Mountains & Minds

CLIMATE ACTION PLAN

OCTOBER 2011

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MONTANA STATE UNIVERSITY

BOZEMAN ▲ MONTANA

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GLOSSARY OF ABBREVIATIONS

AFRI	Agricultural and Food Research Initiative
ATA	Air Transportation Association
ACUPCC	American College and University President Climate Commitment
ASMSU	Associated Students of Montana State University
AASHE	Association for the Advancement of Sustainability in Higher Education
BSCSP	Big Sky Carbon Sequestration Partnership
BTC	Burns Technology Center
CSAC	Campus Sustainability Advisory Council
CBE	Center for Biofilm Engineering
CACP	Clean Air Cool Planet
CAP	Climate Action Plan
CLS	College of Letters and Sciences
CASMGS	Consortium for Agricultural Mitigation of Greenhouse Gases
DOD	Department of Defense
DOE	Department of Energy
DOE NREL	Department of Energy National Renewable Energy Laboratory
DEQ	Department of Environmental Quality
E3A	Exploring Energy Efficiency and Alternatives
EWB	Engineers Without Borders
EPA	Environmental Protection Agency
FTE	Full Time Equivalent
GIS	Geographic Information Systems
GWP	Global Warming Potential
GYE	Greater Yellowstone Ecosystem
GHG	Green House Gas
GDP	Gross Domestic Product
GRH	Guaranteed Ride Home
HVAC	Heating, Ventilation and Air Conditioning
ITC	Information Technology Consultant
IDL	Integrated Design Lab
IoE	proposed Montana Institute on Ecosystems
IPCC	Intergovernmental Panel on Climate Change
LRES	Land Resources and Environmental Sciences
LEED	Leadership in Energy and Environmental Design
MHK	Marine Hydrokinetic
MSDS	Material Safety Data Sheet
MT CO_2e	Metric Tons of Carbon Dioxide Equivalent
MSU	Montana State University
MUS	Montana University System
NRCS	Natural Resource Conservation Service
NECO	Network of Environmentally Conscious Organizations
PECASE	Presidential Early Career Awards for Scientists and Engineers
RFP	Request for Proposal
SOV	Single Occupancy Vehicle
SOFC	Solid Oxygen Fuel Cell
SFBS	Sustainable Food and Bioenergy Systems
TAGs	Triacylglycerides
USDA	United States Department of Agriculture
UFS	University Food Service
WARM	Waste Reduction Model
WTI	Western Transportation Institute
WAC	Wind Applications Center
WfS	Wind For Schools Program
ZERT	Zero Emissions Research and Technology

1. EXECUTIVE SUMMARY

In 2008, Montana State University (MSU) signed the American College and University Presidents Climate Commitment (ACUPCC): www.presidentsclimatecommitment.org. The ACUPCC acknowledges "the scientific consensus that global warming is real and is largely being caused by humans. We further recognize the need to reduce the global emission of greenhouse gases (GHGs) by 80 percent by mid-century at the latest in order to avert the worst impacts of global warming and to reestablish the more stable climatic conditions that have made human progress over the last 10,000 years possible."

As part of the commitment, MSU's Campus Sustainability Advisory Council (CSAC) was established (www.montana.edu/sustainability/csac.html) to advise MSU's President on sustainability and meet ACUPCC obligations, which include the:

- periodic inventorying of GHG emissions;
- development and public reporting of the Climate Action Plan (CAP); and,
- strengthening of research, education, and civic engagement efforts to promote climate stabilization and progress toward sustainability.

The Elements of MSU's Climate Action Plan (CAP)

MSU's inaugural CAP describes current efforts to significantly reduce campus GHG emissions and outlines plans to integrate sustainability into all aspects of university operations, learning, discovery and service. Beginning with a baseline GHG inventory compiled in 2009, mitigation strategies and specific emissions reduction goals are presented. The CAP also presents ongoing and proposed activities that integrate sustainability and climate neutrality into operations, curriculum, research and civic engagement. Additionally, inspired by the uniqueness of place and cultures at MSU, we acknowledge and value the wisdom and traditional practices of native peoples associated with our place here in the Northern Plains and Northern Rockies. We therefore incorporate the Native American ideas of stewardship and community as prerequisites to sustainability, and include this perspective as an important element to the CAP. The CAP will be updated biannually to provide information on progress toward the above goals and new initiatives at MSU-Bozeman.

Baseline Greenhouse Gas Inventory

The 2009 annual baseline GHG inventory revealed that approximately 77,375 metric tons of carbon dioxide-equivalent (MT CO_2e) were emitted from MSU-Bozeman campus operations, as defined by limits provided by the ACUPCC. Of this total, approximately one third are generated by direct fuel combustion on campus, one third from purchased electricity, and one third from indirect emission sources such as transportation and solid waste.

