2010

The University of Montana Climate Action Plan

Cover photo by CL Peacock

The University of Montana
Climate Action Plan

Approved:

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- Dave Atkins, US Forest Service Fuel for Schools Program
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- Hugh Jesse, Director, UM Facilities Services
- Anne Guest, Parking Commissioner
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- Bob Giordano, Missoula Institute for Sustainable Transportation
- Ann Cundy, Transportation Planner, Missoula Office of Planning and Grants
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- Members of UM Forum for Living with Appropriate Technology
- Members of MontPIRG

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Executive Summary

Commitment to Climate Action

Leaders of the University of Montana recognize humanity is impacting our climate and are committed to taking action. In 2007, President George Dennison became one of the first 100 charter signatories of the American College and University Presidents Climate Commitment (ACUPCC), pledging the University to reduce and eventually neutralize its greenhouse gas emissions. Determining a timeline and steps to achieve climate neutrality started with the 2008 Greenhouse Gas Inventory and culminates in this Climate Action Plan. Also included herein are strategies to incorporate sustainability in education, research, and community outreach.

The University of Montana's Climate Action Plan (CAP) outlines strategies for achieving climate neutrality by 2020. Not all of the emission reduction strategies in the diverse portfolio identified are within the funding ability of the University. Overall success of the plan is dependent on obtaining external funding for a few strategies with large emissions reduction potential. Even with this uncertainty, the campus community advocated for the aggressive carbon neutrality date of 2020 to spur deep cuts in emissions quickly.

An interim emission reduction goal of 10% below 2007 levels by 2015 was selected based on strategies with foreseeable funding. It may seem to be a huge leap to then attain carbon neutrality by 2020, but if funding is realized for the larger emission-cutting strategies, this may be achievable.

This Climate Action Plan is just the beginning of UM's efforts to mitigate its contribution to climate change. It is intended to be a living document that is amended as new information becomes available and the success of efforts evaluated. The ACUPCC recognizes the rapidly changing situation surrounding climate change mitigation and accommodates updates to plans at any time.

Climate Action Plan Development Process

Completing this Climate Action Plan was undertaken as a community effort. A public involvement process was designed and implemented through public meetings, internet social networking, stakeholder meetings, media announcements, and an all-campus survey. Ideas to reduce greenhouse gas emissions were collected and analyzed using the Clean Air-Cool Planet campus carbon calculator. Strategies were then prioritized and a timeline developed to establish emission reduction interim goals and a target date for carbon neutrality. A draft plan was made publically available for review and comments incorporated in the final plan in as much as possible.

The Climate Action Plan was coauthored primarily by UM's Sustainability Coordinator and ASUM's Sustainability Coordinator with input from a Technical Working Group that met every two weeks during plan development. Technical Working Group members included campus professionals and local topic experts were occasionally invited. An Education Working Group convened to write the section of the plan detailing goals and strategies to incorporate sustainability in curriculum, research, and community outreach. The Sustainable Campus Committee made up of staff, students, faculty, and administrators provided guidance and served as advisory authority. University Executive Officers were the final decision making authority.

Greenhouse Gas Profile

In 2008, a Greenhouse Gas (GHG) Inventory was completed that identified UM's primary sources of emissions as well as a steadily increasing trend due to growth. On-campus production of steam (On-campus stationary) for heating buildings is the highest contributor with 36.1% of total campus emissions. Close behind is transportation which accounts for 31.6% of total emissions. Transportation includes air travel, commuting, and University fleet. The third highest emitter is purchased electricity used to power buildings and other campus operations which makes up 30.8%. The inventory revealed that the operation of buildings on campus contributes 2/3 of the emissions attributed to UM.

The graph below shows a breakdown of the largest emission sources and includes emissions from solid waste and agriculture - a term used to describe the maintenance of campus grounds. The line indicating emissions due to agriculture is just below solid waste but is difficult to pick out on the graph below. Although grounds maintenance and the decomposition of solid waste contribute greenhouse gas emissions, their part is small in comparison to the other sources. Due to time constraints, they were not dealt with in detail in this first Climate Action Plan.

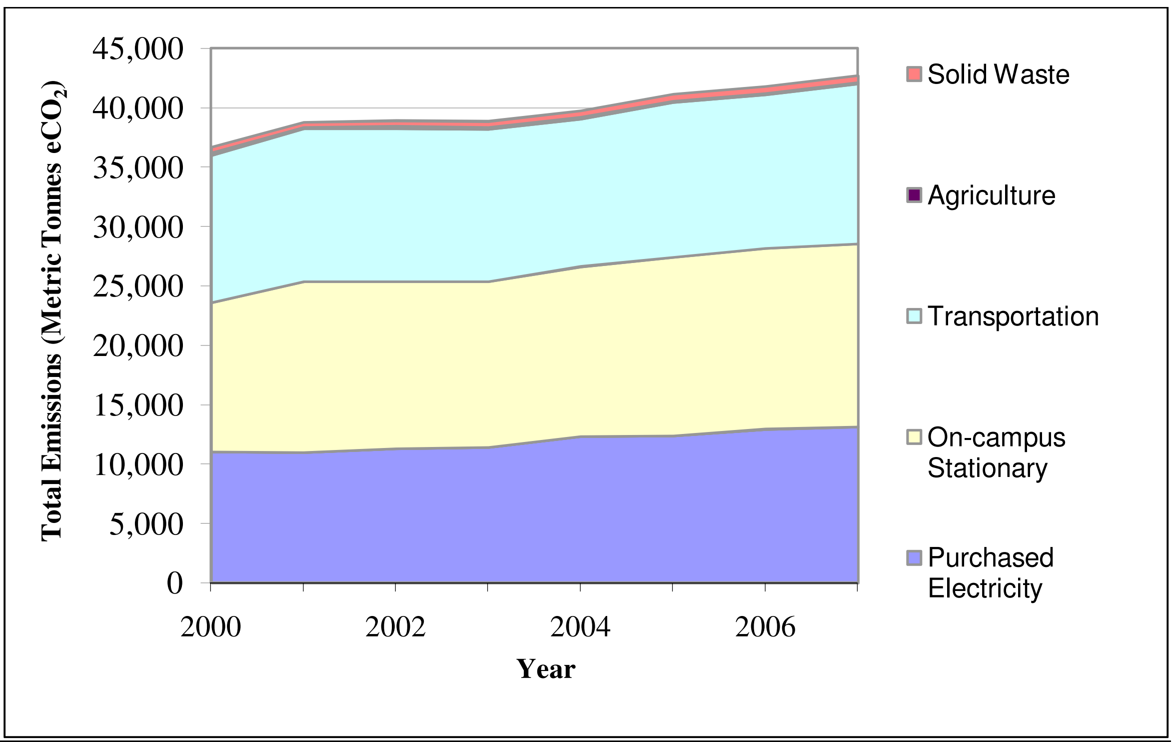

Figure 1. Greenhouse Gas Profile

Greenhouse Gas Reduction Strategies

The greenhouse gas emission reduction strategies collected through the public involvement process and analyzed for emission reduction potential, energy savings, and costs were categorized as follows:

- Energy Efficiency and Conservation
  - Energy efficiency upgrades to existing buildings (including lighting retrofits)
  - Behavior modification to conserve energy
  - 4-day work week
  - Reduce building energy consumption over breaks
  - Retro-commissioning (optimize operation of heating, air conditioning, and ventilation systems)
  - Reduce vending
  - Turn-off drinking fountain coolers
  - Provide compact fluorescent light bulbs for on-campus residents' task lighting
  - Energy-wise IT
- Transportation
  - Behavior modification to increase use of alternative transportation
  - Replace rental fleet with more fuel-efficient vehicles as much as possible
  - Reduced commuting due to a 4-day work week
- Wind Power
  - Invest in a wind project in a high wind area of Montana and obtain Renewable Energy Credits
- Biomass Energy Generation
  - Obtain energy from an on-campus wood-fired boiler, off-campus synthetic natural gas plant, or some combination of both
- Carbon Offsets
  - High-quality carbon credits or local projects to offset GHG emissions

Green Buildings are not included as a separate category for two reasons:

1. LEED for New Construction has already been adopted by the University
2. The projected energy savings due to LEED is included in the business as usual base case

Greenhouse Gas Reduction Goals

Three scenarios were developed to achieve carbon neutrality by 2020. These scenarios were compared with the "Business as Usual" or "No Action" base case. If no action is taken, UM's GHG emissions will continue to grow and essentially double by 2050.

Public feedback indicated strong support for energy efficiency and conservation. Those strategies are generally within the ability of the University to implement and address building energy consumption, the largest source of GHG emissions. When developing the reduction scenarios, the strategies categorized as Energy Efficiency and Conservation, as well as Transportation, are referred to as Direct Emission Reductions and are included in Scenarios 2 and 3. Scenario 1 shows the costs of using carbon offsets alone for comparison. The scenarios to achieve carbon neutrality by 2020 that were considered are as follows:

- Scenario 1 - Carbon Offsets
  - All emissions offset using carbon offsets purchased annually.

- Scenario 2 - Direct Emission Reductions and Wind Power
    - All emissions reduced by energy efficiency and conservation, alternative transportation, and wind power scaled to offset all remaining emissions.

- Scenario 3 - Direct Emission Reductions, Wind Power, Biomass Energy Generation, and Carbon Offsets
    - All emissions reduced by energy efficiency and conservation, alternative transportation, wind power scaled to replace purchased electricity, biomass energy generation scaled to replace natural gas, and carbon offsets purchased annually to offset remaining emissions.

The Technical Working Group used best available data to develop the GHG reduction scenarios but there is great uncertainty as to what might be possible in the future. Detailed engineering analyses are needed to determine the most cost-effective ways to implement this plan. The information displayed in Table 1 is based on best guesses and worst-case figures were used to establish conservative estimates. Further research will be needed to refine strategies as implementation goes forward.

Scenario	Capital Costs	Annual O&M Costs	Annual Savings	Annual GHG Emission Reduction
Scenario 1 Carbon Offsets	$840,000 per year. Cost will increase as emissions increase	$0	$0	56,000 MTeCO2 in 2020
Scenario 2 Direct Emission Reduction and Wind Power	$86,000,000	$1,700,000	$6,000,000	56,000 MTeCO2 by 2020
Scenario 3 Direct Emission Reduction, Wind Power, Biomass Energy Generation, and Carbon Offsets	$94,000,000 + $190,000 annually for carbon offsets	$1,200,000	$4,000,000	56,000 MTeCO2 by 2020

Table 1. GHG Emissions Reduction Scenarios

Interim Goals

Interim goals are as important, if not more so, than a carbon neutrality target date. Interim goals are short term, provide the opportunity to measure progress, and encourage starting the downward trend toward carbon neutrality sooner.

To determine a reasonably aggressive interim goal, the energy efficiency, conservation, and alternative transportation emission reduction strategies were plotted on the Business as Usual graph. These strategies were chosen for priority implementation because they are mostly within the University's ability to fund and public feedback indicated a desire to reduce energy consumption. Graphing results are shown below and indicate an interim target of 10% below 2007 emission levels by 2015. It is difficult to correlate the legend to the graph but it does show a list of strategies included and the overall emission reductions achieved.

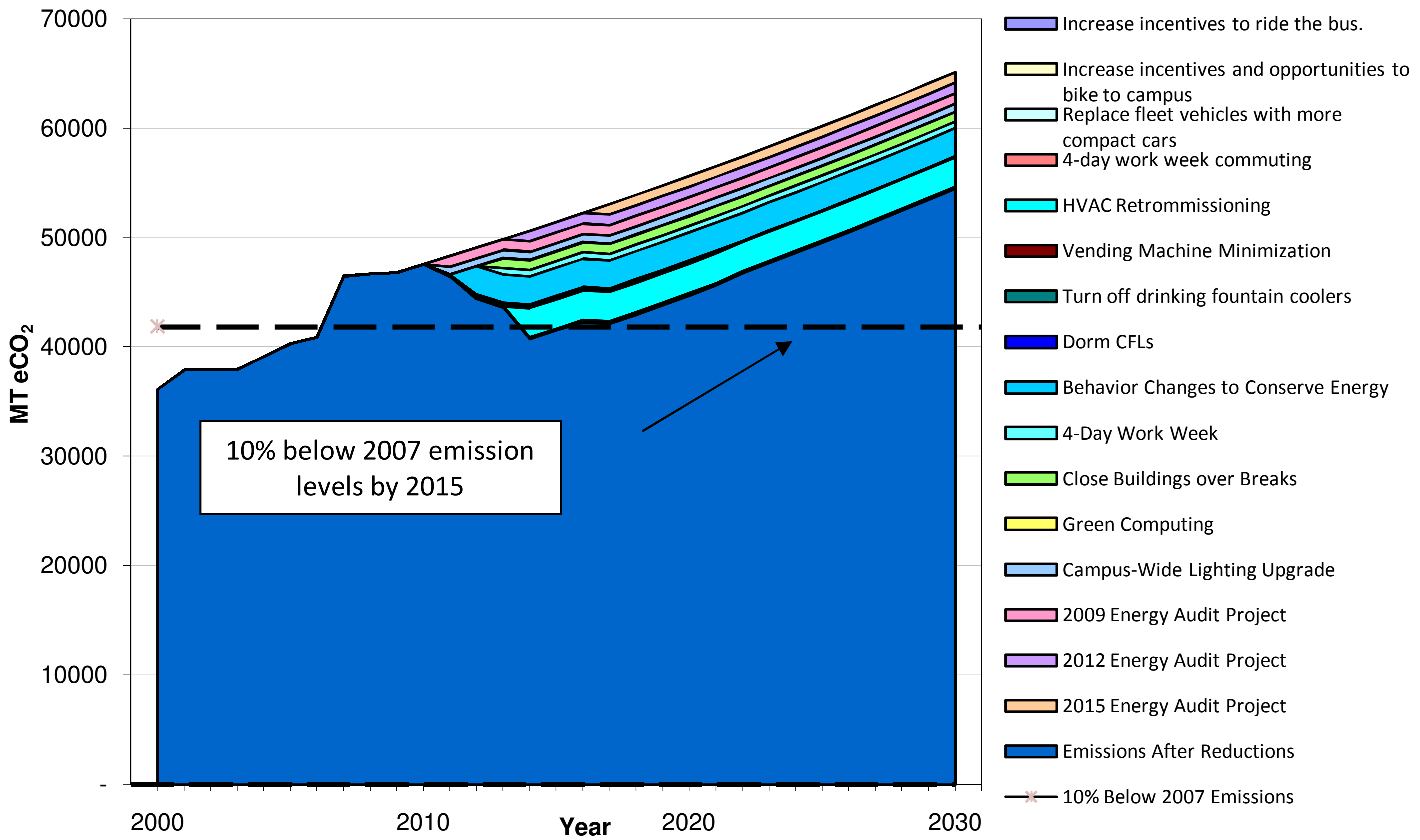

Figure 2. Interim Goal Graph

Education, Research, and Outreach

The ACUPCC emphasizes the importance of incorporating sustainability into institutional curriculum in order to create a learning environment that produces ecologically literate and socially responsible graduates. The University's commitment to the educational component of the ACUPCC is delineated in UM's strategic plan as follows:

> *Goal #2 of UM's Academic Strategic Plan states "Create a campus climate that actively supports sustainability, including environmental responsibility, sustainable operations, and stewardship in our community".*

Directed by the ACUPCC and the Academic Strategic Plan, and spearheaded by a subcommittee of UM's Sustainable Campus Committee, the following broadly identified goals and potential strategies for attaining them have been developed.

Goals/Strategies

Goal: Establish Sustainability and Climate Change as recognized, emphasized, and common themes across the University curriculum. In order to achieve this goal, UM should consider the following strategies:

- Offer Green Thread or other initiatives on a regular basis to help faculty integrate sustainability into existing courses
- Develop a plan for all students to encounter sustainability education
- Develop a network of faculty (at least one per department) to promote sustainability pedagogy across campus
- Increase number of relevant courses to create a "sustainability track" in General Education
- Create a Sustainability Literacy Assessment similar to Writing Proficiency Assessment

Goal: Make Sustainability and Climate Change a center of academic excellence for the University. In order to advance this goal, UM may:

- Establish new faculty lines to support Sustainability areas in EVST and Climate Change Studies minor
- Engage in strategic hiring in other departments and programs to strengthen Sustainability and Climate Change
- Facilitate opportunities for innovative research and teaching across departments, with COT, and with other sectors of the University

Goal: Supplement formal education on Sustainability and Climate Change with informal, practical, and career-oriented education that enhances relationships between UM and community partners. In order to advance this goal, UM may:

- Support service-learning and project-oriented pedagogy that makes UM a more sustainable member of the community
- Make sustainability and climate change prominent features of Orientation, residence hall programming
- Make sustainability and climate change prominent features of UM events and programs that attract off-campus participants (public lectures, extracurricular activities, alumni events, etc.)
- Strengthen relationships with external organizations for internships and work-based learning
- Develop new funding streams to support expanding Energy Technology program

<u>Recommendations</u>

To comply with the American College and University Presidents Climate Commitment, a carbon neutrality date of 2020 and an interim target of 10% below 2007 emission levels by 2015 are recommended. Scenario 3 is suggested for implementation as it offers a diversified approach. The graph below show how Scenario 3 could result in carbon neutrality by 2020. Only projects with large emission reductions are labeled in the legend for clarity. The small wedges are the Energy Efficiency and Conservation and Transportation strategies listed previously. Beyond 2020, additional strategies would need to be implemented, or more carbon offsets purchased, to maintain carbon neutrality.

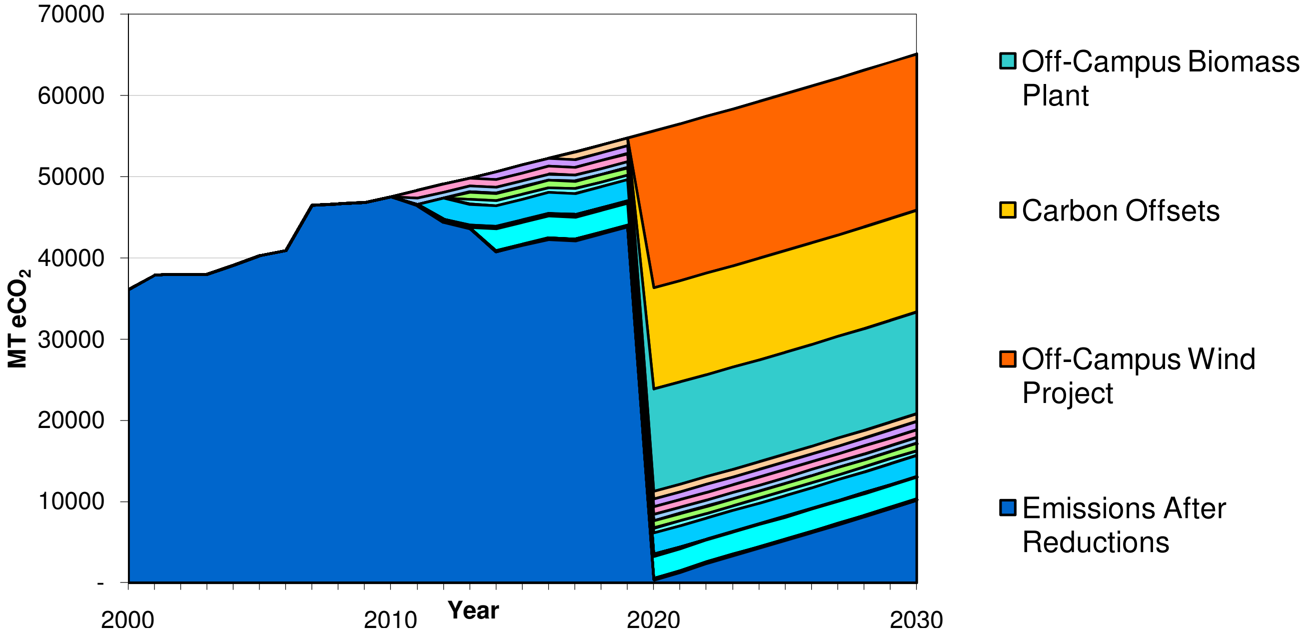

Figure 3. Scenario 3 Overlain on Business as Usual Graph

There are several strategies that should be implemented within the next 5 years if UM is going to make aggressive progress toward reducing GHG emissions. The following are recommended as a priority for implementation:

- Energy Efficiency and Conservation
    - Energy efficiency upgrades (including lighting retrofits)
    - Behavior modification
    - 4-day work week
    - Reduce building energy consumption over breaks
    - Retro-commissioning
    - Reduce vending
    - Turn-off drinking fountain coolers
    - Compact fluorescent light bulbs for on-campus residents
    - Energy-wise IT
- Transportation
    - Behavior modification to increase use of alternative transportation
    - Replace rental fleet with more fuel-efficient vehicles as much as possible
    - Reduced commuting due to a 4-day work week

It is recognized that more study is needed before a 4-day work week could be implemented.

It is recommended that research into wind power and biomass energy generation continues and includes methods of funding these large projects.

Finally, looking into using carbon offset options to offset the greenhouse gas emissions from air travel is recommended. This is one large emission source that does not have a replacement option like wind power for purchased electricity or biomass energy generation for natural gas. Further research into options for carbon offsetting should be conducted and alternatives such as developing local projects that result in emission reductions to offset UM's emissions investigated.

<u>Next Steps</u>

To implement this Climate Action Plan, the strategies identified will need to be prioritized, funded, and assigned for further action. Teams will need to be convened to research wind power, biomass energy generation, funding, and carbon offsetting options. The Sustainable Campus Committee, with the support of the Office of Sustainability, will monitor and report on progress as well as recommend future updates and revisions to the Climate Action Plan.

An important outcome of the planning process has already been achieved.   Awareness of how UM's operations affect our environment has increased and relationships have been developed that will foster the greening of UM. These are some of the benefits of a people-intensive planning process that will be vital to the success of UM's efforts to become climate neutral.

Section 1

Introduction

It is a chilly, October day in western Montana, with the promise of snow in the forecast. This cool, wet weather is a welcome remedy to the forest fire that is burning just south of Missoula in the Bitterroot Valley. Forest fires of varying intensity are not at all unusual here. However in the last ten years, the number of acres burned and intensity of wildfires have increased in the Rocky Mountain West (Running, 2006). Although ecosystem dynamics are inherently complex, scientists believe this altered wildfire pattern is due in part to climate change.

The University of Montana - Missoula is situated in this fire-dependent ecosystem of western Montana that is characterized by river valleys and forested mountains intermingled with open grasslands. Increasing forest fire activity is not the only affect of climate change visible to Montanans. The glaciers of Glacier National Park are retreating, river flow patterns are changing, and the overall temperature is increasing (U.S. Geological Survey, 2008). These changes correspond to increases in global average air and ocean temperatures as documented in the Climate Change 2007: Synthesis Report by the Intergovernmental Panel on Climate Change. A quote from this report puts these changes into perspective, "Average Northern Hemisphere temperatures during the second half of the 20^{th} century were *very likely* higher than during any other 50-year period in the last 500 years and *likely* the highest in at least the past 1300 years." (IPCC, 2007)

Modern industrial activity, especially the use of fossil fuels, also corresponds to rising global temperatures. Again from the IPCC, "Most of the observed increase in global average temperatures since the mid-20^{th} century is *very likely* due to the observed increase in anthropogenic [human-caused] GHG [greenhouse gas] concentrations." (IPCC, 2007)

Leaders of the University of Montana (UM) recognize humanity is having an impact on our climate and have decided to do something about the University's contribution. In 2007, President George Dennison signed the American College and University Presidents Climate Commitment (ACUPCC). This committed UM to develop this institutional climate action plan to become climate neutral. Climate neutrality means, "having no net greenhouse gas (GHG) emissions, to be achieved by minimizing GHG emissions as much as possible, and using carbon offsets or other measures to mitigate the remaining emissions." (Dautremont-Smith, 2007) The ACUPCC also requires Climate Action Plans include strategies to incorporate sustainability in education, research, and outreach.

To comply with the ACUPCC, UM's first Greenhouse Gas Inventory was completed in 2008. The Office of Sustainability with a full-time director was formalized in 2009. Completing this first Climate Action Plan identifying greenhouse gas emission reduction strategies was undertaken as a community effort through public involvement, input from the Climate Action Planning Technical Working Group, and oversight by the Sustainable Campus Committee. Prior efforts of the Sustainable Campus Committee, Facility Services Sustainability Initiatives Team, ASUM Sustainability, and the Recycling Oversight Committee paved the way to institutionalize sustainability in campus operations.

