September 2009

Sustainability Council

Climate Action Plan

This plan outlines methods by which the University of Arkansas flagship campus in Fayetteville will reduce its greenhouse gas emissions by 50 percent between 2010 and 2021, and establishes a target date of 2040 to become a carbon neutral institution. This document is publicly available at http://sustainability.uark.edu.

University of Arkansas

Climate Action Plan

A message from the Chancellor

The management of atmospheric carbon increasingly appears to be the defining issue of our times. Probably more than any other issue on the horizon, our success in managing this challenge will define the quality of life for future generations. Even the favored term *climate change* seems inadequate to conveying the immensity of the emerging problem. We're witnessing the unfolding of a *climate crisis*, and urgent action will be needed to successfully address the problems that now seem imminent.

This plan describes the University of Arkansas's strategy for doing our part to meet the crisis successfully. It has been more than two years in the making, since the University of Arkansas first committed itself to charting a path to achieving carbon neutrality in the winter of 2007. In that time, scientists have observed accelerated glacial melting in Greenland, the Arctic and Antarctica that adds credibility—and gravity—to the work of the American College and University Presidents Climate Commitment. Urgency, however, is no excuse for haste, and this action plan represents a comprehensive, systematic, and consultative approach to addressing carbon neutrality on our campus.

With this plan, we're making the leap from good ideas to sound, cost-effective actions. In the process of implementing the projects described in this plan, we'll address social and community sustainability issues, provide a model for other institutions and businesses to follow, and build positive financial value for the university. We will demonstrate that a campus based on low carbon energy systems can be economically and socially fruitful as well as environmentally sustainable.

As a university, it is our responsibility to be at the leading edge of change, and to bring the intelligence, expertise, energy, and imagination of our campus community to bear on the most difficult problems of the day. We must see farther, think clearer, dream bigger and work harder to solve tomorrow's problems today.

This plan is an important step down the path to doing just that.

G. David Gearhart
Chancellor, University of Arkansas

University of Arkansas

Sustainability Council

Office Sustainability
Bumpers College of Agriculture, Food & Life Sciences

College of Engineering

Student Government

This report can be viewed and downloaded at http://sustainability.uark.edu. The principal contact for the University of Arkansas Sustainability Council and for this document is:

Executive summary

In February 2007, the University of Arkansas's flagship campus in Fayetteville, under the leadership of then-Chancellor John A. White, became a charter signatory to the American College and University Presidents Climate Commitment (ACUPCC). We subsequently initiated aggressive and innovative programs and structures that we expect will lead us to climate neutrality by 2040. This report outlines methods and means by which our institution will reduce greenhouse gas (GHG) emissions by 50 percent below the business-as-usual level (i.e., the level of emissions that the institution would emit with no significant carbon emissions reduction efforts) by 2021. This plan also establishes the goal of achieving climate neutrality (as defined by the ACUPCC) by 2040. Details of the plan's implementation for 2021 – 2040 will be described in a future revision of this document.

A business-as-usual approach would result in annual GHG emissions of approximately 250,000 metric tons CO_2 equivalent by 2021. In contrast, implementation of this plan will result in annual emissions of only 125,000 metric tons of CO_2 equivalent (which was the level of emissions in 1990, the year that the Kyoto Protocol was negotiated) by 2021.

The approach to reducing carbon emissions is sequential. First, we will implement energy conservation and energy efficiency measures to buildings and transportation systems. These measures often pay for themselves in fuel and utility cost savings, and the value of social benefits and carbon emissions reductions make conservation and efficiency even more important. Over $50 million of energy conservation and efficiency work has been approved and funded, and installation is underway across the University of Arkansas campus. More will be accomplished in the next five years under our short-term plan.

Second, we will create campus policies that facilitate energy and water savings, and promote increased recycling of solid waste. These actions will also be implemented during the five-year, short-term plan. A campus building use policy, a recycling policy, a travel documentation policy, and a water conservation policy will complement our existing sustainability policies.

Third, our mid-term plan calls for installation of renewable energy systems and procurement of green energy from local sources. Northwest Arkansas receives abundant solar energy, an average of about 4.5 kWh m^{-2} day^{-1} on an unshaded horizontal surface, which is about the same solar resource as Tulsa, OK and only 10% less than Austin, TX receives. As technologies improve and government policies increasingly promote solar energy, we will install both solar thermal and photovoltaic arrays on campus. The wind resource is not well-documented for northwest Arkansas, but several wind farm developers are collecting data in Washington and Benton counties, and some wind professionals think that there are several class 4 (commercially viable) wind resource sites within 50 miles of the university. Additionally, poultry litter and forest resources are abundant in northwest Arkansas, and there is significant potential to use them as viable sources of biomass energy.

Forest resources across Arkansas also hold promise as sites for managing carbon sequestration projects. Forest carbon sequestration projects are financially and technically complex, and lead time to design and implement them is lengthy. But preliminary analyses suggest that sequestration through enhanced forest management or through reforestation can yield atmospheric carbon reductions more inexpensively than most renewable energy systems (based on the cost/benefit information available in 2009). Under the mid-term plan, we will begin an active research program to assess the technical and financial feasibility of sequestering carbon in Arkansas forests under the management of the University of Arkansas.

Finally, we will acquire carbon credits and related offsets as needed to make our campus fully climate neutral within our long-term timeframe. Some emissions, such as those that result from airline travel and commuter travel, are individually generated. It is efficient, fair, and relatively inexpensive to require travelers to offset travel-related emissions with the purchase of direct offsets. At current prices (just under $10 per MT CO_2e for sequestration projects) most flights would cost only $10 more than they currently do by including purchase of an offset. Similar offsets might be purchased by commuters as part of the parking permit process. This would result in a significant reduction of the institutional carbon footprint, as air travel and commuter travel combine to account for over 15 percent of the institution's carbon emissions.

The plan to achieve carbon neutrality is divided into three phases. Actions taken from now through 2014 are grouped into the short-term plan; those from 2015 through 2021 comprise a mid-term plan; and work from 2022 until 2040 will constitute a long-term plan.

When implemented, the projects described in the short-term plan will accrue $7.5 million in net present value over a 30-year term. Most of the value accrues from energy savings, and represents funds that become available to limit increases in tuition and fees, or for additional jobs and higher salaries for university faculty and staff. The mid-term plan is even more impressive; a forest sequestration plan stands to earn a rapid return on investment while reducing our carbon footprint.

The timeline of building expansion is uncertain, as it depends on the availability of funds from bond issues and other revenues, and the rate of increase of enrollment. If the university adds 1 million sq ft to current space (i.e., 12% additional) by 2040, implementation of this plan will result in a reduction of emissions to 25% below the 2005 level. Addition of 2.5 million sq ft (30% new space) will result in a 17% reduction compared to 2005 emissions.

Because the future impacts of Federal energy policies, the status of available technologies and the future of carbon markets are uncertain, the current plan provides details only for projects that we will implement before 2021. The long-term strategy, which will map our route to full climate neutrality, will be described in a future update of this plan.

List of figures

List of tables

Abbreviations

ACUPCC	American College and University Presidents Climate Commitment
AEP	American Electric Power, the parent company of SWEPCO
ASG	Associated Student Government, the student legislative body of the university
Btu	British thermal units; KBtu = thousand Btu and MMBtu = million Btu
CO_2e	carbon dioxide equivalent; a measure of the impact of a greenhouse gases
ECM	energy conservation measure
ESPC	energy savings performance contract
GHG	greenhouse gas
GSF	gross square feet; building space as measured by exterior building dimensions
kW_{peak}	peak electrical production in kilowatts of power
MT	metric ton, 2204 pounds
RGGI	regional greenhouse gas initiative
SWEPCO	Southwestern Power Electric Company, the provider of electricity to the university

Climate Action Plan

for the University of Arkansas main campus in Fayetteville

1 Introduction

In February 2007, the University of Arkansas became a charter signatory to the American College and University Presidents Climate Commitment, and thereby made a commitment to become a carbon neutral institution of higher learning as soon as it is practical. Being among the first one hundred signatories to make this commitment, the University of Arkansas has taken the lead in higher education in Arkansas toward developing cleaner and greener energy systems, and toward deployment of other carbon emissions reduction strategies for our campus and beyond.

By the summer of 2007, the Applied Sustainability Center in the Sam M. Walton College of Business began operations. Since then it has helped hundreds of area businesses understand how they can operate more efficiently, operate in a manner that is friendlier to local and global environments, and at the same time, sustain local communities. Its development of the Sustainability Consortium in cooperation with Arizona State University and Walmart will develop a sustainability product index for consumer products that will change the way vendors all over the world produce and distribute consumable and durable products.

In Fall 2007, a campus sustainability coordinator was appointed, and the Sustainability Council was subsequently formed. Thirty colleges and programs were offered seats on the council, which then began work to develop programs and projects on campus to reduce the university's carbon footprint, and to make policy recommendations to the university administration. When implemented, those policies and programs will result in a more sustainable campus and community.

All together, over 100 projects and programs, including research, curriculum, extension, facilities, transportation, recycling and community-based projects, are underway at the university (University of Arkansas 2008). Despite significant investments in campus infrastructure and dedicated commitment to energy conservation by the University administration, students, faculty, and staff, greenhouse gas (GHG) emissions have risen every year for which data are available (2002 – 2008). The reality is that growth in enrollment, the addition of on-campus housing facilities, increasingly complex research facilities, and increasing per capita energy demands caused primarily by an electronics-dependent lifestyles (both personal and educational) have combined to increase electricity and other fossil fuel consumption, which results in ever larger GHG emissions. Therefore, a comprehensive and focused climate action plan that provides long-term and clear benefits to all of the university's stakeholders is needed to achieve our goal of climate neutrality.