Mitigation Strategy and Benchmarking

MSU-Bozeman campus intends to implement a near-term emissions reduction strategy based on the following guidance from the University Council:

- continue and complete energy conservation projects presently funded;
- tackle additional cost-effective energy conservation projects as they become reasonable/attainable, contingent upon funding;
- leverage cost-effective technological advancements as they develop;
- comply with mandated energy efficiency requirements for new building projects;
- move resource conservation services in-house, and leverage these services into a Resource Conservation Culture Program; and,
- pursue renewable energy sources, offsets, and/or credits as cost-effective mechanisms become available and/or upon the State of Montana taking action to enable, support, and fund them.

Given the above direction, an ambitious, yet achievable GHG reduction strategy has been developed. An interim goal of 20 percent reduction from 2009 GHG emissions by 2025 has been established. Extensive planning and analysis is required to confidently establish further reduction milestones, and the ultimate goal of net-zero carbon emissions. Planning will continue concurrently with the implementation of early (Phase One and Two) projects during the next two to three years. Results and feedback from Phase One and Two efforts will contribute to CAP course corrections and milestone revisions, and be reported in the next (biannual) CAP release.

Climate Neutrality and Sustainability in Education, Research, and Outreach

MSU-Bozeman seeks to provide an environment that promotes the exploration, discovery, and dissemination of new knowledge, as well as serve the people and communities of Montana. This mission draws on the unique geographic setting and the ethnographic and cultural diversity of Montana, as well as our location in the Greater

Yellowstone Ecosystem and adjacent Great Plains. We use our unique location to instill in students a sense of responsibility to sustain environmental integrity and function and to improve the quality of life for all. Research, education and outreach activities focused on sustainability range from clean energy and sustainable food production to climate change impacts and human health, and they are underway in various centers, colleges and departments at MSU. Many of these activities have historically occurred in isolation with little effort to bridge across departments and colleges. To coordinate and enhance communications, the MSU Institute on Ecosystems (IoE) is currently being launched.

The IoE is a faculty-designed and supported effort that builds on and transforms the existing Regents-approved Big Sky Institute (BSI). The IoE mission, to promote interdisciplinary discovery, education, and engagement focused on a sustainable future for Montana as well as mountain regions around the world, is a strategic alignment of ongoing and future efforts at MSU-Bozeman. The IoE will coordinate climate neutrality and sustainability education, outreach and research efforts amongst undergraduate and graduate students and staff/faculty across campus and within the community, providing:

- a new framework that will increase state and national visibility for Montana University System (MUS) environmental research and educational activities;
- a statewide community of scholars who share common interests in addressing complex environmental questions;
- new connections with partners from other universities, tribal colleges, state and federal agencies, NGOs, small businesses, and communities that will foster innovative opportunities for collaboration; and
- improved engagement with communities and stakeholders to support informed decision-making and development of solutions to environmental challenges.

Engagement and Partnerships

We seek engagement and partnerships in research, education, and service to ensure that objective science information with a practical human perspective is used to envision our future and the steps necessary to achieve it. MSU recently was awarded the Carnegie Foundation's Community Engagement classification, a designation which recognizes an institution's high level of outreach and collaboration with its surrounding community. MSU has a myriad of outstanding examples of environmental and community outreach, as evidenced later in the CAP. While these efforts are not coordinated and widely shared, the IoE will provide a point of contact for collaborations with other MUS institutions (including other MSU campuses, University of Montana, and tribal colleges), state and federal agencies (e.g., USGS Northern Rocky Mountain Science Center, Yellowstone National Park, Northern Region U.S. Forest Service, Bureau of Land Management), nongovernmental organizations (e.g., World Wildlife Foundation, Wildlife Conservation Society, Greater Yellowstone Coalition; Sonoran Institute), MSU Extension, communities, small businesses (e.g., Greater Yellowstone Business Partnership), corporations and foundations, and private citizens.

By setting a strong example through tangible progress toward net zero GHG operations, working with the IoE to effectively educate, train, and graduate students in interdisciplinary sustainability areas (including climate change), and successfully integrating with the surrounding community and region, MSU and the MUS is poised to become a leader in transforming the world toward understanding the science of climate change and seeking solutions that result in sustainable living, choices, and technologies that will ultimately mitigate climate change to the degree humanity has contributed to its causation.

2. BASELINE GREENHOUSE GAS (GHG) EMISSIONS

Baseline Inventory Summary

As a signatory to the ACUPCC, MSU has made an institutional commitment to reduce GHG emissions from campus operations, and ultimately achieve a carbon neutral footprint. The initial step in achieving this goal is to complete a comprehensive GHG emissions inventory. McKinstry Company was engaged by MSU to assist the CSAC in this process. McKinstry is a third-party engineering firm with demonstrated experience in GHG inventories. Working with an experienced third-party for GHG audits reduces overlooked emission sources, establishes consistent methods for subsequent audits, and lends an objective approach to audit processes. It was determined that the total emissions for the 2009 reporting period were 77,375 Metric Tons Carbon Dioxide Equivalent (MT CO_2e), taking into account Scope 1, 2, and 3 emissions (see Figure 2.1). This is a higher than average emissions value when compared to many ACUPCC institutions, but includes thorough data for Scope 3, emissions that are, at this time, omitted by many other institutions.

