



MCDANIEL

COLLEGE



Climate Action Plan

Prepared by the McDaniel College Green Terra Committee
Fall 2009

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GREEN TERRA COMMITTEE

McDaniel College's Climate Action Plan was developed by the Green Terra Committee; a group of students, staff, and faculty dedicated to reducing carbon emissions on campus. The individuals listed below reviewed and edited different portions of the Plan then came together as a group to produce this document. Please direct all comments & questions to:

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EXECUTIVE SUMMARY

Global climate change is one of the most pressing environmental problems facing the world today. Seemingly small changes in average temperature and precipitation can have huge impacts on the natural resources upon which society depends³. History tells us that humanity is sensitive to changes in resource availability: wars have been fought over water and oil; societies have failed due to resource depletion; and populations have migrated when local environmental conditions became uninhabitable¹.

Evidence suggests humans may be contributing to recent global warming trends by emitting carbon dioxide and other greenhouse gases into the atmosphere⁴. Our current actions have been linked to changes in the Earth's climate occurring at an unprecedented rate³. Armed with this data, we must question our role in any activities that are contributing to the problem. In fact, many city and state governments, along with private institutions including colleges and universities, have begun to take action.

In 2007, Dr. Joan Develin Coley, president of McDaniel College in Westminster, Maryland, joined a group of college and university presidents in making a pact to reduce their campuses' carbon emissions. The American College and University Presidents' Climate Commitment (ACUPCC) compels participating institutions to eliminate their contributions to global warming. President Coley challenged the Green Terra Committee to create a Climate Action Plan that will lead the McDaniel campus toward carbon neutrality. This document represents the Committee's recommendations.

In drawing up a Climate Action Plan, the Committee analyzed McDaniel's greenhouse gas emissions from 2007. Using this as a baseline data set, the emissions were divided into smaller "sectors" and a suite of suggestions was proposed for reducing McDaniel's contribution to global warming in each area. The goal of this report is to compare the effectiveness of different strategies for reducing greenhouse gas emissions on campus and to make recommendations for future actions.

This project could not have been completed without the help of several dedicated students in the Environmental Policy and Science (EPS) Program who each researched innovative strategies for reducing greenhouse gas emissions on campus. These students contributed throughout the data collection, writing, and editing phases of the process. This report thus represents the joint effort of the Green Terra Committee and McDaniel College students: Ember Flemming, Zach Hetrick, Daniel Leader, James Dyson, Kacey Decker, Sarah Costa, Stephanie Banik, Kristin Lamb, Sunita Pathik, and Rob Holthause.

MCDANIEL COLLEGE CLIMATE BASELINE

Language used in the ACUPCC refers to reducing an institution's *carbon footprint* to zero. A carbon footprint defines the net amount of carbon dioxide emitted by an institution or individual. Carbon dioxide emissions provide a good measure of an institution's impacts on climate change because it is the most abundant anthropogenic greenhouse gas and thus the most damaging. The carbon footprint analyzed in this report is expressed as the amount of carbon dioxide McDaniel College contributes to global warming on an annual basis. Units of carbon emissions are given as the weight of carbon dioxide equivalent, or CO₂e.

McDaniel College was responsible for emissions equivalent to 20,679 metric tons (MT) of CO₂ in 2007. We refer to this as McDaniel College's *climate baseline*. The largest portion of the emissions (47 percent) was due to purchasing electricity from sources that burn fossil fuels. The next largest source of emissions made up 26 percent of the total and was from the natural gas and oil used for heating. Fossil fuels burned during transportation, including commuting students, commuting faculty, and College-related air travel, made up 21 percent of the emissions. The carbon produced by the breakdown of our solid wastes made up 6 percent of the total College emissions (see Figure 1).

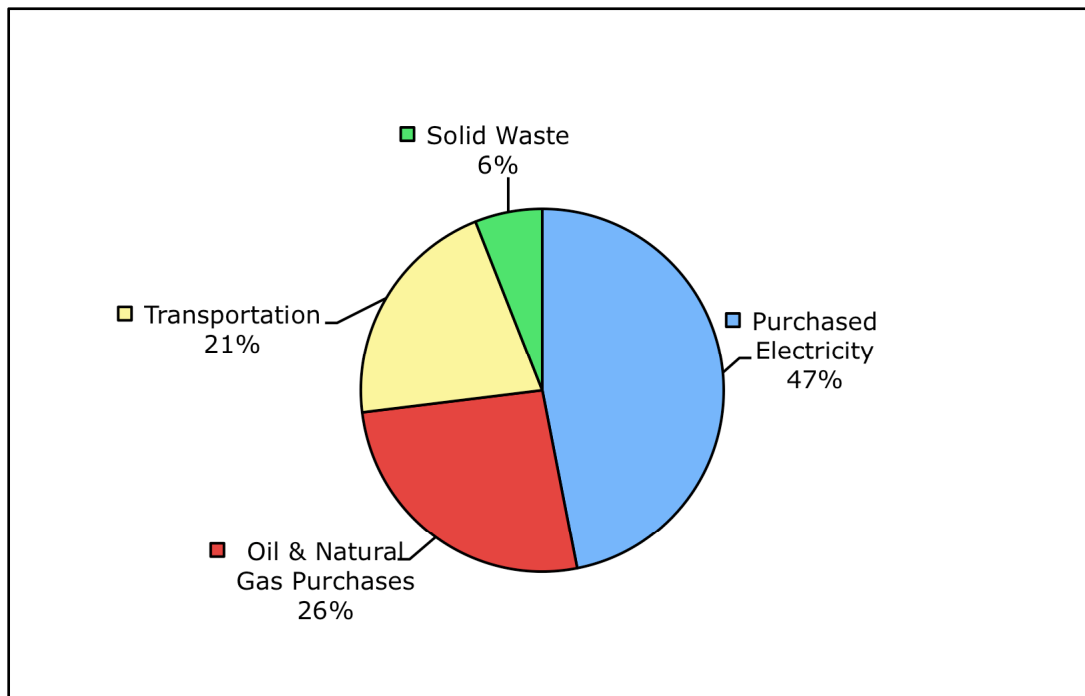


Figure 1: McDaniel College's 2007 climate baseline of 20,679 MT CO₂e

SUMMARY OF SUGGESTED STRATEGIES FOR CARBON NEUTRALITY

The strategies suggested in this report hold the promise of reducing the campus' carbon emissions by as much as 25 percent from 2007 by 2011, and can save the College approximately \$860,000 in operating costs per year. If every suggestion in this report were implemented in one year, it would cost about \$2.7 million and take a little over three years to pay back. Removing the most costly suggestions of installing solar panels and windmills on McDaniel College property would cut costs to about \$635,000 and reduce greenhouse gas emissions 17 percent from 2007 levels. We estimate that it would take just over one year to pay this amount back. Building on these projections, the following paragraphs provide a general overview of our strategy for achieving carbon neutrality across 3 linked phases.

Phase I: Our strategy aims to implement low-cost actions first, which will jumpstart carbon reductions and save the College significant operating costs. Savings realized by the initial actions will free up capital to invest in more costly future actions. According to our analysis, the most cost effective actions are those that decrease our electricity consumption and our waste production. Such actions save the College money for trash collection and electricity purchases immediately. Aspects of the College that warrant immediate investment include: (1) Information Technology; (2) recycling programs; (3) dining services; and (4) individual behaviors of community members (see Table 1).

A focused program to reduce electricity usage and waste production in the sectors mentioned above is estimated to cost approximately \$41,600 the first year, and is likely to save conservatively \$64,800 in the same year (assumes a 7 percent increase in recycling, 1 percent decrease in electricity usage from people turning off lights, reducing food waste by removing trays from the dining room, and starting to compost food waste from the dining hall). Net savings would total approximately \$58,000 to \$78,100 in subsequent years, depending on how much waste is removed with recycling as opposed to trash. Money saved from minimizing solid waste and electrical consumption should be reinvested in measures to further reduce our electric use. Installing motion-sensing switches and more energy-efficient lighting fixtures could reduce greenhouse gas production by as much as 15 percent, saving considerable money.

Phase II: Once the aforementioned conservation measures are in place, McDaniel College should pursue generating electricity from renewable sources. The amount of power generation capacity can be adjusted to the funds available for the project. The estimates employed in this report were calculated by student researchers, not experts in alternative energy engineering, and are thus designed to highlight the relative merits of different actions. According to our calculations, small-scale wind and solar energy produced on College property could be sold back to the power companies to generate a regular line of income, paying for the cost of installing the systems in approximately 7.7 years.

