outline a strategy to maximize the reuse of materials prior to building demolition and to maximize the proportion of demolition materials that are recycled. Information such as vendor pricing and contacts should be incorporated in order to assist the Purchasing Department with developing contracts that meet the goals outlined in the document.

SD.1.4. Seek to achieve zero-carbon buildings.

Green building and sustainable development are rapidly expanding fields. The associated technologies are not only increasing in availability but also in affordability. As a leader in these fields, the University should continue to innovate by ultimately striving to develop 'zero-carbon' buildings. These buildings typically incorporate on-site energy production, purification and reuse of water, and other features to neutralize the building footprint.

Strategy SD.2: Manage the campus forest to maximize carbon sequestration.

The University of Connecticut owns approximately 2,273 acres of forest land in association with the Storrs Campus. Along with a significant urban forest, the University possesses several large forest tracts officially designated as "UConn Forest." These tracts are currently managed by the Department of Natural Resources and the Environment for educational, research, and recreational purposes along with, to a lesser extent, forest products.

UConn Forest lands provide numerous essential benefits including: water quality protection and improvements, water recharge, habitat features critical to insect pest control and pollination services, and air quality improvements including cooling cleansing, reduced summer ambient temperatures and increased oxygen. Campus forest lands also serve as a potential source of energy and products, as well as biotic diversity repositories.

The aesthetic value of these parcels is also significant. The majority of campus community members and visitors enter the Storrs Campus from access points along Route 195. The view of Horsebarn Hill from this roadway with the Fenton Tract as a backdrop has particular aesthetic value for the campus and local community as a visual reminder of the natural history of the region as well as the University's legacy as a land grant institution.

Figure 3.5. The University's forest lands offer a multitude of primary and secondary benefits. (Shown: the Fenton Tract.)

Finally, these forest lands serve as a valuable opportunity to sequester carbon. Carbon sequestration potential (as well as the other above-mentioned benefits and services) can be enhanced and optimized through the proper application of a balanced combination of management techniques and practices. Individual forest management plans currently exist for each forest tract, however the majority of these plans are over a decade old and in need of updating.

The University's forests are an incredibly valuable resource, and like any valuable resource, the forest needs to be actively managed to maximize its worth – economically, academically, and environmentally. More intensive, proactive management of these lands could provide for additional carbon sequestration, as well as offer a variety of research, educational, environmental, and economic opportunities currently not explored. In order to improve the carbon sequestration and other essential benefits realized from our forest holdings, as well as to take advantage of the full suite of other benefits provided by this resource, the following strategies are proposed:

SD.2.1. Establish a permanent position to oversee the management of the University's forest holdings.

There is a recognized need for a paid professional forest manager to best manage UConn forest parcels. Presently, the management plan for each forest parcel is approximately 12-16 years old and in need of updating. In order to further manage these parcels for additional carbon sequestration, an individual or group knowledgeable about this aspect of forestry needs to be involved. Additional resources, including a small labor force and certain specialized equipment will ultimately be required. The associated required investment is small and would be offset by the numerous benefits provided by the forest resource, including potential cost savings or revenue generating opportunities such as local timber production, expanded maple syruping, and carbon offsets.

The proposed position could be established within the UConn Natural Resources and the Environment Department. Alternatively, if such funding cannot be acquired, the University should seek to contract the services to an outside party. (However, since potential research and educational opportunities may be lost through contracting out the position, it is strongly recommended that the University exhaust all avenues to establish this position 'in-house' first.)

SD.2.2. Inventory of the University's forest holdings and establish a plan to maximize carbon sequestration.

In order to best manage the UConn Forest for carbon sequestration potential, regular thorough inventories need to be conducted. Partial forest inventories are presently done on a volunteer basis by the UConn Natural Resources and the Environment Department, though this information is not comprehensive. A comprehensive, well-maintained inventory would be coordinated and managed by the proposed forest manager (see previous paragraph) and student interns, who could be supported by revenues generated from increased forest products production, as called for in resulting management plans. This information can be used to plan how to best steward the resource for maximum carbon sequestration.

SD.2.3. Develop and implement a management plan to improve and expand the campus urban forest.

The University of Connecticut is an arboretum campus, providing numerous unique and high-value tree specimens for the public to experience. Because established trees are comparatively low-maintenance, expanding the urban forest will result not only in increased aesthetic value, but also decreases in maintenance needs (and therefore energy requirements). In addition, if expansion of the urban forest is integrated with construction and renovation efforts, the improved shading benefits providing by the urban forest can result in lower energy requirements for nearby buildings. Improving the quality and of the urban forest can also assist with increasing on-campus carbon sequestration. (Additional benefits include increased wildlife habitat, recreational opportunities such as bird watching, and stormwater management improvements.) The University should therefore develop a comprehensive management plan for the University urban forest, including targets for improvement and expansion over time.

SD.2.4. Establish general forest acquisition goals and a 'no net loss' policy.

The value of creatively managing our forest holdings for carbon sequestration should not be understated. The University of Connecticut has a long academic history in this area. As a result, UConn has the in-house expertise and student interest necessary to become national leaders in this area of research and campus operation. When and where feasible, the University should seek to expand the acreage of the UConn Forest to further increase on-campus carbon sequestration (as well as for the multitude of other benefits described throughout this section). A "no net loss of forest" policy should be adopted to ensure the long-term carbon benefits of management efforts are not lost with new development plans.

The Town of Mansfield's Plan of Conservation and Development (Town of Mansfield 2006) recognizes the need to work University officials to preserve State-owned forest and other natural areas. The Plan also identifies parcels suitable for sustainable development. Therefore, the University should establish forest acquisition and preservation goals in cooperation with the Town to prevent the unintended preservation of low-quality forest lands identified as suitable for sustainable development. Similarly, involving local organizations with an established history of local land preservation and conservation (*e.g.,* Joshua's Trust) will help ensure success in establishing and meeting local forest acquisition and management goals.

Strategy SD.3: Refine campus agricultural practices to minimize fuel and chemical inputs, while maximizing sequestration.

Initially founded as the Storrs Agricultural School in 1881, the University of Connecticut continues to honor its agricultural legacy through an active Farm Services department and through the teaching and research of the College of Agriculture and Natural Resources and the Cooperative Extension System. The primary emissions associated with agricultural operations on campus include methane (CH_4) from domesticated animals (i.e., via enteric fermentation and decomposition of manure), and nitrous oxide (N_2O) as a result of fertilizer applications to soils and animal production (NESCAUM et al. 2003). In addition, energy and fuel use associated with crop and herd management, building operation, transporting food or feed to and from campus, and the disposal of associated wastes contribute additional emissions.

Based upon current estimates, agricultural emissions account for a small portion of our total emissions profile. However the primary agricultural-related emissions – methane and nitrous oxide – are considered 'potent' greenhouse gases. Compared to carbon dioxide, the global warming potential of methane and nitrous oxide are 21 times and 310 times greater, respectively (CTDEP 2006). Therefore, despite comprising only a small portion of our emissions profile, it is important to address these emissions sources to the greatest extent possible. The following strategies will help minimize greenhouse gas emissions associated with campus agricultural practices:

SD.3.1. Develop an agricultural and landscaping waste composting system.

The University has completed design plans for a proposed agricultural and landscaping waste composting facility. The proposed facility will be a 10,000 square foot hoop barn structure constructed on a concrete pad. In addition, the site will contain a 10,000 square foot paved pad for finished compost. The facility is expected to accommodate approximately 36%[2] of the University's agricultural waste (e.g. manure, bedding) and landscaping wastes (e.g. leaves, brush) throughout the year (Table 3.4).

Table 3.4. Proposed Compost Facility Annual Waste Processing and Compost Production[3]

Materials	*Tons per Year*	*Volume Reduction After Composting*	*Annual Compost Production*
Animal Bedding & Solid Manure (Combined)	1,660	40-60%	862.6
Liquid Manure	600	80%	120.0
Leaves & Brush	30	60%	16.0
TOTAL	2,180		987.6

Compared to spreading raw manure on the University's agricultural fields or storing on campus, composting agricultural waste offers numerous benefits and improvements, including a reduction in annual animal waste volumes and generation of research and educational opportunities. In addition, on campus compost production (compared to current waste management techniques) will reduce waste-related campus odors and reduce soluble nutrients and associated ground and surface water

[2] With improvements in inefficiency, the proposed facility may be able to process up to 50% of all campus agricultural and landscaping wastes.
[3]Source: UConn Farm Services, *personal communication*, 7/22/2009.

contamination. Application of the finished product to campus fields and gardens will result in soil plant pathogen suppression, increased yields, and cost savings from decreased mulch and fertilizer purchases. Finally, the University estimates that the facility will result in a net reduction of campus greenhouse gas emissions.

Greenhouse Gas Emissions Reduction[4]

Composting is an aerobic process that converts organic materials such as landscape wastes (e.g. grass trimmings, leaves, branches) and animal wastes (e.g. manure, bedding) into a stable, humus-like material through microbial decomposition. Properly managed composting operations can help to 'offset' campus greenhouse gas emissions through three primary mechanisms:

(a) preventing emissions associated with breakdown in landfills or during storage,
(b) increasing carbon sequestration through improved soil condition and increased crop productivity, and
(c) reducing the need for artificial fertilizers (through replacement with finished compost).

Composting agricultural and landscaping waste prevents the CH_4 and N_2O emissions that would have otherwise occurred during storage or disposal. CH_4 generated during the composting process is assumed to be oxidized and converted into CO_2; consequently, properly managed composting operations emit only negligible amounts of methane. Similarly, organic materials are part of the short-term carbon cycle; therefore, the carbon dioxide emissions associated with their decomposition through composting are not considered 'additional' greenhouse gas emissions[5]. Based upon these factors, the following greenhouse gas emissions reduction estimate assumes that on-campus composting will be a carbon neutral process managed to achieve near-zero methane emissions. Emissions 'offsets' are therefore accrued by avoiding the methane emissions that otherwise would have occurred during storage, spreading, or disposal, and through increased soil carbon sequestration due to compost application as a soil amendment.

Current estimates project that the proposed facility will process approximately 2,180 tons per year of campus agricultural and landscaping wastes (approximately 36% of the total). Assuming that the average manure composition is approximately 80% dairy cow, 7% swine, and 13% chicken, the maximum methane generation capacity is approximately 2.97 MTCO2e/ton (Table 3.5).