Section 2

Plan Organization and Methodology

This Climate Action Plan is organized by first briefly describing in Chapter 3 the results of the 2008 Greenhouse Gas Inventory, the full text of which is located at http://www.umt.edu/greeningum/documents/greenhouseinventory.pdf. Strategies to reduce greenhouse gas emissions are discussed in Chapter 4 and goals and interim targets for establishing a downward trend in Chapter 5. Chapter 6 details how the University is making climate neutrality and sustainability part of the curriculum and other educational experiences for all students.

The objective of this Climate Action Plan is to outline strategies and a timeline for reducing greenhouse gas emissions. It is not a detailed engineering analysis of the ideas considered. Cost estimates are best guesses. Emission reduction potential of strategies was estimated using the Clean Air-Cool Planet campus carbon calculator.

Completing this Climate Action Plan was undertaken as a community effort. A public involvement process was designed and implemented through public meetings, internet social networking, stakeholder meetings, media announcements, and an all-campus survey. Ideas to reduce greenhouse gas emissions were collected and analyzed using the Clean Air-Cool Planet campus carbon calculator. Strategies were then prioritized and a timeline developed to establish emission reduction interim goals and a target date for carbon neutrality. A draft plan was made publically available for review and comments incorporated in the final plan in as much as possible. The public involvement process as designed by Brent Campbell of the local consulting firm WGM is displayed below.

Figure 4. Public Involvement Process

The greenhouse gas emissions reduction strategies herein originated in the ideas generated through the public involvement process. A Technical Working Group was then tasked with developing strategies from these ideas and analyzing them based on costs, savings, and GHG reduction potential. This group met biweekly to complete the plan. Members of the Technical Working Group included:

- Erica Bloom, student, ASUM Sustainability Coordinator
- Jim Burchfield, Dean, College of Forestry and Conservation
- Laura Howe, PE, Assistant Director for Engineering and Utilities
- Brian Kerns, PE, Research and Sponsored Programs, Alternative Energy Specialist
- Cherie Peacock, UM Sustainability Coordinator
- Ashley Preston, Adjunct Instructor in Renewable Energy, COT
- Tony Tomsu, Program Manager, Office of Planning, Budget, and Analysis
- Nancy Wilson, Program Manager, ASUM Transportation Specialist

People with particular expertise were invited to and attended topic-specific Technical Working Group meetings. Campus and local community experts who participated to assist in developing strategies included:

- Ingrid Lovitt, Architect, LEED AP, Design Balance
- Jameel Chaudry, UM Architect/Project Manager
- Louise Lakier, LEED AP, UM Project Manager

- Lee Tavenner, Renewable Energy Specialist, Solar Plexus
- Janelle Stauff, Renewable Energy Specialist, Sunelco
- Alex Zimmerman, UM Mechanical Engineer
- Mike Burke, UM Steam Plant Manager
- Dave Atkins, US Forest Service Fuel for Schools Program
- Ben Schmidt, County Health Air Quality Program
- Hugh Jesse, Director, UM Facilities Services
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- Alex Stockman, Director of Missoula In Motion
- Alex Taft, Missoula Advocates for Sustainable Transportation
- Phil Smith, City Bike Pedestrian Coordinator
- Bob Giordano, Missoula Institute for Sustainable Transportation
- Ann Cundy, Transportation Planner, Missoula Office of Planning and Grants
- Members of UM Climate Action Now student group

An Education Working Group convened to write Chapter 6, Education, Research, and Outreach. This section outlines strategies to incorporate sustainability in UM's curriculum, research, and community outreach. Member of this working group were:

- Erica Bloom, student, ASUM Sustainability Coordinator
- Royce Engstrom, Provost and VP of Academic Affairs
- Nicky Phear, Adjunct Instructor, College for Conservation and Forestry
- Steve Schwarze, Associate Professor, Communication Studies
- Lisa Swallow, Associate Professor of Business Technology, COT

The Sustainable Campus Committee (SCC) gave oversight to the development of this Climate Action Plan. Past and present members of the SCC during the time of plan development were:

- STUDENTS: Jessie Davie, Derek Kanwischer, Erica Bloom, Emily May, Whitney Hobbs, Lindsay Becker
- STAFF: Mike Panisko (Co-Chair), Kelly Chadwick, Paul Williamson, Brian Kerns, Dan Corti
- FACULTY: Phil Condon, Curtis Noonan, Lisa Swallow, Robin Saha, Amy Ratto-Parks
- ADMINISTRATION: Mark LoParco, Charles Couture, Chris Comer
- OFFICE OF SUSTAINABILITY: Cherie Peacock (Co-Chair)

The data used to analyze strategies were derived from a number of sources including:

- 2008 Greenhouse Gas Inventory
- 2009 Energy Audits conducted by CTA consultants
- UM's response to the Governor's 20 X 10 initiative
- Results of similar strategies implemented at other universities
- Research completed by governmental agencies
- Literature review
- University and local experts
- Clean Air Cool Planet campus carbon calculator, version 6.4

Public Feedback

Information about the Climate Action Plan and opportunities to comment were posted on Greening UM's blog, Facebook page, LinkedIn, and Twitter. Comments on the initial draft of this Climate Action Plan were gathered at open house meetings and compiled in the notes located at: http://www.umt.edu/greeningum/documents/PublicComments.pdf.

An all-campus survey was also done to gather comments on the initial draft Climate Action Plan. The survey and the full text of the comments can be accessed at: http://www.umt.edu/greeningum/documents/CompilationSurvey.pdf

For convenience, a one page synopsis of the results of the all-campus survey is located in Appendix C.

A few individuals gave detailed comments on the draft plan. Those comments were included in the final plan as much as possible, but time did not allow for additional extensive analysis that was suggested by some of the comments. However, recognizing that this plan will be revised in the future, these comments are included on the Greening UM website and can be viewed at: http://www.umt.edu/greeningum/documents/IndividualComments.pdf

Some of the comments offered that were not included in this Climate Action Plan could become follow-up studies. As an example, evaluating the consequences of growth on carbon emissions in detail could be done as a follow-up study. Also, some ideas presented require more data gathering, such as analyzing air travel based on who is doing the travelling. This type of work could also be done as a follow-up project to this first Climate Action Plan.

Section 3

Greenhouse Gas Profile

In 2008, a Greenhouse Gas (GHG) Inventory was completed by Jessie Davie, ASUM Sustainability Coordinator, with help from students Kendra Kallevig, Sky Orndoff, and JJ VanDette, and oversight and guidance from Phil Condon, Environmental Studies Professor, and members of the SCC. The inventory was completed using Clean Air-Cool Planet (CA-CP) campus carbon calculator, version 5. Data from 2000 through 2007 was obtained from many university departments and the resulting analysis showed the university's carbon emissions are steadily increasing (Davie, 2008).

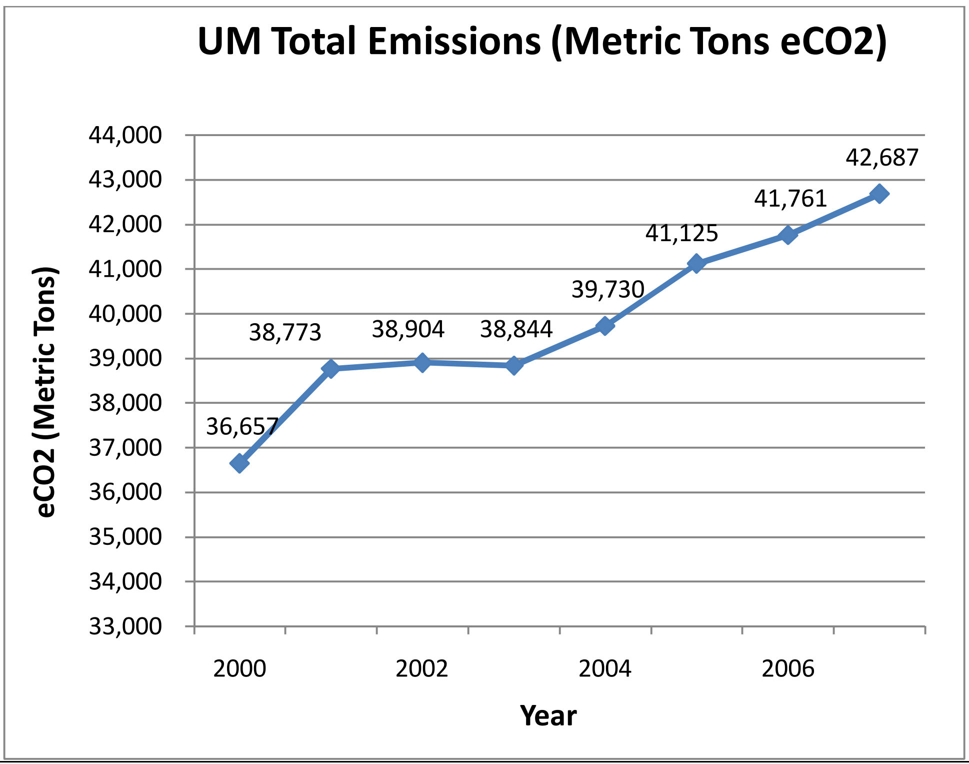


Figure 5. Greenhouse Gas Inventory – Emissions Growth

During development of this plan, the GHG Inventory was updated with new information. The EPA updated carbon emission factors attributed to utilities across the nation to increase accuracy of carbon accounting. This information was incorporated in recent versions of the Clean Air Cool Plant calculator, including the version used for this plan. As a result, UM's estimated GHG emissions from purchased electricity increased in 2006 and 2007. Total emissions estimated for 2007 increased to 46,500 MTeCO2.

The GHG Inventory breaks down emission sources into what is referred to as "scopes". Scopes are a way to categorize greenhouse gas sources by whether they are a direct or indirect responsibility of the university.

Scope 1 Direct Sources	Scope 2 Indirect Sources from Imports	Scope 3 Indirect Sources not directly controlled by UM
On-campus co-generation plant ▪ Steam production ▪ Electricity generation	Purchased Electricity	Air Travel
University Fleet ▪ ASUM Transportation ▪ Facilities Services vehicles ▪ Rental Fleet		Faculty/Staff commuter habits
Fertilizer Application		Student Commuter habits
		Solid Waste Disposal

Table 2. GHG Emissions Scopes

On-campus production of steam is the highest contributor of greenhouse gas with 36.1% of total campus emissions. Close behind is transportation which accounts for 31.6% of total GHG emission. The third highest emitter is purchased electricity which makes up 30.8%. A breakdown of UM's largest sources of GHG emissions is shown in the graph below.

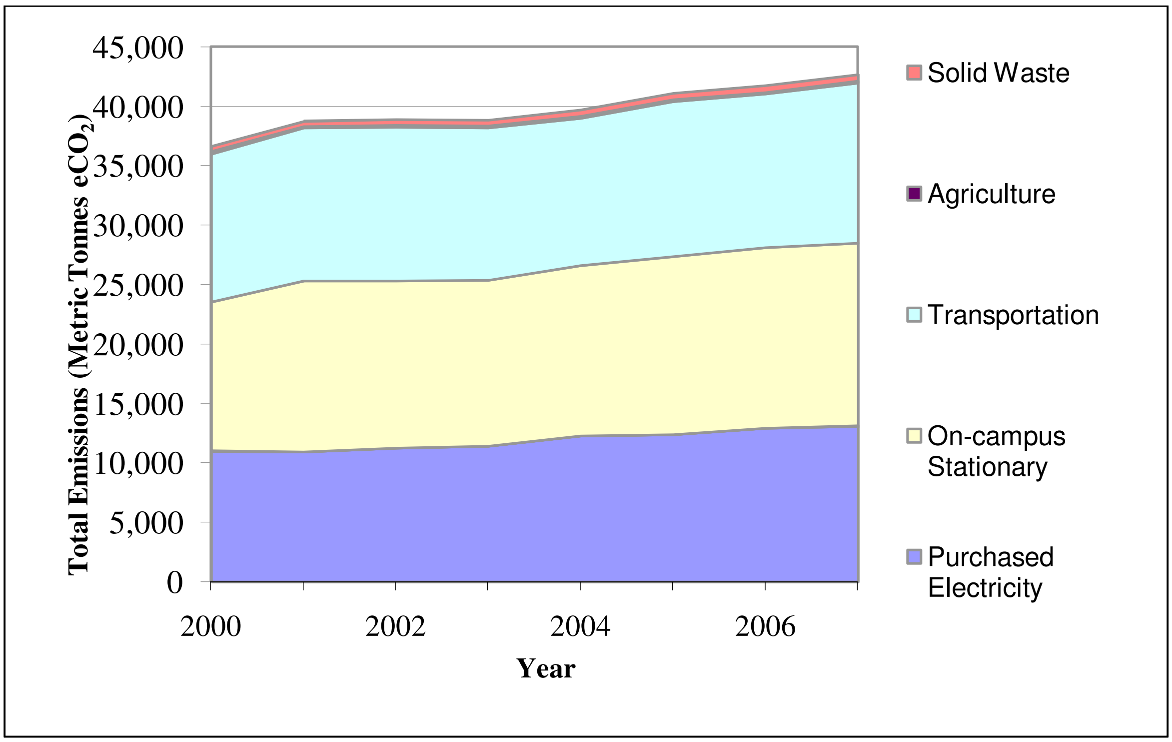


Figure 6. Greenhouse Gas Inventory – Emissions by Sector

To effect the greatest change in GHG emissions, UM's planning effort focused on developing strategies to reduce energy consumption and transportation-related emissions, then to finding alternatives to using conventional fossil fuels. Although on-campus grounds maintenance and the production of solid waste contribute to climate change, their part is small in comparison. Therefore, these areas were not dealt with in detail in this first Climate Action Plan.

Section 4

Greenhouse Gas Reduction Strategies: Opportunities for Action

The University of Montana has existing strengths in greenhouse gas (GHG) emission reduction sectors of energy conservation and efficiency, green building design, dining services operations, alternative transportation, and solid waste management and recycling. Building upon these strengths and broadening their scope, as well as formalizing others, will position UM to make significant reductions in its GHG emissions over time.

The following discussion details strategy ideas generated through the public involvement process undertaken as part of developing UM's Climate Action Plan. The strategies are categorized according to the Greenhouse Gas Emission Reduction Sectors outlined below. Barriers, challenges, and synergies are included in the discussion along with further planning, research, and financing needs. Some ideas presented are in their infancy and require further development prior to implementation. Others are already funded or need no funding and can begin immediately. As a result of the public involvement process and previous conservation efforts, individuals are realizing they can take action to conserve energy and reduce GHG emissions. Actions like turning off lights, adjusting timers, using less hot water, driving less, and turning down the heat are making UM a greener campus.

Greenhouse Gas Emission Reduction Sectors

4.1 Energy Efficiency and Conservation

4.2 Renewable Energy Generation

4.3 Green Buildings

4.4 Transportation

4.5 Offsetting Emissions

4.1 Energy Efficiency and Conservation

Energy consumption for building related infrastructure results in the largest climate impact attributed to the University of Montana. This energy comes from a mix of natural gas and purchased electricity and is used for heating, cooling, hot water, lighting, and to power computers, appliances, and equipment. Directly reducing energy consumption is one of the most significant things UM can do to have a positive impact on our climate. Consuming less also has long-term financial benefits and makes strategies such as incorporating renewables more feasible. The less energy needed, the less funding needed to generate that energy from renewable sources.

Reducing the energy used in existing buildings decreases UM's overall carbon footprint, however adding new buildings will counteract that reduction. The Greenhouse Gas Inventory evaluated energy consumption since the year 2000 and found a steadily increasing trend that correlates to increasing student enrollment and construction of new buildings. If this rate of consumption is projected into the future, the resulting greenhouse gas emissions, measured in metric tonnes of carbon dioxide equivalent (MT eCO2), will increase correspondingly as shown in the following graph. The graph below includes projections for air travel, commuting, solid waste disposal, and University fleet.

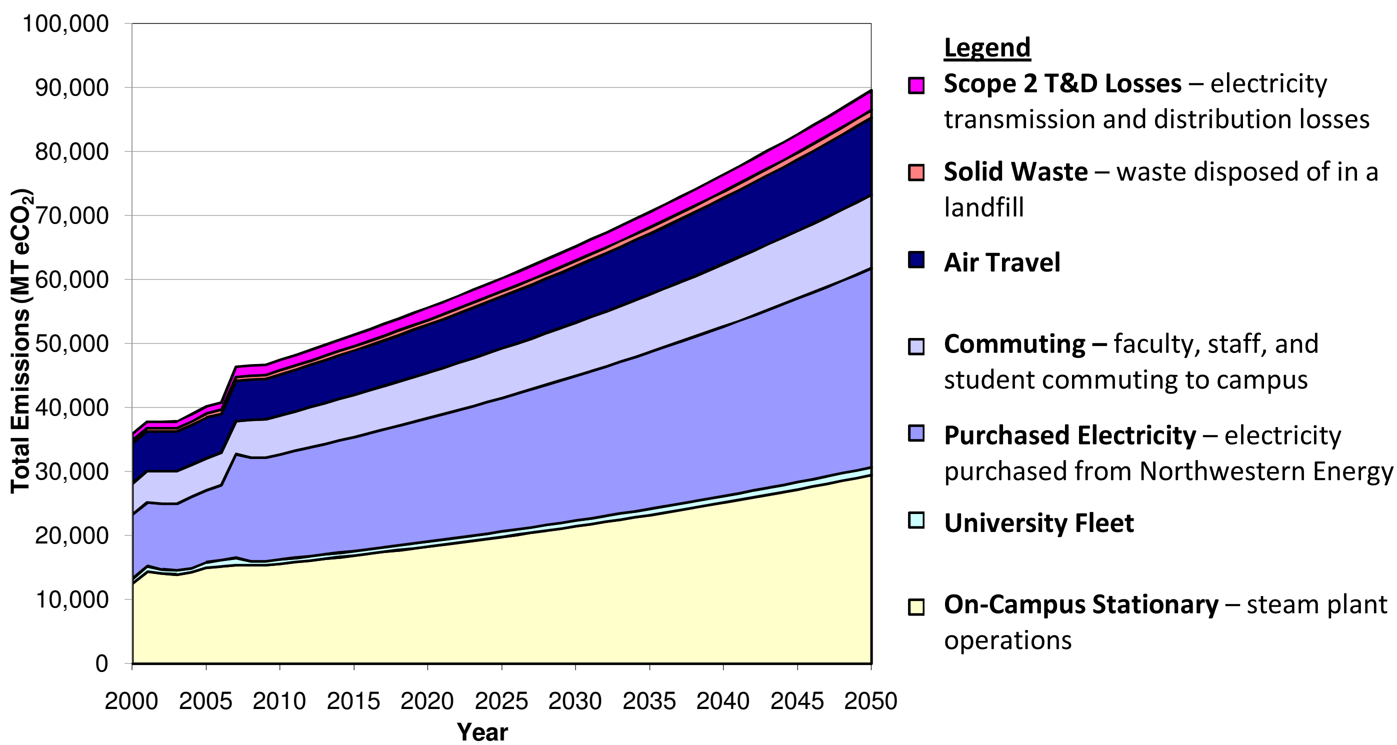


Figure 7. Projection of Greenhouse Gas Emissions

What the graph above does not show is how much more energy would have been consumed if UM had not made the most of energy saving measures like groundwater cooling. This method utilizes the naturally cool temperature of water in the aquifer underlying Missoula to provide cooling via a heat exchange system. This system is installed in new buildings and cooling system retrofits whenever possible. Incorporating groundwater cooling has enabled UM to avoid an increase of electricity consumption of approximately 44% which, as of 2009, is equivalent to 6,600 MT eCO2 annually. Obviously this energy efficient cooling strategy should be continued. Although adding cooling systems will increase the University's overall carbon footprint, groundwater cooling will lower the slope of the growth curve.

In 2007, Governor Brian Schweitzer issued the 20 X 10 initiative directing state agencies to reduce their energy consumption by 20% by the year 2010. The University of Montana embraced this goal and set in place several policies and strategies to achieve it. These include:

- Prohibiting the use of personal space heaters
- Disconnecting non-essential lights in hallways
- Instituting a night setback temperature of 60 degrees
- Day-time temperature setting of 72 degrees in the summer and 68 degrees in the winter
- Requiring all new construction to be a minimum of LEED - Silver certified
- Requiring all new appliances to be Energy Star certified
- Change construction standards to require all new buildings to be 20% more energy efficient than the base case used in LEED computations

Also in response to the Governor's 20 X 10 initiative, UM contracted with a consulting firm to conduct detailed energy audits of sixteen buildings on campus. This was an important first step to identify where significant energy savings could be realized in the operation of the largest energy-consuming buildings on campus. The results of this audit were used to estimate costs and energy savings as part of this plan.

Many ideas for energy efficiency and conservation were identified through the Climate Action Planning public involvement process and a complete list is located in Appendix A. This comprehensive list was narrowed and categorized as outlined below and discussed in detail.

Energy Efficiency and Conservation
Greenhouse Gas Reduction Strategies

4.1.1 Energy efficiency upgrades

4.1.2 Behavior modification

4.1.3 4-day work week

4.1.4 Close certain buildings over breaks/summer

4.1.5 Retro-commission HVAC systems

4.1.6 Reduce vending machines

4.1.7 Turn off drinking fountain coolers

4.1.8 Provide dorm residents with CFL light bulbs

4.1.9 Add trees for summer shading

4.1.10 Energy-wise IT policy

4.1.1 Energy Efficiency Upgrades

In 2009, energy audits were conducted in sixteen buildings on campus as well as a campus-wide lighting audit. The audit identified significant energy saving opportunities from improvements to building infrastructure that include:

- Lighting retrofits
- Lighting motion sensors and timers
- Ventilation changes
- Equipment upgrades
- Steam trap replacement
- Improving building envelopes

As of 2009, some of the recommendations from this audit were already funded projects. For the purpose of climate action planning, the energy audit results are evaluated as three separate projects: an all-campus lighting retrofit; solar thermal for Grizzly Pool in the renewable energy section; and the remainder of identified opportunities as a single, aggregate project.

Over 30 buildings remain to be audited. Therefore, two future projects are estimated that are similar in scope and outcome as the 2009 energy audit. Following are details of projects.

All-Campus Lighting Retrofit
The existing lighting systems in many of the buildings on campus are T-12 fluorescent lamps and magnetic ballasts, screw-in incandescent lamps, and a mixture of LED and non-energy efficient exit signs. The proposed retrofit project would replace energy inefficient lighting with T-8 lamps and electronic ballasts, screw-in compact fluorescents, and LED exit signs. The 2009 energy audit estimated lighting upgrades across campus, in approximately 35 buildings, will cost $1,945,000 (high estimate) and save approximately 1,769,000 kWh of electricity per year. This results in an annual GHG reduction of 730 MT eCO2 and 18,000 MT eCO2 over the life of the project.

The buildings included for lighting retrofits are Adams, Art Annex, Brantly, Clapp, Clinical Psychology, Corbin, North Corbin, Curry Health, Education, Fine Arts, Forestry, Grizzly Pool, Grounds and Labor, Health Sciences, Heating Plant, International Center, Liberal Arts, Lommasson Lodge, Mansfield Library, Mathematics, Miller, Motor Vehicle Garage, Music, N. Underground Lecture Hall, Natural Science Annex, Parking Garage, Par TV, Physical Plant, Rankin, Schreiber Gym, Skaggs, Social Sciences, University Center, University Hall, and Grizzly Stadium.

2009 Energy Efficiency Upgrades
Energy conservation measures identified by the audit include equipment upgrades, stream trap replacements, ventilation changes, and improvements to building envelopes in many of the same buildings previously listed under the lighting project. Funding for these projects was received in 2009 through the state of Montana's Long Range Building Program in the amount of roughly $1,800,000. The resulting electricity savings is estimated at 492,000 kWh per year and natural gas for steam at 14,400 MMBTU annually. Together, the resulting GHG emission reduction is estimated to be 960 MT eCO2 annually and 29,000 MT eCO2 over the life of the project.

Future Energy Efficiency Upgrades

Over 30 buildings were not audited. For the purpose of planning, it is assumed that energy audits will continue every three years until all buildings are completed and resulting identified projects will be funded and implemented. This does not include lighting retrofits as most of those will be installed under the first contract. Funding for this effort is unknown at this time, but including these projects in the Climate Action Plan will show the GHG emission reductions that could be realized. Again, just for the purpose of this plan, two cycles of projects are assumed, every two years, to cover all major buildings. The projects are also assumed to mimic the 2009 project in scope, cost, and energy savings.