To operationalize the ACUPCC commitment, the university is developing policies and implementing energy load management strategies, is putting into place extensive energy conservation and efficiency mechanisms, installing renewable energy systems, purchasing green

power from area producers, developing carbon sequestration projects, and purchasing carbon offsets and/or renewable energy credits. This report presents the initial steps being taken to meet the commitment, and describes what students, staff, and faculty are doing to reduce the University's carbon footprint.

To move from our current level of GHG emissions of 177,537 metric tons of CO_2 equivalent (MT CO_2 e) in academic year 2008 (Table 2) to a climate neutral future, we will

- develop institutional policies, educational programs and other communications that engender energy conservation;
- invest in conservation and energy efficiency measures on campus, including upgrades of campus energy delivery infrastructure;
- develop new partnerships that will result in acquisition of energy derived from renewable energy systems (green power);
- develop and implement carbon sequestration projects; and
- purchase carbon offsets and renewable energy credits.

1.1 Current resource consumption

1.1.1 Building and infrastructure energy

In 2008, buildings on the main campus used 128,049,425 kWh of electricity, which was purchased from Southwestern Power Electric Company (SWEPCO), a wholly-owned subsidiary of American Electric Power (AEP). As SWEPCO's generation portfolio consists of 90 percent coal-fired electricity, use of electricity results in 1.02 kg kWh^{-1} of CO_2e emissions, which is about 67 percent above the national average for all fuels (USEPA 2000).

Purchased electricity accounts for about two-thirds of the university's GHG emissions. Total campus space is 7,568,076 gross square feet (GSF), and building energy use is 69 kBtu GSF^{-1} yr^{-1}, far under USDoE's cited national average of 280 kBtu GSF^{-1} (USEPA-EIA 2003) for annual building energy use on university campuses. The better than average performance is due to 1) northwest Arkansas's submontane subtropical climate, which is neither harsh in winter nor summer, and therefore heating and cooling costs are both moderate, 2) less technological sophistication and therefore less energy demand from the campus's older buildings, and 3) and better than average efficiency in newer buildings and in restored ones. GHG emissions from building energy use are 20.15 MT CO_2e · 1000 GSF^{-1} yr^{-1}.

The campus is growing rapidly and we commit to build new spaces to energy efficient and sustainable design standards. The Innovation Center in the Arkansas Research and Technology

Park During was the state's first LEED-certified building when it was commissioned in 2004 and the Duncan Avenue Apartments were the state's first Green Globes-certified complex when they were opened in Fall 2008.

From 2002 through 2008, space increased from 6.2 million GSF to 7.6 million GSF, a 22 percent jump. During this six-year period, building energy use rose 20 percent. Campus policy commits new construction to meet LEED silver or Green Globes 'two globes' standards, and energy use per GSF will almost certainly continue to drop incrementally as new, more efficient buildings take the place of older, less efficient ones. But long-term goals of becoming a campus of 25,000 students and built environment of 9 - 10 million GSF of space suggest that gross GHG emissions will likely continue to increase even though efficiencies may continue to lower emissions on a per-student and per-GSF basis. Therefore, while conservation and efficiency is an essential base for eventual renewable energy systems, energy conservation measures alone will not be sufficient to reduce total emissions below current levels.

In 2005, the Arkansas Legislature passed Act 1980, which authorizes energy savings performance contracts (ESPCs) to be implemented by public institutions. Under these contracts, engineering firms guarantee energy savings that accrue from energy conservation measures implemented by institutions. Over the past four years, the university has developed three ESPC projects that combine to make a $52 million investment in energy conservation improvements and energy infrastructure upgrades on our campus (Table 1). Upon completion, these projects will reduce GHG emissions by 43,079 MT $CO_2e\ yr^{-1}$ below the level produced by business-as-usual energy uses. Installation of energy conservation measures under these agreements will be complete by January 2011.

By the time that the University of Arkansas signed the ACUPCC in 2007, significant energy conservation programs had already been implemented on our campus, including central plant upgrades, lighting efficiency improvements, and building energy upgrades. Over the past two years, Ozark Hall and the Walton College of Business have been retrofitted with more occupancy sensors and efficient lighting. Over 1500 LED fixtures have been installed in interior applications and a dozen LED fixtures have been installed in outdoor applications.

Table 1. GHG emissions avoided from existing projects.

Project description	**GHG emissions avoided (in MT CO_2e yr^{-1})**	**Cost**
ESPC I, central plant boiler and chiller upgrades*	-542 MT	$14.4 million
ESPC II, Poultry Science Center	4,528 MT	$3.6 million
ESPC III, educational and general buildings, athletics facilities, on-campus housing units, and the student union	39,093 MT	$33.6 million
Relamping upgrades, exterior	508 MT	$.3 million
Total	43,587 MT	$51.9 million

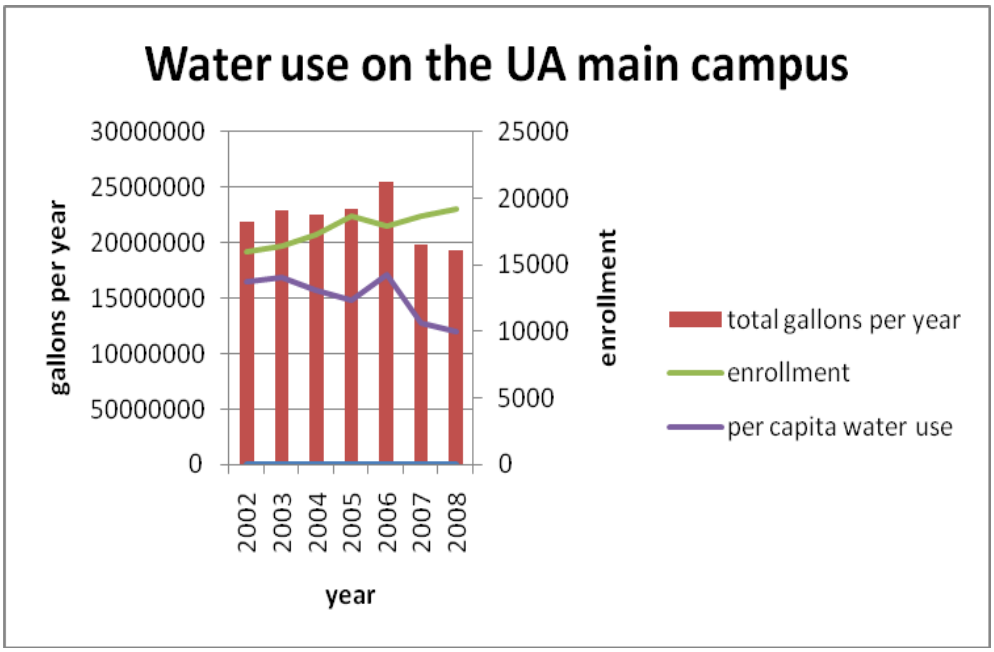
* Central plant projects provide financial savings on utility bills, but the conversion from natural gas to heat pump chillers has resulted in increased GHG emissions for the delivery of district cooling services. This is an example of a project that has a positive financial impact but negative GHG emissions impact.

1.1.2 Water use

Beaver Water District provides water to the University of Arkansas, to Fayetteville, and to surrounding towns and rural areas. Beaver Lake is the source of the district's water. Based on energy use data for 2006 – 2008, water produced by the district produces a GHG footprint of about 23 kg · 1000 gal^{-1}. The university's consumption of about 200,000,000 gallons annually therefore results in 4,600 MT CO_2e yr^{-1} emissions. The emissions due to water delivery are not included in the AASHE/ACUPCC systems of GHG reporting.

Although water conservation has not been a subject of focus and investment over the past few years, per capita water use has dropped for five of the six most recent years. The total of all uses, including personal and research uses, central utility uses, landscape irrigation and athletics fields maintenance was just over 10,000 gallons per student (based on total fall enrollment) in 2008, which is down from over 14,000 earlier in the decade. Central utilities used 35 – 50 percent of all water during most reporting periods from 2002 through 2008. Irrigation accounts for about 30 percent of total water use.

Figure 1. Water use on the University of Arkansas main campus, 2002 – 2008.



An energy savings performance contract will fund the installation of low flow fixtures, automatic flush valves, flow moderators and related building water conservation equipment. Work under this ESPC is scheduled for completion by January 2010.

The quantity of purchased, potable water used can be minimized by substituting non-potable water for irrigation, the installation of water saving fixtures, use of gray water (e.g., sink drain water) in toilets and for irrigation, use of xeric or low-input landscaping, recovery and re-use of process water used by reverse osmosis filters and other research equipment and intentional conservation by personal water users. On the university campus, available non-potable water is generally limited to rain water, as the campus's only surface water, Mullins Creek (Town Branch Creek on some maps), flows at too low of a rate to allow withdrawals.

Total water use varies significantly from year to year, depending on weather conditions and the subsequent need for irrigation and utility water (chilled water and steam). Gross and per capita quantities of water use vary from campus to campus, depending on the number, size and types of athletic fields, whether heating and cooling systems are building-level or district systems, whether non-potable water is available for landscape irrigation, and the type and amount of consumption by research programs. Because seasonal weather variations affect water uses for irrigation and HVAC applications, annual average water use quantities do not necessarily reflect the results of conservation efforts.

1.1.3 Transit and liquid fuels uses

Razorback Transit provided 1.35 million free rides to students and members of the Fayetteville community in FY2009, which kept thousands of cars away from gas stations and out of our parking lots.