Category	Action	Carbon Reduction	% Carbon Reduction from 2007	Initial Costs	Annual Operation Costs	Annual Operation Savings	Annual Net Savings (costs)	Annual Savings (cost) per CO2	First Year Net Cost (gain) per CO2	Time To Recoup Initial Investment	Notes
		MT CO2e /yr		\$	\$/year	\$/year	\$/year	\$/MTCO2e	\$/MT CO2e	Years	
Info. Tech.	Various energy and resource saving measures	351	1.7%	\$27,840	\$2,000	\$36,152	\$34,152	\$98	\$80.2 to 78.2	1.2	Measures include: more online graduate teaching, video conferencing, computer power management, efficient hardware updates
Solar	Install 11,243 square meters of solar panels	1224	5.9%	\$6,850,000	-	\$230,852	\$230,852	\$189	\$5,408	29.7	Size of system can be large or small. This is a large example
Wind	Install 10 Wind Whisper Windmills	56	0.3%	\$70,950	-	\$9,180	\$9,180	\$164	\$1,103	7.7	Size of system can be large or small. Look into federal tax breaks
Recycling	Reduce trash by 21% (251 tons) by recycling more	248	1.2%	\$6,000	\$2,500	\$21,426	\$18,926	\$76	\$(52)	0.3	If 7% reduction can be sustained for 3 years, then we would have a 21% waste reduction
Behavioral Changes	Increase turning off lights in unused spaces	97	0.5%	-	\$2,000	\$15,982	\$13,982	\$144	\$(144)	0.0	Calculations are for a 1% decrease in electrical usage from 2007. Only \$ needed for PR campaign
Dining Services	Trayless dining & composting	62	0.3%	\$1,000	\$291	\$4,731	\$4,440	\$72	\$(55)	0.2	
Lightning	Total lighting	3153	15.2%	\$600,000	-	\$519,405	\$519,405	\$165	\$26	1.2	Estimated \$300k on new fixtures, and \$300k for motion sensor switches
Transport	Total transportation	638	3.1%	\$8,004	\$2,976	\$15,404	\$12,428	\$19	\$(7)	0.6	Replacing old vehicles on normal replacement schedule eliminates most start-up costs,
Carbon Sequestration	Plant 10 acres of trees at Singleton Farm	26	0.3%	-	-	-	-	-	-	-	Can spend money to offset all carbon if we want (would cost millions)
Total		5537	\$0	\$7,563,794	\$9,767	\$853,131	\$843,364	\$152	\$1,214	8.97	
Total Without Solar & Wind	4257	20.6%	\$642,844	\$9,767	\$613,099	\$603,332	\$142	\$9	1.07		

Table 1: Summary of suggested strategies for carbon reductions at McDaniel College

Phase III: Future emissions reductions should focus on the contributions from oil and natural gas purchases (primarily used for heating) and from transportation. Purchasing oil and natural gas is costly, so increasing efficiency in that sector will cut operating costs while reducing greenhouse gas emissions. Some colleges have found it efficient to generate electricity along with the steam used for heating, a process called cogeneration. Cogeneration reduces electricity costs, but requires major infrastructural changes and staff training. Other strategies may include increased usage of geothermal heating and cooling components, infrastructure retrofitting, and changing behavior on campus regarding energy use. The amount of carbon emission from the transportation sector must also be addressed in efforts to reduce McDaniel College's carbon footprint. A focus on reducing the amount of miles-driven and improving fuel efficiency of the campus fleet is a good starting point.

RECOMMENDATIONS AT A GLANCE

The following recommendations by the Green Terra Committee are intended for the McDaniel College Administrative Council, Board of Trustees, and all other members of the College community involved in campus sustainability. It is the expectation of the Committee that these recommendations will be used as a roadmap toward carbon neutrality. It is further hoped that interested students, staff, and faculty at similar academic institutions can find value in our work, and lean on our strategies for their own climate action plans.

ENHANCING CAMPUS PRODUCTIVITY THROUGH GREEN TECHNOLOGIES

- 1) Replace all aging equipment with energy-star compliant forms in the next five years.
- 2) Reduce energy costs in the data center by 30+ percent through server-virtualization.
- 3) Initiate an automated power management system compliance policy.
- 4) Install “thin client” computers throughout the campus.
- 5) Reduce commuter miles with online courses, videoconferencing, and “tele-working.”
- 6) Increase conversion from paper to digital communications.

ENERGY MANAGEMENT AND PHYSICAL PLANT

- 1) Upgrade energy management infrastructure on campus.
- 2) Continue preventative maintenance and equipment replacement.
- 3) Increase purchase and generation of sustainable energy.

EDUCATIONAL OUTREACH

- 1) Promote a reduction in our carbon footprint and a general greening of the campus.
- 2) Encourage student organizations to support sustainable initiatives.
- 3) Ask alumni and trustees to support a list of “green speakers” and contribute information toward a green job data bank.
- 4) Invite faculty to support green efforts through academic programs, lecture events, research, and grant opportunities.
- 5) Include the broader Westminster community to join efforts to green the campus.

CURRICULUM

- 1) Develop formal education opportunities.
- 2) Promote environmental research and internship opportunities.
- 3) Create campus-wide environmental education initiatives.

BEHAVIOR CHANGE WITHIN MCDANIEL COMMUNITY

- 1) Promote the need for reducing wasteful consumption of food, energy, and paper.
- 2) Educate McDaniel community of recycling guidelines and purchase more recycle bins.
- 3) Publicize any progress made in moving the College toward carbon neutrality.
- 4) Work with Admissions Office to relay sustainability initiatives to prospective students.

FOOD SERVICES

- 1) Implement tray-less dining full time.
- 2) Reduce use of disposables in all dining facilities.
- 3) Use bulk items instead of individual packaged portions whenever possible.
- 4) Purchase Energy Star, water savings, and utility savings equipment when available.
- 5) Compost appropriate food wastes.
- 6) Find an alternative for bottled water.

TRANSPORTATION

- 1) Reduce Vehicle Miles Traveled (VMT).
- 2) Switch to cleaner, more energy efficient vehicles and fuels.
- 3) Develop alternative transportation.
- 4) Reduce transportation needs.

CARBON SEQUESTRATION

- 1) Increase vegetative sequestration.
- 2) Fund reforestation projects.
- 3) Purchase Renewable Energy Certificates (REC).

ENHANCING CAMPUS PRODUCTIVITY THROUGH GREEN TECHNOLOGIES

Studies indicate that Information Technology (IT) data centers consume 3-5 percent of the energy used in the U.S., with projections of a doubling of energy requirements every 9-24 months. Much greater technology-related environmental costs are associated with campus printing, the use of computer labs, and technology-assistive equipment in offices and residence halls. Given the relatively short life span of technology items (3-6 years) and the high energy/resource costs associated with equipment creation, approaches to enhancing campus productivity through technology should result in both major reductions in carbon emissions and financial savings.

Through the use of 'back of the envelope' calculations, we have estimated that the implementation of the following six goals can reduce carbon equivalent emissions by 676 metric tons/year while reducing overall operating costs (see Table 2).

Goal 1: Reduce green house gasses through the purchase of energy efficient equipment

In the last few years, McDaniel College has gained real energy efficiencies through the purchase of one-piece Intel iMacs (60 watt; no additional monitor draw), Mac minis in smart boxes (30), and through the purchase of desktop Dell Optiplex desktop systems (44 watts w/o monitor). Additionally, we have replaced nearly 60% of the energy inefficient CRT computer monitors with LCD monitors that consume 2/3 less power. We propose replacing all aging equipment with energy-star compliant forms in the next five years.

Goal 2: Consolidation/virtualization of servers

We propose to reduce energy costs in the data center by 30+ percent through server-virtualization. Traditional servers that run a single application may only be actively processing 10-20 percent of the time. By virtualizing our servers, we may run several applications on a single unit, reducing total server numbers required by a factor of 2 to 4. This will decrease energy processing and reduce heat load and cooling requirements.