Introduction

GHG accounting and reporting was based on the principles set forth in the World Resource Institute GHG Protocol. These are:

- Relevance — Ensure the GHG Inventory appropriately reflects the GHG emissions of the university and serves the decision making needs of users — both internal and external to the university.
- Completeness — Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.
- Consistency — Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document changes to the data, inventory boundary, methods, or any other relevant factors in the time series.
- Transparency — Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.
- Accuracy — Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

MSU's 2009 GHG inventory was based on university data for the 2008–2009 fiscal year (July 2008–June 2009), and was calculated using the Clean Air Cool Planet Campus Carbon Calculator (CACP) v6.4. Data was collected from a variety of sources, and some incomplete data was extrapolated to provide MSU with an estimate based on the best available data.

Reporting Boundaries

Through discussions with MSU, it was determined that the scope of this report would be limited to MSU activities at the Bozeman campus. Additionally, it was agreed that MSU would use the Operational Control Approach in determining organizational boundaries on the campus. Under this approach, MSU is accounting for GHG emissions from all operations under its operational control, which refers to the authority to introduce and implement operating policies, and is consistent with the ACUPCC reporting guidelines. The commitment requires that signatories report on and mitigate emissions from Scope 1 and 2 sources as well as commute and air travel from Scope 3. Comparing this inventory with peer institutions reveals that most inventories focus on required emissions sources. This inventory aims to document all MSU emissions, regardless of the required mitigation responsibilities.

It can be argued that many Scope 3 emissions are not under direct MSU control and should therefore be excluded. Holding the university accountable for personal commute choices and habits could be argued as outside the control of the reporting institution, and should not impact its footprint. MSU believes that it is important to accurately account for all emissions resulting from university existence, and this should not exclude emissions from choices of the campus population, and are therefore included in this report.

Description of Emission Sources

Throughout this report, emissions are grouped into three different Scope categories, as presented in Figure 2.1. Scope 1 emissions are direct GHG emissions occurring from sources that are owned or controlled by the institution. Scope 2 emissions account for indirect GHG emissions that are a consequence of activities that take place within the organizational boundaries but that