The values in the table below were derived from project estimates inputted into the Clean Air Cool Planet's campus carbon calculator. MMBTU refers to natural gas used in the steam plant and kWh is kilowatt-hours which measure the electricity used. For reference, as of 2009, UM emits approximately 46,500 MT eCO2.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Lighting Retrofit	$1,945,000		1,769,000	$87,000	730
2009 Energy Efficiency Upgrades	$1,800,000	14,400	492,000	$70,000	960
2012 Energy Efficiency Upgrades	$1,800,000	14,400	492,000	$70,000	960
2015 Energy Efficiency Upgrades	$1,800,000	14,400	492,000	$70,000	960

Table 3. Strategy 4.1.1 Data - Energy Efficiency Upgrades

Barriers, Challenges, and Synergies

The lighting retrofit and 2009 Energy Audits projects are currently funded through the state of Montana's Long Range Building Program and performance contracting. Performance contracting is a method of leveraging the savings realized from reductions in energy consumption. A third party agrees to pay for and install energy conservation measures in exchange for a share of the energy savings, thus requiring little upfront funding.

Funding and/or the development of a performance contract will need to be accomplished for the 2012 and 2015 Energy Audit projects.

4.1.2 Behavior Modification

One of the most cost-effective ways to save energy and reduce GHG emissions is through changing energy-consuming habits and behaviors. Education and social marketing can result in energy-conscious actions such as turning off unneeded lights, adjusting building temperatures, shutting off equipment, using less hot water, and closing windows and doors. Not only do these habits save energy and money for the University, when people take them home, the benefits to our climate are expanded.

To effect changes in behavior, authors of the book Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing (McKenzie-Mohr & Smith, 1999) suggest starting by identifying barriers, then applying tools such as gaining a commitment from participants through personal contact. The next step is to pilot the community-based social marketing strategy and measure the results. Once effectiveness is established, broad implementation within a community is more easily accomplished. Ongoing monitoring provides evidence that a project is working and gains long-term commitment to the strategy. To optimize this strategy, staff (one full-time employee) should be added to accomplish the needed tasks.

Students of the University of Montana are typically very active and involved in solving a variety of environmental issues. They, along with faculty and staff, would most likely embrace the opportunity to work on behavior changing campaigns and initiatives along with monitoring success rates. In fact, many ideas were, and continue to be, identified through the Climate Action Planning process. Examples include:

- "Practice what We Teach" campaign (turn down the heat, use less AC, turn off the lights, drive less, recycle, power down equipment, etc)
- "Green Monte" video promoting green behaviors
- "Green Griz " events to promote recycling and energy conservation on campus
- Initiate energy saving competitions across campus
- Assign Building Managers and RAs the responsibility of energy conservation
- Provide information to students at orientation
- Acknowledge, celebrate, and reward individual, departmental and building-wide successes
- Have each building pay for own power as an incentive to save
- Meter buildings separately and make sure meters are accurate
- Quantify and measure results of energy conservation (condensate reader)
- Promote Library Sustainability Plan – encourage others to do the same
- Use Kill-a-Watt meters to understand and track individual energy use
- Custodians work from west to east to take advantage of daylight in the evenings
- Custodians start work earlier in the day to maximize daylight
- Encourage energy saving methods of living: unplug chargers when not in use; fill clothes and dish washers completely before using; use lids on pots when cooking; completely shut off devices instead of using power standby modes; use clothes lines instead of dryers; turn off lights; shut off hot water when not using; take shorter showers; etc.

Estimated Savings from Behavior Modification

Research shows that energy savings from behavior modification varies widely (Markowitz & Dopplet, 2009). Claims are made that range from a 5% reduction to as much as 56%, although this higher percentage was for only a two week period. A more reasonable range is 5-30%.

UM's Assistant Director for Engineering and Utilities, Laura Howe, in conjunction with the Climate Action Plan Technical Working Group, estimate energy savings from behavior modifications could be approximated at 5% of the natural gas used in the on-campus steam plant and 10% of purchased electricity. The resulting greenhouse gas and cost savings are estimated from projected natural gas and electricity consumption in 2011 as obtained from Clean Air Cool Planet's campus carbon calculator. Behavior modification projects could start earlier than 2011 but savings from this strategy would begin to be realized by then. The cost associated with this strategy is for staff to implement social marketing campaigns and to track progress.

Natural gas consumption in 2011 = 326,000 MMBTU
5% savings = 16,300 MMBTU

Purchased electricity in 2011 = 41,500,000 kWh
10% savings = 4,150,000 kWh

Strategy	**Implementation Cost**	**Estimated Annual Energy Savings**			**Annual Carbon Reduction, MT eCO2**
		MMBTU	kWh	Discounted Dollars	
Behavior Modification	$120,000	16,300	4,150,000	$243,000	2570

Table 4. Strategy 4.1.2 Data - Behavior Modification

Barriers, Challenges, and Synergies

One of the most significant barriers to this strategy is the present inability to measure results accurately. In order to do this, a metering system or some other method of measuring energy savings would need be designed and funded. Lack of evidence that behavior modifications are working is a barrier to gaining broad and long-term commitment to the strategy.

Examples from Other Universities

Mike Crowley of the University of California at San Francisco recently worked on a project where buildings were sub-metered and data collected before and after a social marketing campaign. They observed a 9% reduction in energy use that they believed was associated with their efforts.

4.1.3 Institute a 4-day Work Week

Instituting a 4-day work week can reduce the amount of heating, cooling, lighting, and commuting needed to operate a university. Some buildings and services still need to operate, such as dorms, dining services, maintenance, and health services, but overall energy consumption and GHG emissions could theoretically be reduced. A more detailed study is needed however to verify the change is worth the benefits.

At least two universities, Utah State and California State Polytechnic University in Pomona, have implemented a 4-day work week and are thus far finding it worthwhile. Cal Poly estimated they have reduced their GHG emissions by 0.4%. The University of New Mexico tried a 4-day work week and found their energy consumption increased due to air conditioning needs so they stopped the program.

Utah Governor Jon Huntsman launched the Working 4 Utah initiative instituting a compressed schedule of 4 ten-hour days for state facilities. Although there are kinks to be worked out in implementing such a schedule, Utah is generally finding that employees like it and the state is saving money from a 13 % reduction in energy use.

To estimate the savings UM might realize from a 4-day work week for the purpose of this plan, it was assumed that no classes would be held on Friday and staff would work 4 ten-hour days. Where possible, building night and weekend temperature settings would be extended to include Friday and lighting controls would be adjusted accordingly. To estimate the savings that might be realized from this strategy, it is assumed that natural gas and electricity use could be reduced by 2% of projected 2010 consumption rates. This strategy is estimated to save approximately 5,000 MMBTU and 812,000 kWh. There would be additional GHG emission reductions from less commuting which is quantified elsewhere.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
4-day Work Week	unknown	5,000	812,000	$54,200	600

Table 5. Strategy Data - 4.1.3 4-Day Work Week

Barriers, Challenges, and Synergies
Challenges to implementing this strategy include getting buy-in from staff, faculty, and students. Not every position will be eligible for a 4/10 schedule which may require more buildings to be operated than desired for maximum savings. This alternative schedule may also have impacts on child care and the ability to utilize carpools/vanpools.

Examples from Other Universities
California State Polytechnic University in Pomona implemented a 4/10 schedule in the summers of 2008 and 2009 and estimate they saved approximately 0.4% of their annual GHG emissions. They further estimate that 60% of the emission reductions came from changes in building operations and 40% from commuting.

4.1.4 Close Certain Buildings over Breaks/Summer

During summer session and over breaks there are far fewer people on campus. Therefore, it may be possible to consolidate areas of use and to close some buildings. Energy savings would then be realized from lower heating and cooling needs, less lighting and equipment use.

Further study is needed to tell exactly which buildings could be closed. Events and staff schedules need to be considered. To approximate the energy savings for this strategy it is assumed that savings would be slightly more than a 4-day work week. Natural gas and electricity use are estimates at 3% less than the projected 2010 consumption rates. It should be noted that if a 4-day work week is implemented, the savings of closing buildings would be somewhat less than estimated here.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Close Buildings over Breaks	unknown	7,400	1,220,000	$80,000	900

Table 6. Strategy 4.1.4 Data - Close Buildings over Breaks

Barriers, Challenges, and Synergies

The barriers and challenges for this strategy would be similar to those for a 4-day work week.

4.1.5 Retro-commission HVAC Systems

Over time, heating, ventilating, and air conditioning systems (HVAC) can become less efficient due to operational and occupancy changes. Retro-commissioning refers to commissioning existing buildings to ensure occupant needs are met as efficiently as possible. Commissioning entails evaluating mechanical, electrical, and controls systems and improving the way they function together. In a report published by Lawrence Berkeley National Laboratory, median commissioning costs for existing buildings are$0.30 per square foot with whole-building energy savings of 16% (Mills, 2004). To estimate the cost and energy savings that might be realized by retro-commissioning buildings on UM campus, it was assumed that 50% of the square footage could be retro-commissioned. The estimated cost of retro-commissioning 50% of UM's campus (including the College of Technology) is $600,000 with an annual energy savings of 25,500 MMBTU of natural gas and 3,250,000 kWh of purchased electricity.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Retro-Commission HVAC	$600,000	25,500	3,250,000	$240,000	2,700

Table 7. Strategy 4.1.5 Data – Retro-Commission HVAC

4.1.6 Reduce Vending Machines

Minimizing the number of vending machines on campus is a strategy that was identified during the public involvement process. Currently vending machines around campus offer juice, pop, and snacks. UM's vending contract does require energy efficient machines and reducing the number of machines would decrease electricity consumption even more. To replace the service, beverage fill stations could be piloted where people can fill their own containers at a cost. This also reduces recyclable plastic and aluminum containers as well as non-recyclable glass. It is roughly estimated that this strategy could save 438,000 kWh of electricity annually.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Reduce Vending	Unknown but assumed minimal		438,000	$20,000	180

Table 8. Strategy 4.1.6 Data – Reduce Vending

Barriers, Challenges, and Synergies

The current contract would have to be renegotiated
Need acceptance by faculty, staff, and students
Need to replace income generated from vending for recycling, etc.

Examples from Other Universities

The University of Idaho is planning to install beverage fill stations on a pilot basis.

4.1.7 Turn off Drinking Fountain Coolers

The idea of turning off the coolers at drinking fountains was brought up as a result of the Governor's 20 X 10 initiative. This strategy wouldn't cost much to accomplish but would save money and reduce GHG emissions by approximately 90 MT eCO2 per year.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Turn Off Drinking Fountain Coolers	$2,000		221,000	$10,000	90

Table 9. Strategy 4.1.7 Data – Turn Off Drinking Fountain Coolers

4.1.8 Compact Fluorescent Bulbs for On-Campus Residents

This strategy entails providing CFL light bulbs to student living in the dorms to be used in their task lighting. Perhaps Northwestern Energy would be willing to provide the bulbs. The CFLs could be provided as a check out item to reduce future costs.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
CFL bulb for dorm residents	$6000			$ 4,600	43

Table 10. Strategy 4.1.8 Data – Compact Fluorescent Bulbs for On-Campus Residents

4.1.9 Add Trees for Summer Shading

Planting trees on the south and west sides of some buildings could add shading in the summer and reduce the cooling needs. The trees should be deciduous to allow sunshine to warm buildings in the winter.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Trees for Summer Shading	$35,000		191,700	$9,000	80

Table 11. Strategy 4.1.9 Data – Trees for Summer Shading

4.1.10 Energy-wise IT Policy

- Replace monitors with Energy Star
- Power management software
- Cloud computing
- Capture waste heat from servers

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Energy-Wise IT	To be estimated			$ 4,400	40

Table 12. Strategy 4.1.10 Data – Trees for Summer Shading

4.2 Renewable Energy

Renewable energy is energy generated from rapidly renewable sources such as sunlight, wind, geothermal, and biomass.

The University of Montana is situated in an area with sunny summers and cloudy stretches in the winter due to valley inversions. Even so, the sun's energy can be utilized to produce electricity and to heat water. Missoula does not have a lot of wind in the valley, but mountain tops, ridges, and other areas of the state have some of the top wind resources in the nation. Sources of woody biomass surround Missoula and offer a large greenhouse gas emissions reduction opportunity. Geothermal, or heat from the earth, can be utilized through heat pumps to efficiently heat buildings. Several opportunities to utilize renewable sources of energy identified through the climate action planning process are listed and evaluated below.

Renewable Energy Generation
Greenhouse Gas Reduction Strategies

4.2.1 Biomass

4.2.2 Solar – Photovoltaic

4.2.3 Solar Thermal - Grizzly Pool

4.2.4 Wind

4.2.1 Biomass

Biomass fuel is derived from biological material such as wood, agricultural crops, and some municipal waste. Biomass can be used for direct heating in wood-fired boilers that produce steam or converted to liquid or gaseous biofuels. Woodchips, wood pellets, and other low-grade wood wastes are a major type of biomass fuel available in the Missoula area.

Two strategies using woody biomass are included in UM's Climate Action Plan: an on-campus wood-fired boiler and an off-campus biomass to syngas (synthetic natural gas) plant. Research into the feasibility is already underway for the off-campus biomass to syngas plant and that strategy is used for worst-case cost estimates in this plan as it is the most expensive option.

On-campus wood-fired boiler

Wood-fired boilers are in place at two nearby university campuses, UM – Western and the University of Idaho. They serve as examples for the UM – Missoula campus. The wood-fired boiler installed at Western initially had several problems which have been resolved. The system at the University of Idaho has been in operation since 1986.

Several concerns and potential solutions were raised about an on-campus wood-fired boiler during the planning process which must be addressed when determining the feasibility of this strategy. They include:

- Air pollution concerns
- Impacts to the historic character of the current steam plant
- Safety issues with several large trucks a day delivering wood chips to campus
- Reliability of the sources of woodchips
- Operation and maintenance costs

Off-campus biomass to syngas plant

Similar concerns are associated with the biomass to syngas technology. They are:

- Ensuring a reliable source of wood for the long term
- The technology is still in the development stage
- Commercial viability is not yet determined
- Overall costs of development and cost of syngas over the long term in comparison to fossil natural gas

Assumptions

Both the boiler and the syngas plant are sized to replace the amount natural gas used in one year at the Missoula Campus. This is approximately 350,000 MMBTU (projected use in 2014).

Cost of the biomass to syngas plant = $35 million

Cost of the wood-fired boiler = $20 million (This also includes costs for associated infrastructure changes such as loading and unloading accesses and working with the historic steam plant building.)

Cost of wood chips $40-55/green ton

The conversion rate from BTU wood to syngas guessed to be 50%

Heating value of wood 17 MMBTU/BD ton (Dave Atkins, USFS Fuel for Schools Program)

The biomass to syngas plant is estimated to consume approximately 41,000 BD (Bone Dry) tons of wood per year at a cost of $1,640,000 per year based on the estimate of $40/BD ton.

The wood-fired boiler is estimated to be 60% efficient (this could be as high as 75%) and consume approximately 34,000 BD tons of wood per year at a cost of $1,371,765 per year.

Electricity could also be produced from both processes but is not included herein. This is something that should be added in future plans and would make the use of biomass even more feasible. As will all the strategies put forward, much more detailed analyses are needed prior to implementing either biomass strategy.

Even though both plants are sized to replace the natural gas used by UM in one year, the carbon reduction for the wood-fired boiler is greater than for the gasification plant. This is because it takes more work to make syngas than to use directly in a boiler. The Clean Air Cool Planet campus carbon calculator assumes some greenhouse gas emissions from the use of wood, although much less than that attributed to fossil fuels.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Wood-Fired Boiler	$20 million	350,000		$1,300,000	20,000
Biomass to Syngas Plant	$54 million	350,000		$460,000	12,500

Table 13. Strategy 4.2.1 Data – Biomass Energy Generation

Examples from Other Universities

Chadron State College, Chadron Nebraska

Middlebury College, Middlebury, Vermont

Mount Wachusett Community College, Gardner, Massachusetts

University of Idaho, Moscow Idaho

University of Montana – Western, Dillon, Montana

University of South Carolina, Columbia, South Carolina

4.2.2 Solar - Photovoltaic

In 2008, Sam Hall, UM College of Technology student, developed a photovoltaic feasibility report for a site on UM's main campus. Data from Sam's report was used to estimate the cost of a photovoltaic array sized to produce 1% of UM's electricity consumption, which is 400,000 kWh (kilowatt-hours) annually. This equals a 326 kW array. The results of this analysis were also compared to recent studies completed by Missoula Children's Theater and the City of Missoula.

Assumptions:

- Sam Hall's report used a rule-of-thumb cost of $10,000 per kW.

- The Missoula Children's Theater project study used a cost estimate of $6,800 per kW.
- A recent project bid for the City of Missoula resulted in a cost estimate $4,800 per kW.
- We used an average cost of $7,200 per kW.
- A 326 kW array would cover approximately 50,000 square feet of roof space.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Solar - Photovoltaic	$2,350,000		400,000	$ 18,000	170

Table 14. Strategy 4.2.2 Data – Solar-Photovoltaic

Barriers, Challenges, and Synergies
Funding

4.2.3 Solar Thermal - Grizzly Pool

The 2009 energy audit project identified and estimated installing solar water heating for Grizzly Pool. Currently steam heat is used to maintain pool water temperature. Either evacuated tube or flat plate solar water heating panels could be installed on the south facing roof of the pool building to capture the sun's energy for partial pool heating. The installation includes piping, pumps, and a heat exchanger which use electricity that would somewhat offset the energy saving from using less steam.

The cost to install solar water heating panels and associated equipment was estimated by audit consultant CTA to be $350,000. Steam savings was estimated at 1963 MMBTU per year and the installation would use 8,500 kWh of electricity annually. The resulting saving in GHG emissions is approximately 100 MT eCO2 per year and 3011 MT eCO2 over the life of the project.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
Solar Thermal Grizzly Pool	$350,000	1963		$ 6,200	100

Table 15. Strategy 4.2.3 Data – Solar Thermal for the Grizzly Pool

Barriers, Challenges, and Synergies
Funding

4.2.4 Wind

Although areas in Montana are blessed with abundant wind, the Missoula valley, and UM's campus in particular, is not one of them. A small scale wind turbine located just north of campus generates data as well as electricity and confirms Missoula's paucity of wind for a large scale project. Even so, UM could take advantage of the state's wind resource by funding, partially or completely, installation of one or more turbines off-site. This could be done through a cooperative-type arrangement, where investors pool their resources to fund the development of a wind farm. The energy generated and put into the utility grid then offsets GHG emissions attributed to the University through Renewable Energy Credits. The University would also receive a portion of the profits when investing in a wind farm. However, a project of this nature will take further study to determine feasibility.

For the purpose of this plan, a relatively large-scale wind project was analyzed with the following assumptions:

- One 80 meter tower with a 1.5 MW (megawatt) turbine
- 33% capacity factor (an industry measure of electrical output that accounts for wind variability. 33% is equivalent to the wind resource at the Judith Gap wind development project.)
- Rule-of-thumb installed cost range from $1.2 to $2.6 million per MW of nameplate capacity (costs as of 2007, per Windustry) For our purposes, we chose $1.5 million/MW as this is assumed to be part of a larger wind farm-type development where fixed costs are apportioned among other towers and investors.
- Installation cost = $2,250,000
- Misc costs = $500,000 (feasibility study, permitting, design, and development)
- Total capital cost = $2,750,000
- Annual costs = $70,000 per turbine
    - Operation & Maintenance: $10,000 to $40,000; suggest $25,000
    - Land Lease: $3,000 to $10,000; suggest $5,000
    - Warranty: $15,000 to $30,000 for up to 5 years; suggest $20,000 for each of the first 5 years
    - Insurance: $8,000 to $15,000; suggest $10,000
    - Administrative & Legal: $6,000 to $10,000; suggest $10,000
- A 1.5 MW turbine would produce, on average, 4,336 MW hrs/year or 4,336,200 kWh/year (based on wind resources representative in Montana)
- UM consumes approximately 40,000,000 kWh/year

Estimates indicate that installing a 1.5 MW wind turbine in a location with an excellent wind resource would offset almost 11% UM's purchased electricity and reduce our carbon footprint by 1,788 MT cCO2. More 1.5 MW turbines could be purchased in the same way, resulting in even higher GHG reduction. Costs, savings, and annual carbon reduction potential shown in the following table could be simply multiplied by number of turbines purchased. This would result in a conservative estimate as economy of scale factors would not be included.

Strategy	**Implementation Cost**	**Estimated Annual Energy Savings**			**Annual Carbon Reduction, MT eCO2**
		MMBTU	kWh	Discounted Dollars	
One Wind Turbine	$2,750,000			$ 200,000	1,800

Table 16. Strategy 4.2.4 Data – Wind Power

Barriers, Challenges, and Synergies

Developing a wind farm takes considerable coordination between landowners, developer, utility company, and permitting agencies. Ideally this work is done by a developer. National Wind is one such developer that may be considering a project in Montana. A meeting with National Wind is planned in January 2010.

It might be possible to collaborate with other universities and campuses in Montana to cooperatively develop a large wind farm. This could help to promote and support the wind industry in the state.

Examples from Other Universities

Carleton College, Northfield, MN
http://apps.carleton.edu/campus/facilities/sustainability/wind_turbine/

St. Olaf's College, Northfield, MN
http://www.stolaf.edu/green/turbine/index.html

Iowa Lakes Community College, Estherville, IO
http://www.iowalakes.edu/programs_study/industrial/wind_energy_turbine/index.htm

4.3 Green Buildings

Making sure new buildings are energy and resource efficient when they are built reduces the long-term increase to overall greenhouse gas emissions attributed to UM. It is already University policy that buildings be constructed to at least LEED Silver certification.

Another option is to certify existing buildings as LEED EBOM (Existing Buildings, Operation, and Maintenance). This certification ensures that all buildings are brought up to stringent energy efficiency standards and conserve the use of other resources. LEED EBOM is currently being evaluated for the Lommasson Center to determine the cost, energy savings, water conservation, and other green standards. LEED EBOM was not evaluated in detail in this plan. It is a similar strategy as the Energy Efficiency and Retro-commissioning projects, although more comprehensive from a sustainability perspective.

Green Buildings
Greenhouse Gas Reduction Strategies

- Leadership and Energy and Environmental Design (LEED)
    - 4.3.1 LEED certification for new building

4.3.1 LEED Certification for New Buildings

LEED certified new buildings are estimated to cost an additional of $4 per square foot and the total implementation cost is based on the growth projections over the next 15 years. LEED buildings are 25% more energy efficient than conventional construction. Even though the Clean Air Cool Planet model projects LEED buildings to cost more then they save, there are many other benefits that are not quantified herein. Those benefits include conservation of other resources and occupant satisfaction.

Strategy	Implementation Cost	Estimated Annual Energy Savings			Annual Carbon Reduction, MT eCO2
		MMBTU	kWh	Discounted Dollars	
LEED for New Construction	$12,000,000	To be added	To be added	-$181,000 (cost)	2,700

Table 17. Strategy 4.3.1 Data – LEED for New Construction

4.4 Transportation

Transportation is a major source of greenhouse gas emissions at UM accounting for 31.6% of total emissions. The primary emission sources within transportation are student, staff and faculty commuting, the University fleet and air travel. See the graph below.