Table 3.5. Maximum methane (CH_4) generation capacity of feedstocks suitable for stabilization by composting[6]

Feedstock	*CH4 (kg/ton)*	*MTCO2e/ton*
Dairy Cow Manure	120	2.760
Swine Manure	141	3.243
Chicken Manure	179	4.117
Grass	101	2.323
Food Waste	190	4.370

If it is further assumed that approximately 60% of the total volume collected (1,090 tons) is pure manure, then approximately 140.8 metric tons of methane or 3,237.6 $MTCO_2e$ are avoided annually

[4] A complete greenhouse gas emission-based lifecycle analysis of the proposed composting facility is beyond the scope of this document. The full GHG impacts of the final facility design, including energy requirements to transport feedstock to the facility, energy used during composting, and energy used to transport the finished product, have yet to be determined.
[5] Brown *et al.* 2008
[6] Adapted from Brown *et al.* 2008 (Table 5, p. 1402)

through composting. Furthermore, for every ton of compost applied to campus soils, approximately 0.07 MTCE are sequestered.[7] Consequently, application of the finished compost generated by the proposed facility could avoid an additional 264.3 $MTCO_2e$ per year. Therefore, an estimated total 3,491.8 $MTCO_2e$ will be avoided annually through campus compost production and application based upon current design plans.[8]

SD.3.2. Identify additional opportunities to use agricultural wastes to generate new products.

Even with the construction of the proposed compost facility, the University will have an excess of animal waste. (It is estimated that the proposed facility will be able to accommodate 26-40% of the manure currently generated on campus.) The University should therefore continue to explore alternative uses of agricultural wastes including the creation of a closed loop system to generate ethanol from organic wastes for use in campus laboratories or methane digesters for manure.

SD.3.3. Maximize the use of organic, conservation-till agriculture on campus.

Organic conservation-till practices have been demonstrated to increase carbon sequestration in agricultural fields (La Salle and Hepperly 2008), while minimizing additional environmental impacts, such as soil erosion. Both the carbon sequestration benefits as well as the additional environmental benefits are significant. (Exceptions to this policy would be appropriate for research purposes.) The University should therefore ensure that management of campus agricultural parcels includes practices such as conservation-till to maximize on-campus soil carbon storage.

SD.3.4. Manage herds to minimize associated emissions.

The university's dairy cattle herds are one of the largest sources of methane emissions on campus. Emerging research has suggested that it may be possible to manage these animals' diets to reduce the associate greenhouse gas emissions (Boadi *et al.* 2004). Similarly, there are 'miniature' versions of popular breeds that eat 60% as much feed as a 'regular' cow, yet can produce up to 76% as much beef (Huffstutter 2009). The Climate Action Task Force recommends that the University consider these research findings and conduct additional research to identify opportunities to minimize the emissions associated with the campus herds. Similarly, the Climate Action Task Force recommends the University evaluate the impact of maintaining only grass-fed herds in order to minimize energy requirements associated with growing and transporting feed. (Exceptions to the above proposed management strategies should be allowed, however, as necessary for research or animal health requirements.)

Strategy SD.4: Minimize the carbon footprint of campus landscaping.

Present landscaping best management practices include avoiding fertilization or irrigation of campus turfs as well as leaving clippings after campus mowing. Further reducing the water, fuel, fertilizer and other chemical and energy inputs associated with landscaping will result in a direct greenhouse emissions reduction. It is therefore recommended that the University:

[7] USEPA 2006b

[8] This is a conservative estimate which does not account for the emissions that would have been released by the decomposition of the animal bedding, leaves, and brush. Including these avoided emissions as well as increases in total compost volume due to efficiency improvements, may increase this estimate substantially.

S.D.4.1. Develop a landscaping master plan to minimize chemical, energy, and water use associated with campus landscaping.

Presently the University lacks a coherent plan to guide campus landscaping operations. Therefore, the University is developing a landscape master plan to resolve issues of function and character throughout the campus as well as to improve the visual appeal of the University. The plan is presently expected to address roads, sidewalks, vegetation and lighting, as well as vehicle and pedestrian traffic. It is recommend that the University work with campus experts (*i.e.,* staff and faculty) and university contractors, as appropriate, to expand the scope of this plan to encourage the development of a well-designed, attractive campus, *while minimizing chemical applications, maintenance needs (i.e., fuel use), and watering requirements.* The plan should address all aspects of campus landscaping operations, and additional goals should include the enhancement and protection of habitat, and the minimization of wildlife-human conflicts. Specifically, the plan should outline a strategy to:

- ***Increase the use of non-invasive, pest resistant, low water requirement, and, preferably, native plant species, including grasses.*** Use of such species will minimize water inputs and result in a decrease in campus energy and chemical use. Similarly, the University should avoid planting monoculture lawns; mixed species lawns help promote biodiversity, which in turn increases resilience to pests, therefore reducing the need for pesticides.
- ***Minimize outdoor watering, while maximizing the efficiency of campus irrigation practices.*** Along with appropriate (*i.e.,* drought resistant) plant selection, the University can make operational and infrastructural changes to reduce outdoor water. Current irrigation systems can be automated based on moisture conditions at the time of watering or time of day. In addition, the University should switch to ultra-low-volume distribution devices for campus irrigation.
- ***Minimize chemical and fertilizer use associated with campus landscaping.*** The University does not currently fertilize campus turf; however fertilizers are used on campus for certain applications. In these instances, chemical fertilizers should be replaced with local organic sources such as campus-produced compost. A comprehensive integrated pest management (IPM) program should also be outlined, including herbicide and pesticide use minimization and the selection of less toxic products. Species such as clover which provide nitrogen fixation, can also be integrated into campus lawns, providing a natural 'fertilizer' source.
- ***Minimize campus mowing through restructuring of campus mowing scheduling, identification of 'no-mow' areas, and promotion of landscaping with native, low-maintenance wildflowers instead of turf.*** Restructuring mowing schedules will result in direct fuel and fertilizer use reductions, and therefore monetary savings and emissions reductions for the university. Mowing frequency at the Depot Campus in particular should be examined. In addition, adjusting campus mowing practices will have numerous secondary benefits, including an increase in staff hours available to address other university maintenance needs, improved wildlife habitat, increased aesthetic value, and decreases in stormwater runoff.
- ***Establish a landscaping 'low-waste' goal.*** Identify opportunities to recycle and reuse organic materials generated through landscaping activities, thereby reducing disposal-related transportation requirements.

S.D. 4.2. Improve turf quality on campus for enhanced carbon sequestration and hydrologic benefits.

Turf presently occupies a large portion of the Storrs campus. Despite being vegetated, these surfaces are often compacted due to pedestrian and vehicular traffic, resulting in reduced rooting depth and therefore limiting the soil's carbon sequestration capacity. In addition, soil compaction results in decreased infiltration capacity, greater runoff, lowered available water for plant growth, and, consequently, increased watering requirements. Compacted turf areas therefore require greater maintenance and do not offer the full range of environmental services that undisturbed vegetation can provide. The University should therefore ***explore turf enhancements that will increase rooting depth and associated carbon storage*,** as well as increase infiltration rates, reduce runoff and associated water pollutants, decrease maintenance requirements, and provide greater benefits to campus wildlife.

Increasing earthworm populations can also help improve the carbon sequestration potential of campus soils. Earthworms have been shown to help maintain a healthy soil, including greatly helping to increase infiltration capacity once a vegetated surface is established. In general, a healthy earthworm population will occur if the proper soil conditions are present (e.g. low compaction, healthy vegetation). However, certain earthworm species, such as African 'red wigglers,' can actually be detrimental to soil quality and carbon sequestration potential. Therefore, the University should ***work with campus experts to identify management measures that will deter the establishment of these aggressive earthworm species*.**

S.D.4.3. Maximize recycling of landscaping organic waste.

It has been observed that present landscaping practices have a tendency to result in large quantities of scrap wood. This wood is treated as waste and transported off-site. Identifying alternative uses for organic 'waste' generated through landscaping practices will therefore result in decreased transportation costs (and associated emissions). Alternative uses for scrap wood, for example, would include habitat enhancement, chipping for animal bedding, erosion protection for campus trail systems, sale to off-campus vendors for conversion into wood pellets/ bricks or for use in a local biogeneration power plant, or mulching to reduce water losses associated with irrigation.[9] Similarly, herbaceous organic wastes could be composted and used to enhance campus gardens.

Strategy S.D.5: Embody and implement low impact development principles.

Eagleville Brook, located in Mansfield, and flowing through the UConn campus, is the first stream in the nation to have an impervious cover based Total Maximum Daily Load (TMDL) allocation for pollutants. In the case of Eagleville Brook, stormwater has been identified as the primary stressor to the stream system. Since a large portion of the Eagleville Brook watershed is occupied by the UConn main campus, the University has been charged with identifying ways to reduce the effective imperviousness in the watershed in order to reduce stormwater runoff. ("Effective" impervious surface is considered to be those impervious surfaces which directly cause stormwater to be delivered to an aquatic ecosystem.)

Low-impact design (LID) strategies seek to minimize environmental disturbance associated with development. In the case of stormwater management, LID techniques seek to reduce the 'effectiveness' of impervious surfaces, by promoting infiltration of stormwater rather than allowing it to runoff along the surface and into a water body. Many of these LID strategies also have secondary benefits that have the potential to affect the University's emissions profile. For example, reducing the amount of impervious cover or selecting to install surfaces with a higher albedo (greater reflective properties), have the added benefit of reducing the heat island effect created by large swaths of impervious

[9] Caution should be exerted when using wood chips for mulch, as tannins released by the wood can inhibit plant growth and reduce decomposition.

surfaces. A reduced heat island effect will result in decreased cooling requirements for buildings in the campus core.

Since reducing effective impervious cover will not only help the University reach its mandatory reduction goal, but will also help the University reduce greenhouse gas emissions through reduction of the heat island effect, it is recommended that the University continue to integrate LID strategies into campus projects. Strategies recommended here are limited to those that that will also contribute to a reduction in the overall heat island effect.

S.D.5.1. Require the use of the LEED for Neighborhood Development Rating System to guide future development decisions.

The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) for Neighborhood Development rating system (USGBC 2007) embodies the responsible growth polices recommended by the CATF, and can serve as a valuable tool to guide future land use and development decisions of the University. Communities that are developed using the LEED for Neighborhood Development principles are designed to include infill development and Brownfield reuse, minimize habitat fragmentation, preserve recreation space, and increased transportation access, among other benefits (USGBC 2008).

A similar rating system, the Sustainable Sites Initiative (2008), can also serve as a useful tool for guiding the site selection process to ensure sustainable development. The Sustainable Sites Initiative includes an 'Ecosystem Services Matrix,' which indicates which credits provide ecosystem services, including 'global climate regulation' and 'local climate regulation,' among others.

The Storrs Center "Main Street" project is a current effort involving a partnership between the University of Connecticut and the Town of Mansfield that embodies these principles. Through this project, 17 acres of a 47.7 acre site adjacent to the southeastern portion of campus will be redesigned into a pedestrian-oriented, mixed-use downtown center. (The remaining 30.7 acres will be preserved for open space and recreational purposes.) During the initial planning phases of the project, design guidelines were developed to ensure that project embodied the principles of smart growth and sustainable development (Mansfield Downtown Partnership 2008) and the project was entered into the LEED for Neighborhood Development Rating System (USGBC 2007). As a direct result of the principles outlined in the LEED for Neighborhood Development Rating System, the Storrs Center project has the potential to become the 'greenest' college town center in the United States. Perhaps most importantly, the project has involved an unparalleled level of cooperation between the University and the surrounding community. Although the Storrs Center project is not included in the current University inventory, the project serves as a valuable model for future development of the Storrs campus.