Every year free rides on Razorback Transit buses allow over a quarter million riders from Fayetteville to shop and make their way to vital services throughout the city.

Ten Razorback Transit routes provide service throughout Fayetteville. The twenty-one bus fleet that serves these routes and other special transit programs used 98,021 gallons of diesel fuel, resulting in 961 MT CO_2e. University Parking and Transit operates several programs that are designed to conserve and/or reduce the use of fossil energy and GHG emissions, including a bicycle loan program (Razorbikes), bicycle racks on Razorback Transit buses, and a rideshare program (GoLoco). Bicycle racks on buses are particularly useful on our campus, as classroom buildings are situated on a hill high above student parking lots. Over 500 bicycle loops are installed at the 40 busiest buildings on campus, and a bike shelter on the north end of campus accommodates 100 bicycles out of the weather. While these programs promote energy conservation behavior, they thus far combine to do little to avoid CO_2e emissions generated from fleet and commuter transportation.

Fuels for non-transit rolling stock (i.e., fleet passenger cars, work trucks, vans, and off-road maintenance vehicles) account for about 1.5 percent of the university's GHG emissions. In FY08 they consumed 208,905 gallons of unleaded gasoline and diesel and produced 2889 MT CO_2e in GHG emissions.

To date, electric vehicles have not been found suitable for widespread use on campus, because 1) the hilly terrain and battery weight and durability issues have limited their application, and 2) high initial costs and low mileage demands result in long return on investment. It is likely that electric vehicles will replace some of our existing fleet of off-road diesel vehicles sometime between 2014 and 2021. It is difficult to predict, however, when the life cycle analysis indicate that their purchase will become viable for our campus, or which models will be durable, flexible, and practical for utility purposes.

Similarly, as hybrid and alternative-fuel system technologies continue to improve and become more reasonably priced, we expect that staff cars and work trucks will be replaced with vehicles that are fueled by hybrid systems, flex-fuels, biodiesel, ethanol, and/or hydrogen fuels.

Emissions from commuter travel rose by 8.8 percent from FY2000 to FY2008. This increase is correlated with the increase in student population, and is expected to increase further until the University of Arkansas student enrollment goal of 25,000 students is achieved. A campaign will be implemented that increases awareness of sustainable transportation practices and provides incentives to participate in "environmentally friendly" transportation.

Skull Creek Trail is a multi-use (bicycle, walk, run, skate) trail that runs from campus through the north central residential area of Fayetteville, within a block or two of hundreds of apartments. Among its 2000 daily users are students who avoid traffic, parking costs and vehicle expenses by commuting on it. Improved public awareness of this resource will increase bicycle use and reduce the number of commuters who arrive to campus one-to-a vehicle. The university and the city could coordinate the

development of additional multi-use trails, especially to serve the downtown and south Fayetteville neighborhoods.

During short- and mid-term implementation of this plan, programs will be developed to increase the adoption of environmentally friendly, healthy travel options. Disincentives to one-to-a-vehicle commuting will be developed and incentives to carpooling, and the use of alternative fuels, zip cars, bicycles and walking will be developed.

Potential parking management changes

Several types of incentives to avoid one-to-a-car commuting could be implemented, including:

- Improvements to existing bicycle programs, by increasing the number of bike racks, providing more bike shelters and by constructing additional multiple use trails on campus and feeding into it.

- Creation of incentives for carpoolers and owners of hybrid, high mileage/efficiency or alternative fuel vehicles. Two types of incentives can be offered: 1) parking permits for carpoolers and drivers of efficient vehicles at a discount from standard rates; and 2) convenient parking lots reserved specifically for high fuel efficiency vehicles.

- Payments to campus users (fulltime students, faculty, and staff) who do not buy a parking permit. (Stanford University has implemented a program that pays students who do not buy parking permits up to $180 per year, and there are signs that it has been successful at reducing commuter fuel use and emissions).

- Creation of an attractive, easily navigable, on-line system for establishing and managing carpools to campus.

- Expansion and improvement of the existing transit bus system, perhaps by adding one or more remote lots with express shuttles to the Union Station bus depot

- Restricting on-campus parking permits for campus users (faculty, students and staff) who live very close to the main campus.

- Provision of zip car rental services for campus users.

- Creation of infrastructure to support hybrid and alternative fuel vehicles, including electrical charging posts and pumps for alternative fuels

- Provision of additional housing on and near campus. Duncan Avenue Apartments, a 200 bedroom Green Globes-certified complex on the south edge of campus that was

opened in 2008, is an example of housing that minimizes the need for commuter travel.

- Telecommuting and/or compressed work schedules for faculty/staff.
- Provision of improved, readily accessible, reliable and affordable technologies for virtual meetings.
- Implementation of landscaping practices to reduce the need for mowing/weed-eating/etc. (native landscaping, xeric landscaping, rain gardens).

Each of these potential solutions will affect the cost and convenience of commuter strategies. Because they affect almost all campus users, a detailed feasibility analyses and a vigorous public dialogue should precede their implementation. Because these processes have not yet been completed, the selection, prioritization, and budgeting for commuter solutions are not detailed in this report.

1.2 Implementing this plan

1.2.1 Campus and public input

In Spring 2009, the University of Arkansas held the inaugural *Students F1rst Sustainability Competition*, which solicited ideas to save energy and water on campus, and to reduce greenhouse gas emissions with innovative programs and projects developed by interdisciplinary student teams. Ideas obtained from proposals submitted in that competition have been integrated into this plan.

A draft of this document was posted on the Sustainability Council's SharePoint site (https://sharepoint.uark.edu/sites/UASustainabilityCouncil/default.aspx) from May through August 2009. The Sustainability Council discussed the approach, outline, and an early draft of this document at meetings on May 19 and July 28, 2009. Public input was obtained from the Fayetteville community at meetings held at the Fayetteville Public Library in August 2009.

1.2.2 Administrative support and approval

Of 23 projects proposed under this plan, four have been approved and funded, three have been approved but funding is pending, fifteen are proposed but not yet approved or funded, and one is dependent upon external policies for implementation (see Tables 4 and 5). Projects that require funding from fees will require approval from relevant campus committees, the University System President and the Board of Trustees. For example, a carbon fee to purchase offset of commuter fuels, perhaps bundled with the purchase of parking permits, must be approved by the campus Transit, Parking and Traffic Committee.

The chancellor's executive committee, which consists of the chancellor, provost, vice chancellors, and vice provosts, considers policy proposals from the Sustainability Council as well as other

campus committees. The executive committee recognizes the strategies in this plan as an appropriate direction for our campus, and endorses this plan as a means for meeting our responsibilities to the American College and University Presidents Climate Commitment. All projects described here must be individually presented to the executive committee for approval, and projects may be dropped, added, or modified if financial or logistical factors change significantly from current assumptions.

1.2.3 Short-term, mid-term and long-term targets

The commitment to become carbon neutral 'as soon as it is practical' is proffered by signatories of the American College and University Presidents Climate Commitment as an intentionally flexible trajectory.

By 2014 we will reduce GHG emissions to the 2005 emissions level or lower, and will therefore emit 163,000 MT CO_2e or less (Table 4).

The year 2021 will mark the University of Arkansas's 150th year as an institution, and as our state's flagship campus of higher learning. By 2021, operations of the university campus will reduce GHG emissions to the 1990 emissions level or lower, and will therefore emit 125,000 MT CO_2e or less. In 2021, a business-as-usual trajectory would result in 225,000 MT CO_2e of GHG emissions, or 1.8 times the 1990 level. This plan shows how the university will reduce, offset, and otherwise avoid 115,000 MT CO_2e of emissions by 2021 (Tables 4 and 5) to meet this target.

By 2040, the campus will avoid and reduce emissions, purchase green power, install and/or manage renewable energy projects, develop and manage sequestration projects, and offset emissions through financial and policy mechanisms at levels that, according to goals and metrics established by ACUPCC, and will make no net contribution to GHG emissions as they are defined by the ACUPCC.

1.2.4 Funding and financing

Energy savings performance contracts (ESPCs) allow the university to install energy conservation, energy efficiency, and renewable energy systems at no cost to capital improvement funds, or maintenance funds. Instead, borrowed funds, including interest on them, are re-paid from guaranteed energy cost savings. The facilities management department has leveraged $52 million under four ESPCs. About $9.7 million was approved in Fall 09 by the university Board of Trustees, and that funding will be applied to additional energy conservation measures to athletics, housing, and Arkansas Union facilities.

Investments in photovoltaic, wind and biomass energy systems will become much more attractive as carbon emissions acquire additional market value through regulatory or legal actions. If carbon markets become regulated in the United States over the next couple of years, initial prices are likely to be $20 - $50 per metric ton of carbon. As carbon markets become stronger, and when the transition is made from voluntary to regulated markets, avoided CO_2 emissions will have fungible value. We therefore include the value of emissions avoided as a financial asset in calculating the net present

value of proposed installations. This change will result in the designation of capital improvement funds to fund renewable energy systems to power the campus.

Across the nation, students have levied voluntary and mandatory fees on themselves to support the purchase and installation of renewable energy systems on campuses. (For examples of student-sponsored projects see http://www.aashe.org/resources/mandatory_energy_fees.php.)

In a poll carried out in Fall 2008 by the University of Arkansas Associated Student Government (ASG), more students (47percent) identified sustainability (e.g., occupancy sensors for lighting and HVAC settings, re-lamping, increased recycling bins, composting food waste) as their most important campus-based issue. Two-thirds of all students are willing to pay some additional fee to fund sustainability projects on campus, and one-quarter are willing to pay $0.50 to $1.00 per credit hour more. A student fee of $0.50 per credit hour would generate over $200,000 for sustainability work on campus.