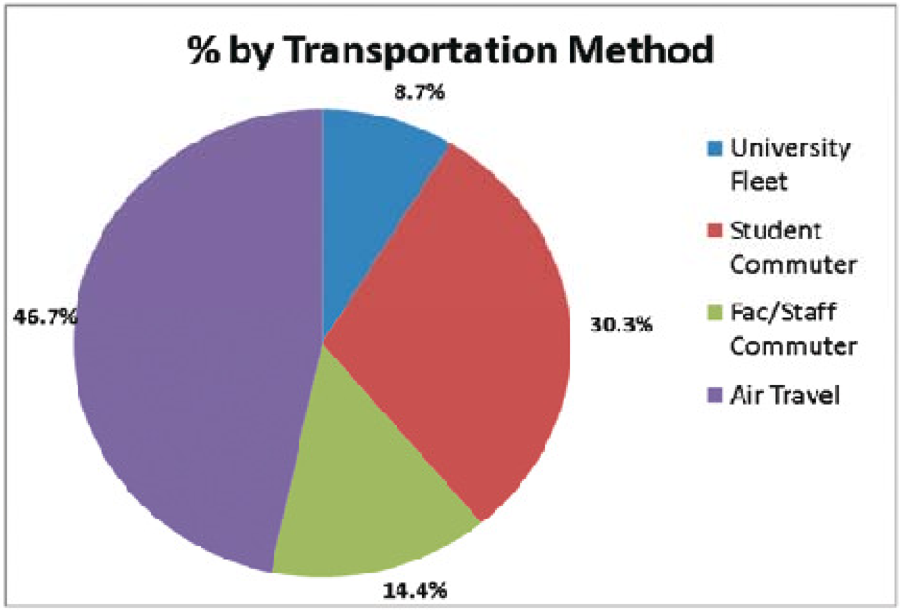


Figure 8. Pie Chart of Transportation GHG Emissions in 2007

In order to assess the updated commuting habits of students, faculty and staff, further surveys should be completed on a bi-yearly basis. Without adequate data it is difficult to determine how much certain strategies will reduce carbon emissions. This plan suggests many ways to lower the campus' carbon emissions and some of these may require significant behavior changes. It would be in the best interest of the University and all transportation entities on campus to conduct surveys to the campus community to gauge the interest and acceptance level of administering these changes.

In addition, a survey could discover the barriers associated with public transportation use, carpooling, and biking to campus. This could be helpful in determining best strategies to address these barriers.

Transportation Strategies

Staff, Faculty and Student Commuting

4.4.1 Promote and provide more bus transportation options
4.4.2 Increase incentives and opportunities to bike or walk to campus
4.4.3 Provide incentives to increase carpooling to and from campus and trips out of Missoula
4.4.4 Implement a parking management plan
4.4.5 Promote community housing plans within the urban core
4.4.6 Promote community and state wide efforts to develop a regional transportation plan
4.4.7 Implement a four day work week

University Fleet

4.4.8 Replace fleet vehicles with more compact cars
4.4.9 Replace some fleet vehicles with hybrid cars
4.4.10 Encourage academic departments to evaluate field trip fleet options
4.4.11 Research and develop alternative fuel options for ASUM Transportation busses

Air Travel

4.4.12 Encourage alternatives and reduction to air travel
4.4.13 Purchase high quality carbon offsets for necessary air travel

Staff, Faculty and Student Commuting

Student commuting contributes to 30.3% of total transportation GHG emissions at UM. Using data from a 2003 student survey to measure commuting habits, the percentage takes into account student travel while attending school but not to and from their home towns to Missoula. The survey found that 56% of students walk, bike or rides the bus to campus, 35% of students drive alone to campus, and 9% carpool to campus. Faculty and staff commuting comprise 14.4% of total transportation GHG emissions at UM. A survey conducted in 2006 by the ASUM Office of Transportation (ASUM OT) found that 35% of faculty and staff drive alone to campus, 32% bike or walk, 17% ride the bus and 16% carpool.

4.4.1 Promote and provide more bus transportation options

Increase ASUM bus frequency of service to East Broadway Park and Ride.

ASUM bus service, funded by student fees, is free and open to the public. In 2008 it provided an estimated 343,593 rides and used 19,881 gallons of fuel. It operates Fall and Spring semesters which averages out to 185 days of the year.

According to ASUM OT data, 16,056 people utilize the E. Broadway bus service annually. This is the least used route because it picks up every 20 minutes compared to other routes that pick up every 15 or 10 minutes. In order to increase the ridership of this route the plan suggests increasing the frequency of pick up to every 10 minutes. ASUM OT believes this will double ridership to 32,112 people annually causing 69,040 miles saved from individual commuters annually. This would account for a total of at least 3,452 gallons of gasoline saved in personal vehicles yet contribute to 2,600 more gallons of diesel used in the new ASUM bus.

In order for increased frequency of pick up time, one more bus would need to be added to the route. The price for purchasing one more bus is $350,000, diesel for one year would cost approximately $6,500 a year and operational costs for one bus are approximately $42,072 which include drivers, repairs and expenses.

When more people ride the bus, traffic on campus decreases as does the need to build more parking spaces. The plan assumes that as the student population grows another parking structure would need to be built if another bus were not added. Therefore, the University would save money by adding another bus instead of building a parking structure.

Strategy	**Implementation Cost**	**Annual Fuel Costs and Savings**			**Annual Carbon Reduction, MT eCO2**
		Personal Vehicles	ASUM busses	Discounted Dollars	
Increase ASUM bus frequency of service to East Broadway Park and Ride.	$350,000	Save 3,500 gallons	Use 2,600 gallons more diesel	$198,000	1.7

Table 18. Strategy 4.4.1 Data – Increase Bus Frequency

Increase awareness of busing opportunities to campus through ASUM while providing incentives to ride ASUM buses.

ASUM OT works hard to inform incoming students about the ASUM bus system. At every orientation they distribute bus maps and schedules along with other transportation resources. Many students who live off campus are aware of the options and utilize these resources. Student ridership has increased by 98% since 2000. This can be contributed to increased visibility on campus as well as increased service.

ASUM OT predicts a 5% increase of bus ridership if more incentives were put into place. The plan suggests continued visibility of ASUM OT through internet services such as Facebook, Twitter, a device to show the next bus arrival on a cell phone, real time bus digital maps on every bus stop and other outreach efforts.

An estimated 4,900 students drive to campus everyday. If ASUM OT increases incentives and outreach they estimate there would be a 5% increase in bus ridership. This would amount to 132,000 less miles driven a year in personal commuter vehicles.

The costs to providing greater bus awareness and incentives include hiring more student workers and developing web base technologies. The costs associated with hiring staff to implement behavior changes are accounted for under the Behavioral Changes section.

Strategy	Implementation Cost	Annual miles Saved from personal vehicles	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Increase education and incentives to ride the ASUM busses	$1,000	132,000	$-48	53.4

Table 19. Strategy 4.4.1 Data – Increase Incentive to Ride the Bus

4.4.2 Increase incentives and opportunities to bike or walk to campus

Construct a bike hub on campus with covered bike parking

Because of the flat geographical layout of Missoula, the city attracts many bikers and walkers. To keep up with the greater Missoula biking culture, ASUM OT is interested in creating a stronger biking campus community by constructing a bike hub that would promote biking to and from campus. Currently, an estimated 4,000 students, faculty, staff and visitors bike to campus daily (ASUM OT survey 2008).

Universities such as University of Colorado at Boulder and Winona State University in Minnesota offer students a central meeting place where students, staff and faculty can do bike maintenance and repairs. Using these examples, UM can build a hub which provides more bike parking, more covered bike parking, showering facilities, maintenance facilities and bike trail maps in Missoula.

According to ASUM OT the construction cost is $350,000 and would require one full time employee at $30,000 a year. ASUM OT estimates a 5% increase of bike users if the hub was constructed. Another option is to simply build a roof with more bike parking underneath. This would promote winter riding and add more bike parking to campus.

As this strategy is an expensive endeavor, more research on possible grant funding will need to be conducted in order to evaluate the feasibility of this project.

Increase visibility of bike incentive programs throughout the year

UM participates in two incentive programs organized by the organization Missoula in Motion: Walk 'n Roll week and The Way to Go club. Walk 'n Roll week is in conjunction with the larger Missoula community and encourages students, faculty and staff to bike, walk or bus to campus one week in the spring. In 2009 students participated in a raffle and won prizes for biking while local businesses offer discounts for bikers. According to ASUM OT survey data, last year there was a 15% increase of bikers in this one week alone. For the Way to Go club students pledge to use alternative transportation at least once a week for their commute. Students can win prizes by logging in their biking miles into a website. These prizes include discounts at local stores, gift certificates and merchandise.

While both these programs encourage alternative methods of transportation and prove to increase biking in Missoula, there remain opportunities to increase the incentive programs on campus. In order to create a stronger bike culture, students can generate points throughout the year and win cash prizes depending on how many days they walked or biked to campus. Another idea is for students to log their bike days and receive credit toward graduation, or even win free bike gear from participating stores. The idea is to reward students who bike and showcase their efforts, therefore encouraging other commuters to bike or walk to campus. There are also plans to create Missoula "Sunday Streets" where certain sections of the streets will be closed off to vehicles.

ASUM OT estimates a 10% increase in bike ridership if these incentives were to take place. Including the bike hub, an estimated 215,000 less miles would be driven a year to campus. The annual discounted dollars accounts for the savings the University would achieve in not building parking if the campus promoted an even greater biking culture.

Strategy	Implementation Cost	Annual miles saved from personal vehicles	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Increase incentives and opportunities to bike or walk to campus	$380,000	215,000	$166,000	90

Table 20. Strategy 4.4.2 Data – Increase Incentive to Walk and Bike

4.4.3 Provide incentives to increase carpooling to and from campus and trips out of Missoula

Increase visibility of rideshare program

With few options for public transportation throughout the state of Montana, traveling by personal vehicle is popular among students and thus many students bring their car to campus. In the 2007/2008 school year 7,403 students registered for a full year parking pass while 2,791 registered for a half year.

Discussions about banning freshman from bringing personal vehicles to campus have circulated in transportation plan meeting. However, until Montana institutes better public transportation methods state-wide and inter-regionally, ASUM OT and the Office of Public Safety do not see this as a viable option because many freshmen rely on their cars to drive home for breaks. However, because many students do have personal vehicles, there are opportunities to increase campus carpooling within the Missoula community and outside the city.

Currently, the ASUM OT website has a link to the national GoLoco rideshare program. ASUM OT encourages students to sign up to this program by distributing pamphlets at tabling events. According to the ASUM OT, this web based program has not been utilized by many students, perhaps because this is a multiple step process that each student is required to go through to join.

One way to increase the University rideshare program is to put up a physical rideshare board in the University Center. Already a board for housing exists, and students can contact the advertisers at their own risk. In addition, the dorms can put up a physical rideshare board in their lobbies. Both of these actions would make it easy for students to contact each other without the complications of an internet rideshare program. In the past, ASUM expressed interest in a physical rideshare board.

Barriers to Analyzing

Students may be utilizing other online ridesharing tools such as craigslist.org or making personal connections. Tracking rideshares is difficult for the University and distributing a campus wide survey could allow ASUM OT to make better estimates of ridesharing.

Work toward a carpool culture by providing incentives to carpoolers

From July 2007 to June 2008 faculty, staff and students combined registered for 12,767 parking permits. This figure includes full year, half year permits as well as motorcycle, carpool, go green retired and commuter spaces. Only 27 permits issued were carpool only spaces. The cost for obtaining a full year student parking permit is $185.00 while a half year student permit is $92.50. Carpool permits are only $10.00 for each member and must have at least three commuters. As shown, it is much more cost effective for the commuter to purchase a carpool permit, however very few students do so.

In order to promote more carpooling the plan suggests creating more education outreach to students who own cars and providing incentives. Incentives to carpooling can include creating parking spots that are closer to buildings that are designated carpool spaces only, and making carpool permits free. Many students have expressed that they do not even know carpool discounts exist. More parking education on the benefits of carpooling should be done at orientations or while students are purchasing their parking passes for the semester. Culturally speaking, carpooling is a behavior adapted by those who are community orientated. A greater awareness of this behavior should be stressed at all levels of the campus.

4.4.4 Implement a parking management plan

Discontinue the sale of parking permits and replace with daily fee stickers

According to the Office of Public Safety, there are approximately 4,000 parking spaces on campus and about 6,000 people drive to campus daily. When a person purchases a parking permit, the incentives to drive to campus as much as possible are great because a person wants to get their full money's worth. Under this strategy, semester and yearly parking permits would be discontinued and students, faculty and staff would instead be required to purchase a daily pass every time they drove to campus. Donald Shoup, a professor of Urban Planning at UCLA, recommends giving a credit to commuters then deducting that credit every time a person parks on campus. This informs the commuter that parking has a daily cost and disincentives driving to campus every day.

Although difficult to determine, ASUM OT estimates a 10% behavior change which assumes that 600 less people would drive to campus everyday. This equates to 666,000 less miles driven annually.

Barriers

Strategies to eliminate parking permits would most likely spur up a fair amount of resistance from commuters due to the inconvenience of purchasing a daily parking pass. Although it is difficult to determine, the Office of Public Safety may loose revenue which in turn would effect funding for campus security. The plan suggests evaluating how the Office of Public Safety receives its funding and possibly finding other sources of funding so that driving to campus is not continually incentivized. This strategy is proposed to begin thinking about opportunities to decrease traffic surrounding campus, motivate public transportation options throughout the city, and create a community of public transport throughout the greater Missoula region.

The costs to this strategy are unknown at this time due to the complexity of how parking operates.

Strategy	Implementation Cost	Miles Saved from personal vehicles annually	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Discontinue the sale of parking permits and replace with daily fee stickers	Unknown	540,000	Unknown	218

Table 21. Strategy 4.4.4 Data – Daily Parking Passes

More parking spaces designated for hybrid or electric cars only

In previous years, the Office of Public Safety offered a “Go Green” parking pass to encourage commuters to drive electric, hybrid or vehicles with a fuel consumption rate of at least 50 miles per gallon. Qualifying vehicles under this policy are listed on the fueleconomy.gov website. Vehicles were offered a discount permit of $61.50 for a full year. In 2007/2008 only 11 permits were purchased, indicating that many commuters do not own cars that meet the high efficiency standards or are not aware of the program.

In order to comply with LEED standards and to create an incentive that is easier to attain, LEED accredited professionals have been working with the Office of Public Safety to make the “Go Green” permits more accessible. Because very few students can afford hybrids which get 50 miles per gallon, and only one car qualified, the plan modified the standard to include cars that comply with Smart Elite fuel efficiency standards. This standard takes into consideration the life cycle of the car and greenhouse gas emissions. Low emissions and fuel economy are both good for the environment. This list also yields 12-14 vehicles, making the permit attainable by more students/faculty and staff. Fuel economy ranges from 33-51 in city and 31-48 on the highway. These standards and the list of complying cars can be found on the following site:

http://www.epa.gov/greenvehicles/Index.do along with information about the rating system

http://www.epa.gov/greenvehicles/Aboutratings.do.

Barriers

Parking is one of the most challenging strategies to include in a climate action plan. If the University chooses to raise parking prices and public transport does not provide more options, then there is a possibility for those who could afford to pay would get better parking spaces and those who could not would be left with fewer options.

Additionally, discouraging parking ultimately leads to a reduction in parking revenues. However, a significant reduction in greenhouse gas emissions could result if the campus did not place incentives for parking on campus. Because of the complexities of parking strategies at UM it is beyond the scope of this plan; however the Office of Public Safety and administrative units should create a comprehensive parking management plan to develop disincentives for driving to campus while finding other sources of funding for the Office of Public Safety.

Additionally, it is understood that handicap parking will still need to be available and the plan does not recommend penalizing those people who must still drive to campus and have parking spots close to campus buildings.

Other Strategies

Raise the price of parking permits for events based on where people park.

Raise the price of parking permits based on the lots closest to buildings on campus.

4.4.5 Promote community housing plans within the urban core

Develop location efficient housing loans for faculty and staff

According to a Missoula in Motion 2006 transportation survey, 74% of 506 UM faculty and staff commute 3 miles or greater to campus daily. Rising housing prices within the University district and the urban core are a main contributor to urban sprawl, preventing a large percentage of faculty and staff from biking or walking to campus. Many faculty and staff do choose to live outside the city; however, the ASUM OT estimates that approximately 1/3 of faculty and staff would live closer to campus if housing prices became affordable.

One option UM can take to encourage more faculty and staff to purchase homes closer to campus is to offer housing assistance programs. The University of California San Francisco participates in a Mortgage Origination Program through their Academic Affairs Office. This program provides first deed of trust financing where eligible participants can take advantage of convenient financing terms that are generally more attractive than those offered by most lending institutions. The Program provides up to 40-year variable rate loans at maximum amounts of 85% to 90% of value depending on loan size.

There are approximately 2,400 faculty and staff combined at UM. Assuming 1,776 of them live further than 3 miles from campus and drive to campus everyday, if 1/3 move closer to campus and have the ability to walk, bike, or take the bus this means 592 more people would live close to closer. Currently, we do not have the data to know how far people live from campus to calculate commuter miles saved

Barriers

The cost of this plan was not analyzed in detail because it is difficult to determine how much each new buyer would need for a down payment or loan. This strategy is highly dependent on market forces and the greater Missoula community development plan. Additionally, although the ASUM OT assumes that about a 1/3 of faculty and staff would move closer to campus, questions remain on how much denser Missoula's urban core could become with a higher population. More affordable faculty and staff housing would need to be built close to campus in the form of apartments or condos.

If the University plans to implement this strategy, significant amount of research would need to be conducted both on campus and throughout the greater Missoula area.

Strategy	Implementation Cost	Annual miles saved from personal vehicles	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Develop location efficient housing loans for faculty and staff	Unknown	333,000	Unknown	134

Table 22. Strategy 4.4.5 Data – Location Efficient Housing

Develop student housing within 3 miles of campus

More development around the Missoula airport and the expressway indicates that urban sprawl has increased to the West. Students are continuing to live farther away from Missoula's urban core because cheaper housing is available farther from campus. As UM student population grows, more affordable and appropriate housing within Missoula city limits is needed. Currently, the ASUM Off-Campus Rental Center is responsible for much of the off-campus student housing. The University administration must recognize that it has a stake in where students live and can play a key role in developing affordable housing within Missoula's urban core.

According to Resident's Life, about 3,000 students live in on-campus dorms, making up about 21% of the student population. That leaves 79% of students living off campus. Currently, there is no way of knowing how many miles away students live off campus. However, a survey conducted is scheduled to go out to the student body this Fall asking where students live, their method of transportation, and barriers to taking public transport. The results of this survey will be very helpful creating more opportunities for transportation options.

The Off-Campus Rental Center suggests creating a partnership between UM and private housing developers. Universities like Portland State are partnering with private housing developers to build off campus apartments for students.

A positive example currently in place is the UM Forum for Living with Appropriate Technology (UM FLAT). This sustainable living unit a block away from campus is owned by UM and operated by students. This home acts as a model for affordable, energy conservation and location efficient housing for students. Plans to convert an entire block to sustainable housing units are in discussion, and if created would enable students to live within walking distance to campus while modeling sustainable living habits.

4.4.6 Promote community and state wide efforts to develop a regional transportation plan

Encourage the North Coast Hiawatha passenger rail option through Missoula

With the high price of airline tickets in and out of Missoula, students and Missoula residents are searching for alternative methods of transportation. Talk of an Amtrak line through Missoula has been circulating between Montana citizens and alternative transportation advocates for some time now. An October 2009 article in the *Missoulian* cited the potential for 360,000 riders a year. The startup costs are estimated to about 1 billion dollars.

According to the *Missoulian* article, the train is 19% more energy efficient than air travel and 28% more efficient than auto travel. Rail services also emit several times less carbon dioxide per passenger-mile than either air or highway travel.

The plan encourages UM to become actively involved in promoting Amtrak route construction through Missoula. A train could potentially decrease the number of cars students bring to campus every year which would help with congestion on campus and lower commuter emissions.

Increase Mountain Line routes to campus

Currently Missoula Mountain Line Bus Company has three routes to UM. Discussions around adding a Lolo commuter route are circulating around Mountain Line and Missoula residents. For fiscal year 2009, 239,044 UM affiliates rode the bus. This number includes students, staff and faculty.

A survey by Mountain Line will be conducted in the next few months asking where the end point of the Lolo Commuter Route should be. At this point, Mountain Line is unsure how many people commute from Lolo to the University everyday, but there have been many requests from faculty to create a service from Lolo to the University. This bus, which is tentatively scheduled to begin service in Spring 2010, has the potential to increase bus ridership. It is difficult to determine how many students this would affect as there is minimal data on where students live. Again, conducting a campus-wide survey on transportation and housing needs of students and faculty would greatly improve decisions on future transportation options.

4.4.7 Implement a four day work week

Instituting a 4-day work week can reduce commuting to and from campus. The University of Utah implemented a 4-day work week and reported significant savings on commuter travel. The plan estimates a 10% decrease in commuting if Fridays became no class days. This is a conservative estimate assuming that some people would still need to come to campus, and Fridays are lower traffic days anyway.

The greenhouse gas inventory and surveys conducted by ASUM OT estimates that 6,000 people drive to campus everyday. This figure includes students, staff and faculty. Assuming that people drive at least 6 miles round trip, and will drive 28 less days a year (every Friday), if 10% less people drove to campus this would equal 100,800 less miles driven annually.

Strategy	Costs to University	Miles saved per vehicle annually	Discounted Dollars	Annual Carbon Reduction, MT eCO2
4-day work week	None	100,800		40.7

Table 23. Strategy 4.4.7 Data – 4-Day Work Week Commuting

University Fleet

The University fleet accounts for all GHG emissions associated with University owned and operated vehicles as well as any recorded University-related ground travel. Facilities Services operates a rental service which the campus community is expected to utilize whenever possible. The table below indicates the type and number of vehicles.

Type	#
Mid Size Sedans	8
Fifteen Passenger Vans	9
Mini Vans	4
Large SUVS	6
Compact Cars	4
Hybrids	5
Large Truck	1
Small Truck 1	1
Total	**38**

Table 24. University Fleet

The University also has a campus-wide bus transportation system through ASUM OT. This service operates 4 routes with 6 buses, including East Broadway Park and Ride, South Campus Park and Ride, College of Technology shuttle and UDASH, the late night bus service from downtown to campus. In 2000 ASUM OT began using biodiesel in their busses; however in 2008 their source discontinued production and currently the buses run on regular diesel.

The fleet vehicles are replaced about every 4 years. The reductions for carbon dioxide emissions are based on 20 year reductions though the cost associated with the replacement for vehicles is only calculated for every 4 years.

4.4.8 Replace fleet with more fuel efficient vehicles

Replace Midsize Sedans with Compact Cars

The University fleet operates 8 midsize sedans one of which is the Ford Taurus. For an automatic 2005 Ford Taurus the fuel mileage is 25 mpg on the highway. The fleet's compact cars include the Dodge Neon model which gets approximately 29 mpg on the highway (www.fueleconomy.gov). If we replace our 8 midsize vehicles with 8 compact cars we would save approximately 1,325 gallons of gasoline per year. In terms of costs, we would save $2,101 per vehicle. (Pre-Requisition Forms – 2010 Model Vehicles Form from).

Replace SUVs with Mini Vans

The University fleet operates 6 large SUVs including 3 Suburban Chevys which get 14 mpg on the highway. The fleet also operates 4 minivans including a Chevy Venture which gets 24 mpg on the highway (www.fueleconomy.gov). If we replace three SUVs with minivans we would save 3,386 gallons of gasoline per year. A 2010 large SUV costs $35,172, while a 2010 Mini Van costs $28,679 (Pre-Requisition Forms – 2010 Model Vehicles Form). If the fleet replaced 3 SUVs with 3 Mini Vans there would be 7 total Mini Vans and only 3 SUVs contributing to a cost savings of $6,493 per new purchased vehicle.

Replacing fleet vehicles with more compact cars appears to be cost efficient for the University and provides significant carbon reduction. When compared to purchasing hybrids, this strategy proves far more beneficial in costs and carbon reductions.

Barriers

The fleet vehicles respond to demand from campus and must meet the needs of users. Some trips require off-road travel which a mini-van would not be able to handle and where an SUV may be necessary. Therefore, replacing as many vehicles as possible with more fuel efficient ones is advised, but understood that not all vehicles will be able to downsize.

Strategy	Implementation Savings per vehicle	Annual gallons of gas saved	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Replace fleet with more fuel efficient vehicles	$8,600	4,700	6,232	42

Table 25. Strategy 4.4.8 Data – Fuel Efficient Fleet

4.4.9 Replace vehicles with hybrid and electric

Replace maintenance trucks with electric trucks

The table below indicates the type and number of vehicles that operate in the maintenance fleet. The fleet already uses one electric truck. The EPA website, fueleconomy.gov, estimates that a Ford pickup gets 21 mpg. An electric truck requires no gas and has zero tailpipe emissions.

Type	#
Large Vans	3
Mini Vans	1
Large Pickups	16
Small Pickups	40
Total	**60**

Table 26. Maintenance Fleet

Barriers

The electric truck currently used is not heavy enough to carry all the maintenance tools and so there is resistance from the maintenance staff to use more electrics. The hybrid car that is scheduled to replace a truck is also facing some resistance because a truck is needed to carry the tools. However, as the market continues to manufacture more durable electric trucks the University should strongly consider replacing all maintenance trucks with electric trucks.