It is recommended that the University **require the use of the LEED for Neighborhood Development Rating System, the Sustainable Sites Initiative guidelines, or a combination thereof, as a tool to guide future growth decisions on the main campus**. In particular, future development decisions pertaining to the Depot Campus could be structured using the LEED for Neighborhood Development rating system.

S.D.5.2. Establish a cap on impervious surface.

In light of the recent Eagleville Brook TMDL, establishing an effective impervious surface cap for the Storrs campus would help to ensure compliance in the Eagleville Brook matter, as well as to cause a reduction in campus emissions. Ensuring no net increase in effective impervious surfaces on campus will:

- Prevent further heat island effects, resulting in decreased campus cooling and heating needs;

- Encourage innovative transportation systems that reduce reliance on personal vehicles and single-occupancy-vehicle trips;
- Encourage the reuse of ‘brown spaces’ and redevelopment of existing buildings over the development of ‘green spaces’ such as campus agricultural or forest lands that possess carbon sequestration potential; and
- Encourage the use of permeable materials and designs that ‘disconnect’ impervious features, thereby reducing stormwater runoff and the associated impacts.

S.D.5.3. Select surface materials that are characterized by a high albedo, high emissivity, and low heat capacity, instead of traditional impervious surface materials.

If surfaces are selected with a higher albedo (greater reflectance and usually lighter color) or treated with a reflective coating, surface temperatures will remain cooler (e.g. ‘cool pavements’), resulting in a decrease in the urban heat island effect as well as other stormwater management benefits (Cambridge Systematics, Inc. 2006). Similarly, surfaces with a lower heat capacity are also preferable to avoid storage of solar energy throughout the day – natural materials such as dry soil and sand, for example have a lower heat capacity than materials such as steel and concrete (USEPA 2009). Reflective vegetation can also be utilized to achieve these results.

In addition, permeable surface materials such as permeable pavers, unit pavers, rubberized tiles, porous asphalt or concrete, and others promote the infiltration of precipitation, in order to better model the natural hydrology of the location. This, in turn, reduces the amount of stormwater runoff resulting from the associated development and results in surface cooling through increased evaporation.

S.D.5.4. Require integration of green roofs into all new building designs; retrofit existing buildings where possible.

As with paving materials, roofing materials can also reach extreme temperatures (up to 160 degrees Fahrenheit); this heat is then either radiated to the surrounding air or transferred via stormwater runoff. Along with selecting light colored roofing materials, vegetative treatments such as installation of living or ‘green’ roofs, can significantly reduce the urban heat island effect (USEPA 2009). In addition, impervious surfaces, such as rooftops, that are treated with an ecological installation (i.e. green roof) contribute to stormwater mitigation, resulting in a decreased overall effective impervious surface area. Depending on type and location, green roofs can also provide additional benefits, including increased wildlife habitat, increased aesthetic value, increased recreational area (i.e. roof-top picnic areas), and potential for outreach, education and research opportunities. Given the combined stormwater and urban heat island reduction benefits that green roofs provide, it is recommended that the University:

- **Require the integration of green roofs into all new building designs.**
- **Retrofit existing buildings with green roofs, where possible.**

Strategy S.D.6: Maximize water conservation and reuse.

The University is responsible for the production, distribution, and treatment of water throughout the campus. In addition to typical domestic water uses (drinking, showers, cooking, etc.) the water system is essential to the production of utilities such as electricity, chilled water, steam production and automatic fire protection systems.

In 2007, the University hired a private contractor to survey and analyze the university's water consumption patterns. The resulting *UConn Water Audit Report* (WMI 2007) concluded that Storrs campus water consumption is approximately 498M gallons annually. The majority of this demand is associated with on-campus residential uses, on-campus academic uses, the central utility plant, and off-campus demand.

The process of pumping, treating, heating and distributing water across campus to meet daily demand requires a significant amount of energy. The USEPA estimates that approximately 0.006kWh of energy is used per gallons per day of water used.[10] Once used, additional energy is required to return the water to the campus wastewater treatment plant for further treatment. Therefore, any measure to conserve water on campus and reduce demand will not only directly benefit local resources, but will also result in a decrease in campus energy demands. Therefore it is recommended that the University:

Figure 3.6. The University's "Stop the Drop" campaign educates about the importance of water conservation.

S.D.6.1. Correct inefficiencies in campus steam utility systems.

On average, the cogeneration produces 80,000 lbs/hr of steam, however only approximately 60% of the associated condensate is being returned. Losses are associated with broken condensate lines, steam trap failure, and losses associated with lines that lead to sanitary waste. To reduce losses it is recommended that the University:

- Make the necessary repairs to the system, including the completion of the steam trap maintenance program in the Central Utility Plant and in the tunnels.
- Develop a maintenance program for steam pits not covered under the current steam trap maintenance project, along with zone and shop/DRL buildings.
- Perform a campus steam trap audit to ensure traps are right-sized and performing properly.
- Conduct annual surveys (*e.g.,* infrared) to locate leaks and failures in the system.

To further reduce waste, the University should add a steam powered chiller(s) to the South Campus chiller plant to utilize surplus steam generated producing electricity during summer months. Installing a South Campus steam chiller to provide that facility and chilled water loop with the same flexible capabilities as the central campus would eliminate the wasteful steam dumping that occurs when electrical demand exceeds steam demand on campus. Several buildings in close proximity to the chilled water and steam lines should be connected to these supplies as soon as possible. This will have the added benefit of decommissioning electric air conditioners and fossil fuel boilers which will lower the overall campus greenhouse gas emissions.

S.D.6.2. Upgrade water fixtures in campus buildings to maximize efficiency.

Existing, older and inefficient fixtures across campus should be phased-out and replaced with the highest efficiency models available. Low-flow showerheads and high-efficiency front loading washing machines are now common throughout campus. Upgrade and replacement efforts should therefore focus on toilets, urinals, and faucets. In addition, in order to ensure fixtures are performing to design

[10] Source: USEPA Region 1 Office, *personal communication*, 11/06/07.

standards, university staff should perform regular checks to ensure low-flow devices are not only installed, but functioning properly. As a general rule, all replacement fixtures as well as all fixtures included in new construction should be low-flow, high-efficiency water fixtures.

S.D.6.3. Construct a water reclamation facility to recycle water from campus sewage treatment operations.

The University operates and maintains its own sewage treatment plant, or Water Pollution Control Facility (WPCF). Average daily demand is approximately 1.4 million gallons per day. Presently, the University releases the treated sewage effluent back into the local watershed without consideration for reuse. There are, however, opportunities to reuse this treated effluent elsewhere on campus, which would reduce overall pressure on our local water supply sources and potentially reduce pumping related energy use.

In 2008, the University began investigation, analysis and design of a potential campus water reclamation system. The system would be developed to recycle water from the University's sewage treatment plant for non-potable water intensive uses. This would allow the university to reduce current demand on potable water. (Conceptually, the project would also include improvements to the treatment plant and distribution system.) Potential uses for this non-potable water include process water for the cogeneration facility, cooling plant and irrigation.

The Climate Action Task Force recommends that the University continue to analyze the feasibility and benefits of constructing a campus water reclamation facility. This analysis should include not only water conservation benefits, but also an analysis for increased energy demand (compared to current requirements to pump and distribute a similar volume of water), to determine the potential for undesirable greenhouse gas emissions increases

Strategy S.D.7: Increase campus recycling and waste reduction rates.

The University has an ongoing goal to increase recycling rates and to reduce total campus waste. In 2004, the University's Environmental Policy Advisory Council (EPAC) formed a Recycling Workgroup to develop action plans to achieve this goal and to evaluate progress. In addition, in 2005, the University hired a private consulting firm to review the campus recycling program and recommend improvements. Implementation of the recommendations in 2007 resulted in a 28% increase in recycling rates over the previous year.[11] However, the U.S. Environmental Protection Agency estimates that each pound of trash thrown away will emit around 0.94 pounds of carbon dioxide equivalent. In 2007, the University disposed 4,928.4 tons of waste or the equivalent of over 4,600 $MTeCO_2$. Therefore, additional increases in campus recycling and waste reduction can still result in substantial decreases in the overall campus emissions.[12]

Several new recycling and reuse efforts have been implemented since 2007. These efforts are assumed to have reduced greenhouse gas emissions associated with campus solid waste disposal during 2008 and 2009.

[11] Recycling weight increased from 881 tons in 2006, to an 1,129 tons of material in 2007
[12] The CACP calculator uses a different emission factor for solid waste disposal. Estimates of emissions reductions will vary depending on the factor selected.

- All campus buildings contain containers for recycling glass, metals, and plastic. (Blue desk side recycling bins are also located throughout academic and office buildings.) In addition, ten large outdoor can and bottle bins were placed in high-traffic locations on campus.
- The Department of Residential Life now places recycling bags in each dorm room on campus to encourage students to recycle within their residence hall. In addition, at the end of each semester, the campus holds a "Give and Go" program to collect unwanted items such as clothing, nonperishable food, furniture and more.
- An e-waste recycling program has become a very important and successful part of the campus recycling program. Drop boxes for recycling old cell phones, ink cartridges, and rechargeable batteries are placed around campus in highly trafficked locations.
- UConn Dining Services switched to trayless dining in all but one dining unit. (Remaining trays on campus are reduced in size to minimize food waste.) In addition, disposable cups have been removed from the dining halls; instead students are encouraged to use a refillable mug to carry beverages out of the dining halls. In addition, recognizing an opportunity to begin food composting on campus, a new cooperative program between the student-led UConn EcoGarden and Dining Services was established. Still in its infancy, the program currently involves only two campus dining areas, but is expected to divert the majority of food waste from these areas towards campus composting and agricultural operations instead of the University waste stream.
- Efforts to collect edible food 'waste' are also expanding across campus. In 2009, a pilot program was implemented by UConn Community Outreach and Residential Life staff to collect unwanted, nonperishable food items from students before they left for the semester. From one residential area alone, the University was able to collect and redirect 846 pounds of food from the campus trash stream to a local food bank.[13]
- UConn Athletics increased recycling outreach during campus athletic events including the placement of recycling containers throughout major athletic venues (*e.g.,* Gampel Pavilion, Rentschler Field). Student volunteers regularly "man the can" at campus basketball games to remind visitors to recycle.
- The UConn Co-Op now offers shoppers the option of selecting a plastic bag or a wooden nickel which can then be donated to a charity, several of which are local environmental efforts.
- Participation in Recyclemania. During their first competition in 2008, the UConn Huskies were in the top 50% for each of the categories in which we competed (per capita recycling, gross tonnage, paper, cardboard, and cans and bottles). In the gross tonnage category UConn placed 32nd out of 200 schools.

In addition to the continuation of the above programs, it is recommended that the University pursue the following additional strategies.

S.D.7.1. Further increase campus food waste recycling.