Goal 3: Power management of PCs

Power management technology was developed for personal computers (PCs) and monitors to reduce energy consumption when they are not in active use and to reduce production of waste heat. The U.S. Environmental Protection Agency (USEPA) estimates that upwards of 70 percent of all new PCs and nearly 100 percent of all PC monitors sold have power management capability. Although the capability is available, the actual use of such controls is not applied. Studies indicate that total PC power consumption can be cut by 50 percent when power management protocols are turned on. IT proposes to initiate an automated power management system compliance policy that remotely controls 24/7 power settings and supplying power strips to reduce power leakage.

Printing, Green Computing and Productivity					
Action	Reduction of CO2 equivalents (in metric tons/year)	Cost for implementation: define time line	Reduction cost (CO2 Metric ton reduction/\$/year	Costs of operation (\$/year)	Return on investment (\$ savings/year)
Switch from old computer monitors to LCD Monitors	17.5-26.5	\$12,000 in a 2 year period; \$6 K/year	\$340-514/MT but savings in electricity would cover costs in seven years	0	Would take 7.4 years to recoup
Virtualization servers	27.3 MT	\$0 as long as we stay with free version.		0	
Power strips	29.03 MT	\$3840	\$132/MT but cost recouped in 2 years due to electric savings	0	Recoup in two years
Power Management system* (software)	248.23 MT	\$0-6,000 for outlay but save \$2268/yr electric costs = \$3732	\$0-15/MT year dependent on version of power management used		After 2.6 years cost recouped; \$2,268.00 thereafter
Thin Client	8.9 MT	\$12,000 but these would replace desktops so no new costs	\$67/MT given used ½ reduction		Electric savings over 6-7 years would cover ½ cost of units
Online Courses*	273 MT	Immediately none-redirecting support; more bandwidth and training (?)	\$50/MT but savings due to rental reduction and new enrollments wipes out cost = \$0		Savings of \$12,000 as no longer require off campus rental + potential for new enrollments
Web videoconferencing	1- 50 MT	Hosting service \$15,000 but cost is subsumed into education cost			
Telecommuting	14-28 MT (5-10 people)	0	-	-	-
Paper management system	10 MT	\$2000/yr but savings over x 4-5 that amount in paper/toner costs	\$200/MT but save approximately \$10,000 per year in printing costs.		Save \$8,000/yr (includes cost of program)
Moving to paperless communications policy	6.46 MT	0	0	0	\$6000

Table 2: Printing, Green Computing and Productivity

Goal 4: Use of “thin clients”

A *thin client* is a lower-cost, centrally managed computer that contain no, or minimal software or hard drives; instead all the information is located on a server in the data center. As software is more commonly served from online services (SaaS) or through servers in the datacenter, it is expected that thin clients and blade PCs will replace desktop PCs in many educational environments. While thin clients may require investments in data center and network upgrades (servers to serve software and documents), the energy savings are 3-6 higher relative to the use of desktops (the clients themselves run on a few watts of energy), and the life cycle of the device is typically 6-8 years gaining a better extended ‘return on investment’ as there are no moving parts. We propose to install prototype installations throughout the campus and expand on thin client use after an analysis of user satisfaction.

Goal 5: Reduce green house gasses by cutting commuting miles

Online courses, web videoconferencing, and “tele-working” all enable users to significantly reduce travel mileage while increasing productivity. Such technologies can be used not only for class sessions, but also to reduce travel for advising, student-student collaboration for projects, and staff attendance at meetings. Below we have outlined a few applications of this strategy.

- McDaniel College’s graduate program has established a new online program directive and will be increasing online course offering by 25% or more in the coming five-year period, greatly reducing commuter miles. Five additional programs will join Gerontology in offering online or hybrid courses this coming fall semester.

- With the use of our new Wimba videoconferencing capabilities, we can offer the option of synchronous online meetings for classes, advising, student collaboration, conferences, and vendor meetings.

- Telecommuting as well as flexible work hours permit increased productivity. Increased use of web UI interfaces and secure VPN access to databases, along with the potential of VoIP services will enable staff to be deployed anywhere that can be reached by a broadband network. We are in the early phases of testing telecommuting options.

Goal 6: The increased conversion from paper to digital communications

In the Spring of 2008, all common labs and departmental labs that requested this option were outfitted with print management capabilities resulting in a near 50 percent reduction in paper printing waste. We will encourage the extended use of this system throughout campus along with the provision of duplex printing options. In order to accomplish this goal, the following steps are recommended:

- Encourage a campus culture that accepts the replacement of paper announcements and reports with digital counterparts, archived on campus intranets. This last year we

established new student and faculty/staff intranets as well as additional online options, and an increasing number of individuals are using these communication modes. We anticipate the replacement of all paper forms for service requests and documents with online equivalents within the next five years.

- Replace paper forms (time sheets, purchase orders, budget summaries), directories, and surveys with online options. We have started this process with use of the online Qualtrics Survey package and have been surprised with its rapid use for numerous tasks.
- Implement a resume or CV management system for interviewing new employees.
- Encourage faculty to accept and make it simple for students to turn in assignments electronically, and implement a faculty Tablet PC program so faculty can mark up assignments online.

ENERGY MANAGEMENT AND PHYSICAL PLANT

After evaluating the results of McDaniel College's carbon footprint study, the purchase of electricity and the use of fossil fuels for heating and hot water promise to have the greatest impact on McDaniel's carbon dioxide generation. In 2007, these two categories produced 15,078 metric tons of carbon dioxide accounting for 73% of the College's total.

All aspects of McDaniel's infrastructure rely on electricity as a primary source of energy. From heating, cooling, lighting, computers, and personal electronic devices to geothermal heat pumps, every system within the College's physical plant relies on this one energy source. The use of natural gas to power the College's steam plant is the primary component of our use of fossil fuels. Steam provides the College with a relatively inexpensive and flexible source to supply buildings with heat and hot water. A successful strategy to contain greenhouse gas production based on energy use must include three major approaches. First, a strongly supported energy management component directed to reduce energy consumed by the colleges HVAC and steam supply system. Second, preventative maintenance and equipment replacement policies need to be enhanced to better consider ramifications upon energy use. Lastly, the strategy must incorporate a means of accessing or generating sustainable electricity supplies.

Goal 1: Upgrade energy management infrastructure on campus

McDaniel currently has several computer-based HVAC control and management systems. These systems allow remote access and control for temperature, airflow, and scheduling for the majority of campus buildings. Using these systems has allowed the College to reduce energy consumption, however, there are improvements and enhancements to the current systems that will allow increased energy conservation.

The College utilizes two primary control system providers, and through these two providers, there are several different control systems that allow energy management capabilities to the majority of campus buildings. By integrating these systems, the College can maintain uniform management and better monitor variations within the HVAC infrastructure. Buildings not under central control through a computer based energy management system will be added to the integrated system as deemed practical.

Recently, McDaniel implemented several practices within the HVAC energy management system that will reduce energy use. Campus-wide set point minimums and maximums, scheduling based upon occupancy, and cycling of steam use are some of these practices. Utilizing an integrated control and management system campus wide in applying such practices will further reduce the College's carbon footprint.

Goal 2: Continue preventative maintenance and equipment replacement

Preventative maintenance of equipment is a continuous process on campus. We utilize several outside vendors to help maintain equipment ranging from elevators to our commercial grade clothing washers. However, through a program administered by the Building Maintenance Department, the Physical Plant maintains most equipment at McDaniel College. A systematic evaluation of equipment is being implemented to provide data that will be used to adjust frequencies in maintenance tasks and types of products used in order to maximize efficiency.

Over the past several years, cost-effective technologies such as automated energy controls and high efficiency lighting have been implemented, successfully reducing the campus' use of electricity, and thus the College's carbon footprint. Likewise, the use of ice storage cooling systems and geothermal heat pumps have dramatically improved the electrical efficiency by which we heat and cool several locations on campus. The College will continue along this path by considering the ramifications of energy use as it replaces outdated systems and equipment. Utilizing LED technology, motion detectors for common area lighting, and purchasing Energy Star products are specific examples.

Goal 3: Increase purchase and generation of sustainable energy

Sustainable energy is available to McDaniel College through two means: purchase or generation. The current electrical grid supplying the campus derives its electricity primarily through the burning of coal or natural gas. Sustainable methods such as nuclear, wind, and solar represent a small portion of the current grid. The basis for the electrical use portion of the campus' carbon footprint includes the make up of sources for the current grid. As the supply sources in the grid change with the increase of sustainable methods, the College's carbon footprint will be reduced. The College should also explore options for the purchase of electricity produced by sustainable methods.