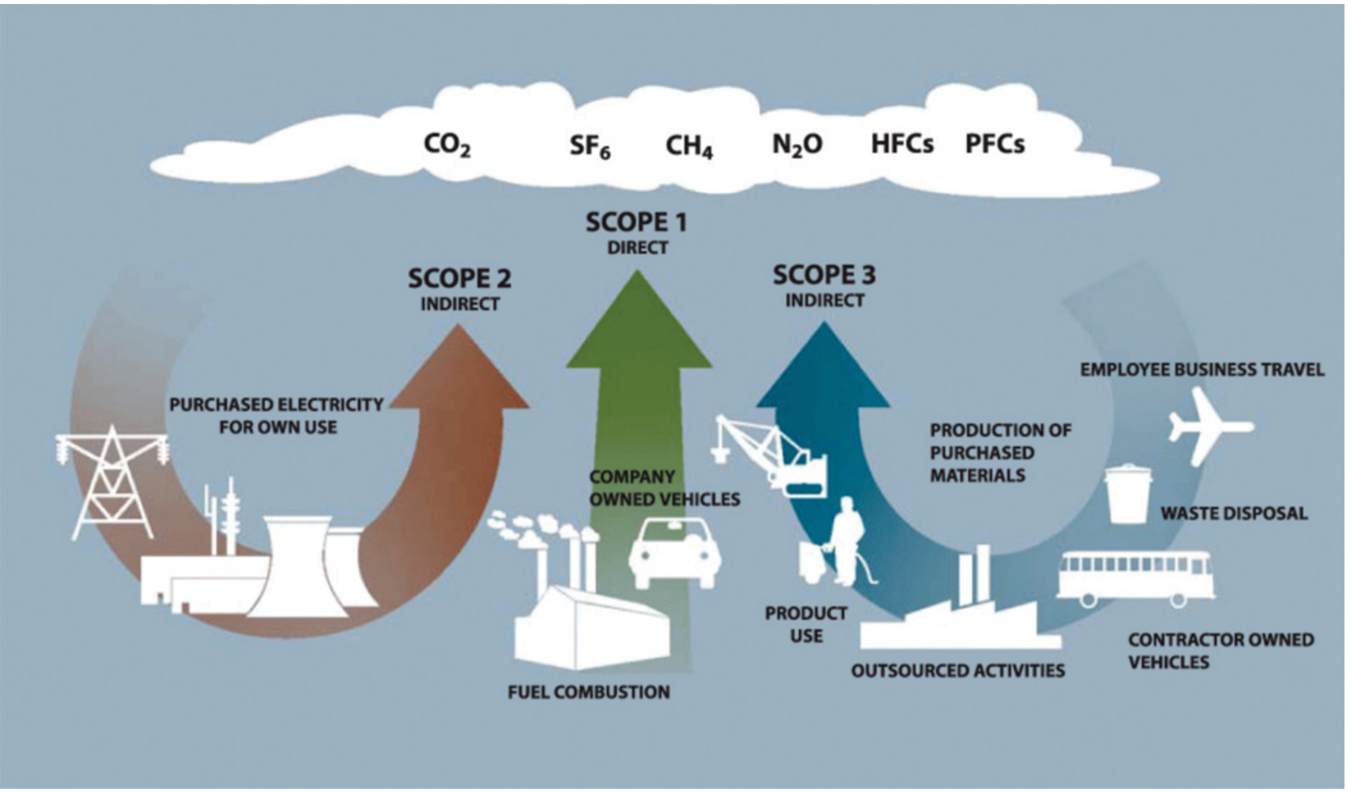

Figure 2.1 Summary of Operational Boundaries – 'Scopes' of GHG Emissions. (World Resources Institute)

occur at sources owned or controlled by another entity, such as purchased electricity. Scope 3 emissions are all indirect emissions not covered in Scope 2, and focus on cultural emissions associated with travel, waste, and commuting habits of the university. By understanding where university emissions are concentrated, MSU will be better prepared to strategically approach reduction to meet the ACUPCC requirements of achieving a carbon neutral campus.

Inventory Results

Well-tracked data for Scope 1 and Scope 2 were typically available for MSU-Bozeman, but some Scope 3 data, specifically other directly-financed air and ground travel, were based upon best available data, recommended conversion factors, and supplemented by estimates from other ACUPCC universities. MSU's emissions presented in this report reflect a higher than average value than comparable universities on the ACUPCC website. It is important to note that many of these institutions have not reported on air travel, and many do not include comprehensive commute data. By omitting these Scope 3 emissions from the GHG reports, MSU-Bozeman total GHG emissions are approximately 43 percent lower than the 77,375 MT CO_2e reported for MSU in 2009. MSU and McKinstry chose to report on all data collected by MSU, and make assumptions for unknown parameters (study abroad air miles) in order to present the most comprehensive footprint information available. Although not all of these emissions are required reporting for ACUPCC, it is recommended that MSU continues to view their GHG inventory holistically and report on full emissions. MSU acknowledges that their reported emissions are likely to change as they evolve their data collection protocols, and are not required to report on all emissions stated in compliance with ACUPCC. Presented in Figures 2.2 and 2.3, 2009 GHG emission data by scope and source is reported in tabular and graphical forms, respectively.

2. BASELINE GREENHOUSE GAS (GHG) EMISSIONS

2009	MT CO_2e	% of Net Emissions	ACUPCC required?
Co-gen Electricity	0	0%	yes
Co-gen Steam	0	0%	yes
Other On-Campus Stationary	21,099	27%	yes
Direct Transportation	639	1%	yes
Refrigerants & Chemicals	1,585	2%	yes
Agriculture	92	0%	yes
Purchased Electricity	20,564	27%	yes
Purchased Steam / Chilled Water	0	0%	yes
Faculty / Staff Commuting	3,733	5%	yes
Student Commuting	4,073	5%	yes
Directly Financed Air Travel	12,335	16%	yes
Other Directly Financed Travel	2,403	3%	recommended
Study Abroad Air Travel	6,688	9%	yes
Solid Waste	2,132	3%	yes
Wastewater	0**	0%	recommended
Paper	0**	0%	recommended
Scope 2 T&D Losses	2,034	3%	recommended
Additional	0	0%	recommended
Non-Additional	0	0%	recommended
Scope 1	23,415	30%	
Scope 2	20,564	27%	
Scope 3	33,397	43%	
All Scopes	77,375	100%	
All Offsets	0		
TOTAL EMISSIONS	**77,375**		

Figure 2.2 2009 GHG Baseline Emissions at MSU-Bozeman
** Data not available

Data Collection Methodology

Below is a summary of how data for this report was collected, and any calculations or extrapolations used to generate the GHG inventory report. For a full list of assumptions and standard calculations, please reference the 2009 MSU-Bozeman GHG Inventory Report in Appendix 1.

General University Data

University Population — The MSU "Quick Facts 2008–2009" report was used for the university population. For faculty and staff, full time equivalent (FTE) employee numbers were used.

Scope One Emissions

- Stationary Combustion — This category accounts for the total direct emissions from stationary combustion on the MSU campus. Stationary combustion refers to the burning of fuels to produce electricity, steam, heat, or power using equipment in a fixed location such as boilers, burners, heaters, furnaces, incinerators, kilns, ovens, dryers, and engines. Any biogenic carbon dioxide emissions that result from the combustion of biomass or biomass-based fuel are not included in Scope 1.
- Mobile Combustion from Direct Transportation — Accounts for the total direct emissions from mobile combustion in MSU-owned fleet such as cars, trucks, tractors, and buses. These emissions were captured from MSU fuel records from motor pool and Gas Island fuel sales for campus fleet vehicles.