Efforts are made at UConn to recover edible food for donation to local shelters and food kitchens or to 'recycle' the food waste through small-scale composting. Despite these efforts, a significant volume of food waste continues to be sent for disposal (i.e. incineration or landfilling) via a local trash hauler each year. Unfortunately, once in a landfill, food waste can contribute significantly to the production of methane gas through anaerobic decomposition. **An estimated 4.37-6.76 metric tons of $CO2_e$ are**

[13] UConn Community Outreach, *personal communication*, 7/21/09.

generated per ton of food waste allowed to decompose anaerobically (e.g. landfilled).[14] Given this, the ultimate goal of the University is to eliminate the practice (and associated costs) of disposing food waste as municipal trash. Food waste should be treated as a commodity, allowing for consideration of revenue generating opportunities (*e.g.* compost or biodiesel production), while minimizing campus environmental footprint. In addition to existing food waste reduction efforts, food waste-related emissions can be reduced through adoption of one or more of the following strategies:

- **Short-Term: Identify community partners to convert University food waste into a usable product.** Current economic and space limitations will restrict the University's ability to conduct on-campus food waste composting in the near future. Therefore, the University should identify community partners interested in accepting campus food waste for conversion to compost, biodiesel, or other use, thereby avoiding disposal through the campus solid waste stream.

- **Long-Term: Developing a campus-wide composting system for processing the University's food waste.**
  Because of the various additional benefits to on-site composting (e.g. publicity, research, reduced transportation costs), the University's long-term goal should be to build upon the existing framework and success of the Dining Services pilot project and animal waste compost facility to develop a campus wide food waste composting system. Such a facility will produce a useful and economically valuable product (*i.e.* finished compost) that can either be used to improve the fertility of campus agricultural lands and gardens or sold or donated to the community. Because application of compost to soil can further increase carbon sequestration through improvements to soil structure and crop productivity, there may be opportunity to develop a 'white tag' program, earning the carbon sequestration credits of compost produced by the campus and donated free of charge to the local community.

S.D.7.2. Establish a green purchasing policy to minimize packaging and other waste associated with campus purchases.

Establish a campus green purchasing policy to ensure waste reduction at both the source (*i.e.,* waste minimization) and upon disposal (*i.e.,* recycling and reuse). Goals of the policy include:

- Minimizing or eliminating packaging. Maximizing packaging recycling, reuse, or composting if packaging is required.
- Encourage selection of products that minimize waste generation, have demonstrated durability, and incorporate local, recycled, or rapidly renewable resources. In addition, products that are energy efficient and locally produced should be given preference.

[14] The U.S. Composting Council (2008) estimates that every metric dry ton of food that goes to a landfill can generate up to 0.25 metric tons of methane in the first 120 days. Thus, composting one ton of food waste has the potential to reduce emissions by the equivalent of up to 5.75 metric tons of CO_2. Brown *et al.* (2008) cited a similar figure, estimating that 4.37 $MTCO2_e$ are generated per ton of food waste.

Emissions Reduction Strategies:

Transportation

Table 3.6. Transportation-Related Greenhouse Gas Emissions Reduction Strategies

T.1.	**Better integrate transportation into campus planning and design decisions**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.1.1.	Develop a modal transportation advisory committee.	N/A			0-2 years
T.1.2.	Develop a campus transportation master plan for travel to and from Storrs.	N/A			2-5 years
T.1.3.	Establish a campus policy that transit be considered when planning new campus buildings.	N/A			0-2 years
T.2.	**Decrease the campus vehicle fleet annual fuel use**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.2.1.	Establish fleet efficiency purchasing requirements.				0-2 years
T.2.2.	Phase out older, inefficient vehicles and replace with higher efficiency vehicles.				0-2 years
T.2.3.	Develop and implement a mandatory vehicle efficiency improvement program.				0-2 years
T.2.4.	Enforce the state anti-idling policy.				In Progress
T.2.5.	Increase the efficiency of campus delivery systems.				0-2 years
T.2.6.	Discourage unnecessary on-campus driving.				0-2 years
T.3.	**Increase the proportion of renewable fuels used annually**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.3.1.	Increase the production and use of biodiesel in university vehicles.				2-5 years
T.3.2.	Increase the use of vehicles that run on carbon-neutral or low-carbon fuel sources.				2-5 years
T.4.	**Decrease annual commuter single occupancy vehicle trip frequency and per capita commuter vehicle miles travelled**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.4.1.	Work with campus unions to encourage flexibility in employee workday definition.				0-2 years

T.4.	**(Continued)**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.4.2.	Increase access and provide incentives for telecommuting and online courses.				2-5 years
T.4.3.	Develop a rideshare incentive program.				0-2 years
T.4.4.	Establish an on-campus carshare program.				In Progress[15]
T.4.5.	Provide a weekday shuttle service to nearby off-campus park-and-ride lots.				0-2 years
T.4.6.	Increase local housing options and availability.				2-5 years
T.4.7.	Improve bicycle and pedestrian safety and access from off-campus housing.				In Progress
T.4.8.	Increase bus and shuttle availability to and from off-campus destinations.				0-2 years
T.4.9	Advocate for the development of a regional light rail commuting option.		N/A	N/A	>5 years
T.5.	**Redesign campus parking to minimize commuter emissions**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.5.1.	Establish a campus parking cap.				2-5 years
T.5.2.	Develop an incentive program to discourage parking pass purchases.				0-2 years
T.5.3.	Implement a campus-wide parking fee increase; use the revenue to fund campus mass transit improvements.				0-2 years
T.5.4.	Price parking according to vehicle fuel efficiency and EPA emissions rating.				2-5 years
T.5.5.	Offer a reduced-cost parking pass, priority parking and related emergency support services for rideshare participants.				0-2 years
T.5.6.	Develop a reduced-cost parking pass for motorcycles and scooters.				0-2 years
T.6.	**Increase walking and biking**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.6.1.	Hire a pedestrian and bicycle coordinator to ensure implementation of Master Plan recommendations.				0-2 years
T.6.2.	Improve campus bicycle amenities and paths.				2-5 years
T.6.3.	Develop a bicycle commuter-incentive program.				2-5 years
T.6.4.	Create an affordable on-campus bicycle shop.				2-5 years

[15] The University is currently exploring the potential for and feasibility of implementing an on-campus car share program; however, the University has not committed to implementing a program at this time.

T.6.	(Continued)	Emissions Reduction	First Cost	ROI	Timeframe
T.6.5.	Establish a campus-wide bicycle loaner program				2-5 years
T.7.	**Reduce the carbon footprint of off-campus travel**	**Emissions Reduction**	**First Cost**	**ROI**	**Timeframe**
T.7.1.	Require vehicle rental programs to provide efficient and alternative fuel vehicle options.			N/A	In Progress
T.7.2.	Negotiate discounted bus and train ticket rates for UConn faculty, staff and students.			N/A	0-2 years
T.7.3.	Discourage air travel to locations within reasonable driving or train distance.				0-2 years

Strategy T.1: Better integrate transportation into campus planning and design decisions

T.1.1. Develop a modal transportation advisory committee.

In order to address changing needs, maximize resource use, and ensure consistency in vision, a regular dialogue must be maintained between the University and the surrounding community. The University should therefore establish a modal transportation advisory committee specifically focused on improving connection and access issues, reducing overall vehicular traffic to and from campus, increasing the availability of public transportation options, supporting pedestrian and cyclists, and encouraging rideshare. Representatives from UConn, Eastern Connecticut State University, Windham Region Council of Governors, and surrounding towns (*e.g.,* Mansfield, Tolland, Windham) as well as individuals with specific expertise in transportation demand management and planning should be included on the advisory committee.

T.1.2. Develop a campus transportation master plan for travel to and from Storrs.

With plans for continued growth in both student body size and infrastructure, it is imperative that the University develop a transportation master plan. This plan should be written to align with the current campus master plan, ensuring that proposed future growth reduces rather than increases transportation needs. For example, the plan should ensure that new buildings are constructed near existing facilities to minimize increased transportation service and infrastructure needs. Furthermore the plan should discourage SOV trips to, from, and around campus, focus on improving mass transit options in the region, encouraging rideshare, and improving access and safety for pedestrians and cyclists.

T.1.3. Establish a campus policy that transit be considered when planning new campus buildings.

It is recommended that the University establish a policy requiring the consideration of transit during campus building planning and design activities. The policy can be developed either as part of the above proposed master plan or as a separate stand-alone policy. The policy should require an analysis of the transportation impact of the proposed building project as well as the participation of transportation representatives during campus planning meetings and site reviews. An evaluation of potential increases in parking demand and other transportation infrastructure under proposed alternatives should also be required with all new construction projects. Finally, the policy should require a statement regarding how the proposed project will contribute to improvements to campus transportation services (*i.e.,* campus bus system) as well as to pedestrian and bicycle access and safety.

Strategy T.2: Decrease the university vehicle fleet's annual fuel use.

The University does not currently have established standards or goals regarding fleet efficiency or composition. For several years, annual preferred vehicle purchasing lists have been used by University Purchasing agents to encourage university buyers to purchase the most fuel efficient vehicles possible. However, until 2008, these lists remained recommendations not University mandate. **In 2007, the State of Connecticut, passed legislation (PA 07-242, Section 122) which mandates that beginning January 1,**

2008, "any car or light duty truck purchased by the state shall have an efficiency rating that is in the top third of all vehicles in such purchased vehicle's class…" As a state agency, this requirement applies to all University vehicle purchases after January 1, 2008. In addition, state law now requires that fifty per cent of all new car and light duty trucks purchased by the state after January 1, 2008 must be alternative fueled, hybrid electric or plug-in electric vehicles. This is a state-wide requirement, however, rather than a direct mandate for individual state agencies such as the University. Consequently, less than 1% of the University's 600-vehicle fleet remains comprised of hybrid-electric or electric vehicles.

T.2.1. Establish fleet efficiency purchasing requirements.

According to state legislation all new vehicles purchased must now be among the most efficient (*i.e.,* top third) available vehicles in that given vehicle class. The University should establish additional fleet fuel efficiency standards to further mirror state law and to maximize campus fleet efficiency. Recommended policy components include:

- Establish an average fleet fuel efficiency goal for the Storrs campus fleet.
- Establish vehicle composition goals for the fleet (e.g. 50% hybrid electric or plug-in electric vehicles).
- Establish guidelines to ensure that vehicles are right-sized for the intended use.

T.2.2. Phase out older, inefficient vehicles; replace with higher efficiency vehicles appropriate for the intended use.

Older, inefficient vehicles may be inadvertently costing the University money through unnecessary fuel use. The University should develop a low-cost trade-in system to encourage the replacement of these vehicles. Additional incentives, such as subsidies for purchase of new vehicles in the top 10% of their class for fuel efficiency, may also help encourage older vehicle replacement.

T.3.3. Develop and implement a mandatory vehicle efficiency improvement program.

Proper vehicle maintenance (e.g., tire pressure checks and tune-ups) helps ensures that a vehicle will run more smoothly and require less fuel. Therefore, the University should develop a vehicle efficiency improvement program. All university-owned vehicles should be required to regularly participate in the program.

T.2.4. Enforce the state anti-idling policy.