To meet the financial challenges of implementing the 23 projects outlined here, financial resources will be developed from:

- Special funds, including funding secured under energy savings performance contracts, through which lower utility bills pay directly for conservation and renewable energy projects as cost savings accrue;
- Alumni and friends who continuously donate to causes that strengthen the long-term viability of the university;
- Students, who contribute to sustainability efforts at colleges and universities across the nation, through voluntary and mandatory self-levies, through special fees and through class gifts;
- Capital improvement, maintenance and operations, and deferred maintenance budgets, which will purchase hardware as they fit into the Campus Strategic Plan and other long-term infrastructure timelines;
- Campus users (students, staff and faculty) fees, and departmental funds, in the forms of travel offsets, parking fees, and similar levies that represent user-pay, pay-as-you-go financing;
- Grants and contracts, from government agencies and private foundations that support green energy and carbon reduction programs; and
- Private and corporate contributors and donors, who see value in becoming part of the effort to fulfill the University's commitment to responsible energy management.

Finally, real financial savings will be realized from some projects implemented under this plan. Some of those savings may be used to finance other projects described here. For example, as we save money and energy from burning waste motor oil and waste vegetable oil, those savings may be used to purchase bicycle racks or composting facilities. Such funding arrangements will depend on cooperation

between programs and departments that generate benefits and those that have funding needs to initiate new projects. When real savings are documented, the interdepartmental fungibility of those savings, specifically as a source of funding for additional carbon reduction projects, is strongly encouraged.

When all stakeholders make substantive contributions to the development and implementation of solutions, acceptance of a successful long-term strategy is likely.

2 University of Arkansas greenhouse gas (GHG) emissions inventories

2.1 2002 – 2008 GHG inventories

Over the past year, a team of graduate students, professors, facilities managers, and consultants have put together GHG emissions inventories for the years 2002 through 2008. The inventories were conducted in accordance with procedures developed by *Clean Air Cool Planet*, which provides a commonly used campus calculator.

Fall 09 registration is 19,835 students, making it the state's largest university campus. Although the Arkansas Agricultural Research and Extension Center (AAREC, known locally as "the farm") is only two miles north of the main campus, the Division of Agriculture is administratively separate from the Fayetteville campus, and the emissions and potential credits from its facilities, farmland, and forests are not included in these GHG emissions inventories. For purposes of defining and tracking the University of Arkansas - Fayetteville campus's GHG emissions, the campus is defined as 1) 157 buildings located on the 345 acre main campus, 2) four major buildings (plus support buildings) on a 125 acre campus in south Fayetteville (the Arkansas Research and Technology Park), and 3) the emissions due to Razorback Transit, commuter travel, air travel and staff fleet travel.

A summary of GHG emissions from the University of Arkansas campus in Fayetteville is shown below (Table 2).

Table 2. University of Arkansas, summary of GHG emissions, 2002 – 2008. (Sightlines 2009)

Total Emissions		FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008
Scope 1								
Scope 1 Utilities	MTCDE	28,603	30,520	25,403	24,164	23,352	25,279	27,630
Vehicle Fleet	MTCDE	2,305	2,500	2,907	2,917	2,923	2,898	2,852
Refrigerants and Chemicals	MTCDE	-	-	-	4,717	1,179	-	2
Agriculture	MTCDE	5	5	5	5	5	5	5
Total Scope 1	**MTCDE**	**30,913**	**33,024**	**28,315**	**31,803**	**27,459**	**28,182**	**30,489**
Scope 2								
Purchased Electricity	MTCDE	81,428	80,913	89,186	91,141	96,872	92,374	102,657
Purchased Steam / Chilled Water	MTCDE	-	-	-	-	-	-	-
Total Scope 2	**MTCDE**	**81,428**	**80,913**	**89,186**	**91,141**	**96,872**	**92,374**	**102,657**
Scope 3								
Faculty / Staff Commuting	MTCDE	4,319	4,279	4,139	4,255	4,288	4,314	4,358
Student Commuting	MTCDE	12,097	12,060	11,931	12,412	12,821	12,959	13,507
Directly Financed Air Travel	MTCDE	13,807	13,807	13,807	13,807	13,807	13,807	15,614
Other Directly Financed Travel	MTCDE	-	-	-	-	-	-	-
Study Abroad Air Travel	MTCDE	-	-	-	-	-	-	-
Solid Waste	MTCDE	825	825	825	825	868	782	760
Wastewater	MTCDE	0	0	0	0	0	0	0
Paper	MTCDE	0	0	0	0	0	0	0
Scope 2 T&D Losses	MTCDE	8,053	8,002	8,821	9,014	9,581	9,136	10,153
Other Scope 3	MTCDE	0	0	0	0	0	0	0
Total Scope 3	**MTCDE**	**39,101**	**38,973**	**39,522**	**40,314**	**41,365**	**40,998**	**44,392**
Total Gross GHG Emissions		**FY2002**	**FY2003**	**FY2004**	**FY2005**	**FY2006**	**FY2007**	**FY2008**
Total Gross GHG Emissions	MTCDE	151,442	152,910	157,023	163,257	165,696	161,555	177,537
Offsets								
Total Offsets	**MTCDE**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Net GHG Emissions		**FY2002**	**FY2003**	**FY2004**	**FY2005**	**FY2006**	**FY2007**	**FY2008**
Total Net GHG Emissions	MTCDE	151,442	152,910	157,023	163,257	165,696	161,555	177,537

A summary by scope (category of emissions) shows that natural gas use and transportation energy expenditures have been steady over the past six years, while the use of purchased electricity has risen by 25 percent.

Figure 2. University of Arkansas GHG emissions by scope, 2002 – 2008.

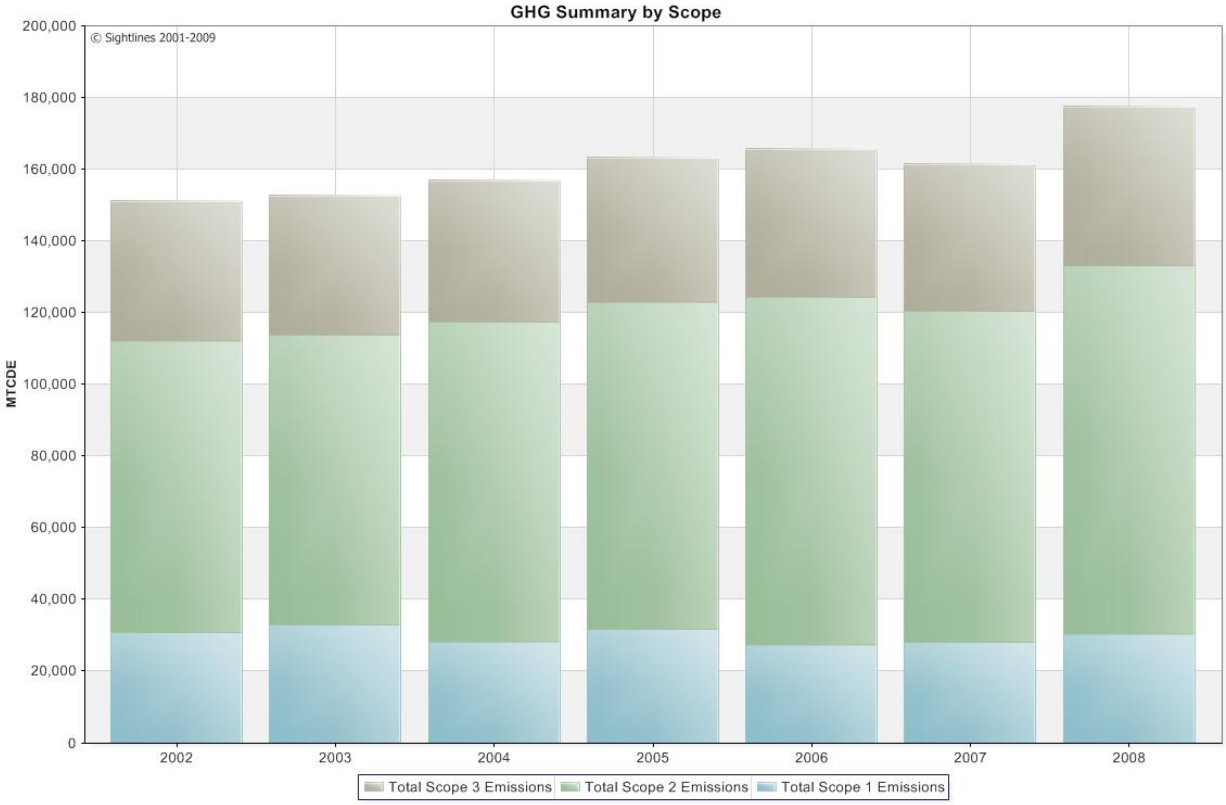


Table 3. University of Arkansas, emissions trends by FTE students, campus users, and building space, 2002 – 2008. (Sightlines 2009)

Total Emissions		FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008
Gross Emissions								
Scope 1	MTCDE	30,913	33,024	28,315	31,803	27,459	28,182	30,489
Scope 2	MTCDE	81,428	80,913	89,186	91,141	96,872	92,374	102,657
Scope 3	MTCDE	39,101	38,973	39,522	40,314	41,365	40,998	44,392
Total Gross Emissions	**MTCDE**	**151,442**	**152,910**	**157,023**	**163,257**	**165,696**	**161,555**	**177,537**