Replace mid size sedans with hybrid mid size sedans

Apart from the maintenance trucks, the fleet operates 8 midsize sedans which get approximately 25 mpg on the highway. A 2010 Ford Fusion costs $19,620. A Ford Fusion Hybrid gets 36 mpg on the highway and costs $27,625. As shown, it is more expensive to replace fleet with hybrid cars than switching to more compact cars, and the fuel savings is actually less. The plan suggests purchasing smaller cars that are not necessarily hybrids to save money and fuel.

Strategy	Implementation Costs	Fuel Saved per vehicle	Discounted Dollars Annually	Annual Carbon Reduction, MT eCO2
Replace vehicles with hybrid cars	$64,000	2,700	$1,300	24

Table 27. Strategy 4.4.9 Data – Hybrid Vehicles

4.4.10 Encourage academic departments to evaluate fleet options

Academic departments are the highest users of fleet vehicles and can look for ways to combine trips with other departments and within their own departments when going on field trips and for faculty research. In the 2008/2009 school year mid-size sedans and compact sedans took a total of 800 trips, averaging to 350 miles a trip. If 10% of those were combined trips 28,000 less miles a year would be driven. The plan suggests making field trip consolidation a bigger priority among departments and in athletics.

4.4.11 Research and develop alternative fuel options for ASUM Transportation buses

From 2000 to 2008 the ASUM buses operated on biodiesel fuel sourced from a local supplier. With no current commercial availability ASUM buses went back to using regular diesel fuel. ASUM uses 19,881 gallons of gasoline a year in all six buses. At about $2.50 a gallon this amounts to $49,702 a year for diesel fuel. If ASUM switched to 80/20 blend of biodiesel it would cost about a dollar more a gallon increasing the price to $69,583 a year.

Because there is no longer a local supplier, the University can start a program through the College of Technology and other departments to teach students how to produce, manufacture and store biodiesel. Another idea is to use fryer grease from Dining Services to turn into fuel. Not only would this turn our current ASUM diesel buses into biodiesel, but it would develop hands-on research opportunities for students and faculty.

Strategy	Implementation Costs	Gallons of gasoline saved per vehicle	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Research and develop alternative fuel options for ASUM Transportation buses	$19,881	19,881		42

Table 28. Strategy 4.4.11 Data – Alternative Fuel for Buses

Other Strategies

Purchase low rolling resistant tires for all fleet vehicles

Add an ASUM bus route from the Missoula transfer station to campus.

Air Travel

According to the greenhouse gas inventory, in 2007 the University traveled 8,007,646 miles and spent $2,001,911 on air flights. This data did not include athletic travel because that information was not available at the time of the inventory. Travel from student's home to campus was also not included, but all study abroad trips and faculty, administration and student individual business travel was. Since the 2008 GHG Inventory, data from athletic travel was gathered and indicates that in 2009 they traveled 1,529,216 miles and spent $382,304 on air travel. In order to convert dollars to miles traveled we divided dollars by factor $0.25 per passenger air mile. This shows that the University travels an estimated 9,500,000 miles a year.

According the 2007 GHG inventory, air travel amounts to 46.7% of all UM's transportation GHG emissions, not including travel by the athletics department. Significantly reducing the University's air travel is challenging because in order to continue the athletic program, study abroad and other university related travel, traveling by air is the most time efficient and sometimes the only means of transportation.

Because UM is located in Montana, a state sparsely populated and somewhat isolated from other major universities, there are barriers to eliminating air travel. However, opportunities do exist to significantly reduce the number of flights taken. One of the most widely accepted strategies by other universities is to purchase high quality carbon offsets when air travel is unavoidable and encouraging departments to use video and teleconfrencing. The strategies below represent ideas generated by stakeholder groups including the Athletic department.

At this time more data is needed to adequately address which departmental units on campus are the highest air travelers. This can be done by separating out administration, faculty and student travel or breaking it down by colleges. As shown, the only specific data calculated was from Athletics while the rest of campus was calculated as one. In order to move forward in reducing carbon emissions through air travel and developing a strong carbon offset program comprehensive data analysis research will be required.

4.4.12 Encourage departments to seek alternatives and reduction to air travel

Encourage more video and teleconferencing with departments

Already departments across campus are utilizing video and teleconferencing to minimize costs associated with traveling. The Athletics department reports a decrease in air travel this year from holding teleconferences. The plan recommends giving incentives to faculty that utilize video and teleconferencing instead of traveling to conferences. The University can set up a videoconferencing center, perhaps in the UC, that is equipped with appropriate technology such as screens and microphones. This center could hold large amounts of people and become a regional videoconferencing hub for Montana. Encouraging more people to visit UM would generate revenue for the University in multiple forms.

Evaluate necessity of air travel

The plan suggests academic departments, administration, and Athletics evaluate their necessity of air travel. Understanding that air travel is inevitable to running a globally minded university, there remain ways to reduce the amount UM travels. Many departments are already cutting back on air travel due to budgetary restrictions. The plan does not suggest limiting each department to a certain number of flights per year; however greater awareness about carbon emissions from flying is recommended within each department.

4.4.13 Purchase high quality carbon offsets

Many universities are exploring ways to address air travel by purchasing high quality carbon offsets. One example is the University of Wisconsin Athletic department who purchased carbon offsets for its entire season of home games, an estimated 8,100 tons of carbon dioxide emissions.

The offset company in Missoula, Clear Sky Climate Solutions, provides projects that sequester carbon funded by carbon offsets. Two of these projects are in Montana and include a responsible rangeland project and a dairy methane capture project. Purchasing from this company is one avenue the University can take to offset its carbon emissions through air travel. More options are discussion in section 4.5.

The table below shows the cost to offset all air travel which is equal to 9,500,000 miles by purchasing carbon offsets at a cost of $20 per MTeCO2.

Strategy	Implementation Costs	Discounted Dollars	Annual Carbon Reduction, MT eCO2
Purchase high quality carbon offsets for air travel	$148,000		7,400 MTeCO2

Table 29. Strategy 4.4.13 Data – Carbon Offsets

4.5 Offsetting Emissions

The concept of carbon offsets may be confusing or little understood by some people and this section is an attempt to demystify the topic. We will briefly consider a working definition, utilization, history, quality issues, quality assurance, and market data.

Definition

The American College and University President's Climate Commitment (ACUPCC) consortia offers this by way of a definition[i]: "…a carbon offset is a reduction or removal of carbon dioxide equivalent (CO_2e) greenhouse gas (GHG) emissions that is used to counterbalance or compensate for ("offset") emissions from other activities." To elaborate further: a carbon offset is a free-market tradable financial instrument that represents the effects of one metric ton of carbon dioxide that is removed from the atmosphere or prevented from entering the atmosphere in the first place.

The large concentration of carbon dioxide in the atmosphere makes CO_2 the principal contributor to the earth's greenhouse effect but despite its notoriety, it is only one of several greenhouse gases[ii] that contribute to the problem. The concentrations and effects of all the greenhouse gases can be expressed in terms of Global Warming Potential ("GWP") or carbon dioxide equivalency ("CO_2e"), even though not all greenhouse gases contain carbon (nitrous oxide, N_2O, and sulphur hexafluoride, SF_6, are 2 examples). So then, the expression "carbon offset" is not precisely accurate but the term has become standard usage and is well-understood. In essence then, one carbon offset equals the same global warming effect of one tonne[iii] of CO_2, no matter what actual greenhouse gas is being considered.

Carbon offsets are an intangible commodity. In much the same way as a stock market transaction, a purchaser of carbon offsets typically just receives a receipt indicating the details of the transaction: date, vintage (the year the offset was created), and number of offsets. These instruments could be resold or brokered by the purchaser but in most retail sales of offsets, they are "retired" or permanently removed from the market by the broker at the time of the purchase. It is only when an offset has been retired from the marketplace that the purchaser can legitimately apply it to the reduction of the purchaser's carbon footprint.

Utilization

As individuals, institutions and corporations pursue carbon neutrality (the ACUPCC prefers to use the term "greenhouse gas (GHG) neutrality"), the emerging operative motto is "reduce what you can, offset what you can't."[iv] This phrase embodies a two-step approach: the first step is emissions reductions achieved through avoidance, efficiency, conservation and, perhaps, investments in renewable energy generation or carbon offset projects. The second step is to then purchase the requisite amount of carbon offsets to gain neutrality after all reasonable measures have been implemented in step one. With few exceptions, purchasing carbon offsets will become the final strategy with which one can achieve carbon neutrality. The ACUPCC promotes the follows strategic approach[v]:

1. Avoid GHG emissions as much as possible, as soon as possible
2. Reduce direct GHG emissions as much as possible, as soon as possible
3. Ensure all of the built infrastructure and operations are as energy efficient as possible immediately
4. Reduce fossil fuel-dependent means of transportation
5. Replace all fossil fuel derived energy sources with clean, renewable energy sources
6. Adopt an expanding boundary in terms of GHG emissions for which the institution takes responsibility
7. Evaluate the option to develop and/or invest in credible , real offsets

It is important to note in the above strategy that offsets are recommended only after other mitigation strategies have been explored and implemented. But a case can also be made for an institution to immediately achieve carbon neutrality by the application of offsets even before efficiency and conservation have been fully implemented. So doing thrusts an additional financial incentive upon the institution to quickly and thoroughly apply all cost-effective emission reduction measures in order to minimize the financial burden of offset purchases. In 2007, this strategy was adopted by the College of the Atlantic[vi] in Bar Harbor, Maine and it became the first American institution of higher learning to become carbon neutral.

History

The first carbon offset project was implemented by Applied Energy Services (AES) in 1989. The project involved planting 50 million trees in Guatemala in order to offset the anticipated carbon emissions from a proposed coal power plant in Connecticut. While the coal plant was eventually built, the poorly conceived offset project foundered[vii] but the upshot was that the offset concept was made manifest for the first time. The Kyoto Protocol was established in 1997 to come into force in 2005. The Protocol anticipated the development of a carbon offset trading market that would result from global cap and trade legislation. It was hoped that the offset market would mimic the successful U.S. 1990 acid rain mitigation program[viii] that involved cap and trade of sulfur dioxide and NO_x. In the United Kingdom, the first ever multi-industry voluntary emissions trading market began operating in 2002 but ceased when the mandatory European Union Emissions Trading Scheme began in 2005. In 2003, the Chicago Climate Exchange was the first organization in the U.S. to attempt to commercialize carbon offsets in a voluntary market.

As of November, 2009, there are dozens of retail offset providers across the globe engaged in developing projects and brokering offsets. If or when the U.S. enacts GHG emission cap and trade legislation, it will impact the carbon offset market immediately and in a big way. Such a move will have similar impacts on fossil fuel pricing and potentially make alternative energy strategies more financially attractive and cause greater investments in energy conservation and efficiency measures.

Quality Issues

The fact that the market for carbon offsets is relatively new means that the products (the carbon offsets), the projects that generate offsets, the developers of those projects, agencies that certify offsets, the brokers and the buyers of offsets are all evolving in terms of quality and sophistication. As with any emerging market, there is often an initial flood of market entrants – new companies, developers, products and advertising campaigns – that attempt to differentiate products and attract customers through a variety of strategies. In such a young and novel market dealing with an intangible commodity, the notion of offset *quality* has become an important and controversial topic. Essentially, an offset project needs to quantify two things: 1) the baseline greenhouse gas emissions that would have occurred without the project; 2) the amount of GHG emissions removed or prevented by virtue of the project's existence. To the degree that a project can clearly and forthrightly compute those quantities would bestow upon it a high perception of quality in comparison to a project where the calculation of those quantities are unknown, uncertain or in other ways suspect. This is just one aspect of the quality debate.

Another rather critical attribute is that of *additionality*. In order to qualify as additional, an offset project must show that it is a direct consequence of offset sales. It is this attribute which determines whether or not a project reaches beyond "business as usual." As an example, a project to capture and burn landfill methane gas in a steam turbine would not qualify as an offset project if local air quality regulations had required mitigation of the landfill gas.

Besides the attributes described above, different independent certifying organizations have promulgated various other criteria that offset projects must meet in order to receive their certification. Certifications are explained in the section on quality assurance. In order to serve its higher purposes as a community role model and teaching institution, the ACUPCC has carefully evaluated issues of offset quality and has proposed the following list of attributes[ix] as contributing to high-quality offsets. Note that not all offset projects will be able to perform well in all of these areas but that should not necessarily preclude such projects from consideration.

1. Transparent: All project details are provided.
2. Real: Offsets result in net reduction of emissions and do not come about by way of some accounting adjustment.
3. Additional: Project passes tests showing it is legitimately a result of offset purchases.
4. Measurable: Can the amount of carbon dioxide offset by project be quantified?
5. Permanent: Is the reduction irreversible?
6. Valid and Verifiable: Have projects been evaluated by an outside party?
7. Synchronous: Is the timing of the reduction appropriate?
8. Account for Leakage: Have potential inadvertent emissions increases elsewhere been accounted for? For example, if a sector of forest is preserved, does that push logging or firewood gathering into other unprotected areas?
9. Include Co-Benefits: Does the project have other social, environmental and economic benefits?
10. Enforceable: Are the offset investments backed up by a contract? As an example, if a forestry project burns down, is there some recourse to vouchsafe the expected offsets?
11. Registered: Is the reduction counted only once and custody transfer adequately tracked?
12. Double Counting: Is the reduction claimed by one entity only? For example, an energy efficiency project by a city will unload a power plant. The city legitimately takes credit for the offsets produced. But perhaps the power plant has also performed some energy efficiency measures and takes credit for power reductions due to both its efficiency work and that of the city.
13. Retired: Have the credits been pulled out of the market?

One further point requires some elucidation: renewable energy certificates ("REC's" or "green tags") are not the same as carbon offsets. While a carbon offset is one tonne of CO_2e, a REC represents the environmental attributes of one megawatt-hour of electricity generated by a renewable energy source. It is possible to interconvert REC's and carbon offsets if the carbon intensity of the electrical grid where the renewable energy generator is connected is known. REC's are bought and sold via a similar market trading mechanism as carbon offsets and provide distinct financial incentives to developers of renewable energy but, because the amount of GHG emissions that are offset by a renewable energy generator can be nebulous (which particular fossil fuel plant is unloaded by the renewable energy generator?) as well as potentially double-counted (once by the renewable energy generator and once by the reduction in the fossil fuel power plant), REC's must be carefully scrutinized in order to be considered high quality carbon offsets by ACUPCC's protocol.

<u>Quality Assurance</u>

The carbon offset market is young and evolving. Most companies offer legitimate goods and quality services, but there are occasionally some participants whose products, projects or sales methods may not be aligned with the industry's best practices. In an attempt ensure quality offsets, to protect consumers, and to foster buying confidence, several certifying agencies and standards have been created across the globe. They all endeavor to provide objective, third-party evaluation of the quality attributes of offset products (see section on Quality Issues) that can result in certification of those offsets that pass such examination. Each offset is assigned a serial number which is recorded and tracked throughout all transactions until its final retirement from the market. Such procedures help ensure that verifiable audit trails exist and that no offset is double-counted by different projects or is sold to multiple consumers. A discussion of the various standards and how they compare to the ACUPCC's quality criteria is provided in ACUPCC literature[x].

Market Data

The price of offsets is dynamic, fluctuating with supply/demand imbalances. A recent survey of 15 carbon offset providers (November, 2009) showed that there is quite a range of retail[xi] prices per carbon offset – from a low of $1.00/tonne CO_2e to a high of $425/tonne CO_2e, but these low and high points were untypical outliers. The median and mode were $14 and $10/tonne CO_2e respectively and seemed to be more representative for most of the providers. Features such as type of project, quality of the offset as well as market trading forces can all influence pricing. See the table below for survey data.

Company	$/tonne CO_2e
GreenAnySite.com	1.00
Carbonfund.org	10.00
Sustain Our Planet	10.00
4Offsets.com	10.00
Trees, Water & People	10.00
Carbon Credit Environmental Services	10.00
GreaterGood.org	10.00
Be Green	14.00
ClearSky Climate Solutions	15.00
Enpalo	20.00
CO_2logic	20.00
Tricorona	25.00
Cleaner Climate	25.00
Rainforest Rescue	25.00
Western Colorado Tree Preserve	425.00

Table 30. Pricing Survey of Carbon Offsets

4.6 Evaluation of GHG Emissions Reduction Strategies

Strategy Evaluation

The GHG emission reduction strategies described in Section 4 were compared using the bar graph on the following page. The graph displays the annual amount of GHG reduction in metric tonnes of carbon dioxide equivalent (MTeCO2) per strategy along the horizontal axis and the annual cost or savings per MTeCO2 reduced along the vertical axis. The width of the bar is relative to the quantity of eCO2 reduced. The height of the bar, either above or below the x-axis, displays the relative cost or savings. The order of the strategies from left to right corresponds to how they are listed in the legend. The strategies are listed in order of greatest costs to greatest savings. Please note that some bars are difficult to see because of their relative greenhouse gas emission reduction is small.

The benefit of the bar graph on the next page is that it helps to see which strategies should be highest priority for implementation to achieve the greatest reduction in greenhouse gas emissions. It also helps to point out strategies that are worth implementing even though a strategy is toward the bottom of the priorities list based only on cost per MTeCO2. The Biomass Energy Generation, Wind Power, and LEED for New Construction are such projects. All can achieve large reductions in GHG emissions.

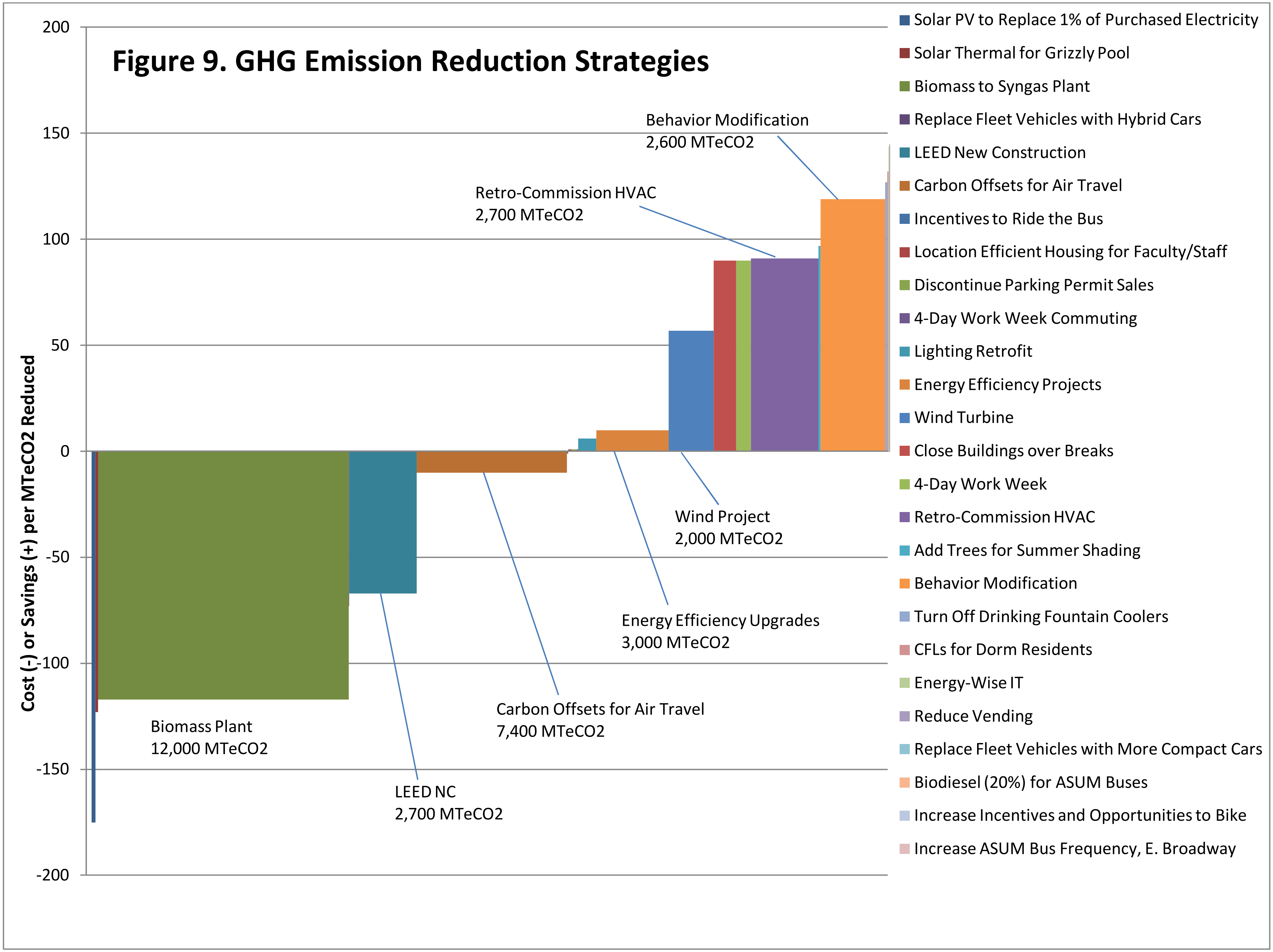


Figure 9. GHG Emission Reduction Strategies
Cost (-) or Savings (+) per MTeCO2 Reduced
200
150
100
50
0
-50
-100
-150
-200
Behavior Modification
2,600 MTeCO2
Retro-Commission HVAC
2,700 MTeCO2
Wind Project
2,000 MTeCO2
Energy Efficiency Upgrades
3,000 MTeCO2
Carbon Offsets for Air Travel
7,400 MTeCO2
Biomass Plant
12,000 MTeCO2
LEED NC
2,700 MTeCO2
Solar PV to Replace 1% of Purchased Electricity
Solar Thermal for Grizzly Pool
Biomass to Syngas Plant
Replace Fleet Vehicles with Hybrid Cars
LEED New Construction
Carbon Offsets for Air Travel
Incentives to Ride the Bus
Location Efficient Housing for Faculty/Staff
Discontinue Parking Permit Sales
4-Day Work Week Commuting
Lighting Retrofit
Energy Efficiency Projects
Wind Turbine
Close Buildings over Breaks
4-Day Work Week
Retro-Commission HVAC
Add Trees for Summer Shading
Behavior Modification
Turn Off Drinking Fountain Coolers
CFLs for Dorm Residents
Energy-Wise IT
Reduce Vending
Replace Fleet Vehicles with More Compact Cars
Biodiesel (20%) for ASUM Buses
Increase Incentives and Opportunities to Bike
Increase ASUM Bus Frequency, E. Broadway

Section 5

Climate Action Goals

When President Dennison signed the American College and University Presidents Climate Commitment, he pledged UM to achieve climate neutrality as soon as possible. Determining a timeline and steps to reach no net greenhouse gas (GHG) emissions started with the Greenhouse Gas Inventory and culminates in this Climate Action Plan. But these initial efforts are by no means the end of the story. They are the beginning, not the end. Any plan with a long time frame is due to be upset by unforeseen circumstances. The process of refining goals to achieve climate neutrality will be ongoing as new information becomes available and the success of efforts evaluated. In fact, the ACUPCC recognizes the need for revisions and accommodates updating Climate Action Plans at any time. The goals set forth herein mark the path toward a zero carbon footprint campus and point the University in the right direction to reduce its impact on our climate.

Using data from analysis of the GHG emission reduction strategies described in Chapter 4, three scenarios were developed to achieve carbon neutrality by 2020. These scenarios are offered to display the variety of ways greenhouse gas emissions can be mitigated. The scenarios are described below and compared with the "Business as Usual" or "No Action" base case. It is important to note that some strategies with large emission reduction potential, i.e. energy from biomass, and wind power, do not presently have funding sources. External funding from grants or other means would need to be obtained before these strategies could be implemented. The scenarios presented show the options for achieving carbon neutrality, suggest strategies that should be a priority for implementation, and indicate the magnitude of the work that it will take to mitigate all greenhouse gas emissions attributed to UM.

Strategies included in the implementation scenarios are lumped together and categorized as follows.