Figure 3.7. The State of Connecticut has aggressive anti-idling laws in place to prevent unnecessary vehicle fuel use and to protect air quality.

Connecticut state law (R.C.S.A. 22a-174-18) prohibits the idling of any vehicle for longer than 3 minutes.[16] The law applies to all vehicles in Connecticut and although the law is intended to encourage voluntary compliance, violations are subject to enforcement by Department of Environmental Protection staff. (In addition, Public Act No. 02-56, An Act Concerning the Idling of School Buses, gives ticketing authority to

[16] Exceptions are made during extreme weather conditions, for health reasons, and for certain service vehicles.

police who witness school buses idling for longer than 3 minutes.) The University should therefore work with state staff to encourage awareness of the law on campus and to enforce violations as they are observed.

T.2.5. Increase the efficiency of on-campus delivery systems.

University-owned as well as privately owned vehicles travel throughout campus making daily deliveries. The University is presently completing an access management study examining the details of campus traffic and deliveries to maximize pedestrian safety and operational efficiency. It is recommended that during this process, the University evaluate the feasibility of implementing a hub-and-spoke delivery system to consolidate trips throughout campus, thereby minimizing fuel use associated with these deliveries. In addition, the number of vehicles entering the campus core, particularly large delivery vehicles, would be reduced, thereby increasing pedestrian safety and campus aesthetics. Under the proposed hub-and-spoke delivery system, off-campus delivery vehicles would be allowed to enter the campus only through pre-established access points and routes. Deliveries would then be dropped off at a 'hub' along the campus perimeter, consolidated, and then re-routed to the campus core via cleaner or more fuel-efficient vehicles.

T.2.6. Discourage unnecessary on-campus driving.

Most locations on campus are within walking and biking distance, or are accessible by the university's campus bus system. Unnecessary on-campus driving wastes fuel, releases additional greenhouse gas emissions, and contributes to campus congestion. The University should therefore discourage on-campus driving through:

- **replacement of core roadways with sidewalks, bicycle lanes and shuttle bus-only lanes, and**
- **speed limit reductions, increased frequency of speed bumps and stop signs, or other measures on remaining roadways.**

Measures such as these slow or restrict average personal vehicle travel time across campus making walking, bicycling, or utilizing public transportation more appealing options. By encouraging transportation mode shifts away from personal vehicles, the University will decrease greenhouse gas emissions, save fuel and associated costs, increase pedestrian safety, and create a more aesthetically appealing campus.

Strategy T.3: Increase the proportion of renewable fuels used annually

T.3.1. Increase the production and use of biodiesel in university vehicles.

Biodiesel can be used as a direct replacement for #2 diesel and heating oil. Switching to biodiesel results in reductions in both sulfur and aerosols. Furthermore, pure biodiesel is considered carbon-neutral because the organic material used to produce the fuel is part of the short-term carbon cycle. Therefore, replacing a portion, if not all, of the 200,000 gallons of diesel used annually on campus would result in substantial greenhouse gas emissions reductions.

Presently, the university replaces approximately 1% of total vehicle diesel requirements with B100 biodiesel. The University has the capacity to expand biodiesel production thereby increasing this percentage. The campus transportation system (*e.g.,* buses) and agricultural vehicles and equipment (*e.g.,* tractors, etc.), in particular, would serve as logical points of expanded biodiesel use on campus;

campus buses travel regularly throughout campus generating excellent publicity and outreach opportunities, while use of biodiesel in the agricultural operations is a logical extension of the university's commitment to sustainable agriculture.

It has therefore been proposed that a biodiesel production facility be developed on the UConn Depot Campus. The proposed facility would include a partnership between the University, the towns of Mansfield and Tolland, and a private biodiesel blending and distribution company. Under the proposed arrangement, the blending and distribution company would purchase the entire output of the plant, blend it with petroleum products into typical commercial product formulae for heating oil and transportation fuel, and resell the final product to the university and other interested customers (*i.e.,* Mansfield and Tolland). Proposed output capacity is estimated to be 50,000-100,000 gallons per year of biodiesel.

Figure 3.8. A biodiesel powered tractor displayed during the University's 2009 Earth Day Spring Fling.

The proposed agreement is beneficial to the University for a variety of reasons. Notably under the proposed tolling arrangement, the University avoids all responsibility associated with transporting the finished product. Furthermore, by outlining a contract which allows the University to sell biodiesel to the private blending and distribution company at the rack price and purchase the product fuels at the state contract price it is assumed that the University can reduce the cost of diesel fuel purchases by roughly 10%. Finally, the proposed project has direct academic and research synergies. The university would continue to remain at the forefront of test method development for the industry. In addition, the facility provide ample opportunity for collaboration with other departments, colleges, and research groups (*e.g.,* fuel cell, biobutanol fermentation).

T.3.2. Increase the use of vehicles that run on carbon-neutral or low-carbon fuel sources.

Figure 3.9. New England's first zero-emission fuel cell-powered hybrid bus made its debut in Connecticut on April 10, 2007.

[17]Vehicles fueled by carbon neutral or low-carbon fuel sources (*e.g.,* solar, fuel cell, hydrogen) are increasingly available, but in most cases, are still cost prohibitive. Nevertheless, with recent and ongoing increases in investment in green technologies and infrastructure, vehicles powered by carbon neutral sources are expected to become more viable options in the future. Therefore, a long-term goal of the campus should be to expand the use of vehicles powered by fuel cell, hydrogen, solar, or other carbon-neutral sources.

Strategy T.4: Decrease annual commuter

[17] Photo courtesy of The Connecticut Hydrogen-Fuel Cell Coalition)

vehicle miles travelled

T.4.1. Work with campus unions to encourage flexibility in employee work day definition.

A high proportion of the approximately 4,000 faculty and staff employed at the UConn Storrs campus share the same residence, many also have one or more children currently attending the University. The University should therefore encourage campus unions to allow employees shift flexibility (*i.e.,* start and end times, duration) to accommodate carpooling from individual households. Additional incentives such as a single, reduced rate 'family' parking pass could also be offered to families willing to revoke their privileges to one or more campus parking passes in exchange for the discounted 'family' pass.

T.4.2. Increase access and provide incentives for online courses and telecommuting.

The University presently offers a variety of online courses, but can continue to expand its offerings. In particular, the University should increase the proportion of off-campus students enrolled in one or more online courses. Doing so will help reduce annual student commuter miles and the associated greenhouse gas emissions. In addition, online courses reduce the University's need for physical teaching space and the energy required to maintain that space.

In order to encourage enrollment in online courses, the University should expand course offerings by increasing the number and diversity of courses offered, as well as the time (*e.g.,* night versus day) and day of the week that courses are offered. To encourage development of new courses, the University should provide incentives and support to faculty willing to offer online sections of an existing course or create a new course offering.

Similarly, the University should increase telecommuting options for employees. Telecommuting allows an individual to perform their work duties from home via telephone and computer access. Allowing individuals to telecommute one or more days a week will reduce annual faculty and staff commuter vehicle miles. Secondary benefits may also include decreased campus traffic congestion and parking demand, as well as improved employee morale and productivity.

T.4.3. Develop a University rideshare incentive program.

The University benefits from increased participation by campus members in rideshare programs. Fewer vehicles travelling to campus results in a reduced parking demand and the need for associated transportation infrastructure. In addition, campus congestion is reduced thereby increasing pedestrian safety and campus beauty. Finally, average greenhouse gas emissions per commuter per mile is decreased, reducing the University's overall greenhouse gas profile.

Ridesharing, however, inevitably involves trade-offs. Individuals forfeit access to a personal vehicle at their convenience to instead share the burden of driving (*e.g.,* fuel costs, vehicle wear) with a group. For some individuals, the desire for the convenience of a personal vehicle will outweigh the direct benefits of rideshare. Therefore, the University should develop an incentive program to provide additional benefits or rewards to those who choose to carpool.

- **Reduced-cost parking pass.** Individuals who register for a carpool parking pass forfeit their right to an individual parking pass. Therefore to offset this 'loss' and to encourage participation in the carpool program, the University should offer the carpool parking pass at a significantly reduced charge to each individual.

- **Reserved priority parking for carpool and vanpools.** To provide further incentive as well as to increase awareness and visibility of the program, carpools and vanpools should be guaranteed parking in a desirable location on campus (*e.g.*¸ parking garages, central lot).

- **Automatic enrollment in a guaranteed ride home program.** A guaranteed-ride-home service provides the user with an alternative source of transportation in the case of urgent situations and emergencies. Presently, individuals who participate in an Easy Street® vanpool are automatically eligible for the Connecticut Commuter Services Guaranteed Ride Home Program.

  The University should develop a UConn-specific program to address all university members participating in a carpool, vanpool, or other rideshare program. Any individual who registers with a carpool should be automatically enrolled in the on-campus guaranteed ride home service. The individual is then ensured that the University will provide them a ride home free of charge in the case of an emergency. The specific details of the service will need to be determined by the University, but can be directly linked to the establishment of a group carpool parking pass. (For example, in order to qualify an individual may need to register for the carpool parking pass, thereby forfeiting their individual pass.)

- **Development of an expanded on-line, interactive campus community carpool tool.**

  Presently, the University's Human Resource Department provides employees and students access to a campus carpool list.[18] Individuals register their contact information and commute origin on this list and can then identify and contact individuals with whom they might be interested in carpooling. Once an individual has found an appropriate carpool partner or team, it is assumed they will then remove themselves from the list.

  This tool is an excellent starting point to match individuals interested in developing a regular carpool arrangement. However, the current tool does not provide incentives to individuals hesitant to carpool. In addition, the tool has very limited flexibility and doesn't allow individuals in identifying a rideshare partner for one-time trips to off-campus destinations (*e.g.,* for academic conferences, students returning home during break, etc.).

  It is therefore recommended that the University either develop an expanded ride matching service or work with external partners to promote existing resources that would result in increases in campus carpooling. Connecticut Commuter Services, for example, has partnered with NuRide to encourage rideshare in the state. Individuals can participate in the NuRide network free of charge and earn rewards for their transportation decisions (*e.g.,* bicycling, carpooling).

T.4.4. Establish an on-campus carshare program.

In response to concerns and frustrations expressed by students who are ineligible for parking passes (e.g. freshman and sophomores) and their families, UConn Storrs Off Campus Student Services is presently exploring the option of implementing a campus carshare program at the Storrs campus. Development of a University carshare program allows members of the University community access to a vehicle at their convenience without requiring ownership or possession of a vehicle on campus. Therefore it is expected that developing a campus carshare program would provide additional benefits to the University including:

[18] https://secure.uconn.edu/hr/carpool/

- Increased individuals willing to forfeit access to a personal vehicle on campus, thereby reducing overall parking demand and the associated impacts.
- Increased participation in rideshare programs, further reducing parking demand and campus congestion.

To encourage participation the University should considered discounted membership for those individuals willing to forgo a personal parking pass or who register as part of a campus rideshare.

T.4.5. Provide a weekday shuttle service to nearby off-campus park-and-ride lots.