Emissions per FTE Student		FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008
Gross Emissions								
Scope 1	MTCDE	2.52	2.68	2.24	2.46	2.05	2.07	2.14
Scope 2	MTCDE	6.65	6.56	7.07	7.05	7.24	6.79	7.22
Scope 3	MTCDE	3.19	3.16	3.13	3.12	3.09	3.01	3.12
Total Gross Emissions	**MTCDE**	**12.36**	**12.40**	**12.44**	**12.63**	**12.39**	**11.88**	**12.49**

Emissions per Campus User		FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008
Gross Emissions								
Scope 1	MTCDE	1.95	2.08	1.74	1.91	1.61	1.62	1.69
Scope 2	MTCDE	5.14	5.08	5.50	5.48	5.67	5.32	5.69
Scope 3	MTCDE	2.47	2.45	2.44	2.42	2.42	2.36	2.46
Total Gross Emissions	**MTCDE**	**9.56**	**9.61**	**9.68**	**9.82**	**9.70**	**9.31**	**9.84**

Emissions per 1,000 GSF		FY2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008
Gross Emissions								
Scope 1	MTCDE	4.99	5.22	4.24	4.74	4.04	3.82	4.03
Scope 2	MTCDE	13.15	12.78	13.36	13.59	14.24	12.54	13.56
Scope 3	MTCDE	6.31	6.15	5.92	6.01	6.08	5.56	5.87
Total Gross Emissions	**MTCDE**	**24.45**	**24.15**	**23.51**	**24.34**	**24.35**	**21.93**	**23.46**

2.2 Summary of key trends of GHG emissions

Having developed detailed GHG emissions inventories for a seven-year period from 2002 through 2008, several trends in campus energy use and GHG emissions can be observed:

- Although space on our campus grew by 21.5 percent and fall enrollment was up 19.7 percent between 2002 and 2008, GHG emissions rose by only 18.7 percent. Building energy use was up only 17.6 percent during the six-year period. Accordingly, both per capita and per-GSF emissions have declined over that period.

- Over 80 percent of our total energy use is building energy use. Razorback Transit, fuels used by commuters to and from campus, airline travel and other energy uses account for under 20 percent of the total.

- The use of natural gas on campus declined by 7 percent between 2002 and 2008. This is partly due to improved building efficiency, and partly due to replacement of a gas-fired chiller with a heat pump chiller at the central plant. Installation of the latter saves money on utility costs and results in a slightly higher GHG emission than the gas-fired chiller did.

- GHG emissions attributable to solid waste declined by 8 percent over the seven year period, a reflection of an increasingly effective recycling program that is managed by Razorback Recycling.

- Because of a growth in enrollment, emissions due to commuting rose by 8.8 percent during the seven-year period.

- Despite nearly $20 million of investments in on-campus energy efficiency and conservation in buildings and the system of utility infrastructure, GHG emissions have increased 25 percent over the past decade. An additional $30 million of work is currently underway, and gross emissions should begin dropping by 2012.

- Emissions per FTE student and per campus user have remained steady over the seven year reporting period. Emissions per GSF have dropped slightly from 2002-2003 levels, and will drop more when energy conservation measures under ESPC have been completed (Table 3).

- We have established a goal to increase enrollment by 6,000 students (above current enrollment) and to add between 1.5 million and 2.5 million GSF of space to campus buildings over the next decade. Our growth mode makes our commitment to reduce GHG emissions 50 percent below the business-as-usual level by 2021 more difficult than it would be if enrollment and building space were held constant.

- The University of Arkansas has not yet initiated the use of offsets or sequestration as tools to reduce our GHG emissions inventory.

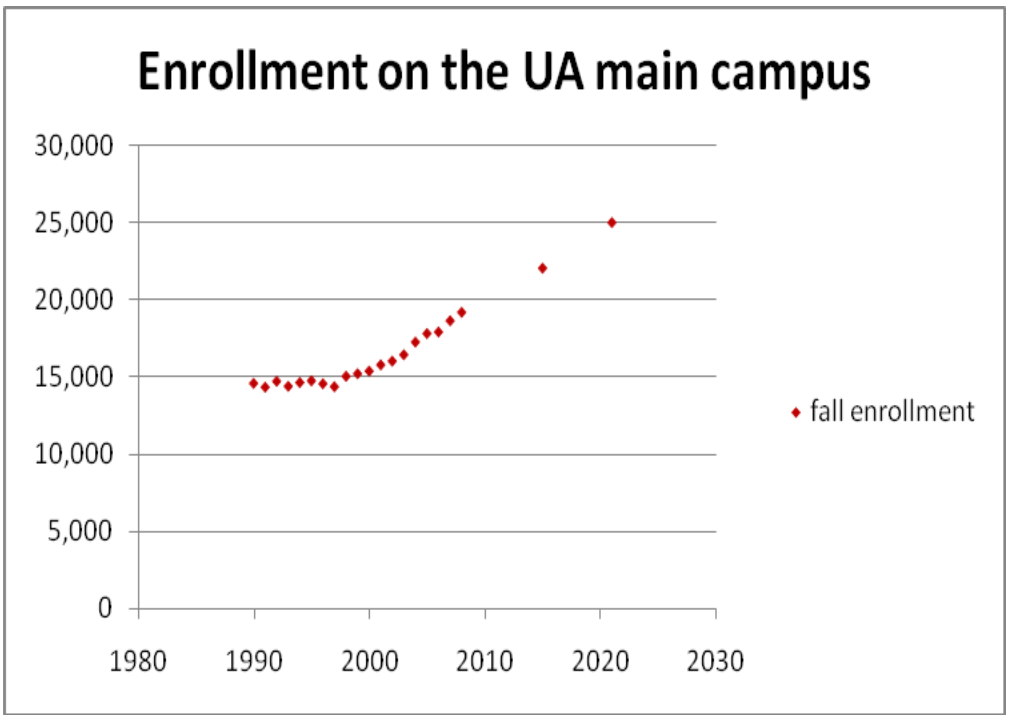
2.3 Estimated 1990 emissions

As 1990 was the year that the Kyoto Protocol was negotiated and has become a baseline year for many purposes, the University of Arkansas will use the 1990 emissions level as an interim emissions target. Based on available data for enrollment, building space and utility bills, GHG emissions were approximately 125,000 MT CO_2 e in 1990.

3 Projected campus energy demand, 2010 - 2040

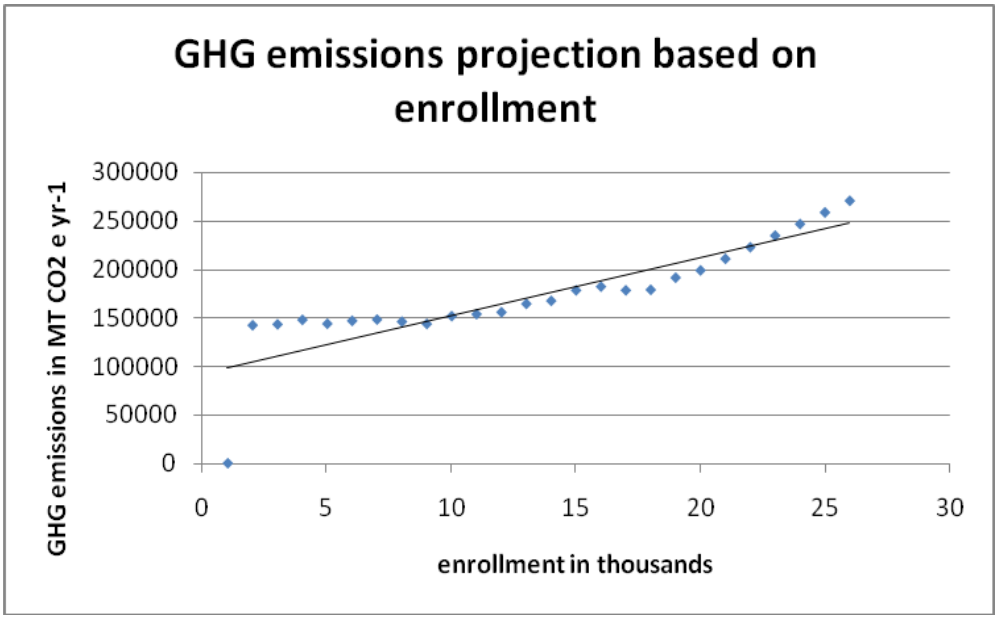
The master plan for the University of Arkansas in Fayetteville projects that the campus will grow significantly in building space and in enrollment over the next 10 – 20 years. In an attempt to improve the proportion of Arkansans who have a college education, the main campus has established a goal of enrolling 25,000 students by the year 2021. There are no specific enrollment goals beyond 2021, and this plan assumes that enrollment will rise less than 10% between 2021 and 2040.

Figure 3. Enrollment on the University of Arkansas main campus.



Based on extrapolations of energy uses and GHG emissions from our2002 – 2008 GHG emissions inventory, we expect emissions of 250,000 MT CO_2e under a business-as-usual energy use scenario when enrollment reaches 25,000 students.

Figure 4. GHG emissions projection based on enrollment.



To accommodate classroom space and other facilities for 6,000 additional students, the main campus will expand its current capacity of 7.66 million GSF to about 8.5 million GSF by 2021 and between 9 and 10 million GSF by 2040. Extrapolations from 2002 – 2008 datasets show that a campus of 8.5 million GSF would emit 220,000 MT CO_2e yr^{-1} and a 10 million GSF campus would emit about 250,000 MT CO_2e yr^{-1}.