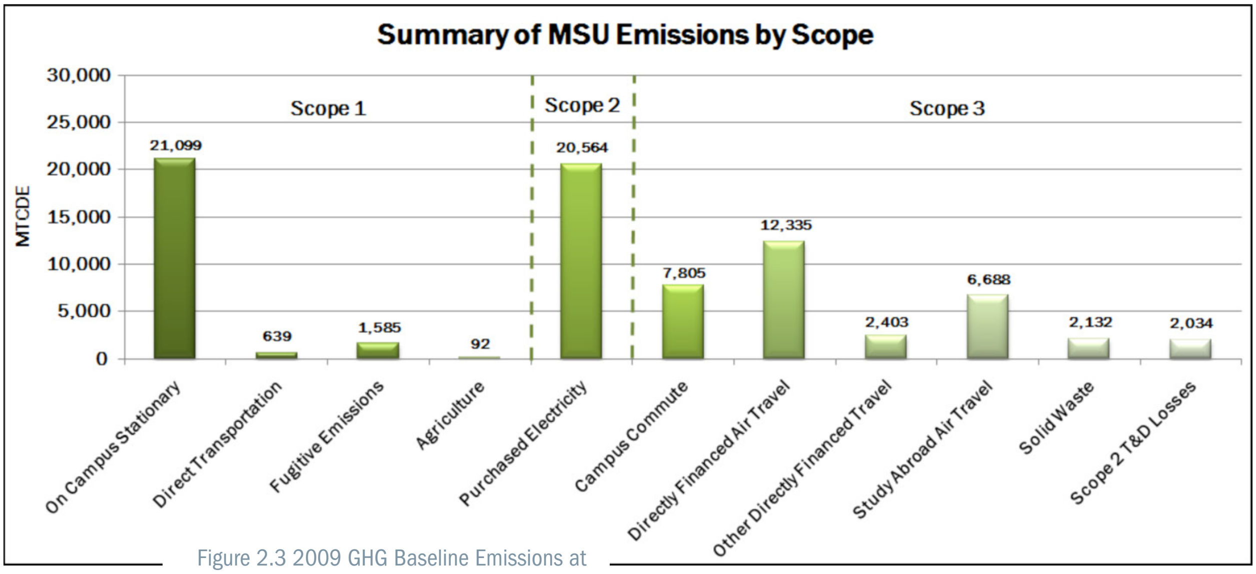

Figure 2.3 2009 GHG Baseline Emissions at MSU-Bozeman

- Fugitive Emissions — Data for emissions due to the intentional or unintentional release of GHGs in the production, processing, transmission, storage, and use of fuels and other substances were acquired through MSU Facilities Services. This includes releases of hydro fluorocarbon during the use of refrigeration and air conditioning equipment and methane leakage from natural gas transport. The Clean Air Cool Planet (CACP) calculator identifies specific emissions factors for each type of refrigerant used on campus based on the Global Warming Potential (GWP) for the individual refrigerant. For refrigerants not in the CACP calculator, MSDS sheet values for GWP were used.
- Agricultural Emissions — This captures emissions from on-campus fertilizer production and application.

Scope 2 Emissions

- Purchased Electricity — This captures the total indirect GHG emissions resulting from the generation of electricity purchased and used by MSU. Default eGRID region and sub-region emissions coefficients for Bozeman, Montana (supplied in the Clean Air-Cool Planet Campus Carbon Calculator v6.4) were used for all electricity emissions calculations.
- Purchased Steam — MSU does not purchase any steam or chilled water.

Scope 3 Emissions

Commute Transportation — A commute survey was created and administered by ASMSU. This survey was distributed to faculty, staff and students on the MSU campus. Survey Questionnaire results are supplied in Appendix 2. Results from this survey were used to calculate emissions from student, faculty, and staff commuting. Extracting usable data required query sorting of the survey responses, and is explained below. A total of nine sorted reports were used to compile commute data for the GHG inventory.

CACP methodology for calculating commuting data bases calculations on FTE student population, giving part-time students equivalent of one-half a full-time student. This may not accurately capture the complex commute patterns of students going to and from campus, but until more accurate tracking is established, the CACP protocol will be used for MSU calculation.