- Energy Efficiency and Conservation
  - Energy efficiency upgrades (including lighting retrofits)
  - Behavior modification
  - 4-day work week
  - Reduce building energy consumption over breaks
  - Retro-commissioning
  - Reduce vending
  - Turn-off drinking fountain coolers
  - Compact fluorescent light bulbs for on-campus residents
  - Energy-wise IT
- Transportation
  - Behavior modification to increase use of alternative transportation
  - Replace rental fleet with more fuel-efficient vehicles as much as possible
  - Reduced commuting due to a 4-day work week
- Wind Power
  - Invest in a wind project in a high wind area of Montana
- Biomass Energy Generation
  - Obtain energy from an on-campus wood-fired boiler, off-campus synthetic natural gas plant, or some combination of both

- Carbon Offsets
    - High-quality carbon credits or local projects to reduce GHG emissions

Green Buildings are not included as a separate category for two reasons:

3. LEED for New Construction has already been adopted by the University
4. The projected energy savings due to LEED is included in the business as usual base case

As previously noted in this plan, a few key strategies need more investigation prior to implementation. They include a 4-day work week, wind power, and biomass energy generation. These strategies are included in the alternative scenarios because it will take projects of this scale to significantly reduce UM's GHG emissions and eventually achieve carbon neutrality.

Although feedback from the all-campus survey indicated reluctance to purchase carbon offsets, they are included in some scenarios for the sake of comparison.

Business as Usual

If no action is taken, UM's GHG emissions will continue to grow as shown on the graph below. Clean Air Cool Planet carbon calculator was used to develop this graph and growth in population and building square footage were assumed to be similar to UM's growth pattern over the last 15 years. Energy consumption attributed to new buildings was assumed to be 25% less than in the past due to the implementation of LEED New Construction for all new buildings. Even so, UM's GHG emissions will nearly double in 40 years if no action is taken to reduce emissions.

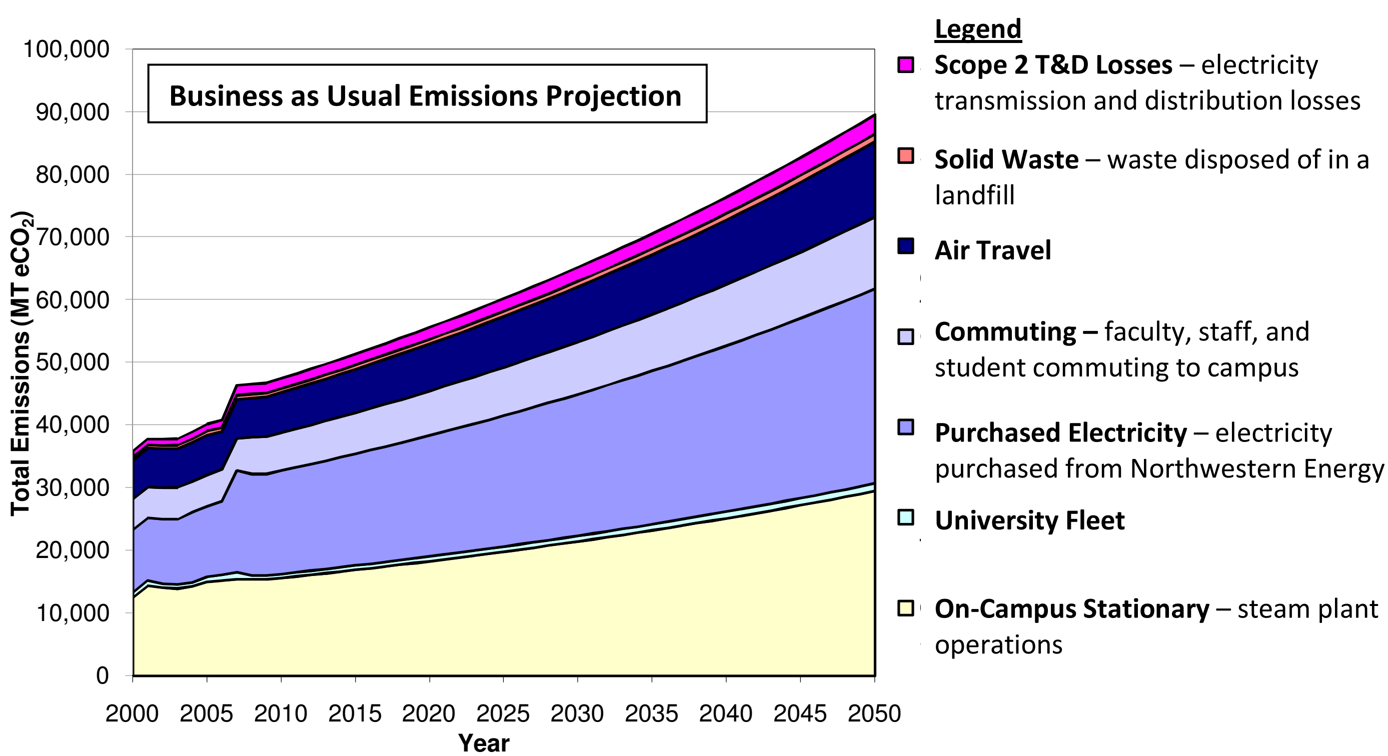


Figure 10. Business-as-Usual GHG Emissions Projection

Lacking data to justify using a different growth pattern, the Business as Usual growth projection based on 15 years of UM's growth history is used as the base case in the following emission reduction scenarios.

Scenarios to Achieving Carbon Neutrality

The ACUPCC is a commitment to achieving carbon neutrality, but how and when is left up to each university to determine. This, as it turns out, is no easy task. There are many unknowns at this point of the planning process with incomplete data and emission reduction technology and methods of carbon accounting continuing to develop. When the draft of this plan was released for comment, a carbon neutrality date was not included. It was left open to assess the will as well as financial ability of the University. Through the public comment process, a date of 2020 was put forth by students. Member of the Technical Working Group considered this date, and offer the following scenarios to achieving carbon neutrality by 2020.

Public feedback indicated general consensus that emissions directly produced by UM should be the first priority for reduction. These include emissions from the use of buildings and transportation related to UM. The strategies that address these emissions are those categorized under energy efficiency and conservation and alternative transportation. These are also the strategies UM has the ability to fund over time. Therefore, energy efficiency and conservation and alternative transportation strategies are included in each scenario except Scenario 1.

Scenario 1 – Carbon Offsets

This scenario assumes all emissions will be offset using carbon credits, or offsets. The concept of offsetting carbon is explained in detail in Chapter 4. For this scenario, it is assumed that all University emissions will be offset by purchasing quality carbon offsets from the open market. The average price per metric tonne of eCO2 from the pricing survey displayed in Chapter 4 is $15/MTeCO2. In this scenario, offsets would be purchased in year 2020 and every year thereafter to maintain carbon neutrality. Other ways are available to create carbon offsets, such as by funding GHG emission reduction projects, which produce multi-year offsets. Conceivably, these projects could benefit a local community or even a branch of the University. However for the purpose of this plan, estimates were based on the cost of open market carbon offsets.

Scenario 1	Capital Costs	Annual O&M Costs	Annual Savings	Annual GHG Emission Reduction
Carbon Offsets	$840,000 per year Cost will increase every year as emissions increase	$0	$0	56,000 MTeCO2 in 2020

Table 31. Scenario 1 Data - Carbon Offsets

The graph below depicts carbon credits offsetting UM's GHG emissions. The amount of carbon offsets shown in yellow is equal to the quantity of emissions in 2020, purchased every year. To maintain carbon neutrality, carbon offsets would also need to be purchased in increasing quantities as emissions grow. This amount would be equal to the blue triangle in the lower right of the graph.

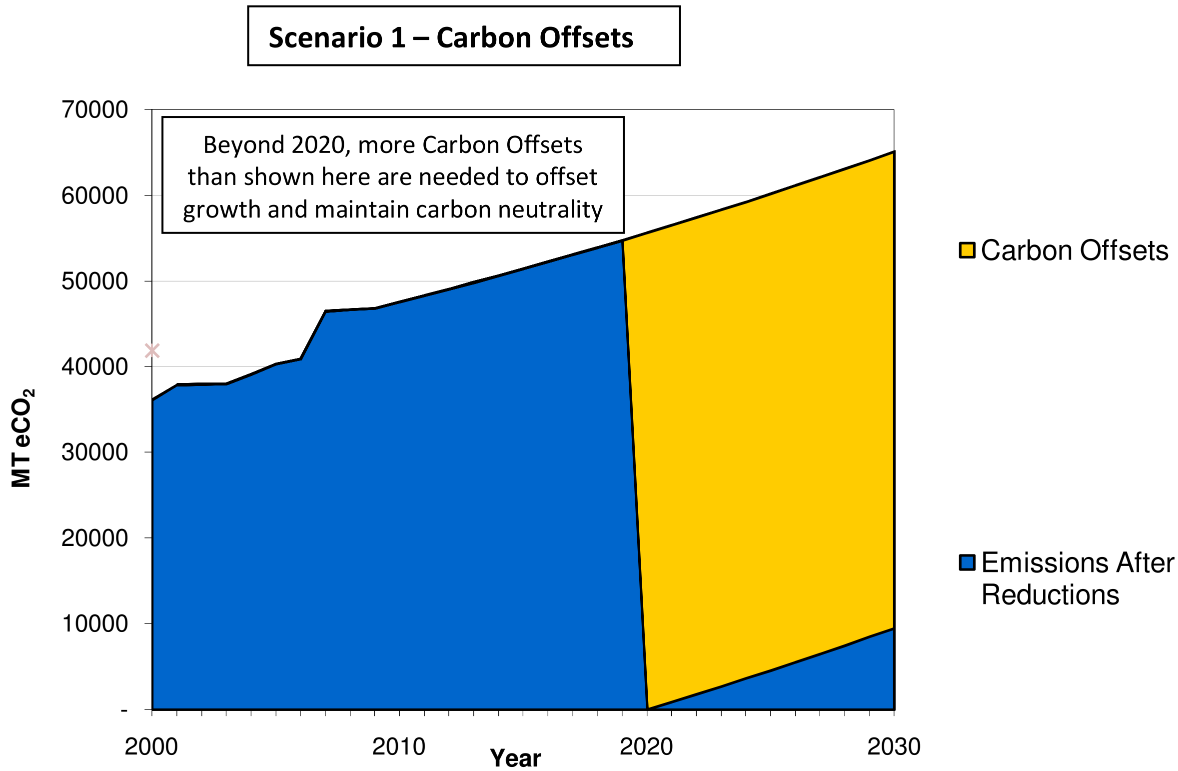


Figure 11. Scenario 1 Emissions Reductions

Scenario 2 – Direct Emission Reduction Strategies and Wind Power

This scenario assumes GHG emissions will be reduced by a combination of energy efficiency and conservation, alternative transportation, and wind power. The wind and biomass strategies, along with carbon offsets, offer the primary mechanisms to achieve carbon neutrality. This is because these strategies can be scaled up and can achieve large reductions in GHG emissions. The wind power strategy in this scenario is scaled to achieve carbon neutrality when combined with energy efficiency, energy conservation, and alternative transportation strategies. It is estimated that it would take twenty-five 1.5 MW wind turbines to offset the GHG emissions remaining (45,000 MTeCO2) once all energy efficiency, conservation, and alternative transportation strategies are implemented. The direct emission reduction strategies (efficiency, conservation, and transportation) are estimated to reduce 11,000 MTeCO2. The capital cost for the wind turbines are estimated at $76,000,000 and the capital costs for all other strategies are estimated to be $10,000,000. Cost estimates are based on information located in Chapter 4.

Scenario 2	Capital Costs	Annual O&M Costs	Annual Savings	Annual GHG Emission Reduction
Direct Emission Reduction and Wind Power	$86,000,000	$1,700,000	$6,000,000	56,000 MTeCO2

Table 32. Scenario 2 Data – Direct Reductions and Wind Power

The graph below shows the emission reductions achieved by energy efficiency and conservation, alternative transportation strategies, and a large investment in wind power. Only the wind project and remaining emissions are labeled in the legend for clarity. Beyond 2020, additional strategies would need to be implemented to maintain carbon neutrality.

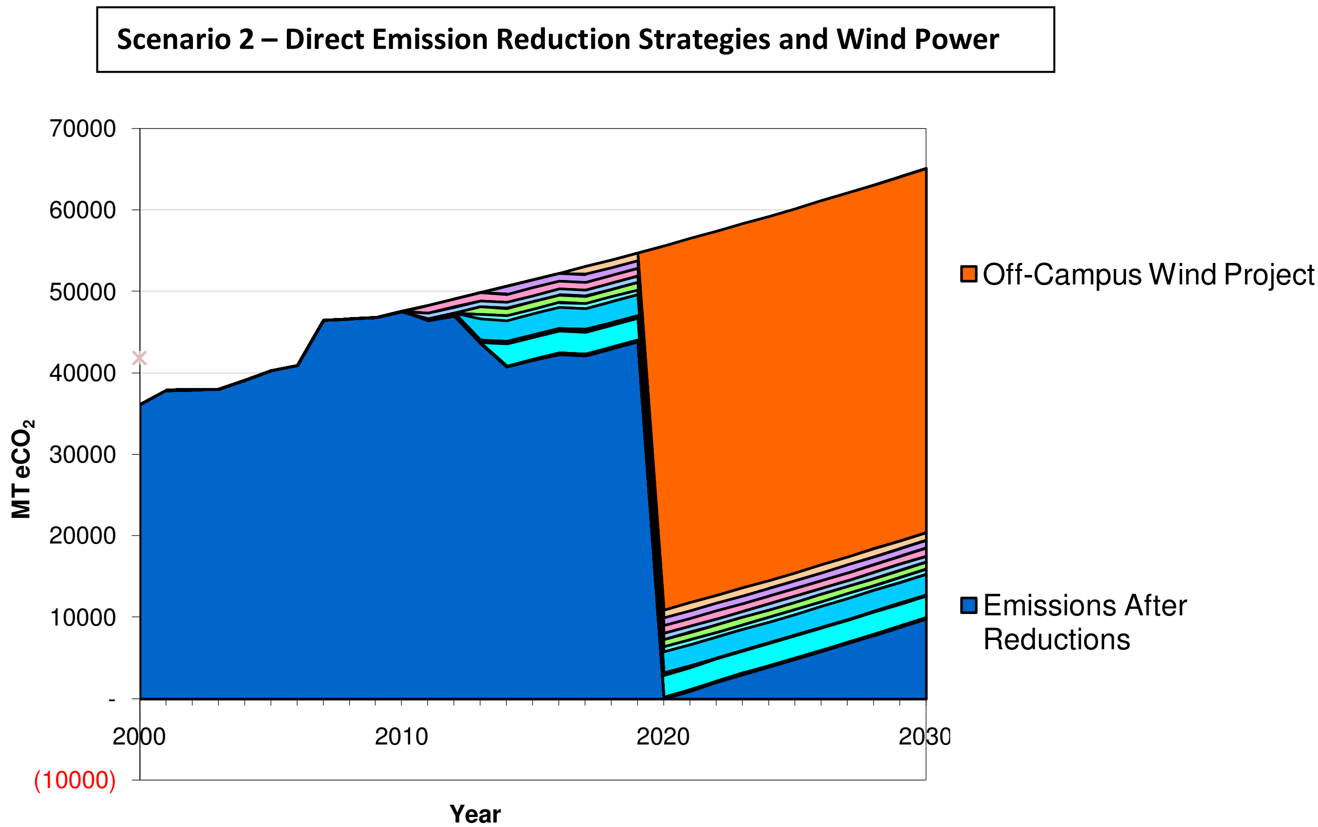


Figure 12. Scenario 2 Emissions Reductions

<u>Scenario 3 – Direct Emission Reduction, Wind Power, Biomass Energy Generation, and Carbon Offsets</u>

This scenario assumes GHG emissions will be reduced by a combination of energy efficiency and conservation, alternative transportation, wind power, biomass energy generation, and carbon offsets. Biomass was not scaled similar to wind power because costs to do so become unreasonable. By combining a variety of strategies, the University can diversify its greenhouse gas emission reduction options in the most cost effective way. As noted for several elements of this plan, more in-depth analysis is needed to determine the specific mix. This scenario is offered for the sake of comparison.

Wind power estimated in this scenario is sized to replace the electricity used by the University. The biomass strategy is sized to replace the natural gas consumed. Biomass could produce electricity along with thermal energy, however estimating the potential electricity production is beyond the scope of this plan. The remaining greenhouse gas emissions in this scenario would be offset by purchasing quality carbon credits. If biomass produced electricity was included in the mix, fewer carbon credits would be needed, saving their annual cost. Specific costs and greenhouse gas emission reductions were estimated as follows:

- Direct, on-campus emission reduction projects = $10,000,000 to mitigate 11,000 MTeCO2
- Wind power = $30,000,000 to mitigate 20,000 MTeCO2
- Biomass energy generation = $54,000,000 to mitigate 12,500 MTeCO2
- Carbon offsets (PAID ANNUALLY) = $190,000 to mitigate 12,500MTeCO2

Scenario 3	Capital Costs	Annual O&M Costs	Annual Savings	Annual GHG Emission Reduction
Direct Emission Reduction, Wind Power, Biomass Energy Generation, and Carbon Offsets	$94,000,000 + $190,000 annually for carbon offsets	$1,200,000	$4,,000,000	56,000 MTeCO2

Table 33. Scenario 3 Data – Direct Reductions, Wind Power, Biomass Energy Generation, and Carbon Offsets

The graph below shows the emission reductions achieved by energy efficiency and conservation, alternative transportation strategies, wind power, biomass energy generation, and carbon offsets. Only the projects with large emission reductions and remaining emissions are labeled in the legend for clarity. Beyond 2020, additional strategies would need to be implemented or more carbon offset purchased to maintain carbon neutrality.

Scenario 3 – Direct Emission Reduction Strategies, Biomass, Wind Power, and Carbon Offsets

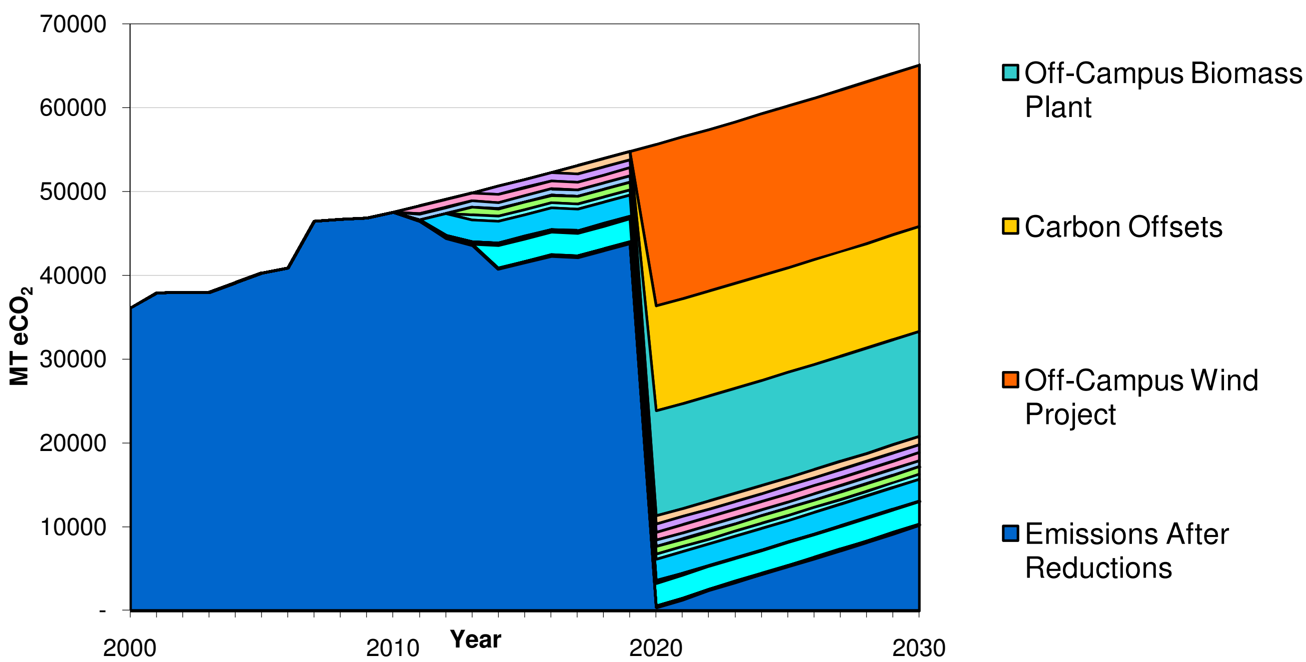


Figure 13. Scenario 3 Emissions Reductions

The table below shows all scenarios in one table:

Scenario	Capital Costs	Annual O&M Costs	Annual Savings	Annual GHG Emission Reduction
Scenario 1 Carbon Offsets	$840,000 per year. Cost will increase as emissions increase	$0	$0	56,000 MTeCO2 in 2020
Scenario 2 Direct Emission Reduction and Wind Power	$86,000,000	$1,700,000	$6,000,000	56,000 MTeCO2 in 2020
Scenario 3 Direct Emission Reduction Wind Power, Biomass Energy Generation, and Carbon Offsets	$94,000,000 + $190,000 annually for carbon offsets	$1,200,000	$4,,000,000	56,000 MTeCO2 in 2020

Table 34. All Scenarios Data

<u>Carbon Neutrality Goals</u>

Scenarios 1 through 3 show alternative ways to achieving carbon neutrality by 2020. Other dates commonly selected by ACUPCC colleges and universities are 2030 and 2050. If Scenarios 1 through 3 were adjusted to a longer timeframe, one could conclude the costs would simply be less per year when stretched over more years. This does not take into account the costs of delaying climate action however. The longer UM depends on energy from fossil fuels, the more at risk it is to rising energy prices and possible taxes on emitting carbon. Additionally, if the costs to mitigate the effects of climate change are allocated to greenhouse gas emitters, UM would benefit financially from having low to no greenhouse gas emissions.

<u>Interim Targets</u>

Interim targets are as important, if not more so, than a carbon neutrality goal. Interim targets are short term, provide the opportunity to measure progress, and encourage starting the downward trend toward carbon neutrality sooner.

To determine a reasonably aggressive interim goal, the energy efficiency, conservation, and alternative transportation greenhouse gas emission reduction strategies were plotted on the Business as Usual graph. These strategies were chosen to implement first because UM has more control over funding these strategies and public feedback indicated a desire to directly reduce emission before investing in off-campus projects. Timing of strategy implementation was estimated based on the time needed to fund, design, and construct strategies. Graphing results are shown below and indicate an interim target of 10% below 2007 emission levels by 2015. It is difficult to read the specifics of the graph and the legend but it is intended to show the strategies included and the overall emission reduction achieved, not a specific timeline for implementation.

If 2020 is the carbon neutrality date, strategies such as wind power, energy from biomass, and/or carbon offsets would have to be implemented by 2020 in some combination as noted above. Realistically, wind turbines and biomass options could not be operational prior to 2015. Offsets could be purchased at any point.