McDaniel College should consider investing in two types of sustainable energy sources – solar and wind power. While both methods directly produce electricity, the College will not use the energy it generates at all times. Given the campus electrical grid *must* have a continuous reliable supply of electricity, we should continue to purchase electricity through vendors. The electricity the College generates by solar and wind would instead be sold to the regional electrical grid. This exchange can contribute as a major offset to the College's carbon footprint, bringing us closer to carbon neutrality. The estimated value of this offset will be equivalent to the electricity these systems produce. Goals for carbon dioxide reduction can be set based on the capital available to invest in each technology and the infrastructure (including physical space) required by each method. The following are two currently available options and the resulting potential impacts.

a. Solar option for McDaniel College

When evaluating the potential for a large-scale photovoltaic panel system installation, a few key preliminary factors must be included in the analysis. Location will single-

handedly determine the success of a photovoltaic panel system. Panels should be installed on south-facing slopes to achieve maximum efficiency. The integrity and character of the building should also be considered. Photovoltaic systems are long-term investments, so they should be located on top of buildings with the appropriate supportive infrastructure. Highly trafficked buildings also provide an opportunity to advertise the system and the College's commitment to sustainability.

Available surface area will determine the maximum photovoltaic generation capacity. Maximum production can be determined by multiplying the available surface area by the average kW output per square foot of a photovoltaic panel. At this time, the *average* kW output per square foot of photovoltaic panel is 10 watts for a flat panel. For the following calculations, an actual solar panel example was used that produces 13 watts per square foot*. The total kWh output can be determined based on the physical size of the system.

Another necessary factor to consider is grid connection. Photovoltaic panel systems can either be independent from or connected to the utility grid. If independent from the grid, the system must connect to a battery to store excess generated electricity. Grid-independent systems tend to cost 20-30% more to account for electricity storage requirements. Grid-tied systems use the utility grid as the battery. When excess electricity is produced, the grid takes up the electricity. The grid-supplied electricity will act as credit that the utility company deducts from future bills by a process called net metering. McDaniel utilizes a number of utility grids, so ease of grid-connection should be a factor.

Once the details of a system are determined, cost and electrical output can then be calculated. An investigation into regional retailers of solar panels indicates a lowest price of \$200 per square meter, including installation. A grid-tied system will be less expensive than a grid-independent system and is likely a better choice for McDaniel. Costs reported herein should be considered rough estimates, with formal estimates supplied by the company installing the system.

The output of a system depends on the solar radiance of its location and the efficiency of the system. The Westminster area gets, on average, 5.3kWh per square meter per day. Inefficiency factors vary based on the system, but most systems are between 80-88%. Therefore, to determine the electrical output of a photovoltaic panel system in Westminster, the system size (kW) is multiplied by the solar radiance and an 85% inefficiency factor.

The Decker and Gill buildings on campus are suggested sites for large-scale photovoltaic panel system installation. Although not south-facing, both buildings offer large surface area. Solar installers may find other optimal installation locations based on other parameters, thus a detailed profile of all McDaniel buildings as possible locations is recommended.

Solar panels are estimated to produce 174.6 kWh per square meter each year. At our current utility rate, the solar panels would then generate \$16.16 in energy credits per square meter per year. Without considering federal grant incentives or utility rate

increases, the College would receive 1.6 cents per dollar invested each year. When considering federal grants and utility rate increases, we can expect 3.4 cents for every dollar invested.

For each dollar spent in the first year (not including federal grants or utility rate increases), we will reduce .000096 metric tons of CO₂e. For each dollar spent including federal grants and utility rate increases, we will reduce .00015 metric tons of CO₂e. To reduce 10% of our current electricity usage (1775742 of 17757420 kWh) and carbon generation from that electricity (970 of 9701 metric tons) it would thus require:

- 10,104 square meters of surface area
- \$2,020,800 depending on federal grant incentives and utility inflation
- The annual operational savings would amount to \$263,874
- In 7.7 years, the investment would be completely paid off

b. Wind energy at McDaniel College

Renewable energy in the form of wind is an excellent model that can reduce the College's carbon footprint while sending a message that McDaniel is becoming greener. There are several different directions McDaniel can take in pursuing wind energy. Below are two methods – micro wind turbines and utility grade turbines.

(1) Micro wind turbines

McDaniel can approach wind power on a small scale with micro wind turbines. Micro wind turbines are less expensive than their utility grade counterparts, however, they are also less efficient in terms of kWh produced/year and the tons of carbon offset/year. With a utility grade turbine being a huge investment, it may be advantageous to start with a micro wind turbine system and move on to a larger system later.

After extensive research, two micro wind turbine systems were chosen to conduct a cost benefit analysis based on energy efficiency, cost, and design. The first is a 12 kW system using ten 1,000-watt turbines by AeroVironment (AV) called the AVX 1000.

This particular system has several advantages, given it can be integrated into new or existing buildings and be placed on the parapets of the buildings, rather than on a roof. According to AV, when wind hits the side of the building, it travels upwards and the wind speed increases. Towards the roofline of a rectangular flat-roofed building, there are regions on the windward edges where the wind is sheltered and increases in turbulence and acceleration. With the turbine system located on the parapet, it takes advantage of this increased wind speed and can result in an increase of power production by 30 to 40%. Other advantages of the system are that it is quiet and structurally enhances the building while providing a great visual aid towards our efforts. The system can be also purchased with a canopy, which provides more avian safety.

The second micro turbine option is the Southwest Windpower Whisper 500. This turbine is quiet; hence the name, and can perform well in high wind speed environments. It consists of two rotor blades (15 feet in diameter) with a fiberglass reinforced design and patented side furling over-speed protection to give maximum output at any wind speed. In the calculations provided below, we use an analogous model (Southwest Skystream 3.7 (1.8 kW)).

Comparison of two units:

The MD Online wind site (MEA) calculates financial and emissions offsets for specific addresses, specific turbine models, and seven other variables. We have employed the MEA for this comparison. The campus is located within an area classified as Wind Class 2 (marginal), so placement of units is especially critical. Calculations for wind speed are equal to 11.89 mph (average speed for this location) and for 15 mph (if units are placed strategically; i.e. located on the parapet to take advantage of increased wind speed or exposed, hilly spots near the golf course).

Optimal calculation for 15 mph wind speed: Estimates indicate a simple payback between 16 and 21 years, a simple lifetime cost savings between \$1452 and \$5049, and actual cost of units after federal rebates between \$7,664 and \$9,038 per unit. We anticipate that for these systems to have an impact, we would need 10 units. With 10 units, we can produce between 42,270 – 61,850 kWh of energy and between 22 – 33.5 tons of CO₂e/year.

Calculation for average 11.89 mph wind speed (non-optimal conditions for the location): Simple payback is the length of time in years that it will take for the wind turbine to offset its cost through utility savings. If the wind turbine cannot offset its cost during its lifetime, then there is no payback. Estimates indicate it would take between 40-60 years for payback (with a lifetime use of 30 years), thus this scenario is not fiscally feasible.

(2) Utility grade turbine

If McDaniel wishes to pursue wind energy at a larger scale, then we should look to Carleton College as a model. The capital cost of a larger scale wind turbine is \$1.8 million, which includes the turbine, property, land lease, interconnection equipment, transmission lines to the DG, business interruption insurance, taxes, wind developer costs, and maintenance. The turbine would create 5,000,000 kWh/year. If McDaniel purchased a 1.65 MW wind turbine, this would offset 2,731 tons a year, or 13% of our carbon emissions. An example of such a system has been implemented at Carleton College, which stated their turbine offsets 4,318.1 tons of carbon dioxide/year, 1,665.8 tons of carbon monoxide/year, and 1.5 million tons of carbon dioxide within its lifetime.

EDUCATIONAL OUTREACH

Educational outreach to promote a reduction in our carbon footprint and a general greening of the campus will be multi-dimensional and vary according to the stakeholders of the college: students, alumni, faculty & staff, administrators, and the wider Westminster community.