- Commute Preferences — To determine primary commute patterns for students, faculty and staff, each group was sorted individually. Responses to question four of the survey would then show the primary commute habits of each group (bus, SOV, carpool etc). Because the survey separated commute choices by season, averages were calculated for the GHG Inventory inputs. For faculty and staff, full-year averages were used because they are employed on a 12 month pattern. For student averages, spring/fall and winter response averages were used to determine percent utilizing each mode of transportation as their primary commute choice during the school year.
- Driving Distance — To determine the average trip distance for drive-alone commuters, each response group was filtered to sort by status (student, faculty or staff), and to those that selected “drive-alone” as their primary commute choice. The survey allowed respondents to specify distance they lived from campus. An average of these values was calculated for each group to enter into the CACP workbook. Any extreme outlier responses were omitted.
- Bus Distance — To determine the average trip distance for bus commuters, each response group was filtered to sort by status (student, faculty or staff), and to those that selected “bus” as their primary commute choice. The survey allowed respondents to specify distance they lived from campus. An average of these values was calculated for each group to enter into the CACP workbook.
- Weeks Worked/Trips Per Week — Values entered for the number of weeks commuting were assumed based on MSU data for employee benefits and academic calendars. It was assumed that all employees and students were commuting five days per week, to and from campus.

Air Travel — Air travel accounts for a large portion of most universities GHG emissions. Reported emissions from air travel for MSU are estimates based on best available data and extrapolations. The following bullets explain the methodology to calculate these Scope 3 emissions from MSU.

- Athletic Air Travel — Athletic air travel was tracked by MSU for the 2008–2009 academic year. This data was provided in dollars spent for each trip. The CACP input requires air miles, so to extrapolate air miles from these dollar values, the recommended ATA conversion factor. It is entered into the CACP workbook as student air travel.

- Faculty and Staff Air Travel — MSU air travel spending is automatically tracked through the university purchasing card records and expense reports. The total spent on university air travel related to research and other travel was converted to air miles using the ATA conversion used throughout all MSU air travel calculations; this is equivalent to approximately 12,756,878 air passenger miles.
- Study Abroad Air Travel — At this time, MSU does not track or record air miles associated with study abroad travel. Rather than leave this value at zero, the reporting team used estimated study abroad miles based on other reporting universities based on air miles per student. This estimate will be refined in future reports at MSU develops tracking protocol to capture study abroad travel.

Other Transportation — Reported emissions from air travel for MSU are estimates based on best available data and extrapolations. The following bullets explain the methodology to calculate these Scope 3 emissions from MSU research travel.

- Reimbursement for Mileage — Calculated from total dollar value reported by MSU using 2007–2008 standards reimbursement rates per mile.
- Fuel Costs — Calculated based on total reported fuel expenditures at $2.50 per gallon.
- Bus Mileage — Bus data was only available specifically for athletic teams. For bus-only trips, MapQuest.com round trip distances between MSU and the opponent city were used for mileage. For trips where busses and airlines were used, it was assumed that each bus on the trip traveled 150 miles. Number of busses were based on number of participants (provided by MSU Athletic Department) and bus capacity of 49 passengers.
- Solid Waste — This captures the total indirect GHG emissions resulting from the incineration or decomposition of MSU's solid waste.
- Offsets — MSU does not currently purchase any offsets for their GHG emissions.

[1] The ACUPCC Instructions for Submitting a Greenhouse Gas Report states that 'for guidance on calculating air travel emissions, you may consult "Guidance on Scope 3 Emissions, pt 2: Air Travel" on the AASHE Blog. The AASHE Blog states that you can use statistics on the average price per passenger air mile from the Air Transportation Association of America to convert the total air travel expenditure into passenger air miles. Since the figures from the ATA exclude taxes, AASHE recommends adjusting the cost per passenger mile up by 20 percent to take taxes into account. The ATA data indicates that the nominal domestic yield in dollars per passenger mile was $0.1384 in 2008. Adjusting this cost up by 20 percent per AASHE recommendations results in a cost of $0.16608 per passenger mile.

Report Omissions

Various inputs were omitted from this report due to a lack of data availability. MSU acknowledges these omissions impact the accuracy of this report, and are working to collect these data for future reports. The future inclusion of these inputs may or may not significantly change MSU's GHG footprint.

- Paper — MSU data not available.
- Wastewater — MSU data not available.

Recommended Inventory Improvements

Through the process of collecting, compiling, and reporting the 2009 GHG Inventory, gaps in current data collection processes were identified. The most critical improvements need to be addressed in accurate data collection for air travel miles and commute transportation patterns.

It is recommended that for future commute transportation surveys, MSU consider alternative methods that will reach more respondents. It is also recommended that the question "How many miles do you live from campus?" be rephrased "How many miles is your daily commute?" Because some campus members may not come in exactly 5 days per week, or may make multiple trips per day, "How many trips/miles per week do you drive?" is another suggested revision. For instance, it was found that some faculty not on campus responded with 100's of miles from campus (probably not their daily commute) which could skew averages if outliers had not been omitted. This change would more accurately capture what the emissions impact from daily commuting is for MSU employees and students.

The commuter survey did not account for commuting via light rail or commuter rail. If and when this becomes an option for campus commuters, it should be added to the response options.