Shuttle service should be provided at regular intervals (*e.g.,* half hourly) during the start and end of the work day to accommodate flexibility in work hours. Initial lots for priority consideration would be the I-84/Rt. 195 lot and the Rt. 66/Rt. 6 lot. These existing park-and-ride lots, which are often underutilized, provide convenient off-campus, free parking for UConn employees and students. By providing a regular shuttle service to and from the lots, the University would reduce on-campus parking demand and traffic congestion, while also reducing commuter produced greenhouse gas emissions.

T.4.6. Increase local housing options and availability.

The University houses approximately 75% of all full-time undergraduate students attending the Storrs campus as well as a small proportion of the staff. The remaining students, faculty, and staff live off campus. By working with the surrounding communities to increase available housing options, the average commute distance can decrease and the proportion of individuals living within walking, bicycling or public transit distance of campus can increase. (It is important to note, however, that the more dispersed student housing becomes, the more difficult it will be to serve those residents with a bus system.) Therefore increases in off-campus housing need to be coordinated through a regional plan.

This is a long-term strategy to reduce campus greenhouse gas emissions, and in order to be truly successful with this strategy the University will need to integrate this goal into campus planning. In addition, the University will need to ensure that this goal is communicated and integrated into state and local planning policy as well as state infrastructure policy development.

T.4.7. Improve bicycle and pedestrian safety and access from off-campus housing.

Many of those individuals living within walking and bicycling distance regularly commute to campus by foot or by bicycle. Consequently, the University and the Town of Mansfield have several projects underway to improve, among other goals, bicycle and pedestrian access in the local community. The Town is completing final stages of the Hunting Lodge Road bikeway/walkway project, which will provide an 8-foot wide paved bikeway and walkway for residents living along Hunting Lodge Road to access the main campus. A similar project was completed in 2007 along Separatist Road. Both roads (*i.e.,* Hunting Lodge and Separatist) house a significant number of campus faculty, staff and students; the bikeway and walkways will therefore provide safer access to the campus from these residences. Similarly, the University is in the planning and design phases of a North Hillside Road extension project. The proposed extension, which would serve as an alternate entrance to the University, will include a bikeway and walkway. Notably, the extension will provide direct access for on-campus residents to a nearby shopping plaza, reducing the need for off-campus personal vehicle trips.

The above mentioned projects will contribute to an atmosphere of improved bicycle and pedestrian safety and access between the surrounding community and the campus. However, the University can take additional steps, potentially increasing the proportion of off-campus residents commuting to campus by bike or foot. The State of Connecticut's *2009 Statewide Bicycle and Pedestrian Plan Update,* identifies supporting and encouraging pedestrian and bicycle connections between neighborhoods, commercial areas, employment centers, schools, state and municipal parks, and other destinations serving the community as one of seven state goals relating to bicycling and walking. In addition, the *Regional Transportation Plan* (WINCOG 2005) cites improvements to bicycle and pedestrian facilities as a major regional transportation need, and provides specific recommendations for the Town of Mansfield including University owned properties. The University should therefore work with the State as well as the surrounding communities to continue to improve bicycling and pedestrian connections in the area. Emphasis should be placed on continuing to connect the campus via walkways and bikeways to nearby off-campus areas densely populated students, faculty and staff.

T.4.8. Increase bus and shuttle availability to and from off-campus destinations.

Despite a dedicated Transportation and Parking Services Office, transportation from the UConn Storrs campus to the surrounding communities remains limited. (A summary of available transportation options is provided in Table 3.7.) The primary off-campus transportation available to University community members includes:

- *UConn Services: Campus Bus and Shuttle Service*. The University currently provides transportation to the Depot Campus and to nearby University owned housing sites via the UConn campus bus system. Students are charged a $35 per semester fee to fund this service. Only privately owned housing, located along the existing university bus routes are serviced; regular public transportation is not provided to the majority of off-campus housing located in Mansfield. The University does not currently provide regular transportation to nearby metropolitan areas; however shuttles are available on request to the airport, train station and ferry for a fee.
- *Public Transit: Local Bus Services*. Additional limited day-time public transportation is also provided between the Storrs campus and Willimantic via the WRTD Storrs-Willimantic bus. Peter Pan Bus, a private bus company provides twice daily service from the campus to Manchester, Hartford, and Providence for a fee as well.

It is recommended that the University expand bus and shuttle availability from the campus to:

- **Off-campus housing complexes in the surrounding communities** (*e.g.,* Tolland and Windham County) known to house a high density of students, faculty and staff; and to
- **Nearby urban centers**, including Willimantic, Manchester, and Hartford, Connecticut as well as Providence, Rhode Island (Figure 3.10).

Specifically, it is recommended that the University work with the State and surrounding communities to pursue the following improvement needs relating to public transit, many of which were cited in the Windham Council of Governors (WINGOG) *2005 Regional Transportation Plan*:

- Expansion of UConn shuttle bus routes to service all larger apartment developments in Mansfield, Willington and Ashford in addition to continued service to UConn’s Depot campus.
- Enhancement of the WRTD, Willimantic/Storrs bus service to increase service hours and the frequency of service stops, including expansion of bus service along Routes 44 and 32, including service to UConn’s Depot Campus.
- Expansion of Dial-a-Ride program to include evening and weekend service and out-of-region services.
- Expansion of Hartford commuter bus service to UConn’s Depot and Storrs campuses.

Table 3.7. Available Off-Campus Transportation Services			
Service	**Availability**[19]	**Cost**	**Additional Notes**
Campus Bus System	Mon. – Thurs. (7a-12a) Fri. (7a-10p)	$35/semester (mandatory student fee)	University Service; limited to UConn-owned housing and adjacent housing only; Website
University Shuttle Service	By request. Destinations include Bradley International Airport, Union Station (Hartford, CT), and the New London, CT ferry terminal.	$50/one-way $100/round-trip	University Service; Website
Husky Watch (Police escort service to/from campus)	Daily (6p-8p)	Free with UConn ID	University Service; limited off-campus range; does not service individuals who are suspected of drinking; Website
WRTD Storrs-Willimantic Bus Service	Mon.-Fri. (7a-7p) Sat. (9a-5p)	Free with UConn ID	University-Municipal Partnership; Website
GUARD Dogs	Fri. & Sat. (11p-3a)	Free to UConn Students	Private Service; Website
Peter Pan Bus	Twice daily service with additional AM route on Friday and Sunday.	$13-16/one-way $25-31/round-trip	Private Service; Website

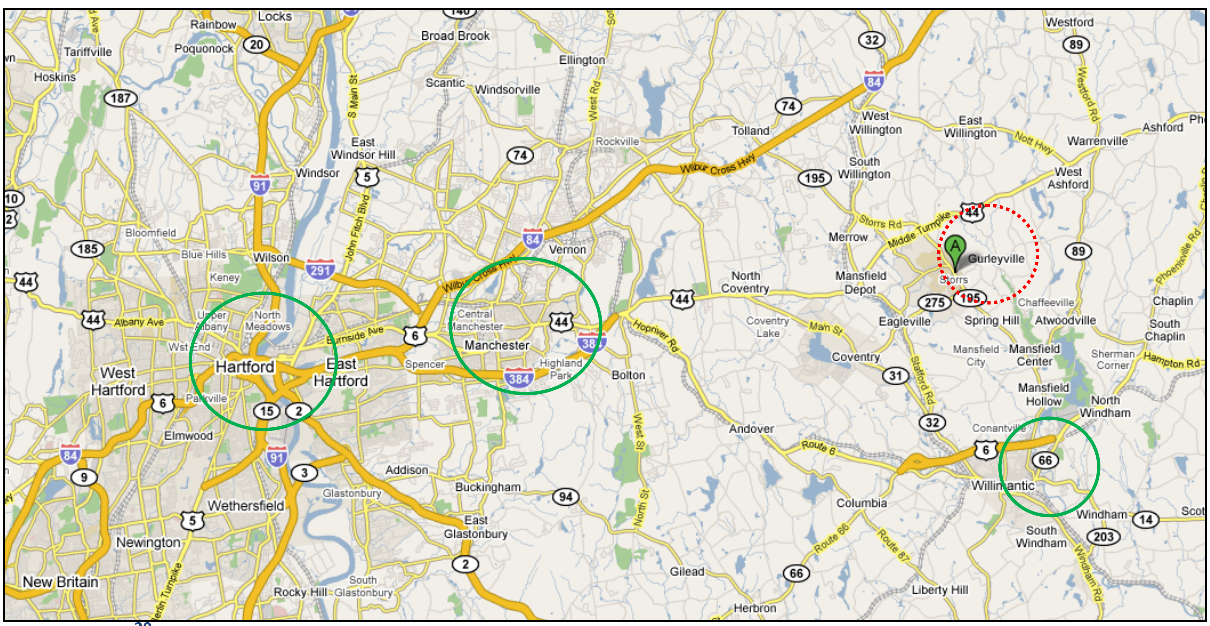

Figure 3.10.[20] **Map of the UConn Storrs campus (red dashed circle) and nearby urban regions (solid green circles).** Willimantic is located approximately 9 miles south of the UConn campus, and features the Eastern Connecticut State University campus as well as several smaller local businesses and food establishments. Manchester and Hartford are located approximately 20 and 25 miles west of the UConn Storrs campus,

[19] As of March 2009; trip availability and fees are likely to change.
[20] Figure generated using Google™ Map.

respectively, and feature a wealth of shopping, dining, and entertainment opportunities. Providence, Rhode Island (not shown) is located approximately 54 miles to the east of the campus.

Primary barriers to improving public transportation between the Storrs campus and the surrounding communities have historically included funding limitations, the rural nature of the surrounding community, and a high level of access to personal vehicles (and corresponding low demand for public transportation). Therefore, the University will need to address these issues in order to address improvements to off-campus transportation services. The University should consider all potential partnerships, including partnerships with regional business centers (*e.g., the* Buckland Hills and Evergreen Walk areas in Manchester).

T.4.9. Advocate for the development of a regional light rail commuting option.

Given the University's proximity to Willimantic, CT and Eastern Connecticut State University, as well as to Hartford, CT, light rail should be considered as a potentially viable future option (e.g. long-term emissions reduction strategy) for campus commuters and visitors. The *2005 Regional Transportation Plan* specifically advocates for the 'establishment of additional passenger service along the New England Central Railroad, including passenger stops to serve Willimantic and the University of Connecticut, including the Depot Campus.' Light rail would allow increased access to the campus without compromising the beauty of the region or creating undesirable traffic congestion. The University should therefore continue to advocate for the exploration of regional light rail commuting options.