Figure 5. Planned growth of space on the University of Arkansas main campus.

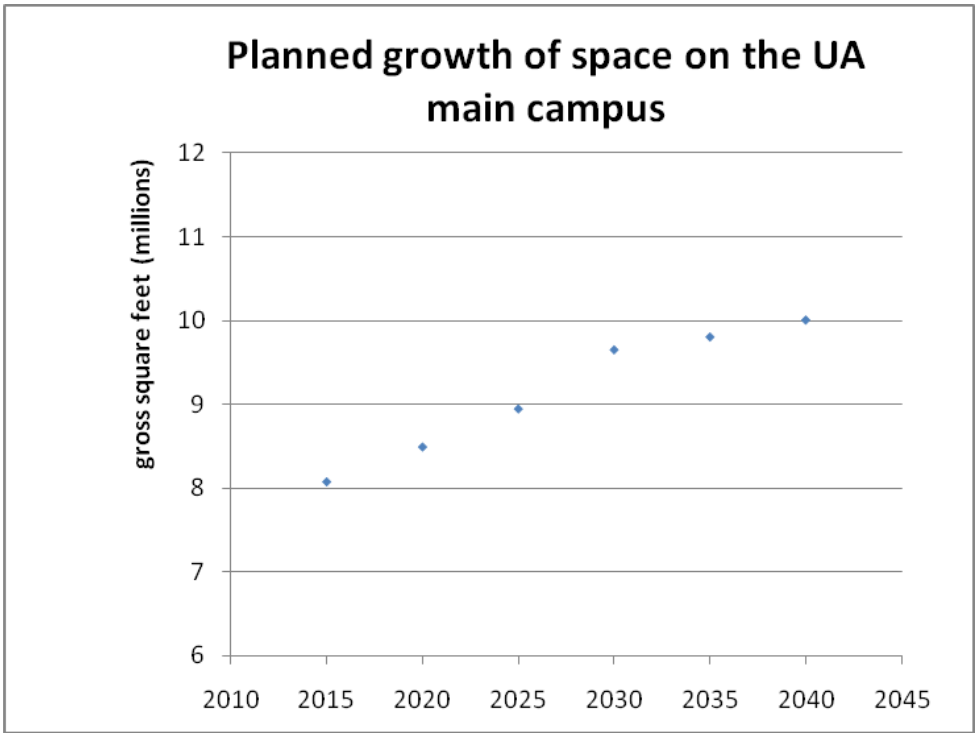
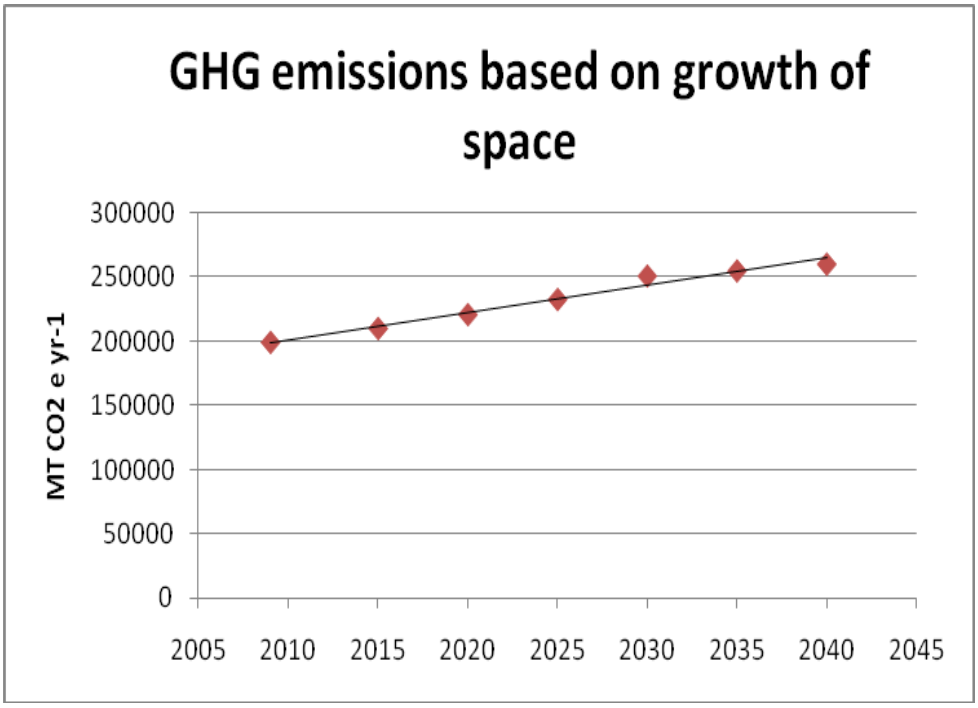


Figure 6. GHG emissions based on the growth of space.



4 State and Federal policies and GHG emissions

There is little question that state and federal GHG emissions policy will influence the capability of the University of Arkansas Fayetteville campus to reach its GHG reduction goals. Whether governed by the voluntary carbon markets (e.g., the Chicago Carbon Exchange, the American Carbon Registry, and the California Climate Action Registry), by non-binding agreements (e.g., ACUPCC and the US Mayors Climate Protection Agreement) or the mandates of federal legislation, the landscape of carbon management decision-making is in a state of rapid change. Even without new legislation, the bases for understanding and acting on climate change are changing for carbon markets. New scientific understanding changes the standards of applicability, quantity and permanence of carbon sequestration. New players in the marketplace bring different long-term financial and environmental goals. International influences such as European carbon markets affect GHG management, and may change goals for institutions in Arkansas and across the nation. Add to these policy uncertainties the rapid change of energy systems and carbon reduction technologies and the most effective control of future emissions becomes even more uncertain. For these reasons, this plan will be modified as opportunities arise to reduce and offset carbon emissions more cheaply or practically than we can now predict.

This uncertainty is not particularly bad. Technological advances, in some ways driven by markets and public perception of need, give us traction. There is a continuing tension toward reducing or capturing GHG emissions. While GHG specific policy gets much of the public attention relative to GHG management, actions across a spectrum of policy arenas continues to reduce GHG emissions. Some examples include:

- Fuel standards legislation and incentives for alternative fuels development at both state and national levels
- Conservation easement tax credits and other land and water conservation incentives
- State and federal farm legislation focused on conservation of wetlands, riparian zone protection, wildlife habitat protection and reforestation
- Research incentives for bio-fuel and bio-energy development and systems deployment
- Increased fuel/mileage standards for cars and light trucks
- Urban stormwater management rules, financial incentives and penalties
- Carbon capture and storage, nuclear power and other alternative energy development incentives
- Policies that enable privately funded voluntary, incentive-based sequestration strategies

Control of GHG emissions resultant from the day-to-day operation of the University of Arkansas is in large part determined by the energy sources available to the system. As the viability of renewable energy systems improves, including wind, solar, bio-fuels, advanced hydrokinetic, geothermal and other sources, and as new mandates require continuous reduction in GHG emissions, high emissions rates due to SWEPCO's coal-heavy portfolio will decline. Carbon regulation will give the university more control over its level of GHG emissions in the future.

As the discussion of alternative strategies for GHG emissions limitations continues at the federal level, states are taking charge. Three groups of states and Canadian territories spanning the width of the United States have organized or are in the process of organizing market-based GHG emissions cap and trade systems. RGGI (the Regional Greenhouse Gas Initiative) is the product of cooperation among ten Northeastern and Mid-Atlantic states that are interested in creating new green jobs and spurring innovative developments in clean energy.

The Western Climate Initiative includes six western states and the provinces of British Columbia and Manitoba. The partnering entities have agreed to the common purpose of a cap and trade program designed to meet their long term GHG management objectives.

Five states are formal parties to the Midwestern Greenhouse Gas Reduction Accord and an additional three states are involved as observers. By the close of 2008 there were a total of 22 states committed to regional carbon markets with an additional eight states acting as observers. These initiatives by states and territories are a strong indicator of the changing GHG policy landscape in the United States. They also provide new incentives for investment in technologies that increase energy efficiencies and reduce GHG emissions. This combination of policy and technological change paints a bright future for GHG emissions reductions, but leaves unanswered the questions of which alternatives will emerge as the policy or technology of choice.

EPA's recent (April 2009) inclusion of CO_2 and other GHG as air pollutants under the Clean Air Act adds political strength to the possibility that federal regulation of GHG in some form will soon be a reality.

The combination of state-based policy development, technological advancement and probable new federal policies or laws points toward development of a national consensus on GHG policy. The state of carbon markets and the extent to which they affect the options in this plan will guide which policies and programs we pursue. As these factors unfold we will remain diligent observers in the tradition of our university heritage to "take good notes." We'll initiate projects that best take advantage of local opportunities as they develop.

5 Actions to reduce and mitigate GHG emissions

To reduce GHG emissions and our institutional carbon footprint, the University of Arkansas will implement five types of projects and programs.