For future accurate reporting, MSU should establish protocol for tracking air miles for faculty and staff travel, for-credit study abroad, and athletics. The most accurate reporting would come from direct collection of passenger miles (ground or air) rather than dollar amounts. In the current athletics tracking system, some recommended improvements would include miles driven on each bus and rental car. From the data provided, it is difficult to accurately convert dollars spent into miles driven. As MSU refines their data collection methods, future GHG Inventories will represent more accurate Scope 3 emissions.

3. EMISSIONS REDUCTION SCHEDULE, MILESTONES, AND CARBON REDUCTION GOAL

3.1 Identification of emissions trajectory and reduction potential

As part of MSU's energy management program, detailed data regarding the use of energy in Campus buildings is tracked. For the purposes of this planning effort, the data has been restricted to electrical and natural gas energy consumption over the course of the last 22 years (1988–2009). Gross energy consumption for each utility has been tracked and compared to the gross building area increase. Electrical consumption has increased at an average rate of about 1.6 percent annually (Figure 3.1) over this time period while gross square footage has grown approximately 0.6 percent annually. Likewise, natural gas consumption has an annual average rate of 1.3 percent over the same time span (Figure 3.2). The disparity between a modest increase in the built environment and the more aggressive growth in energy consumption is due to the proliferation of electrical equipment, mechanical loads, and MSU's continued growth in areas of research requiring energy-intensive support systems.

In order to identify the relative energy efficiency of MSU's buildings and potential energy conservation projects, campus was categorized into eight building types/functions. An energy index (annual energy use per unit area) was calculated for each category. In addition to benchmarking buildings by energy index, the energy magnitude was also considered in determining where mitigation focus should be applied. When energy magnitude is considered, 93 percent of all building energy is concentrated in five of the eight building sectors. These sectors include Research-Owned Buildings, Campus Core (State Owned academic and research buildings), Residence Halls, Family Housing, and Other Auxiliary Buildings, as presented in Figure 3.3.