Strategy T.5. Redesign campus parking to minimize commuter emissions

Across the nation, parking has traditionally been undervalued. Parking generates costs through construction activities, lost opportunity costs for the land in question, maintenance costs, and operational costs including public safety requirements. Despite this, there is continued demand for reliable, convenient parking to service the growing number of vehicles travelling to campus each day. Unfortunately, providing convenient, easily accessible parking for all has a variety of negative environmental and social impacts. Traditional asphalt parking spaces result in increased stormwater runoff, elevated urban heat island effects, and habitat destruction, among other negative environmental benefits. Providing an excess of parking results in land, which otherwise could have been conserved as vegetated common spaces or built for academic or research purposes, to instead lie underutilized. An excess of parking also contributes to the transportation demand management issues associated with increases in single-occupancy-vehicle trips to campus. When all individuals are guaranteed a convenient and private parking space, there is little incentive to carpool or utilize public transportation. In order to maximize the efficiency and revenues generated from campus parking, while minimizing the associated negative environmental and social impacts, it is recommended that the University:

T.5.1. Establish a campus parking cap.

Several colleges and universities have established a campus parking cap, committing to no net increases in campus parking area. Such a cap encourages innovation in campus parking and transportation systems, while providing the added benefit of protecting campus natural resources.

Limiting campus parking increases the value of existing spaces. Those individuals who wish to continue to drive to campus by car will pay an increased price for the opportunity to continue to park on campus. On the other hand, those individuals who do not require access to on-campus parking are likely to forego their ability to purchase a parking pass. A properly designed parking price system can therefore increase parking-related revenues while decrease the number of parking spaces available. (Decreased parking further increases net profit through decreases in maintenance and safety personnel requirements.) More importantly, restricting campus parking results limits the number of vehicles travelling to campus each day. Instead, individuals will be encouraged to switch to alternative modes of transportation (*e.g.,* foot, bicycle, bus). In turn, per capita greenhouse gas emissions associated with campus commuting will decrease.

The University of Connecticut has already committed to achieving significant impervious surface reductions, as recommended by the Eagleville Brook Total Maximum Daily Load requirements. Establishing a net parking cap, will assist the campus in achieving local water quality goals, while still allowing considerable flexibility in parking design.

T.5.2. Develop an incentive program to discourage parking pass purchases.

The University should identify ways to encourage faculty, staff and students to not purchase on-campus parking, thereby reducing demand and the emissions that otherwise would have been generated through vehicle trips to campus. Potential incentives might include offering a cash-out option, free membership in a campus carshare program, discounted regional mass transit passes, or a free bicycle loan.

T.5.3. Implement a campus-wide parking fee increase; use the revenue to fund improvements and expansions to campus mass transit options.

Parking is traditionally undervalued at the university. Parking rates at comparable institutions are almost double the UConn-Storrs rates. Increases in campus parking prices can help reduce campus parking demand and the associated maintenance and operational costs, while generating increased revenue. Revenues collected should be directed towards improvements in campus transportation systems, in particular, campus transportation services (*e.g.,* buses or shuttles) to off-campus housing.

T.5.4. Price parking passes according to vehicle fuel efficiency and emissions rating.

A parking system that is based upon greenhouse gas emissions is likely to result in real decreases in campus emissions. The proposed parking fee increased discussed in Strategy T.5.3. could also be developed based upon vehicle fuel efficiency and emissions rating. The proposed system would require individuals to specify their vehicle make, model, and year. This information in turn would be used to identify the associated EPA emissions rating for the vehicle. A CAP 'surcharge,' pro-rated according to vehicle emissions rating, would then be added to the parking pass cost. Vehicles above a certain emissions threshold (e.g. 'cleaner' vehicles) would be exempt from the surcharge. Similarly, vehicles registered as part of a rideshare group (*e.g.,* carpool or vanpool) would be exempt. The funds generated from this charge would be used to make additional improvements to campus transportation systems in order to further reduce associated emissions.

T.5.5. Offer a reduced-cost parking pass, priority parking and emergency support services for rideshare participants.

As the University continues to expand, increasing the proportion of campus members that participate in carpool and vanpool services will be an important strategy to maintain or reduce campus parking demand. In addition, as discussed previously in this section, increasing the proportion of individuals participating in a carpool or rideshare program will help reduce greenhouse gas emissions associated with commuter trips to campus. The University should therefore encourage rideshare by offering a reduced cost parking pass and priority parking for registered campus carpools and vanpools. To ensure a reduction in individual vehicles travelling to campus (and therefore total commuter miles), individuals registering for the reduced rate rideshare parking pass will be required to forfeit an individual parking pass. However, to accommodate rideshare group members faced with unusual or urgent situations which require the use of their personal vehicle, the University could offer a guaranteed ride home service (*e.g.,* Strategy T.4.3.), provide discounted parking to registered carpoolers in the parking garages, offer a limited number of single-use day passes, or a similar alternative to provide insurance against emergency transportation needs.

T.5.6. Develop a reduced-cost parking pass for motorcycles and scooters when registered as the sole vehicle.

Presently, motorcycle owners are allowed to register their motorcycle as a second vehicle for a significantly reduced rate ($10). However, individuals wishing to register only a motorcycle must pay the full parking permit cost, thereby eliminating any parking-based incentive to commute via the smaller, more fuel efficient vehicle.

Motorcycles and scooters require less parking area per vehicle and have a higher fuel economy than most cars, trucks and SUVs. Therefore, the University should encourage the use of motorcycles and scooters by offering a reduced-price parking pass for this class of vehicles. In addition, parking areas should be specifically designated for these vehicles, to accommodate retrofitting existing spaces with a kick-stand pad to prevent vehicle damage during warmer months. Increases in the proportion of individuals commuting to campus by motorcycle or scooter will result in decreased commuter-generated greenhouse gas emissions.

Strategy T.6. Increase walking and biking

The University's Master Plan, first released in 1998, emphasizes the creation of a pedestrian core and improving bicycling on campus. Specifically recommendations to improve pedestrian circulation included:

- Circulate vehicles around the perimeter of neighborhoods to minimize conflicts between pedestrians.
- Promote pedestrian circulation as the primary mode of on-campus movement.
- Remove existing roads which are not required for daily access to increase the pedestrian environment.
- Control and monitor service vehicle access on pedestrian walkways.
- Properly identify and furnish all campus walkways in order to provide a safe and comfortable, efficient and safe route to campus.
- Work with the community to establish pedestrian walkways and bikeways along major community roads leading to campus.

Recommendations to improve bicycle circulation on campus included:

- Coordinate and work with the community to establish dedicated routes to the campus.
- Plan to provide dedicated bicycle lanes within the campus roadway system.
- Provide bicycle storage facilities at each University facility.
- Provide lockers, showers and change rooms for promoting bicycles as an alternative to the car.

- Develop and maintain a unified bicycle sign and pavement marking system throughout campus.
- Cooperate with state, county and local jurisdictions in planning for bicycle facilities.

Similarly, in 2005 in an effort to assess the current attitudes towards bicycling on campus, the Institute for Transportation Engineers (ITE) student chapter on campus surveyed faculty, staff and students throughout campus. The resulting data were used to develop a proposal for a campus bicycle master plan. The plan included a proposed network of bicycle lanes, sharrows and signage throughout campus (Figure 3.11).

T.6.1. Hire a pedestrian and bicycle coordinator to ensure implementation of Master Plan recommendations.

Over the past decade the University has made progress towards improving pedestrian and bicycling access and safety on campus. Notably, parking and roadways have been moved towards the outer perimeters of campus in order to establish a pedestrian campus core. In addition, recent improvements were also made throughout campus to significantly improve the visibility of pedestrian safety features including lighting, crosswalks, and associated signage. Nevertheless, many of the recommendations of the Master Plan (developed over a decade ago) and the ITE campus bicycle plan (developed four years ago) remain unimplemented.

The University should therefore hire a pedestrian and bicycle coordinator to increase the rate at which bicycling and pedestrian objectives outlined in the Master Plan are implemented. In addition, the coordinator will serve as the primary staff person responsible for:

- Identifying additional strategies to improve pedestrian and bicyclist safety and access on campus;
- Working closely with the Town of Mansfield to improve local access and safety issues (*e.g.,* from off-campus housing and adjacent shopping districts to campus);
- Identifying and pursuing funding opportunities related to improvements to campus bicycling and pedestrian services; and
- Developing a campus bicycle and pedestrian outreach program to increase campus awareness and safety.

T.6.2. Improve campus bicycle amenities and paths.

A coordinated bike path system does not exist on campus. As recommended by the Master Plan, the University should strive to develop and maintain a unified bicycle sign and pavement marking system throughout campus. In addition, bicycling amenities are presently limited and in need of expansion. Therefore, it is recommended that the University:

- Increase and enhance existing on-campus bicycle pathways to improve connectivity, visibility and appeal.
- Improve signage throughout campus to raise awareness and increase safety.
- Increase the availability of bicycle racks, including those with shelter from the elements.
- Install bicycle storage lockers in campus perimeter parking lots and near residence halls.
- Increase storage within residence halls.
- Ensure that bicycle racks and/or storage lockers are located near all transit stops
- Ensure that campus buses are equipped with bicycle racks. (Priority should be placed on first outfitting those buses that service periphery lots and off-campus apartments.)