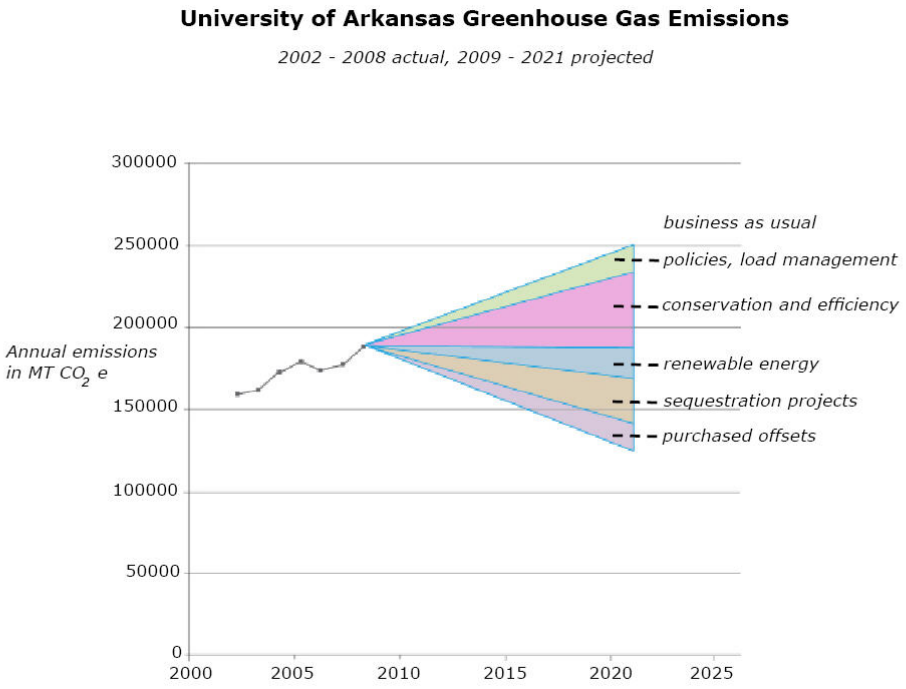
The university will create and take advantage of energy saving policies. We will assess federal and state energy conservation policies, and develop ways to take advantage of financial incentives that they provide. We will also develop campus water conservation and waste minimization policies. We will install energy conservation and efficiency systems and devices on campus buildings and in our transportation systems. From 2008 through 2010, we will have implemented three energy savings performance contracts that have resulted in installation of $52 million in energy conservation and efficiency measures on campus.

Solar energy is abundant in northwest Arkansas, about 4.5 kWh m^{-2} day^{-1} (USDOE 1994), and wind energy, though only documented at a limited number of sites, is thought to be suitable for commercial wind development at select locations (Terry Tremwel, personal communication). Facilities Management, Transit and Parking, and other auxiliary departments will procure and install and/or otherwise acquire power from renewable energy systems. Solar energy, wind power, and biomass energy systems each have potential to power the buildings and transportation systems of our university.

We intend to develop the capacity to offset and mitigate carbon debits with carbon sequestration projects. Forests and agricultural soils provide opportunities for carbon sequestration, on and off of university-controlled lands. The university intends to develop partnerships and other business relationships that will facilitate acquisition of carbon credits through lands that we purchase, lease, or otherwise manage for the primary purpose of carbon sequestration.

Finally, if projects and programs in the categories above do not fully meet our greenhouse gas reductions goals, we will evaluate the viability of procuring carbon credits through green tags (renewable energy credits), carbon credits from voluntary or regulated exchanges, or from similar financial instruments.

Figure 7. Greenhouse gas emissions at the University of Arkansas, 2002 – 2008 actual, 2009 – 2021 projected.



5.1 Short-term actions: reduce GHG emissions to the 2005 level by 2014

This plan establishes the goal of reducing institutional GHG emissions to the 2005 level of emissions, 163,000 MT CO_2e, by 2014.

The projects proposed here represent a mix of projects, some which are underway and others that are not yet vetted or approved by advisory and administrative structures. Some are already being implemented. Others have been approved for implementation and are queued for action. Still others require feasibility analysis, policy analysis and formal approval.

Over the next five years, the University of Arkansas will implement projects that begin to reduce GHG emissions on campus and in transportation systems that bring workers and students to campus. Over the next five years we will:

- complete installation of $52 million of energy conservation improvements under energy savings performance contracts, which will result in avoidance of about 39,600 MT $CO_2e\ yr^{-1}$ in emissions;
- install one or more arrays of photovoltaic panels on campus, totaling at least 25 kW_{peak} capacity;
- double the number of bicycling commuters to and from campus, through improved services and incentives;
- double the amount of recycled materials on campus, through an improved Razorback Recycling program and a new campus recycling policy;
- reduce energy use by computers and other information technology hardware up to 30 percent, through innovative networking, server sharing, and software that controls networked displays and printers;
- develop a campus building energy use policy that controls set points and hours of use;
- install an energy dashboard for campus housing facilities;
- provide retro-commissioning of all campus buildings, which will provide us with hands-on real-time monitoring of building energy systems and will thereby improve energy use efficiency; and
- substantially reduce deferred maintenance, and thereby gain building energy efficiency;

By implementing these measures, we will avoid over 40,000 MT CO_2 e yr^{-1} of GHG emissions compared to business as usual. We therefore expect to emit 160,000 MT CO_2e or less by 2014.

5.2 Mid-term actions: reduce GHG emissions to the 1990 level by 2021

About half of current GHG emissions can be avoided at an average cost of $25 MT CO_2e^{-1}, by carrying out 23 projects. A few of these projects are already underway, and most can be funded by low cost, department level allocations. Although this plan reveals initial costs and annual costs for developing and managing carbon reduction projects, it does not identify specific sources of funding for some individual projects. (There are a few exceptions to this, such as the funding mechanism that is automatically tied to energy savings performance contracts.) Students, faculty, staff, alumni, foundations, corporate partners, government programs and private donors should share the cost of developing initiatives that become high priorities under this plan.

Table 4. Short-term GHG emissions reduction strategy, 2010 – 2014

University of Arkansas **GHG emissions reduction plan**							
Short-term strategy: 2010 - 2014							
Project	**Initial cost**	**Annual cost**	**Net present value**	**MT CO_2e avoided yr^{-1}**	**$/MT CO_2e avoided**	**timeline**	**status**
Campus policies							
1. IT power management	$75,000	$0	$6,314,286	3,060	$1	2011	c
2. Building energy and use policy	$75,000	$0	$2,695,148	1,306	$2	2011	c
Conservation and efficiency							
3. Waste oil to space heat	$20,000	($1,500)	$21,429	4	($38)	2011	b
4. Trayless dining	$0	$0	$77,252	71	$0	2008	a
5. Building energy dashboard (for housing)	$40,000	$4,000	$2,801,606	1,358	$1	2011	c
6. Bicycle program	$70,000	$0	$357,143	77	$61	2011-2014	c
7. Energy savings performance contracts (educational and general)	$42,000,000	$0	$485,714	31,730	$44	2008 - 2010	a
8. Energy savings performance contracts (auxiliaries)	$9,700,000	$0	$416,200	7,363	$44	2009 - 2010	a
9. Increased recycling	$100,000	$28,000	($106,619)	400	$78	2011	a (see note)
10. Food waste to compost	$8,000	$10,000	($127,820)	40	$257	2010	b
Renewable energy							
11. Campus WVO to biodiesel	$20,000	($5,000)	$107,143	49	($75)	2009	a
12. On-campus wind generators	$32,402	$0	($4,099)	13	$10	2012	c
13. 25 kW photovoltaic array	$108,265	$0	($40,408)	37	$37	2012	c
Sequestration							
14. Improved forest management	$710,000	$10,000	$796,739	1,000	$57	2014	c
Purchased offsets							
15. Pay offsets for air travel	$0	$145,303	N/A	15,624	$9	2011 - 2021	d
16. Commuter offsets with parking permits	$0	$151,869	N/A	16,330	$9	2011 - 2021	d
Totals	**$52,883,667**	**$342,672**	**$7,479,427**	**75,403**	**$28**	**2010 - 2014**	
Status							
a							
b -							
c -							
d -							
e –							

Table 5. Mid-term GHG emissions reduction strategy, 2015 – 2021

University of Arkansas GHG emissions reduction plan							
Mid-term strategy: 2015 - 2021							
Project	**Initial cost**	**Annual cost**	**net present value**	**MT CO_2e avoided yr^{-1}**	**\$/MT CO_2e avoided**	**timeline**	**status**
Campus policies							
17. Parking incentives and restrictions						2015 - 2021	d
Conservation and efficiency							
18. Bicycle program	$70,000	$0	$357,143	77	$61	2015- 2021	c
19. Diesel to CNG in bus fleet						2015 - 2021	d
Renewable energy							
20. 15% renewable energy from SWEPCO	$0	$34,415	$0	3,083	$11	2015 - 2021	
21. 250 kW photovoltaic array	$872,651	$0	($55,429)	370	$5	2015 - 2021	c
22. Purchased electricity from area wind farms		$688,299		26,520	$26	2015 - 2021	c
Sequestration							
23. Improved forest management	$7,000,000	($250,000)	$13,067,387	10,000	$11	2015 - 2021	d
Purchased offsets							
24. Renewable energy credits, other offsets						2015 - 2021	d
Totals	$7,942,651	$1,161,013	$13,230,452	40,051	$22		