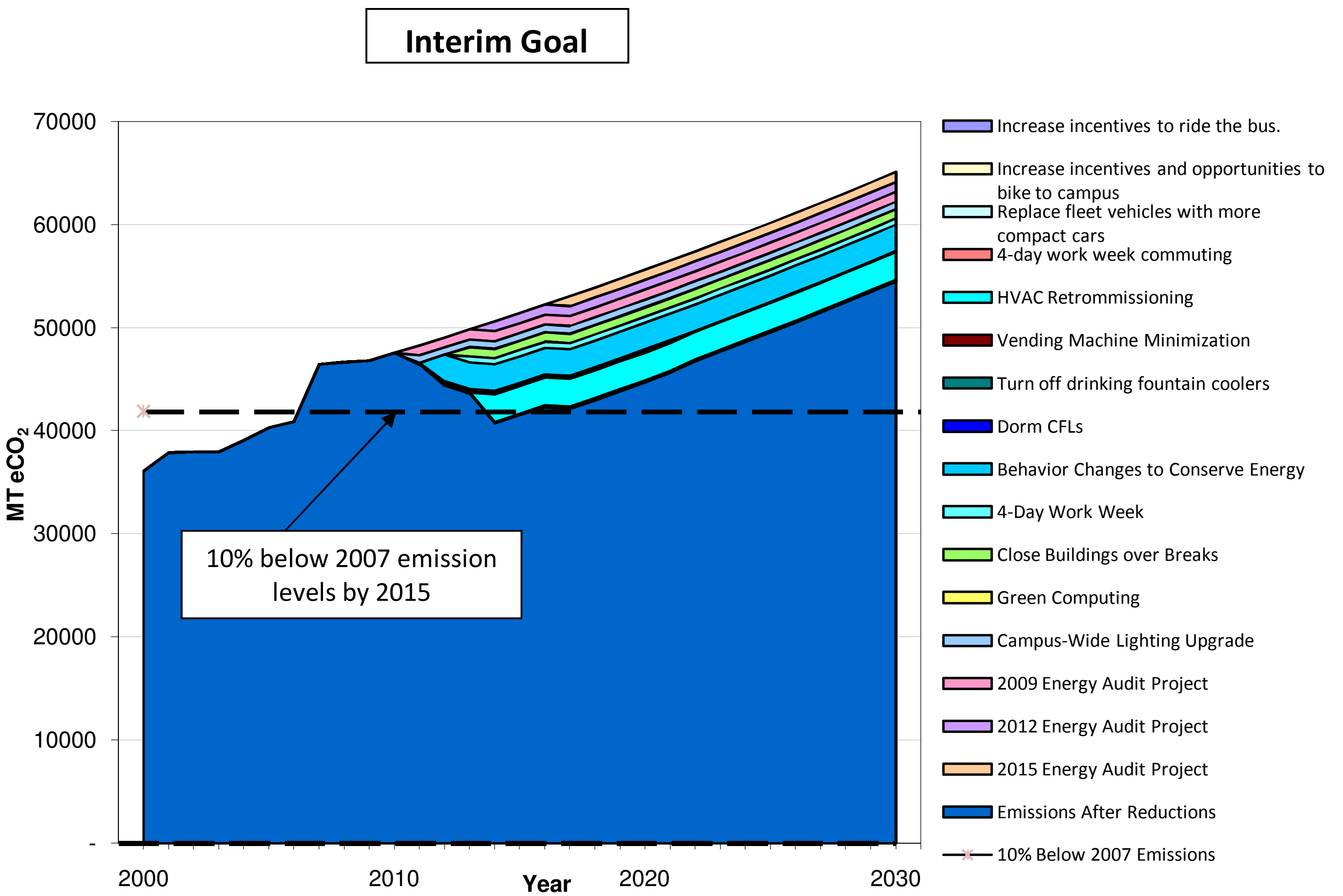


Figure 14. Interim Goal

Recommendations

To comply with the American College and University Presidents Climate Commitment, the Technical Working Group recommends selecting a carbon neutrality date of 2020 and an interim target of 10% below 2007 emission levels by 2015. Scenarios 1 through 3 indicate several ways carbon neutrality can be achieved as well as the magnitude of this endeavor. The Technical Working Group recommends a high priority on implementing direct emission reductions such as those that can be achieved through energy efficiency and conservation and alternative transportation. Those strategies are listed below:

- Energy Efficiency and Conservation
    - Energy efficiency upgrades (including lighting retrofits)
    - Behavior modification
    - 4-day work week
    - Reduce building energy consumption over breaks
    - Retro-commissioning
    - Reduce vending
    - Turn-off drinking fountain coolers
    - Compact fluorescent light bulbs for on-campus residents
    - Energy-wise IT
- Transportation
    - Behavior modification to increase use of alternative transportation
    - Replace rental fleet with more fuel-efficient vehicles as much as possible
    - Reduced commuting due to a 4-day work week

The Technical Working Group also recommends seeking funding for wind power and a biomass energy generation project. Finally, the Technical Working Group recommends looking into using carbon offsets to offset the greenhouse gas emissions from air travel. This is one large emission source that does not have a replacement option like wind power for purchased electricity or biomass energy generation for natural gas. Costs for offsetting air travel could be added on to the price of a plane ticket. For example, the cost to offset a round trip flight from Missoula to Washington, DC is approximately $15. Further research into options for carbon offsetting should be conducted and alternatives such as developing local projects that result in emission reductions to offset UM's emissions investigated.

Section 6

Education, Research and Outreach

Background

The ACUPCC emphasizes the importance of incorporating sustainability into institutional curriculum in order to create a learning environment that produces ecologically literate and socially responsible graduates. This section of the plan describes what UM is currently doing to institutionalize sustainability in education, research, and community outreach. Strategies for increasing the scope of these efforts in the future are also included.

UM Provost Royce Engstrom recently led a campus effort to update UM's comprehensive Academic Strategic Plan. Completed in late 2009, UM's commitment to the educational component of the ACUPCC is delineated in the strategic plan as follows:

> *Goal #2 of UM's Academic Strategic Plan states "Create a campus climate that actively supports sustainability, including environmental responsibility, sustainable operations, and stewardship in our community".*

Directed by the ACUPCC and the Academic Strategic Plan, and spearheaded by a subcommittee of UM's Sustainable Campus Committee, the following broadly identified goals and potential strategies for attaining them have been developed. These goals are expounded upon in the Education/Curriculum, Research and Community Outreach sections outlined below.

Please note that both the Research and the Community Outreach sections are in the early developmental stages; this should be considered when reviewing this plan.

Goals/Strategies

Goal: Establish Sustainability and Climate Change as recognized, emphasized, and common themes across the University curriculum. In order to achieve this goal, UM should consider the following strategies:

- Offer Green Thread or other initiatives on a regular basis to help faculty integrate sustainability into existing courses
- Develop a plan for all students to encounter sustainability education
- Develop a network of faculty (at least one per department) to promote sustainability pedagogy across campus
- Increase number of relevant courses to create a "sustainability track" in General Education
- Create a Sustainability Literacy Assessment similar to Writing Proficiency Assessment

Goal: Make Sustainability and Climate Change a center of academic excellence for the University. In order to advance this goal, UM may:

- Establish new faculty lines to support Sustainability areas in EVST and Climate Change Studies minor
- Engage in strategic hiring in other departments and programs to strengthen Sustainability and Climate Change
- Facilitate opportunities for innovative research and teaching across departments, with COT, and with other sectors of the University

Goal: Supplement formal education on Sustainability and Climate Change with informal, practical, and career-oriented education that enhances relationships between UM and community partners. In order to advance this goal, UM may:

- Support service-learning and project-oriented pedagogy that makes UM a more sustainable member of the community
- Make sustainability and climate change prominent features of Orientation, residence hall programming
- Make sustainability and climate change prominent features of UM events and programs that attract off-campus participants (public lectures, extracurricular activities, alumni events, etc.)
- Strengthen relationships with external organizations for internships and work-based learning
- Develop new funding streams to support expanding Energy Technology program

Education and Curriculum

The Green Thread Initiative

The University of Montana has implemented a faculty development program on sustainability called the Green Thread Initiative. This initiative features a two-day faculty development workshop each spring and is intended to infuse issues of sustainability into courses across the UM curriculum. The first Green Thread workshop was held on campus in May 2009 with 20 faculty participants from seven colleges and schools. The purpose of the workshop was to help faculty revise existing courses by incorporating place-based learning and connecting sustainability to core concepts in their respective disciplines.

Sustaining the workshop remains a challenge in light of existing financial resources. For persistent and pervasive exposure to sustainability in the university curriculum, the workshop needs a commitment of ongoing financial support from UM, as well as support in seeking external funding or developing an entrepreneurial dimension to the program.

The 2010 Green Thread workshop recruiting strategy involves asking prior participants and steering committee members to do a short presentation at spring departmental meetings. In addition to recruiting for the workshop, this will help to establish a network of departmental faculty to promote sustainability pedagogy across campus.

Sustainability Areas of Study in Environmental Studies Program

The Environmental Studies Program has been engaged in education about sustainability since its inception. EVST has several areas of study that focus on different dimensions of sustainability. The broadest is the Sustainability Studies area of study. With this Focus Area of Study, students will increase their understanding of our earth's limited capacity to support all forms of life and to provide for the needs of human society.

Students will learn how to reduce our demands on the earth through increased resource efficiency and choosing simpler but more joyful lifestyles. Students have the opportunity to identify & develop more sustainable means of providing food, shelter, mobility and other necessities.

In addition, students can pursue a focal area of study in Sustainable Business or Sustainable Food and Farming. All of these programs require students to complete an internship with a local sustainable business, the Sustainable Business Council, the PEAS farm, or non-profit organization whose mission addresses sustainability.

Local Solutions to Climate Change is graduate course that emphasizes local and state policy approaches to climate change. Students work on a variety of applied research projects that have included assessing the potential of wind power for the University of Montana. As an outgrowth of that project, two students proposed and successfully advocated for the Renewable Energy Loan Fund (RELF), a voluntary student-fee to support student-initiated renewable energy projects on campus. Most recently, students in the class conducted a municipal greenhouse gas emissions inventory for the City of Missoula. In spring 2009, students presented their preliminary findings to the Missoula Greenhouse Gas Energy Conservation Team, the Mayor Engen's Advisory Group on Climate Change and Sustainability, and the Mayor's Administrative Leadership Team. The inventory covers the municipal wastewater treatment plant, municipal buildings, the municipal fleet (vehicles and equipment), employee commuting, lighting, and embedded energy in drinking and irrigation water. The final report is an excellent example of positive synergy between UM and the City's efforts to reduce their carbon footprint. The report will be published in early 2010 and includes numerous recommendations to build on the City's existing emission reduction and energy conservation efforts. The course will continue to provide timely and needed policy analysis and community engagement and service learning opportunities to students.

Climate Change Studies Minor

The University of Montana offers one of the nation's first undergraduate interdisciplinary minors in Climate Change Studies. This minor combines the strengths of a focused, interdisciplinary examination of climate change with the applied, solutions-oriented learning demanded by the topic. The program educates students in three areas of the climate change issue: science, society, and solutions. Further, the focus on solutions and applied learning helps students develop critical thinking and problem solving skills.

The Climate Change Studies minor is open to students across campus and is intended to complement a student's disciplinary focus. As of December 2009, twenty-one students have officially registered for the minor from thirteen different majors, including geography, environmental studies, journalism, business administration, ecology, applied sciences, philosophy, and more.

This Climate Change Studies minor requires 21 credits comprised of a 3-credit interdisciplinary introductory course and 6 credits in each of the following areas: climate change science, climate change and society, and climate change solutions. To provide students with flexibility and appeal to a diversity of interests, each area has a variety of courses to choose from, several of which will fulfill General Education requirements. There are a total of twenty-three course offerings within the Climate Change Studies program from thirteen different departments that span the College of Forestry and Conservation, the College of Arts and Sciences, the College of Technology, and the School of Law.

Three Environmental Studies students, Yaicha Bookhout, Zach Brown and Melissa Hayes, are credentialed by SustainUS for the United Nations Framework Convention on Climate Change meetings in Copenhagen, Denmark from December 7-18, 2009. The students are traveling to Copenhagen with support from the Wiancko Family Foundation, the UM Provost's Office and an anonymous foundation. The students will chronicle the negotiations, their experiences and the actions of non-governmental parties in blogs and by twitter.

Energy Technology Associates of Applied Science

The University of Montana College of Technology (UM COT) offers an AAS degree in Energy Technology (ET). While students come to the program for a variety of reasons, one of the primary motivations is the desire to do something to promote sustainability and therefore address climate change. Since energy choices are largely responsible for the lion's share of greenhouse gas emissions, changing how we use energy is one of the most important means at our disposal to affect the rate of climate change. In essence, having once identified the problem, the next question is "What then, shall we do?" and this program offers students an opportunity to learn about the social, environmental, economic, and political impacts of different energy technologies.

The program introduces students to energy efficiency measures as well as the full suite of energy systems and technologies. While students are expected to master the fundamental principles of energy science and the basic skills of energy technology, they are also encouraged to develop the critical thinking skills necessary to assess the impacts of different energy systems on social and environmental sustainability. Graduates of the program are general practitioners skilled in renewable energy system design, installation, maintenance, troubleshooting, and operation; site identification and assessment for renewable energy installations; structural audits for energy efficiency and conservation; project management; regulatory compliance; and, preparation of basic economic, environmental, and social assessments. The ultimate goal of the program is to provide graduates with the skills necessary to evaluate energy efficiency in buildings, design and install renewable energy systems, as well as the knowledge to enable them to make well-informed energy choices that contribute to environmental and social sustainability.

UMCOT's energy program is one of the first of its kind in the country and has the advantage of both longevity and uniqueness. Program sustainability, however, will require development of faculty lines as well as funding streams. The growth rate is unprecedented and the demand is quickly outstripping our ability to meet it. Moreover, an increasing number of ET students are seeking to continue into 4 year programs, preferably at UM, and preferably with some emphasis in energy. Currently, the only extant pathway is the Bachelors of Applied Science which limits the opportunity for many. UM is strategically placed to be at the forefront of energy literacy education at the 2 as well as 4 year level. Ultimately, when it comes to climate change and sustainability, it is not enough simply to educate students to the problem; one must also offer students the means to investigate alternative approaches that may lead to solutions.

School of Journalism: Master's Degree in Environmental and Natural Resource Journalism

The School of Journalism recently revamped its Master's degree program, changing it from a general journalism graduate program to one focused on Environmental and Natural Resource Journalism. The new program was approved by the Board of Regents last year and is in its first year of operation. The new program responds to a critical need for journalists trained to tell compelling stories that illuminate the complex relationship between nature and society. Our graduate students will work with world-class science and journalism faculty to produce cutting-edge stories in a spectacular physical and academic setting.

Beyond their practical training and research in environmental journalism, students will choose courses from an array of subjects reflecting the University of Montana's commitment to the conservation of nature and the well-being of humanity. Students will produce print and photo stories, multi-media projects, web and broadcast documentaries that address global as well as regional issues like wilderness policy, environmental health, endangered species, forestry and mining practices, and the management of public lands, climate change and natural resources.

Sustainability in WRIT 101 Classes

Inspired by the Green Thread workshop, WRIT 101, the freshman writing composition course, integrated sustainability as its primary writing theme beginning fall of 2009. Professors who had attended the 2009 workshop developed their curriculum based upon ideas of sustainability. While still maintaining the integrity of an introductory writing class, the course now encourages students to think critically and introspectively about their connection to environmental issues and sustainability. The assignments (such as personal academic essays, op-ed pieces and personal essays) ask students to explore themes related to restoration, bio-regionalism, sense of place and sustainability.

In its first year, the new curriculum received positive feedback from both students and teachers. Incorporating these issues into introductory writing classes is an excellent demonstration of how the campus is committed to teaching sustainability across the curriculum. The professors have plans to continue this program in subsequent years.

Campus Climate Exchange & Focus the Nation

In January 2008, UM hosted "Focus the Nation" – a one day national global warming 'teach-in'. 35 UM faculty members, from a variety of disciplines (including Environmental Studies, English, Chemistry, Business, and Modern Classical Language) participated. These faculty members incorporated climate change into their classes on the selected day through discussion and assignments. Nobel Laureate and climate change expert, Steve Running, as well as US Senator and member of the Environment and Public Works committee, Max Baucus, participated in the event.

Following Focus the Nation, UM initiated "Campus Climate Exchange" in February of 2009. Similar in scope, Provost Engstrom asked faculty from across campus to spend time making climate change relevant to their discipline on that date. This teach-in resulted in more than 1,100 students from various disciplines being exposed to climate change topics.

Public Lecture Series - Continuing the Climate Change Dialogue

In spring 2008, the Wilderness Institute hosted a public lecture series titled *Climate Change: Moving from Science to Solutions.* The series included speakers from varied disciplines and fields - science, policy, ethics, religion, law, journalism, education, and more - each with practical experience working in innovative ways to understand, adapt, and effectively respond to climate change. Each lecture regularly drew between 250-400 people; 144 were UM students enrolled in the lecture series for course credit.

UM sponsors many climate change lectures across campus. Climate change-related lectures offered fall 2009 featured international climate change activist Dr. David Orr, Former Senator John Warner and Retired Admiral Dennis McGinn, among others.

To provide opportunities for faculty and students to learn about faculty research, and enhance opportunities for collaborative interdisciplinary research among faculty, we would like to develop a 400-level UG *Climate Change Faculty Seminar Series* each spring semester for two credits. Rotating faculty would present a public lecture about his/her current research, to be followed the next day by a discussion session for students, the course instructor, and presenter.

Enhancing Faculty Collaborations

Appending the current Visiting Scholars program to focus on climate change scholars would allow UM students and faculty to interact with practitioners who come to UM to teach and lecture about cutting edge climate-related topics. Faculty and students participating in this program will benefit from their collaboration across campus and with visiting scholars. They will better understand the multiple dimensions of climate change issues and how their particular discipline contributes to an understanding of the issues and their solutions.

Faculty at the UM are planning to contribute to the National Council for Science and the Environment's initiative to create a nationwide learning community called CAMEL (*C*limate, *A*daptation, and *M*itigation *e-L*earning). The CAMEL initiative will engage educators and scholars in order to develop curricular content based on the best available research and on the most appropriate pedagogical methods for enabling students to tackle complex problems.

NSF Ethics Education Grant

To engage students in the study of climate change impacts and solutions, the University of Montana is developing its capacity to use internet-based education tools. For our newly developed introductory course, *Climate Change: Science and Society* (required for all students enrolled in the minor), students aggregate information and deliberate over alternatives to achieve a particular solution to climate change. This "Online Deliberation Center" (ODC), developed in a three-year National Science Foundation grant on ethics education for science students, is a novel use of wiki software to promote factually based, thoughtful and cooperative deliberation. This tool is especially well-suited to allow a diverse group of students to cooperatively deliberate to craft solutions addressing climate change.

UM Student to Student Education

UM student groups, as well as the ASUM Sustainability Office, engage students in campus initiatives to promote sustainability and educate students. Many positive outcomes have developed from student led projects; however, more can be done to reach a broader range of students, especially in the dorms. One such program is Eco-Reps, a peer to peer outreach forum that utilizes student environmental champions. Founded by Tufts University, this program encourages students living in the dorms to participate in weekly meetings and focus on educating their dorm-mates about environmental issues and encouraging fellow students to live in a more eco-friendly way. This program could become a credit-earning class or internship so that students are motivated to attend meetings and become active in engaging other students.

Research

Greenhouse Gas Inventory

During the 2007/2008 school year, students and faculty completed the first greenhouse gas inventory for UM. Led by the ASUM Sustainability Coordinator and supervised by an Environmental Studies faculty member, the inventory acted as a research project that required students to compile carbon emission data from all sectors of campus, including utilities, transportation, solid waste, and grounds. The data gathered was then entered into the Clean Air-Cool Planet calculator and analyzed by students. Not only did this inventory enable UM to establish its baseline, it also provided a meaningful learning opportunity for students to become engaged in campus operations. Following the completion of the Climate Action Plan, another greenhouse gas inventory will be completed with significant coordination by students.

Faculty and Student Research

With the development of the Climate Change Studies minor, faculty and students engaged in climate change research and activism are working collaboratively.

Following is a sampling of research projects pursued in various disciplines during 2008-2010:

- Communication Studies: public discourse surrounding climate change; rhetorical strategies used to shape public perception of climate change
- Economics: International environmental economics and climate change policy
- Ecosystem and Conservation Sciences: Forest ecophysiology; soil carbon cycles; field measurements of how wildlife responds to climate change
- Energy and Business Technology: Renewable energy technology
- Environmental Studies: Conservation biology; climate change policy; energy efficient building construction; greenhouse gas inventory
- Ethics: Ethical and philosophical issues arising from climate change, public deliberations over geoengineering
- Geography: Arctic and alpine climatology, long-term climate analysis, permafrost variability, climate/ground interactions, and urban effects on climate.
- Geosciences: Physical processes in snow and ice in Alaska and Greenland to understand connections and feedbacks between the cryosphere and the climate system
- Political Science: Sustainable climate policy: China and the USA
- Society and Conservation: Drought Impacts and Responses in Montana

Students in the introductory *Climate Change: Science and Society* course research various climate change impacts and solutions. Working collaboratively, students present their research on the "Online Deliberation Center" (ODC). Students have researched and created wiki pages addressing the following topics:

- Climate Change Impacts: Disappearing Glaciers in the Alps, Effects on Oceans (coral reefs, etc.), Sea Level Rise in Bangladesh, Effects on the Inupiat tribe, Climate Change in Montana in the last 20,000 years, Possible Climate Change Scenarios in Montana, Fire in Rocky Mountains, Impact of Climate Change on Ski Industry.

- Energy Alternatives and Energy Efficiency: Wind, Solar, Hydro, Clean Coal, Nuclear, Biofuel Power and Heat Generation, Natural Gas, Microbial Biofuel and Hydrogen Production, Green Architecture, Smart Grids, UM's Revolving Energy Loan Fund.
- Climate Change Policies and Politics: Cap and Trade, Carbon Tax, Reducing Emissions from Deforestation and Forest Degradation, Renewable Energy Standards, Waxman Markey Bill, Timeline of Kyoto Protocol, United Nations Framework Convention on Climate Change, Montana Climate Mitigation, COP15 negotiations.
- Land Use and Transportation: Forest Carbon Sequestration, Changing Transportation Patterns, Biodiesel as an Alternative Fuel Option.
- Consumption: Reducing Material Use, Recycling, Living Simply, Energy Audit for an Average College Student.
- The Media and Social Movements: Communicating Climate Change: BBC World, Missoulian, Foxnews; Organizations opposed to climate change; The Greenbelt Movement; What a College Students can do to Combat Climate Change.
- Climate Change Adaptation: Goals, types, challenges, adaptation fund, adaptation and development

We intend to expand opportunities for students to engage with climate mitigation and adaptation, both through campus initiatives and work with organizations at the national and international levels. This will involve developing and maintaining a network of campus, community, national, and international partners to develop internships and service learning opportunities. It will also involve finding ways to fund student travel to work with other organized climate initiatives in the USA and abroad, student travel to conferences, and student research. These opportunities will enable students to develop practical knowledge of the challenges and opportunities related to climate change, integrate and apply information and techniques learned in the Climate Change Studies minor to real-world problem-solving, and become part of a larger national/international network working to understand and respond to global climate change.

Renewable Energy Loan Fund (RELF)

UM also has a new application-based educational opportunity available for students. The Renewable Energy Loan Fund (RELF) is a campaign aimed at starting a campus-wide fund to help pay for energy efficiency and waste reduction projects. In 2009, UM students supported a student fee that sets aside money to implement energy reduction projects. The revolving loan will be repaid with the cost savings and then recirculated. The RELF committee began meeting in the fall of 2009 and will set up an application process for students to submit energy savings proposals to the committee.

Community Outreach

The Forum for Living with Appropriate Technology (UM FLAT)

The UM FLAT is an experiential live-in resource (house) for UM students to demonstrate the practicality of sustainable living. In a time of rising energy costs, 'conservation of energy' is the most effective means of demonstrating appropriate development at UM and Missoula. By experimenting with and educating others about the social, ethical, and environmental benefits of appropriate technology, the UM FLAT helps to establish the University of Montana as a model for exhibiting efficient building practices. The ultimate goal of the UM FLAT is to encourage the development of efficient and affordable homes for a sustainable society. By

retro-fitting an existing home the utility of the UM FLAT demonstration resources could be easily applied to the Missoula community.
Currently, the UM FLAT is retro-fitting its garage to be more energy efficient in order to act as a classroom. Further ideas include turning the existing neighborhood block into an eco-village for educational purposes and to model sustainable living.

Green Griz Game
On February 21, 2009, the theme of the men's basketball game at UM was "green." The "Go Green" game was an effort to bring the University's commitment to sustainability initiatives and environmental stewardship to Griz fans. During the game, fans could purchase a variety of Farm to College food items, including MT-made hot dogs and buns. Student volunteers provided fans with information about the efforts of UM Recycling on campus. Waste was recycled and composted. Finally, students helped to raise enough money to purchase enough carbon offsets to offset half of the emissions associated with the game. The game was a collaborative effort of ASUM Sustainability Center, UM Dining Services, UM Athletics, UM Recycling, and UM student group volunteers (UM Climate Action Network and Students for Real Food).

Farm to College
In the spring of 2003 University Dining Services and four UM graduate students teamed-up to create the UM Farm to College Program, dedicated to increasing the percentage of local food used to feed the campus community. Through this program, UM plays a greater role in supporting Montana's economy, strengthening the local community and helping to preserve Montana's natural and cultural heritage. Additionally, the program is dedicated to reducing environmental impacts by shortening the physical distance that the food travels.

The UM Farm to College Program supports agriculture and economic development statewide by purchasing Montana products to serve in campus' dining venues. The program educates the campus community and others about Montana food and agriculture, thereby strengthening connections between the urban and rural areas of our state.