Potential students will be able to access clearly stated and prominently displayed policies, activities, and academic programs concerned with the aforementioned goals through college websites, brochures, tour guides, and counselors. Freshmen will have an opportunity to pledge their support for a green campus when they enter the McDaniel community and will be invited during their first month to attend workshops, student activities, and clubs and be given a list of academic courses and programs dealing with environmental issues. The general student population will be encouraged to support a sustainable campus in all student clubs and leadership programs, information and activity sessions (e.g. facebook, google read), academic courses, garden projects, film nights, lectures, reading circles, exhibitions, creative projects, etc.

Alumni and trustees will be asked to support a list of “green” speakers and to provide information/connections for a job data bank, accessible to every McDaniel student, on possible/actual jobs in green economies. In return, both alumni and trustees will be informed of green initiatives and programs via college websites, student newspaper, and quarterly college magazine.

Faculty will be invited to support these efforts through academic programs, lecture events, research, and grant opportunities. They will also lend their expertise to survey the wider campus community with regards to institutional strengths and weaknesses in the implementation and future design of sustainable practices, level of stakeholder interests, and commitments.

The wider Westminster community will be invited to join our efforts to green the campus through attending campus events and by providing opportunities for internships, collaborations, K-12 outreach, fundraising, etc.

CURRICULUM

Two objectives of the McDaniel College Campus Strategic Plan (2009-2014; Objectives 2.3.4, 5) indicate that the plan should support and:

- Foster political, social, and *environmental* engagement across the campus and in the Westminster community.
- And raise campus awareness and support of *environmental and ecological concerns* that impact all global communities.

In the spirit of supporting both initiatives, the Green Terra Committee proposes the following series of educational programs. Environmental education can take place formally in classes, or informally through collaborative research and campus-wide ‘green’ activities.

Goal 1: Develop formal educational opportunities

The Environmental Policy and Science (EPS) program, established just over five years ago, was developed to reinforce both scientific inquiry and policy analysis. The mission of this young, expanding program is twofold. The primary emphasis of its faculty is to train the next generation of professional environmental scientists, conservationists, and environmental policy makers, through the comparative study of the complex and interdependent nature of natural and human systems, and by the requirement of hands-on experiences that foster the development of laboratory and field skills and enhance cultural sensitivities of its students both here and abroad. The second goal of this dedicated team is to educate all members of our campus community, so that they may better support the needs of all life on Earth through lifelong choices predicated by a true appreciation of environmental functions.

Currently the two full-time faculty members offer courses to both majors and non-major students. Due to the increasing number of majors, and additional FYS, SIS and WID requirements, their ability to offer non-major courses is diminishing just as demand is increasing. We recommend that the program be allocated additional faculty (FT or adjuncts) so the program can continue to educate non-majors.

Goal 2: Promote environmental research and internship opportunities

Environmental research and internship opportunities provide *all* students with to the opportunity to specifically help protect human health and safeguard the local and global environment. Currently, there is no designated physical space where students (majors/non-majors) can work as a team or individually to support research directed to either of these causes. We thus suggest the following actions:

- A physical laboratory space should be found for the EPS program to support environmentally directed research and internships, and resources be allocated for studies located off campus (for both majors and non-majors). Currently the EPS program has no such physical space, making research opportunities quite difficult.
- Currently there are no dedicated vehicles for student or faculty involved in field research. Given field work often requires transport out of state, and for longer periods of time, current restrictions on campus-owned vehicles prohibits their use for this purpose. Thus we recommend that one or more such vehicles be provided for those students and faculty involved in environmental research and internship programs.

Goal 3: Create campus-wide environmental education initiatives (informal learning opportunities)

Informal learning opportunities provide students with the opportunity not only to learn about the environment, but to take part in collaborative efforts to contribute to campus and global sustainability. In the last two years members of the Green Terra Committee and students in both the EPS program and Environmental Action Club (EAC) have volunteered their time to help coordinate the following two programs:

Recyclemania: This is the second year our campus participated in the USEPA sponsored *Recyclemania* College Competition. EPS & ECA students along with Green Terra members set up and monitored recycling receptacles, completed a door-to-door education program in the dorms, conducted a weekly *Raffelmania* contest, set out promotional materials, sponsored bi-weekly campus events and set up a website (<http://www2.mcdaniel.edu/recyclemania/index.html>). The impact was immediate, and given the short notice for participation, the campus did well.

Earth Day: The EPS Honors Society organized its first campus-wide educational Earth Day Celebration in 2008.

There is no set funding for either of these events. Green Terra would like to recommend that funding be set aside for events that support informal environmental initiatives, similar to that provided for other entertainment events. In addition to the continuation of these events, Green Terra suggests the implementation of one or more of the following initiatives:

- a. Orientation program: The inclusion of sustainability into the New Student Orientation Program. A number of the events discussed in this chapter can easily be included as part of the FYS program. By reinforcing the environmental benefits of each initiative, all new students can learn that environmental stewardship is part of the culture of the campus.
- b. Campus green garden: Explore the possibility of a campus garden space; benefits may include food production for dining students, composting of waste, and creating a space to practice hands-on permaculture and gardening for students and staff.

One such example is Gettysburg College campus garden. By having the garden on campus, students study environmental topics hands-on, such as ecology, sustainable agriculture, food systems and nutrition. Labs for the environmental studies classes can also be conducted at the garden. Produce goes to underprivileged local residents, and students have started a compost program with the cafeteria. Students also provide community outreach programs through gardening workshops.

We suggest the provision of one or more spaces on campus for students/staff/faculty to grow early spring/early fall crops for students and summer gardens for faculty/staff. Also required are seeds and cultivating equipment.

c. Faculty-led initiatives:

- Participate in the *National Teach-In on Global Warming Solutions*. This program is an opportunity to highlight the progress of our campus towards meeting the obligations of the President's Climate Commitment and to engage the broader community in a discussion of goals and solutions. Each year close to 500 colleges, universities, and other institutions have participated in this program sponsored by AASHE. Thus, we recommend that the College support a campus membership in AASHE.

- Support faculty participation in AASHE's *Sustainability Across the Curriculum Leadership Workshop*. We cannot continue to depend on the two EPS faculty members to sustain the majority of environmental education efforts on campus.

- Support Jan Term or informal courses that relate to environmental sustainability with the option to have these courses taught by faculty or professional non-faculty with a significant environmental background (i.e. environmental architects/builders, permaculturists, energy specialists).

d. Green communications:

- Weekly “Green” email to students, faculty, and staff offering tips and solutions for environmental concerns and an environmentally –oriented web site with interactive features (blog, wiki, surveys).

- House a Green library on campus – a special section in our McDaniel College library that students can be referred to throughout the educational programming series.

e. General environmental education:

- Have all students, faculty, and staff calculate their carbon footprints. This could be done in classes or as a program. Again, offering solutions for them to lower their impact.

- Purchasing Green – a poster, pamphlet, lecture, or presentation on how to buy “green,” such as Viva Terra furniture, Method cleaning and soap products, and Simple Shoes.
- Clean Green Day – this is a great project for spring! We could have all of the ingredients necessary to make your own eco-friendly cleaning products.
- Supporting student reuse/recycle programs- EBay Your Garbage – If you need to purchase something, why not check EBay first to see if someone else needs to get rid of something. You could find a bargain and avoid buying something new (which leads to more manufacturing). *Freecycle* is another option, as well as end of the year collection system to donate usable items to Goodwill or other non-profit charities.

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## BEHAVIOR CHANGE WITHIN MCDANIEL COMMUNITY

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Positive behavior, defined as behavior that helps the College meet the ACUPCC, must be rewarded and *negative behavior*, defined as actions that prevent the College from meeting the commitment, should be discouraged. Environmentally responsible purchases, technology, and capital projects do much to decrease carbon emissions, but the engagement of students, faculty, and staff is what will sustain the institution’s carbon neutrality. This engagement is necessary from the top down: the College President, departmental deans and directors, faculty, staff, and students must all be equally invested in order for McDaniel to reach its goal.

The Administrative Council, in conjunction with the Green Terra Committee and Environmental Action Club, will be the driving force behind insuring that community behavior is consistently environmentally conscious. The first major behavior shift would promote the need for reducing wasteful consumption of food, energy, and paper. The second would be to make sure the community understands recycling guidelines and opts to recycle any waste that meets those guidelines. Last, but most important, is to publicize any progress made in order to show the community that their actions are making a difference in moving the College toward carbon neutrality (see Table 3).