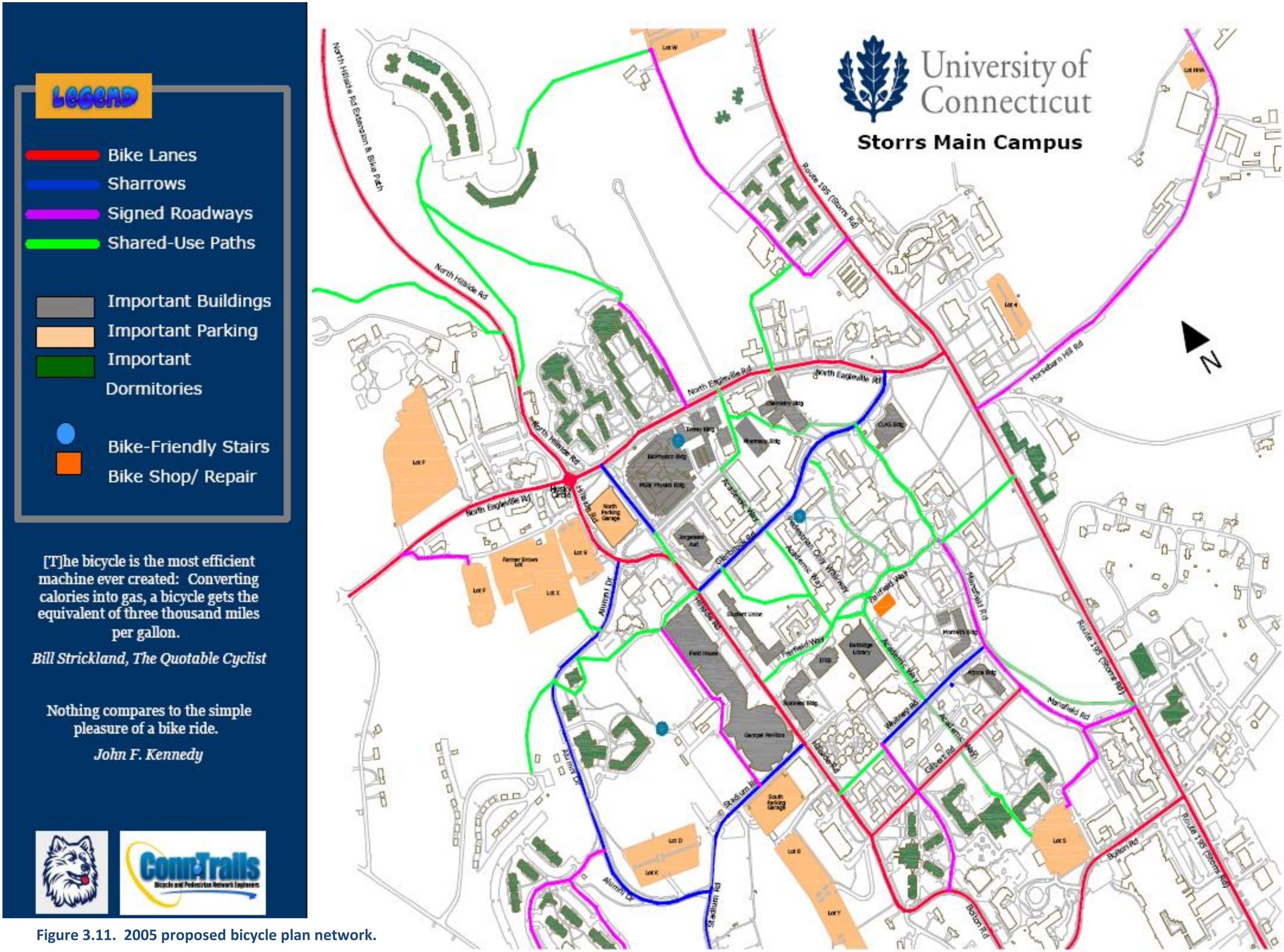

Figure 3.11. 2005 proposed bicycle plan network.

T.6.3. Develop a bicycle commuter-incentive program.

Numerous faculty, staff and students live within bicycling distance to campus. The University should therefore develop a bicycle commuter-incentive program to increase bicycle ridership to campus, and therefore reduce vehicle trips to campus and parking demand. Potential incentives might include a monetary reward to cyclists willing to forfeit access to a parking permit, free shower and locker access for registered bicycle commuters, and a guaranteed-ride-home service for emergencies. Cyclists can also be offered the opportunity to purchase low-cost daily parking permits (*e.g.,* via an online system accessible from home) to allow for exceptions when a personal vehicle is required (*e.g.,* poor weather conditions, illness, etc.). An on-campus network of bicycle commuters should also be established to connect individuals interested in identifying commuting partners or groups.

T.6.4. Create an affordable on-campus bicycle shop.

Presently, the nearest bicycle repair facility is located 7 miles off campus. There are no nearby bicycle repair facilities that are directly accessible by public transportation. Therefore to increase accessibility to repair services, and therefore encourage bicycling as a primary means of transportation, it is recommended that the University establish a bicycle shop on campus, or, alternative, work with the Community to establish a shop directly adjacent to the campus. Recommended potential locations therefore include the new on-campus student recreational services facility or in association with the Storrs Center Project.

T.6.5. Establish a campus-wide bicycle loaner program.

The University offers bicycle rentals for a fee through the UConn Outdoors program. Pricing is designed for daily rather than semester use, however. (For example, based on present costs, bicycle rental for the semester (*i.e.,* 15 weeks) would cost $900.) Furthermore, rental options are limited to mountain bikes rather than commuter bicycles. Unfortunately, individuals able to afford this rental rate are likely to purchase their own bicycle rather than rent from the University, making the program an ineffective option for a campus bicycle loaner program. It is therefore recommended that the University establish a separate campus bicycle loaner program, either university-run or outsourced (*i.e.,* run by a local private business). The proposed program could also be potentially run out of the bicycle shop proposed in T.6.5.

Strategy T.7. Reduce the carbon footprint of off-campus travel

Off-campus travel contributes significantly to the University's overall greenhouse gas inventory. Primary modes of off-campus travel include rental cars, air travel, and, to a lesser extent, bus, train, taxi and ferry trips. In addition, personal vehicle mileage reimbursed by the University is included in the 'off-campus travel' category of the inventory.

The University is limited in its ability to reduce the emissions associated with off-campus travel. Strategies that seek to eliminate the need for travel (*e.g.,* videoconferencing, telecommuting) or encourage mode shifts to those that emit less greenhouse gas emissions per capita per mile, can, however, minimize these emissions. In addition, the following strategies are recommended:

T.7.1. Require vehicle rental programs to provide efficient and alternative fuel vehicle options.

The University recently negotiated a contract with Enterprise for an on-campus Enterprise vehicle rental office. The contract contains specific vehicle fleet guidelines, requiring a minimum 10% of the available daily rental fleet be composed of gasoline hybrid electric vehicles (GHEVs). In addition, the available fleet will include a mix of vehicle sizes and rental rates increase with vehicle size. It is recommended that the University work with Enterprise to identify additional measures to minimize the carbon impact of related off-campus travel. In addition, similar language should be included in future University contracts with other off-campus travel-related agencies.

T.7.2. Negotiate discounted bus and train ticket rates for UConn faculty, staff and students.

To encourage students, faculty and staff to utilize existing regional bus and train services for off-campus travel, the University should work with participating companies to establish and promote a discount rate or incentive program (*e.g.,* a mileage reward program) for UConn ID holders.

T.7.3. Discourage air travel to locations within reasonable driving or train distance.

The University should discourage air travel to locations that are within reasonable (*e.g.,* several hours) driving or public transit distance. For example, prior to reimbursement the University should require written justification or documentation that costs or other variables precluded travel to the location by train or car. In addition, the University should seek to educate faculty, staff and students regarding impacts of air travel. The University should therefore develop a list of 'green' airlines (*e.g.,* those that purchase carbon offsets, use alternative fuels, or otherwise seek to reduce their carbon footprint) and encourage the purchase of flights from companies on this list.

References

Boadi, D., Benchaar, C., Chiquette, J., and Massé, D. 2004. Mitigation strategies to reduce enteric methane emissions from dairy cows: Update review. Canadian Journal of Animal Science. 84: 319-336.

Brown, S., Kruger, C., & Subler, S. 2008. Greenhouse Gas Balance for Composting Operations. Journal of Environmental Quality. 37: 1396-1410.

Cambridge Systematics, Inc. 2006. Cool Pavement Report (EPA Cool Pavements Study – Task 6). Cambridge Systematics, Inc.: Chevy Chase, MD. 64 p.

Connecticut Department of Environmental Protection (CTDEP). 2006. *Connecticut Greenhouse Gas Inventory: 1990–2001*. CTDEP: Hartford, Connecticut, USA. 6p. Accessed 01 April 2009 at http://ctclimatechange.com/documents/FinalCT-2006-Inventory-V6.pdf.

Environmental Health & Engineering, Inc. (EH&E). 2009. *The First (Big) Step to Reducing Your Campus Carbon Footprint (Whitepaper).* 9 pg. Available at http://www.eheinc.com/form/CampusRetroCx.pdf.

Huffstutter, P.J. 2009. "Farms downsize with miniature cows." Los Angeles Times (Online). Accessed 03 June 2009 at http://www.latimes.com/news/nationworld/nation/la-na-miniature-cows24-2009may24,0,7037767.story.

La Salle, T.J. and Hepperly, P. 2008. *Regenerative Organic Farming: A Solution to Global Warming*. Rodale Institute: Kutztown, Pennsylvania, USA. 13p. Accessed 01 April 2009 at http://www.rodaleinstitute.org/files/Rodale_Research_Paper-07_30_08.pdf.

Mansfield Downtown Partnership, Inc. & LeylandAlliance, LLC. 2008. Design Guidelines for a Sustainable Community. Leyland Alliance, Inc. 46 p. Accessed 27 April 2009 at http://www.storrscenter.com/.

Northeast States for Coordinated Air Use Management (NESCAUM), Connecticut Department of Environmental Protection, and Connecticut Clean Energy Fund. 2003. *Connecticut Greenhouse Gas Inventory: 1990-2000*. 71p. . Accessed 01 April 2009 at http://ctclimatechange.com/pdf/CC_Inventory_Report.pdf.

Sustainable Sites Initiative. 2008. "About Us." *Sustainable Sites Initiative (Online).* Accessed 28 April 2009 at http://www.sustainablesites.org/about/.

Town of Mansfield. 2006. Mansfield Plan of Conservation and Development. Town of Mansfield Town Council and Planning and Zoning Commission. Accessed at www.mansfield.ct.org/town/departments/pnz/pocd/index.php on

United States Department of Energy (USDOE). 2006. "Solar Water Heating." Solar Energy Technologies Program Website. Last Updated 20 July 2006. Accessed 22 June 2009 at http://www1.eere.energy.gov/solar/sh_basics_water.html.

United States Department of Energy (USDOE). 2008. "Benefits of Geothermal Heat Pump Systems." Energy Efficiency and Renewable Energy Website. Last updated 30 December 2008. Accessed 22 June 2009 at http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12660.

United States Department of Energy (USDOE). 2009. Audit Report: Department of Energy Efforts to Manage Information Technology Resources in an Energy-Efficient and Environmentally Responsible Manner. May 2009: OAS-RA-09-03. 30 pg. Accessed 23 June 2009 at http://www.ig.energy.gov/documents/OAS-RA-09-03.pdf.

United States Environmental Protection Agency (USEPA). 2006a. Labs21 Environmental Performance Criteria: Version 2.1. Available online http://www.epa.gov/lab21gov/pdf/epc21_printable_608.pdf.

United States Environmental Protection Agency (USEPA). 2006b. Solid waste management and greenhouse gases: A life-cycle assessment of emission and sinks. EPA630-R-02-006. U.S. Environmental Protection Agency: Washington, DC. Accessed 20 July 2009 at http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/TMAL6GDR3K/$File/Energy%20Savings.pdf

United States Environmental Protection Agency (USEPA). 2009. Reducing Urban Heat Islands: Compendium of Strategies. USEPA: Washington, DC. Updated 9 February 2009. Accessed 29 April 2009 at http://www.epa.gov/heatisld/resources/compendium.htm.

United States Green Building Council (USGBC). 2007. Pilot Version: LEED for Neighborhood Development Rating System. The U.S. Green Building Council. 166 p. Accessed 27 April 2009 at http://www.usgbc.org/ShowFile.aspx?DocumentID=2846.

United States Green Building Council (USGBC). 2008. "LEED for Neighborhood Development." *U.S. Green Building Council (Online).* Accessed 27 April 2009. At http://www.usgbc.org/DisplayPage.aspx?CMSPageID=148.

Water Management, Inc. (WMI). 2007. UConn Water Audit Report: Water Conservation Opportunities. Prepared by Water Management, Inc., Alexandria, VA, for the University of Connecticut. Accessed 03 June 2009 at http://www.fo.uconn.edu/Dec%2007%20Wtr%20Plan.pdf.

Windham Region Council of Governments (WINCOG). 2005. Regional Transportation Plan. Accessed 17 August 2009 at http://www.wincog.org/publications/RTP.pdf.