Climate Change Internships & Practicums
Many climate change solutions courses incorporate applied project work that enhance student learning, engage students in real-world climate change related challenges and opportunities, help students develop strategies for analyzing and addressing problems, and establish connections within a larger community working on climate change solutions. Courses use a variety of approaches that require students to build on foundational knowledge in climate science and society areas and develop valuable "solutions" skills. These approaches include internships, practicums, and other courses that actively engage students in applied projects.

Climate change internships engage students directly with climate mitigation and adaptation, both through campus initiatives and work with regionally-based organization. Through internships, students gain supervised, practical work experience with specific projects and organizations, they create a network of professional contacts, and have opportunity to apply ideas and approaches studied in the Climate Change Studies minor.

Recent internships include:

- The Sustainable Business Council - helping advance green business practices in local entities
- The Montana Department of Natural Resources and Conservation - developing recommendations for a carbon offset program
- Montana Audubon - synthesizing information on Montana bird species, summarize what is known and what is speculated to happen with continued global warming, and developing outreach materials that advance bird conservation.
- Trout Unlimited - assembling available scientific literature on the effects of climate change of fisheries and developing outreach materials that describe such risks.
- Pew Environment Group – participating in a national campaign focused on the connections between global warming and transportation system reform.
- Climate Solutions – developing relationships and partnerships with Montana's agricultural community to support for strong climate legislation.
- Missoula Urban Demonstration Project – conducting a carbon and waste production footprint analysis.
- The Elements Tour – developing curriculum and helping to spread education about sustainability and renewable energy development.

The Climate Change Practicum course enables students to design and implement a capstone project involving a creative solution to climate change. A project proposal, narrative activity log, documentary report, and public presentation required. During the fall 2009 students worked collaboratively on a campaign to help advance federal climate legislation. Students organized on a 350.org rally that included several speakers, numerous booths, and attracted media attention; students wrote and lobbied for the successful passage of an ASUM resolution; students wrote numerous op-eds, were interviewed by journalists, and developed skills in organizing and working with the media.

Community Outreach Component of Environmental Citizenship course
In this course, students are required to engage in a service learning activity. Student projects in this course have included:

- Greening of "Welcome Feast" to reduce carbon footprint - students used climate footprint analyses and dining product research to work collaboratively with UM Dinning Services and Student Services staff to plan menu and meal service items to lower the carbon footprint of fall Welcome Feast and include sustainability education materials.

- Energy conservation survey of staff and administration in Main Hall - students used social marketing concepts to design and administer a survey on energy use and conservation attitudes and behaviors and provided energy conservation recommendations.

Service Learning Component of Sustainable Business Practices Course
In small groups, students examine local businesses utilizing a sustainability assessment instrument. The instrument looks at nine areas of social and environmental sustainability (for example: facilities, energy, water, waste, community, etc) and students use management's response to craft suggestions as to ways to implement sustainable practices. Students engage in the necessary research and write a report outlining tangible actions that owners/managers may take to improve performance in one of the areas covered by the assessment instrument.

Climate Change Studies Field Based Learning

The Climate Change Studies minor advisory committee plans to develop more opportunities for field-based learning. Montana provides vast opportunity for students to get into the field to see first-hand the impacts of climate change (melting glaciers, beetle killed forests, drought stressed ranchers, etc.) as well as potential solutions (wind farms, solar energy production, fuels for schools projects and more). We are planning a fall welcome weekend for students interested in the climate change minor and sustainability initiatives on campus, and will try to develop an extended, one-credit, field course during the semester.

COT Energy Technology Program Outreach

Under the auspices of a WIRED grant, the energy technology program sponsored energy efficiency and renewable energy workshops and presentations in areas such as green building, wind energy in Eastern Montana, geothermal energy in the western US and Iceland, and biodiesel.

That same grant also allowed us to develop partnerships with campuses across the state. Stone Child College hosted a series of Energy Efficiency and Renewable Energy workshops designed to increase tribal awareness of energy opportunities in their region and to promote enrollment in their energy courses. Blackfeet Community College also sponsored a series of workshops in the spring of 2009 on renewable energy, as well as hosting a 3-day field experience for energy tech students for the summer practicum. Our successful partnership with Miles Community College continues to provide students in the Miles City area with access to energy courses at UM COT, while at the same time stimulating development of a bio-energy program at Miles CC. We have recently finalized an articulation agreement with Flathead Valley CC that allows their students to participate in the ET program while remaining in the Flathead.

On the UM campus, the Environmental Studies program has been particularly supportive of the energy tech program, and EVST students are enrolled in many NRG courses. We have worked with the Climate Change Studies minor to cross- list NRG courses for their solutions module, providing CCS students an opportunity to explore the science and technology of energy systems. The geosciences department developed and continues to staff one of our key specialty energy courses in fossil fuels.

COT Energy Technology Field Work

Midway through their 2-year studies, energy technology students complete a field practicum and in their final semester develop an internship with an organization in renewable energy or energy efficiency. Practicum activities include site visits to commercial, community, and residential scale renewable energy installations around the state of Montana and hands-on experience working with the energy technologies in use today.

The first cohort of students completed internships spring of 2009 with organizations such as CTA Architects, McKinstry, SBS LLC, and the UM Sustainable Campus Committee. Ongoing internships include working with Redfield Construction and Action for Eastern Montana and ET students also participated in Montana’s state building energy audits. In addition, our students have sought industry recognized certifications such as RESNET HERS rater, LEED AP, NAHB Green Building Program Verifier, NABCEP PV-Entry Level Certificate, and others.

Section 7

Conclusion

Recommendations

To comply with the American College and University Presidents Climate Commitment, a carbon neutrality date of 2020 and an interim target of 10% below 2007 emission levels by 2015 are recommended. Scenario 3 is suggested for implementation as it offers a diversified approach.

Next Steps

To implement this Climate Action Plan, the strategies identified will need to be prioritized, funded, and assigned for further action. Teams will need to be convened to research wind power, biomass energy generation, funding, and carbon offsetting options. The Sustainable Campus Committee, with the support of the Office of Sustainability, will monitor and report on progress as well as recommend future updates and revisions to the Climate Action Plan.

An important outcome of the planning process has already been achieved. Awareness of how UM's operations affect our environment has increased and relationships have been developed that will foster the greening of UM. These are some of the benefits of a people-intensive planning process that will be vital to the success of UM's efforts to become climate neutral.

Appendices

APPENDIX A

Following is a complete list of ideas suggested through the Climate Action Planning public involvement process:

Energy Efficiency and Conservation

- "Practice what we Teach" campaign for being green (i.e. turn down the heat, use less AC, turn off the lights, reduce transportation emissions, purchase energy efficient equipment and use efficiently, recycle, collaborate with others to share equipment when feasible, etc)
- Create a "Green Monte" video (recycling, turning off lights and equipment, etc)
- More Green Griz events to promote recycling and energy conservation on campus
- Initiate energy saving competitions across campus
- Provide students with CFLs for their dorm rooms (perhaps NWE will provide the bulbs)
- Assign Building Managers for each building who will be responsible for championing energy conservation
- Institute a 4 day work week
- Put up a suggestion box for energy saving ideas
- Custodians work from west to east to take advantage of daylight in the evenings
- Custodians start work earlier in the day to maximize daylight
- Utilize work-study students to go around and shut off lights
- Provide education and campaigns to turn off office/dorm lights when not in use ("Please Flip Me Off" campaign)
- Acknowledge, celebrate, and reward individual, departmental and building-wide reductions in energy use
- Install energy-efficient exterior doors or airlocks and install sweeps (needed at the Adams Center)
- Utilize building space more efficiently; possibly extend hours of use
- Longer winter break, shorter summer break and minimize energy consumption in buildings not needed
- Evaluate academic calendar to maximize energy savings
- Every employee/student gets a Kill-a-Watt meter to understand and track energy use
- Capture waste heat off a bank of servers
- Cloud Computing (remote servers)
- Pilot LED street light section in parking garage.
- Conduct a Water Leakage Study on campus (water costs money and takes energy to transport)
- Continue with energy audits for all campus buildings
- Retro-commission and balance HVAC systems around campus
- Disseminate results of recent energy audit so others can see what kind of ECMs could be done
- Speed up replacement of CRTs with flat screens
- Change out dining services equipment with energy efficient models
- Campus-wide lighting retrofit (not cheap but some of this is already being done)
- Where possible, convert constant air flow systems to variable air flow
- Replace steam traps where needed (already being done in places)
- Minimize air changes for energy savings while still maintaining comfort and meeting requirements
- Continue to upgrade stream tunnels
- Install motion detectors for lights in bathrooms, offices, printer rooms, kitchens, etc.
- Reduce lighting in areas that where possible

- Turn off computers and copiers at night; install power saving modes on computers
- Eliminate or reduce the number of vending machines
- Adjust timers on lights
- Turn some lights on only at events (Adams Center)
- Check to see if emergency lighting is at minimum required
- Promote Library Sustainability Plan – encourage others to do the same
- Have each building pay for own power as an incentive to save
- Train RAs, VAs, and CAs to watch lights and heat temps
- Educate students on energy use and recycling at orientation
- Insulate pool/pool cover (in ECM project)
- Quantify and measure results of energy conservation(condensate reader)
- Meter buildings separately and make sure meters are accurate
- Install window treatments to reduce solar gain
- Fund-raise for energy conservation upgrades
- Get multiple donors to create a sustainability fund
- Passively heat, cool, and light buildings
- Provide clothes lines for family housing
- Pilot beverage fill stations as a way to eliminate vending machines
- Teach students to unplug chargers when not in use and other energy saving methods of living: fill clothes and dish washers completely before using; use lids on pots when cooking; completely shut off devices instead of using power standby modes
- Provide staff education and training on saving energy and being green
- Turn off coolers for drinking fountains
- Eliminate hot water for sinks where possible
- Replace/upgrade roof insulation campus-wide
- Increase preventative and operational maintenance
- Limit after hours events to certain buildings and power-down the rest
- Add insulation to steam piping in buildings
- Expand digital controls for night temperature setback
- Replace single pane windows or add storm windows

<u>Reduce/Reuse/Recycle</u>

- Provide students recycling bins for their dorm rooms that they take down to the recycling collection stations
- Try completely compostable plates, cups, silverware at events/have people throw all away including food scraps and compost everything
- Shred cardboard to make cellulose insulation
- Create a recycled glass art program
- Encourage automatic payroll deductions to increase funding for recycling program
- Education students, faculty , and staff on how to recycle efficiently so that we may increase quantities without increasing the budget
- Education RAs on recycling
- Eliminate paper ticketing for events; use web-based system

- Quantity benefits of recycling and share; more recycling means less waste hauled to the landfill which equals dollars saved that would have been spent on extra trash pickups.
- Conduct a paper study. Institute paper reduction methods and use of recycling content paper
- Reduce the quantity of catalogs printed or go to electronic version only
- Install water bottle filling stations at events
- Add trees to shade buildings in the summer
- Reduce and consolidate electric appliances (printers, refrigerators, etc)

Transportation Strategies

- Increase ASUM bus service on East Broadway
- Increase visibility of ride share programs through ASUM
- Develop a Parking Management Plan
- Reduce number of parking spaces on campus 30% by 2020
- Free parking for carpooling
- More onsite childcare
- Free bikes for freshman and international students
- Encourage intercity public transit between MT cities
- Encourage more video/telephone conferencing
- Evaluate busing athletes to games instead of flying (may not be feasible because of distance)
- Supply the President with a hybrid vehicle
- Initiate a "walk with Dennison day" promoting walking to campus
- Increase incentives for riding bikes, buses, or walking. Give students points which can be redeemed for money or a prize; give a time allowance for staff who bike or walk to work
- Provide/increase ASUM bus service for football games
- Build covered bike parking
- Look for grants or funding sources for alternative fuel: bio-diesel bus
- Install air stations around campus for bike tires
- Put a ride-share notice board at the UC and/or on the web
- Continue to improve bike and pedestrian routes on campus and connections to local area
- Increase the number of electric vehicles used around campus for maintenance and recycling. Charge these vehicles with solar powered charging stations.
- Allow people who can to work from home
- Provide fee-based, solar powered electric vehicle charging station for commuters (fund with grants)
- One day a year encourage no cars on campus
- Institute a Zip Car program – car sharing. Could then encourage freshman not to bring cars to school.
- Encourage and reward efficient use of air travel i.e. go to multiple meetings or conferences in one trip; utilize web-based conferencing and meetings
- Give employees higher mileage rate for using more fuel efficient vehicles
- Encourage staff use of bicycles for on-campus travel
- Hold more double header athletic events to reduce number of trips

Renewable Energy

On-Campus

- Solar PV and thermal on roofs with appropriate orientation
- Cover parking garage with a roof of solar panels
- Solar thermal for pool
- Biomass: On-Campus wood fired boiler
- Burn excess paper to create energy
- Create passive heating and cooling buildings with minimal mechanical systems.
- Install a Sterling engine solar collection for educational purposes
- Evaluate wind generation from roof tops
- Go back to creating biodiesel from fryer oil
- Generate electricity from exercise equipment

Off-Campus

- Develop wind farm on State school trust lands, i.e University Mountain
- Biomass: Off-site gasification

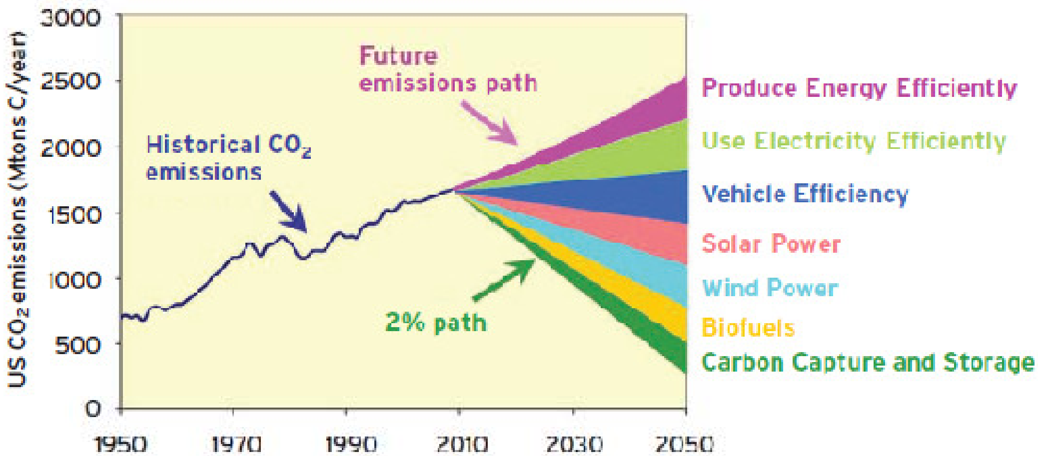
Green Buildings

- Go for LEED Gold, Platinum for new buildings
- Certify existing buildings as LEED EB (Existing Buildings) This would work well with retro-commissioning project
- Install green roofs for energy savings and aesthetics

Landscaping

- Install native and water-wise vegetation around residences
- Replace 2-cycle maintenance equipment with electric or 4-cycle
- Minimize watering as much as possible

Recommended GHG Emission Reduction Goals
The National Wildlife Federation (NWF) published a guide to campus climate action planning in 2008 advocating for greenhouse gas emissions reduction of at least 80% by 2050. This is based on current recommendations by scientists, although this may be changing to become more aggressive in light of new evidence. The NWF suggests a “2% pathway – steady, verifiable progress in emissions reduction averaging at least 2% per year below a 2005 baseline level across all sectors of society (see graph).” (David J. Eagan, 2008) The NWF pathway results in a 30% reduction in emissions by 2020 and greater than 80% by 2050.



(David J. Eagan, 2008)

Architecture 2030 is an environmental advocacy group founded in 2003 by Edward Mazria. Mazria, architect and author of The Passive Solar Energy Book published in 1979, maintains that the building sector is responsible for 48% of the energy consumed in the United States. This energy use and resulting greenhouse gas emissions make the building sector the major contributor to global warming. Architecture 2030 has initiated The 2030 Challenge asking the building community to create carbon-neutral buildings (zero fossil-fuel, GHG emitting energy to operate) by 2030. As learned from UM’s GHG Inventory, use of campus buildings and associated infrastructure comprise 2/3 of the GHG emissions attributed to UM. Therefore, The 2030 Challenge is applicable when considering UM’s GHG emission reduction goals.

The Kyoto Protocol of 1997 set carbon reduction targets in relation to 1990 greenhouse gas emission levels. Although Al Gore of the United States signed the Protocol, it was never submitted for ratification. The Protocol sets an emissions reduction target of 7% below 1990 levels by 2012 for the United States. This equates to an emission level of approximately 25,000 MTeCO2 for UM. 10% below 2007 emission levels equals 42,000 MTeCO2 and 30% equals 32,500 MTeCO2 for UM.

The Intergovernmental Panel on Climate Change (IPCC) is an organization of scientists tasked by the United Nations to publish special reports relevant to the implementation of the UN Framework Convention on Climate Change (UNFCCC), an international treaty. The UNFCCC lead to the Kyoto Protocol. The IPCC’s fourth assessment report, Climate Change 2007, includes a Summary for Policymakers (IPCC, 2007) which discusses a range of GHG emission reduction scenarios. As stated in this report, although some impacts of climate change are unavoidable, "many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilization levels. Delayed emission reductions significantly constrain the opportunities to achieve lower stabilization levels and increase the risk of more severe climate change impacts." (IPCC, 2007)

From the above background information the urgency to reduce overall emissions sooner rather than later is identified as well as the reality that specific dates are not easy to pinpoint. Therefore, to add context to UM's carbon neutrality target and goals, a comparison with other universities was completed.

Comparison with other Universities

UM is not alone is its quest to set GHG emission reduction targets. Some universities have already identified goals and are on their way to lowering emissions, while others just recently completed Climate Action Plans for the ACUPCC. The universities in our region have the same plan deadline as UM so their information is not yet available. The table below outlines the emission targets for a few of the leading universities. While each is unique, carbon neutrality is most often the target and interim goals are based on projects the individual university has initiated or reductions they believe they can realistically achieve.

School (# of students)	GHG Inventory MTCDE and baseline year	GHG Emissions Target	Interim Goals
Brown University (8,000)	73,000 MTDCE 2007	42% below 2007 levels by 2020	4% per year for first four years
Middlebury College (2,400)	30,000 MTDCE 2006	Carbon neutral by 2016	TBD
Oberlin College (2,800)	45,000 MTDCE 2007	Carbon neutral by 2020	TBD
University of California, Berkley (34,000)	209,000 MTDCE 2006	26% below 2006 levels by 2014	No formal goals
University of California, Santa Barbara (21,000)	47,600 MTDCE 2000	Carbon neutrality	2000 levels by 2010 1990 levels by 2020 80% below 1990 levels by 2050
University of Colorado at Boulder (29,000)	120,000 MTDCE 2005	Carbon neutrality	20% by 2020 80% by 2050
Yale University (11,300)	260,000 MTDCE 2005	43% below 2005 levels by 2020	No formal goals
Majority of Universities w/ recently submitted plans (over 100 plans)		Carbon neutral by 2050	
The University of Montana (14,000)	*43,000 MTDCE 2007*	*??*	*10% below 2007 levels by 2015* *30% below 2007 levels by 2020*

APPENDIX C

Synopsis of the All-Campus Survey Results written by the ASUM Sustainability Coordinator:

The survey results indicated that overall students advocated for more aggressive interim goals and carbon neutrality date, while responding that the plan's goals looked good. Some students replied that the goals seemed arbitrary or they did not understand where the goals came from. Only a few responded that the plan appears costly, unachievable or that global warming does not exist. Most staff and faculty responded similarly, however more seemed doubtful that the University would reach these proposed goals.

Students seem weary of carbon offsets to achieve carbon neutrality. Out of 60 student respondents, 36 responded no at some level to carbon offsets. Either they felt they needed more specifics about the projects, wanted to spend the money on energy efficiency and conservation, thought it was just a way for the campus to look better, or just said no. Perhaps greater education about carbon offsets is needed in order for the campus and especially students to make informed decisions. The 23 that said yes to carbon offsets on some level again stressed the importance of spending money on projects benefiting the university and suggested that carbon offsets could have potential benefits. Many people had strong concerns about the amount we travel by air and felt a carbon offset program would make sense with air travel.

Both faculty and staff seemed more resistance to carbon offsets, again wondering how this benefits the university and would be economically feasible. Some did support offsetting and were enthusiastic about the process.

Across the board energy efficiency and conservation received support. Many mentioned that upgrading windows, fixing air leakage from windows and doors with seals is necessary and not emphasized in the plan. A lot of people mentioned the inconsistently of temperature in buildings and stressed retro-commissioning HVAC systems. It appears even if the respondent did not believe in climate change and renewable energy they still want the buildings to be energy efficient.

Incorporating these projects into our curriculum and student projects is another thing people seemed to care strongly about (across the board). Suggestions included partnering with COT and utilizing the academic departments to promote the plan, i.e. Marketing, Communications, Conservation and Chemistry. We are an institutional setting and should allow students and faculty to research the feasibility of many of these projects as well as working on behavior changes. People recommended that more student involvement and awareness about this plan is needed.

The concern for the biomass plant came up quite a few times. Generally, students, staff and faculty advocated for wind and solar and wanted to see these renewable energy projects start up sooner. Although some saw the benefits of biomass as great student research opportunities, others were concerned with the costs, the feedstock, transportation issues, and the air pollution of an on-campus boiler. Again, greater education of what biomass entails could be used. However, this really seems to be a sticking point. People who want renewable energy are more for wind and solar.

As far as costs, here is a quick count of the number of students who expressed how much they would pay in fees.
24 people : less than 10
19 people : $10-50
12 people : $50-100
15 people : $100 or more
A few said they would pay nothing, and asked why this was not an option. Those people were already fairly skeptical about the whole plan. Some students said they would not want to pay more because they already pay a lot and why should the burden be placed on them. Funding from grants, the state, and administration should bear the brunt of the cost.

A few faculty and staff answered the fee question and the responses varied. Most of those who responded said they would pay $10-$50 or less than $10. Quite a few said they would not want to see students pay more for these projects as tuition is already high enough.

Implementing a 4-day work week came up a lot as well. Some faculty said absolutely not to a 4-day work week because of research needs, while some staff really seemed to like it. Although there was a big mix of answers, people generally supported not having class on Friday rather than shutting down the university.

Overall, I feel this campus is largely mixed in opinion when it comes to a Climate Action Plan. This may be a result of Montanan culture and opinions, difficult financial times, and personal responsibility versus administration and government responsibility. All these factors play into people's perspectives. The majority of people want our buildings to be more energy efficient—that seems to be the one thing everyone can agree on.

Bibliography

IPCC. (2007). *Climate Change 2007: Synthesis Report, Summary for Policymakers.*

Running, S. W. (2006). Climate Change: Is Global warming Causing More, Larger Wildfires?". *Science Express* , 927-928.

U.S. Geological Survey. (2008, July 25). *Northern Rocky Mountain Science Center*. Retrieved October 28, 2009, from

NORock: http://nrmsc.usgs.gov/research/glacier_retreat.htm

Endnotes from Section 4.5 Carbon Offsetting

[i] ACUPCC "Voluntary Carbon Offset Protocol", November 2008.

[ii] See Table 2.14, Fourth Assessment Report: Climate Change 2007, Intergovernmental Panel of Climate Change http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_Ch02.pdf

[iii] A "tonne" is common terminology used to represent a metric ton which equals 1,000 kilograms which in turn equals 2,200 pounds.

[iv] This motto is trademarked by Carbonfund.org http://www.carbonfund.org/site/pages/how_help/

[v] ACUPCC "Investing in Carbon Offsets: Guidelines for ACUPCC Institutions, November 2008 p. 8.

[vi] College of the Atlantic http://coa.edu/html/netzero.htm

[vii] "To Keep the Oil Flowing: A Conversation on Carbon Credits", Dag Hammarskjold Foundation, 2006.

[viii] "Cap and Trade: Acid Rain Program Results" U.S. Environmental Protection Agency http://www.epa.gov/airmarkt/cap-trade/docs/ctresults.pdf

[ix] ACUPCC "Investing in Carbon Offsets: Guidelines for ACUPCC Institutions, November 2008 pp 18-25.

[x] Ibid pp 26-34.

[xi] The term "retail" means prices that individuals might pay for limited quantities of offsets. Commercial and industrial clients and other large quantity purchasers can often negotiate for better unit pricing.