The College’s participation in *Recyclemania* creates a culture where it is the social norm to recycle. With a healthy dose of competition, and a lot of signs around campus, students are realizing what they throw away does matter, and what we recycle matters even more. Creating competition between residence halls and academic departments not only decreases the amount of waste and increases recycling habits, but it also creates a campus culture that is aware of their consumption and trash and rewards behavior that moves the College toward carbon neutrality.

Recycling					
Action	Reduction of CO2 equivalents (in metric tons/year)	Cost for implementation: define time line	Reduction cost (CO2 Metric ton reduction/\$/year)	Costs of operation (\$/year)	Return on investment (\$ savings/year)
Increase Recycling efforts on campus to decrease waste production	Hoping to reduce waste 7% in 2009 (decrease of 74 tons)	50 bins at \$55 per bin (\$2,750) for updated recycling receptacles. \$2,700 for programming initiatives	73	\$2,700 for programming initiatives	Approximately \$2,500 (\$2,524) in year one, \$5,200 for each year thereafter.

Table 3: Recycling

Energy efficient programs that have been instituted, such as geothermal energy, automated lights within academic buildings, and automated thermostats, also serve as a positive motivator. As the college moves toward building and renovation projects, environmentally friendly practices will be publicized on the college intranet, Internet, and social media pages. With the understanding that the institution is committed to decreasing its emissions from the top down, and those who help its mission are positively rewarded, we will sustain a community who consider it a mission to reduce, reuse, and recycle.

FOOD SERVICES

A large expenditure of time, money, and energy routinely goes into food preparation for the campus community. This area of campus operations consumes a significant portion of resources and generates large volumes of waste material, making it an excellent candidate for the adoption of focused and appropriate sustainable practices. The following goals outline a plan to minimize the environmental and social impacts of their operations while continuously providing a variety of nutritious and sustainable grown foods. McDaniel College Food Services has already taken a number of steps toward the attainment of this goal, including:

- Food is cooked to order and batch cooked to reduce food leftovers.
- Going tray-less one day a week results an average 350# savings in food waste.
- Eco-Mug Program: A reusable mug is available for purchase at \$3.00 per mug. Future beverage purchases receive a 25-cent discount when using the mug.
- Purchased a new dish washing machine that uses 30 percent less water.
- Replaced two freezer and four cooler units with more energy efficient units.
- Fair trade, organic coffee is sold at the Budapest Café.
- Use environmental friendly chemicals whenever possible.
- Purchase produce cleaned and ready for use, saving water and reducing food waste.
- Recycling used fryer oil with an outside vendor at no cost to the College.
- Using bulk products when possible to avoid waste of individually packaged portions.

In order to reduce the annual production of CO₂e, a concerted effort must be made to significantly cut our food waste in dining areas. This portion of the plan is divided into five sections based upon priority. The following items are recommended:

Goal 1: Implement tray-less dining full time

McDaniel College implemented tray-less dining one day a week (saving an average of 350 pounds less food waste). The reduction in pounds of waste hauled as a result of tray-less days results in two benefits. First, given there is less waste going to the waste center, there is less CO₂e gas being emitted in the landfill. The current waste savings results in a reduction of 47MT of CO₂e. Additionally, there are monetary savings gained by a reduction of pounds of waste hauled each week that results in an annual savings of \$4,731. This figure does not include savings in the reduction of water and energy for cleaning, and hopefully over time, a reduction in predictable food consumption that will permit less food to be cooked needlessly.

Goal 2: Reduce use of disposables in all dining facilities

We will investigate the possibility of moving to all dish and glassware in the Englar Dining Hall, excluding whenever possible use of disposables. We should investigate the purchase of compostable flatware and plates for the Decker Center Grill and Gill Center

Sandellas. Given the higher costs of compostable alternatives, we are researching the possibility of using ceramic plates and bowls in the Grille for those who eat in.

Goal 3: Use bulk items instead of individual packaged portions when ever possible

Currently all condiments are purchased in bulk except peanut butter. This is due to allergy and cross contamination issues.

Goal 4: Purchase Energy Star, water savings, and utility savings equipment

Replace the remaining two coolers and two freezers in the dining kitchen.

Goal 5: Compost appropriate food wastes

The motivation for composting includes: financial savings on waste hauling services; no longer a need to purchase fertilizer for plant beds; and the reduction of greenhouse gas emissions that would have been produced had everything gone to the landfill. Applying the USEPA Waste Reduction Model, this translates into an approximate 15-ton reduction of greenhouse gases (CO₂e).

Goal 6: Find an alternative for bottled water

Dining Services should investigate the possibility of eliminating the use of bottled water for functions and use pitchers of ice water with glasses instead.

TRANSPORTATION

Transportation is a major factor in the amount of carbon dioxide that McDaniel College emits every year. Last year, the College emitted an estimated total of 4,322 metric tons of carbon (MTC) from transportation alone, making it the third largest contributor on campus at 17 percent. The Committee estimates that from the College fleet and commuting, 341,296 gallons of gasoline and 3,206 gallons of diesel were used during the year. The College fleet consists of 28 on-road vehicles and the Physical Plant oversees the operation and maintenance of only 18 of these. This academic year, the total number of registered vehicles of undergraduate students is 756. This includes those that keep their cars on campus and those that commute to McDaniel. The total number of graduate students registered for classes in the fall of 2009 is 2,124, however, only 896 cars are registered to park. Faculty and staff also contribute to the commuters on campus.

The following 4 goals are designed to reduce the contribution of transportation to McDaniel's carbon footprint.

Goal 1: Reduce Vehicle Miles Traveled (VMT)

Reducing the number of vehicle miles traveled is an objective that will directly influence the College's goal to become carbon neutral. This includes several policies and programs that will implement specific regulations in order to create incentives for reducing the number of vehicles on the road. We have outlined below 3 such opportunities.

a. Increase parking permit fees

One strategy for reducing the number of cars on campus would be to increase the cost of parking permits given out to McDaniel students. The proposed amount change would charge freshmen and sophomore undergraduate students \$200 and junior and senior undergraduate students \$150. Graduate students would pay \$50, which is double the cost for current graduate students.

If we assume that there would be a 10 percent reduction in the current 756 registered vehicles belonging to undergraduates, and in the current 896 registered vehicles belonging to graduate students, this would bring the registered number of vehicles from 1,652 down to 1,486 vehicles. This would also reduce the number of miles driven and number of gallons of gasoline used by students, but would not likely reduce the number of commuter miles (which is what we count in our carbon budget) because students who live off campus still must commute.

b. Promote the "Share-A-Ride" Board

A popular incentive seen on many college campuses is a system that promotes carpooling and ridesharing among the students who live on campus. Carpooling is a great way to not

only reduce carbon emissions, but creates a sense of community among the student body. We propose purchasing a large, very visible “Share-A-Ride” poster and securing it in a location that is prominent and obvious to students, staff, and faculty. Students (undergraduate and graduate) drove a total of 4,756,460 miles in 2007. If the Share-A-Ride board could increase student carpooling from 13 percent of commuters to 25 percent of commuters, the total number of miles traveled would reduce by 15,539 miles. This would then reduce the amount of carbon emissions by 134 MT CO₂e.

c. Bike Patrol by Campus Safety

Campus Safety currently has three bikes that can be used for patrolling the campus. The suggested strategy is to create a policy that would require all officers to use bikes to patrol campus when weather is appropriate for such activities. We assume the amount of time spent on bikes is approximately equal to 7 months a year, 4 weeks per month, 4 days a week on average due to weather, 2 hrs. per day reduced driving, and 10 miles per hr. of reduced driving. That would save 1,400 miles of driving a year. The campus vehicles get an average 22 mpg. That would save the College from buying 63 gallons of gasoline. At \$2/gallon, that would save the College \$126 and reduce carbon emissions by 1 MT CO₂e.