Notes to Table 4

1. Power management for plug loads plus software control of computer servers, printers, screens, and other components A project implemented by the Walton College of Business IT department has reduced electrical loads by 600,000 kWh yr^{-1} or 60 MT CO_2e yr^{-1}. By expanding this program to be a campus-wide effort, avoided emissions will total about 300 MT CO_2e yr^{-1}. About $10,000 in staff time will be required to draft and establish a campus energy use policy. After the initial effort, no further expenses will be required.
2. Building energy and use policy. A policy that establishes uniform temperature set points and building use times for all general and educational use buildings will save up to 5,000 MT CO_2e yr^{-1}. About $10,000 in staff time will be required to draft and establish a campus energy use policy. After the initial effort, no further expenses will be required.
3. Transit and Parking accrues 3,000 gal yr^{-1} of waste oil. Waste oil space heaters (120,000 Btu hr^{-1} units) cost $2,500 each, burn 0.5 gal hr^{-1}. For a heating season of 750 hrs, 3,000 gal will fuel eight heaters. Assumes that waste oil as a fuel is worth $0.50 gal^{-1}.
4. Trayless dining , initiated by Chartwells in Fall 08, reduced food waste from 200,000 lbs yr-1 to 100,000 lbs yr-1. One MT food waste creates 0.82 MT CO_2e (USEPA 2002). 50 MT food scraps avoided · 0.82 MT CO_2e/MT food scraps = 41 MT CO_2e yr^{-1}.
5. University Housing operates 20 residence halls that cover 1.45 MM GSF or 18.9 percent of total campus space. A Lucid building energy dashboard costs $40,000 for 20 buildings, and has an annual M&O cost of $4,000. Five colleges and universities report average of 11 percent savings in dorm competitions (http://www.luciddesigngroup.com/energycompetitions.php). 11 percent savings · 125,000 MT CO_2e yr^{-1} for electricity emissions · 0.189 (housing space/total campus space) = 2600 MT CO_2e yr^{-1} avoided by installing dashboards in 20 campus residence halls.
6. 500 new bicycle parking spaces (loops or staples) at $100 per bike, plus one covered bike shelter at $20,000. Bicyclists will save 20 gallons of gasoline yr^{-1} each.
7. Based on projected and guaranteed savings based by an energy services company under three existing campus-wide energy savings performance contracts.
8. Based on energy savings calculated by Energy Systems Group and Johnson Controls Inc (ESCOs), and on CO_2 emissions calculated from central plant upgrades.
9. Double the current rate of diversion from landfills from 30 percent to 60 percent. Add one worker fully loaded.
10. The project will be a partnership between Chartwells and Facilities Management. The installation cost of $8,000 includes delivery of an Earth Tub from Boston Mountain Solid Waste District and assumes that university trades shops will install the system for the cost shown. A 0.25 FTE worker, needed to collect food waste and maintain the tub, costs $10,000 yr^{-1} fully loaded.
11. Already in place; $15,000 initial installation cost. 100 gal $week^{-1}$ processed; $1 gal^{-1} cost to refine saves $1 gal^{-1} or more below diesel costs. 5,000 gal yr^{-1} = 50,000 kg CO_2e avoided yr^{-1}.
12. The wind energy resource has not been well documented. The results of financial analysis could change significantly with relatively small changes in assumption about wind availability.
13. In northwest AR, 1 kWpeak of photovoltaic panel produces 126 kWh mo^{-1} · 126 kWh· kW_{peak}^{-1}· mo^{-1} · 25 kW_{peak} · 12 mo yr^{-1} · 1.02 kg CO_2e kWh /1000 kg MT^{-1} = 39 MT CO_2e avoided yr^{-1} · kW_{peak}^{-1}.

14. Unstocked coastal pine forest costs about \$700 ac^{-1}; 1000 ac costs \$700,000. An initial forest plan costs \$10 ac^{-1}. Forest management costs are taken from removals, and average about \$10 ac^{-1} yr^{-1} is assumed over a long term. The residual value of the forest land and its performance as an investment are not included in this analysis.
15. Based on the prices published at http://www.naturalstrategies.com.au/transport/reduce-offset-air-travel-emissions, sequestration projects begin at \$9.30 MT^{-1} from *GreenFleet*.
16. The same offset purchased for airline offsets can be purchased to neutralize commuter emissions.

Notes to Table 5

17. A wide range of parking incentives and restrictions will be considered to reduce emissions from commuter travel.
18. See note 6. By 2015 bicycle parking will be expanded from 1,000 to 1,500 spaces on campus and additional infrastructure will be put into place.
19. Compressed natural gas (CNG) emits about 85 percent as much GHG as gasoline, and CNG currently costs \$1.11 gal^{-1} equivalent, but the comparative cost of CNG and diesel over a long term is very uncertain. Maintenance and operations are probably more expensive for CNG than for diesel, but the overall actual budget is not known. See http://www.cleanairnet.org/infopool/1411/propertyvalue-17731.html for information about the economics of CNG buses. There are also national energy security and energy supply benefits to conversion from gasoline and diesel to CNG.
20. SWEPCO will provide green power as required under a cap-and-trade program. 124MM kWh yr^{-1} electricity · 0.10 of the portfolio · \$0.005 kWh^{-1} additional cost = \$62,000 yr^{-1} additional electricity cost.
21. This assumes that PV will cost \$4/kW_{peak} installed by 2015, and will have efficiency similar to current technology.
22. The analysis assumes that wind energy will be available at \$0.01 kWh^{-1} higher cost than SWEPCO's overall portfolio and that 20% of campus electricity needs would be met through area wind farms.
23. See note 14 for basic assumptions. During the period 2015 – 2021, the forest sequestration project will be expanded to include 10,000 ac of land. A conservative estimated net income of \$25 ac^{-1} yr^{-1} is assumed.
24. Beyond user-pay, pay-as-you-go purchased offsets for commuter and commercial air travel emissions, renewable energy credits and sequestration offsets could meet our emissions reduction goal if other projects do not perform as expected.

5.3 Long-term actions: achieve climate neutrality by 2040

By 2021 the University will have reduced GHG emissions to half the level that would have been emitted under a business-as-usual scenario. Most of the practical strategies and technologies related to energy conservation and energy efficiency will be in place by then. Renewable energy applications will be available in the form of technologies that are not yet foreseeable. The technical viability, market prices, and policy supports for carbon sequestration in soils, on farms, and on forests will have costs and values that are currently not predictable.

In addition to continuing focus on conservation and efficiency, the university will deploy a combination of purchased green energy, university-generated green energy (from on- and off-campus systems), sequestration projects and purchased offsets to become climate neutral by 2040. The mix of technologies, policy instruments and market mechanisms that we will use will be determined by future revisions of this plan.

6 Curriculum and education

The University of Arkansas offers several degree programs that provide knowledge and capacity to manage tomorrow's world more sustainably, including a PhD in environmental dynamics and a PhD in agronomy with a specialization in environmental sciences.

UA operates at least fourteen centers and programs across colleges of engineering, architecture, arts & sciences, business and agriculture that carry out research, extension, and educational efforts related to sustainability. Several of these centers have been developed specifically to address sustainability topics. The publication *Sustainability at the University of Arkansas* (available at sustainability.uark.edu) is updated annually, and provides detail about the projects and programs that relate to sustainability on our campus. Overall, over a hundred efforts that teach, research, or implement some dimension of sustainability are under way on our campus.

The Center for Agricultural and Rural Sustainability (CARS) works to increase prosperity for rural Arkansas through sustainable practices. The Center provides leadership in Arkansas and the world in balancing the demands of community, agriculture and ecosystems in order to meet the needs of current generations while enhancing the opportunity for future generations to meet their needs.

The Applied Sustainability Center is translating Arkansas' legacy of conservation and the ingenious use and reuse of resources into best management practices for businesses that will increase their long-term profitability and at the same time benefit society through more judicious use of land, water, air, fossil fuels and other natural resources. The Applied Sustainability Center works with a wide range of partners to facilitate the rapid development of sustainable business practices and promote their application across the retail and consumer goods industries.

In the Fall 2011 semester, the University of Arkansas expects to offer a Professional Science Masters degree in Sustainability Analysis. The program proposal has submitted it to the Arkansas Department of Higher Education, and we expect to open the program to the first cohort of students in Fall 2011. A new course, *Fundamentals of Sustainability*, will focus on biological impoverishment, greenhouse gas management and climate action. Additional core courses are *Sustainability and Ethics*, *Agricultural and Resource Economics*, *Environmental Politics* and *Life Cycle Assessment*. Graduates of this program should be able to understand and appreciate the basic principles of economics, ecosystem services, resource management, economic prosperity and related ethical issues; design and execute experiments with minimal supervision; participate effectively as members of interdisciplinary teams, prepare technical reports, project plans, and regulatory documents; prepare and present information to a wide variety of constituents, from customers to stockholders to the general public; and to apply their knowledge of sustainability and skills to various areas within an institutional framework, be that a company, non-governmental organization (NGO), community organization, or governmental organization.

A capstone project will focus on a locally relevant, applied problem in sustainability. Students will learn how to assess the impact that personal, professional and corporate activities have on global climate change. The program will train students to become sustainability officers in corporations and organizations, community leaders, entrepreneurs, and developers of green programs and organizations.

U of A also intends to develop an undergraduate multi-disciplinary minor in sustainability, and a research program that focuses on life cycle assessment of consumer products.

7 Monitoring and reporting

The American College and University Presidents Climate Commitment calls for biannual GHG emissions inventories and periodic updates of climate action plans. This report is submitted in September, 2009. Progress reports on our institutional GHG emissions inventory will be submitted annually on a continuous basis. A comprehensive update of this plan will be undertaken as the short-term activities are successfully implemented, and this plan will likely be updated in 2013 or 2014. In the interim, specific strategies may be changed to facilitate more rapid progress, lower overall costs of reducing carbon emissions for the proposed projects or for new ones, in response to newly emerging technologies, and/ or to improve the quality of life or financial benefits to the university community.

This report is available as a pdf to the general public on the campus sustainability website, http://sustainability.uark.edu. Members of the University of Arkansas community (i.e., persons with a uark.edu email account) can find this report, its supporting documents, and related work undertaken by the Sustainability Council at the council's SharePoint site, https://sharepoint.uark.edu/sites/UASustainabilityCouncil/default.aspx.

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