Goal 2: Switch to cleaner, more energy efficient vehicles and fuels

This strategy focuses on having McDaniel College purchase energy and fuel-efficient vehicles that emit no carbon or a considerably less amount during their operation. The College has a fleet of vehicles that are used for various tasks for maintenance, grounds work, post office deliveries, and food services. The vehicles will eventually need to be replaced, and so it will be beneficial if cleaner vehicles are purchased. The following strategies will help achieve this goal.

a. Purchasing electric utility vehicles for grounds maintenance

The College owns 12 utility vehicles (5 John Deere traditional gator series and 3 Toro workman, and 4 golf carts) that are used by maintenance and the grounds crew for transporting equipment around campus. John Deere sells the traditional series at varying prices starting at \$6,569 to \$10,919. The same vehicle is also sold in an electric model for \$8,929. Instead of purchasing fuel to power these vehicles, energy would be needed to charge the batteries. Fully charged, the vehicle could run for 12 hours (requiring 12 hours to recharge) and at the current estimated cost of a kWh (13 cents), the total comes out to approximately \$1.56/charge.

b. Replacing older college fleet vehicles with fuel efficient vehicles

There are currently 28 on-road vehicles that McDaniel College owns. All of the vehicles run on unleaded gasoline, although there is ground equipment that operates on diesel. While it is not realistic to replace the entire college fleet, it is realistic to consider replacing the vehicles that have exceeded 100,000 miles and those that are either very old models or those that haven't been used in a number of years. There are six vehicles that

are over 100,000 miles and are from the 1980's and 1990's. Two vehicles have not been used regularly since 2007 and could possibly be replaced. We propose the purchase of energy and fuel-efficient vehicles to replace the eight vehicles that are old and not in use.

Last year, McDaniel purchased 13,325 gallons of gasoline. Assuming that the gasoline was for the 28 McDaniel vehicles alone, and that each vehicle got an equal amount, then every vehicle would get about 476 gallons of gasoline per year. Without the actual amount of mpg/vehicle known, it is assumed that each vehicle currently receives 15 mpg. A newer model of any of the pick-up trucks (those that receive 20-mpg) could do the following: driving the same amount of miles as previous years would save the purchase of 119 gallons of gas per vehicle. At an estimated \$2/gallon, that would save the college \$238/replaced vehicle each year. Most importantly, it would reduce the carbon output by 1,037 kgCO₂ for each vehicle replaced. If the six pick-up trucks mentioned above were replaced, that would equal a total reduction of 6,226 kgCO₂ (over six metric tons).

c. Burn bio-diesel in fleet diesel vehicles

A mixing facility could turn waste oil from the campus dining halls into biodiesel that could be used in standard diesel vehicles. The campus currently produces 200-300 gallons of waste oil per month, which would make the same amount of biodiesel. This development will have the capacity to produce 200-300 gallons/month of biofuel, translating to 2400-3600 gallons/year. This could replace the approximately 3200 gallons of diesel purchased for fleet vehicles in 2007 and could reduce our greenhouse gas emissions by 32 MT CO₂e.

Goal 3: Develop alternative transportation

Public transportation can reduce carbon emissions by keeping more vehicles off the road. However, availability is a major problem. McDaniel College does provide alternative options on the weekends and around break time with a shuttle service that offers students rides to local stores and to the airport and train stations before and after major holiday breaks. Another option that has recently made its way onto campus is a shuttle service offered by Carroll County known as CATS. With the new stop located on campus, students may now have more opportunity to travel to local destinations. By promoting these alternative means of transportation, the McDaniel College community has the potential of benefiting from removing vehicles from the road, which would then directly influence the reduction of carbon emissions. This could be accomplished in two ways:

a. Improvement of McDaniel College's pre-existing shuttle services

This strategy suggests expanding the times offered to students who travel home for breaks and to increase publicity of the free services offered on Saturdays. By offering students the option of getting to places off campus easily, it may give students more of an incentive to leave their cars at home and to use the shuttle as an alternative way to travel. We recommend an extra trip to the airport and train station for earlier departures. Another idea to consider is improving the advertisement of the shuttle services so that students are

aware of their options. Combining the efforts of McDaniel's shuttle service and CATS, it is assumed that there would potentially be a 5 percent reduction in carbon emissions. Therefore, 750 metric tons of carbon equivalents would be reduced.

b. Promote the Carroll Area Transit System (CATS)

Promoting CATS should begin as soon as possible. Along with McDaniel's shuttle services, there hopes to be a combined total of 1 percent reduction, which would total to about 150 metric tons of carbon equivalents.

Goal 4: Reduce transportation needs

For many of the students who live on campus, transportation is necessary to leave campus. One way to prevent extra trips is to reduce the need for transportation and to encourage alternative ways of travel. In order to reduce the campus community's general need for transportation; the College should take some steps in offering its students, faculty, and staff options to make it as easy as possible. The following ideas encourage the use of bicycles and ideas for encouraging students to not commute long distances.

a. Bike Racks: We propose the installation of more bicycle racks and possibly replacement of the four that the College currently has. This would send a positive message about using bicycles to the campus community and could possibly encourage the increase of cycling. The proposed locations to install new racks are by Blanche Hall, between Lewis and Eaton Halls, by the new Academic Building, by DMC, by the Gill Gym, by Garden Apartments, by Decker Center, and another in North Village. This would result in a 1 percent reduction of emissions, or 150 metric tons reduced

b. Local Job Fair: McDaniel College could host a job fair with local employers to represent their business and hand out applications. The main focus would be from retail or restaurants within a 10-minute driving distance from McDaniel to try and encourage students to drive as little as possible. The magnitude of potential green house gas reduction equals 1 percent of emissions, or 150 metric tons.

c. Future Considerations: Several future considerations would add to the campus' carbon savings. First, the College should encourage faculty/staff/students to drive fuel-efficient vehicles. This could be accomplished by providing special parking spaces closest to campus for those who drive fuel-efficient vehicles. Second, provide day care on campus for faculty and staff parents. Those who work at McDaniel may need to bring their children to a daycare center during the day. If there were a place on campus that could provide some form of child services, then their parents wouldn't need to make an extra trip in their car. Third, convert to fuel-efficient landscaping. Electric-powered lawn equipment and self-heating pathways would greatly reduce emissions. Fourth, there could be more incentives for carpooling, such as reduced parking fees.

CARBON SEQUESTRATION

This section will focus on carbon mitigation strategies through vegetative sequestration on and off campus, and investment opportunities in Renewable Energy Credits. Sequestration is a viable option for greenhouse gas reduction as a result of photosynthesis and microbial growth. Vegetation and soil microbes sequester carbon dioxide in the form of new tissues, providing a continual, maintenance free option for storing carbon emissions. Practices that increase sequestration also enhance the quality of the soil, water, air, and wildlife habitat. An additional method for reducing carbon outputs called Renewable Energy Credits (REC), are also considered. Purchasing RECs offers McDaniel College an opportunity to become involved in energy trading schemes that put a more personalized price tag on carbon-offset regimes.

Google Earth was used to geographically survey the campus and establish an estimate for the amount of vegetation. Equations that translate vegetation mass into CO₂ equivalents were used to estimate total sequestration potential for the campus.

Baseline data for carbon sequestration on campus

The campus has ample vegetation, which appears to cover roughly 0.11415 square miles, or 29.56 hectares, of vegetation. According to a recent USDA Forest Service studies for Maryland, urban forests in our area (Baltimore) store 37.1/metric tons of carbon per hectare and sequester 1.2 metric tons/ha/yr. (http://www.fs.fed.us/ne/syracuse/Data/State/data_MD.htm).

Based on this conversion, our current 'forest' sequesters 35.5 MT/CO₂e per year, or approximately 0.17% of its 20,679 MT CO₂e emissions through the use of woody vegetation. However, this number may likely be an underestimate, given that the campus houses many older, bigger trees that store substantially more carbon. Only a detailed tree campus count can give us correct figures. According to USDA Forestry statistics, 100 fast growth trees of the age of 60 can sequester 25 MT CO₂/yr (see Table 4). This calculation does not include existing vegetation on the Singleton Farm.

Years	MT CO ₂ sequestered/surviving 100 Fast growth trees	2MT CO ₂ sequestered/surviving 500 Fast growth trees
1	0.45	
10	2.9	14.5
20	6.42	32.5
30	10.58	52.9
40	15.05	75.25
50	19.97	99.85
60	25.12	125.6

Table 4: Sequestration potential of woody vegetation

Goal 1: Increase vegetative sequestration

One option to improve passive carbon sequestration would be to increase the amount of vegetation both on and off campus. While relatively few spaces exist on campus where additional significant amount of vegetation may be planted, the institution does own property off campus (Singleton Farm) that could be used for additional sequestration.

Trees for planting are available through programs such as the Maryland Department of Natural Resources' "Tree-Mendous Maryland." The cost for trees through this program runs currently \$4.59 per tree, and on a per hectare basis, it would cost approximately \$5000 (436 tree/acre; 1 acre = .4046 ha). Due to mortality over time (predation, disease, competition between growing trees) the trees are stocked at initial high densities.

Given the high initial cost of \$5000/ha = 1.2 MT CO₂/yr. reduction, this method will not yield a desired substantial reduction in CO₂e in a short period of time. However this is one time cost, and the MT absorbed would increase substantially over time. This figure also does not consider harvesting the trees in 25-40 year rotation, which should yield an income at least equivalent to costs. If the species selected had a high enough value, it is not unreasonable to expect an 11% or more return (after deducting labor costs) according to county forestry studies. Other gains may also include rebates for planting, beautification of property, and creation of a study area for environmental courses (the previous study forest at Singleton Farm was removed to create a small housing development).

One consideration that does come to mind through this introductory study is the value of the current woody vegetation on campus. Its current sequestration capacity of 35.5 MT/CO₂e per year may appear small relative to the total CO₂e generated by the campus, but these trees are performing a number of additional valuable services as well.

Goal 2: Fund reforestation projects

By funding reforestation projects, McDaniel College could claim to be offsetting a certain amount of its carbon footprint. This may be accomplished through:

a. Donating to either a non-profit or for-profit organization, which would then take the funding and use it towards specific projects. A typical example of a for-profit organization would be ClearSky Carbon Offsets, LLC. This company offers a number of carbon-offset programs that McDaniel College could invest in. The organization offers a very specific form of donation for carbon sequestration, which is through their "Donate a tree" program. This program specifically protects coastal mangrove forests in Panama. The cost for this program is a going rate of \$10 per tree. Using the same calculations as before, the result is much more efficient, coming in at \$1,670 per MT CO₂e. It is important to note that this program is tailored to individuals, and that bulk pricing may be available to McDaniel College. Additionally, as an institution of higher learning McDaniel College may be able to invest in large-scale programs which would bring noteworthy publicity to the campus.

b. A perhaps more viable option for McDaniel College to invest in would be the American Forest Organization. According to their website, the American Forest Organization is one of the oldest and most established 501(c)(3) non-profit conservation groups in the United States. Based in Washington, DC, the organization offers a going rate of \$1 per tree, with options of donating anywhere from 25 to 1000 trees. In addition to this, American Forests offers optional programs for larger donations and greater giving opportunities. Depending on the amount given, American Forests offers tax deductions for donations over the amount of \$15, and also sends a certificate to the institution recognizing its contribution. Using the calculations similar to those above, the cost for donating to this organization comes to \$167 per MT CO₂e emissions. In order to offset 20% of McDaniel College's carbon emissions, we would have to invest \$690,678.60 into a program equivalent to American Forests.

Goal 3: Purchase Renewable Energy Certificates (REC)

Our campus could become involved in a Renewable Energy Credit (REC) trading program. According to the United States Environmental Protection Agency, RECs represent "...the environmental, social, and other positive attributes of power generated by renewable resources. These attributes may be sold separately from the underlying commodity electricity." In this instance, McDaniel College would be purchasing electricity from an REC supplier in place of a standard utility company- or, in simple terms, RECs allow McDaniel College to purchase its electricity from renewable sources instead of fossil fuel powered sources. This will cut the institution's footprint by reducing the amount of carbon dioxide that is released due to electricity consumption.

In 2007, McDaniel College purchased 17,757,420 kWh worth of electricity, netting 9,701 MT CO₂e in emissions. This figure gives us a usage per MT CO₂e with our current electricity supplier of 1830.47 kWh. According to the Center for Resource Solutions, REC programs which purchased Green-e certified energy in 2006 removed 550 MT CO₂e per kWh generated. If McDaniel College were to switch completely to REC programs, it would offset 9685.87 MT. Thus, McDaniel College could come close to becoming carbon neutral with regards to energy consumption, let alone 20%. To achieve the 20% mark, McDaniel College would need to purchase RECs for 7,582,300 kWh. As McDaniel College's energy budget was \$3,107,002 for 2007, the average commercial rate for electricity was \$0.17 per kWh. Making a conservative estimate of average renewable energy being twice as high, the cost to offset 20% of McDaniel College's carbon footprint is \$2,653,338.30 (see Table 5).

Sequestration and Renewable Energy Credits					
Action	Reduction of CO2 equivalents (in metric tons/year)	Cost for implementation : define time line	Reduction cost (CO2e Metric ton reduction/\$/ year	Costs of operation (\$/year)	Return on investment (\$ savings/year)
“Tree-Mendous Maryland”	1.2 -2.6 MT CO2e per hectare of trees	\$5000/ha	Depends on goal: Tree longevity 120 years; \$18-\$35/MT CO2e/yr. If harvest trees, costs should be absorbed by sales	N/A	N/A
American Forests	2.6 MT CO2e per acre of trees	One time cost per tree of \$1	\$167 per MT CO2e per year	N/A	N/A
Renewable Energy Credit Trading	550 MT CO2e per kWh	Must switch over to REC trading program-membership costs vary	\$3235.29 MT CO2e per year.	Unavailable due to different prices for different programs	Unavailable due to volatile markets

Table 5: Sequestration and Renewable Energy Credits

REFERENCES

1. ACUPCC Reports. 2008. "GHG Report for McDaniel College." *American College & University Presidents Climate Commitment*. 25 Oct 2008.
<<http://www.aashe.org/pcc/reports/ghg-report.php?id=350>>.
2. Alexander, Kathleen. 2008. "Tree Benefits Page." *Colorado Trees*. Colorado Tree Coalition. 24 Nov 2008. <<http://www.coloradotrees.org/benefits.htm#carbon>>.
3. American Forests. 2009. "About American Forests." *American Forests*. 11 Mar 2009
<http://www.americanforest.org/about_us/>.
4. Bisson, C.L, *et al.* 2003. "Carbon Neutrality at Middlebury College: A Compilation of Potential Objectives and Strategies to Minimize Campus Climate Impact."
5. Center for Resource Solutions. 2007. "Green-e Energy." *Center for Resource Solutions*: San Francisco, CA.
6. Clear Sky. 2009. "Clear Sky Climate Solutions, for our Shared Future. *Clear Sky Climate Solutions*. 11 Mar 2009.
<http://clearskyclimatesolutions.com/zen_cart/index.php?main_page=index&cPath=3>.
7. Galloway, Terry. 2008. "Tree-Mendous Maryland." *Tree-Mendous Maryland*. 05 Mar 2008. Maryland Department of Natural Resources. 24 Nov 2008
<<http://www.dnr.state.md.us/forests/treemendous/index.html>>.
8. Gleick, P.H. 1998. "Water and conflict." In: P.H. Gleick, *The World's Water*, 1998-1999, Island Press, Washington, D.C. pp. 105-135.
9. Marland, G., T.A. Boden, and R.J. Andres. 2008. "Global, Regional, and National CO₂ Emissions." In *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.
10. Nowak, David J. and Daniel E. Crane. 2002. "Carbon Storage and Sequestration by Urban Trees in the USA." *Environmental Pollution*; 116(3): 381-389.
11. Nowak, David J. and Daniel E. Crane, and John F. Dwyer. 2002 "Compensatory Value of Urban Trees in the United States." *Journal of Arboriculture*; 28(4): 194-195.

12. Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, eds., "IPCC, 2007: Summary for Policymakers." In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK.
13. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, eds., "IPCC, 2007: Summary for Policymakers." In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.
14. United States Census Bureau, International Data Base. 2009. "World Population Information and Country Summary". <http://www.census.gov/ipc/www/idb/index.html>. Accessed March 30, 2009.
15. United States Environmental Protection Agency. 2002. *Guide to Purchasing Green Power*. GPO: Washington, DC.
16. Wayburn, Laurie A, Jerry F. Franklin, John C. Gordon, Clark S. Binkley, and David J. Mladenoff, Norman L. Christenson, Jr. 2000. *Forest Carbon in the United States: Opportunities & Options for Private Lands*. 1st. Pacific Forest Trust, Inc.
17. Yadvinder, Mahli, Patrick Meir, and Sandra Brown. 2002. "Forests, Carbon and Global Climate." *Philosophical Transactions: Mathematical, Physical and Engineering Sciences* 360, No. 1797(2002): 1567-1591.