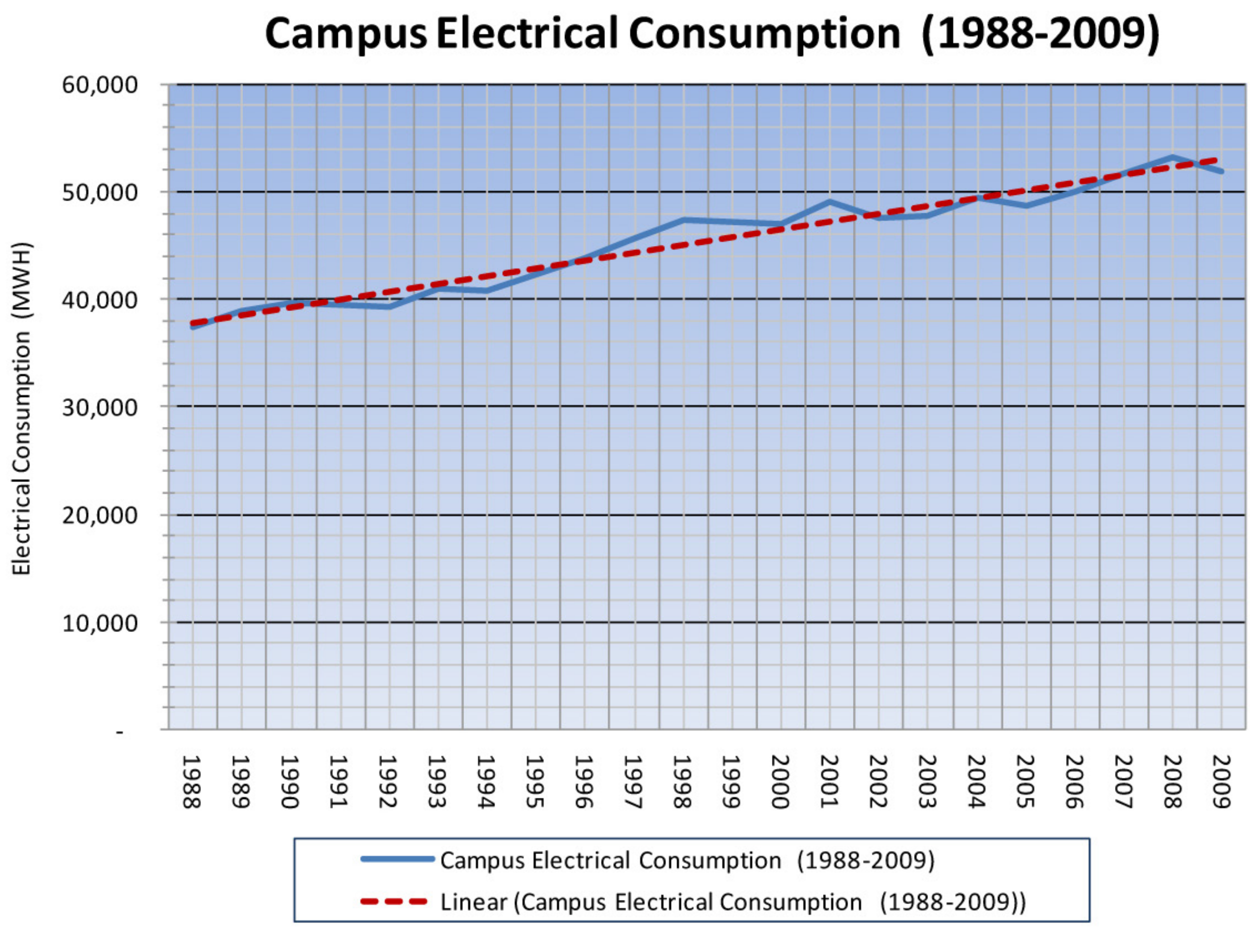

Figure 3.1 MSU-Bozeman Campus Electrical Consumption History

3. EMISSIONS REDUCTION SCHEDULE, MILESTONES, AND CARBON REDUCTION GOAL

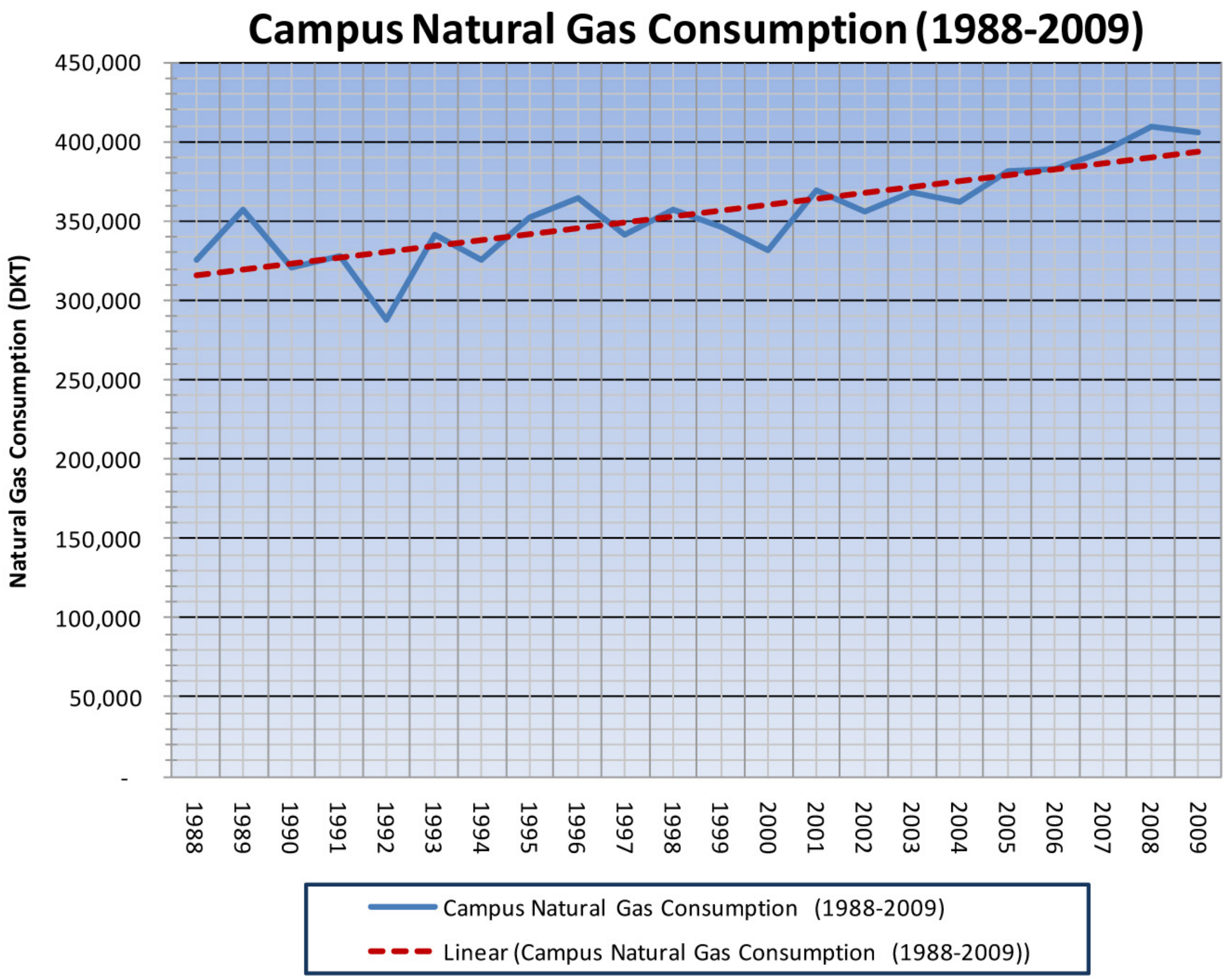

Figure 3.2 MSU-Bozeman Campus Natural Gas Consumption History

3. EMISSIONS REDUCTION SCHEDULE, MILESTONES, AND CARBON REDUCTION GOAL

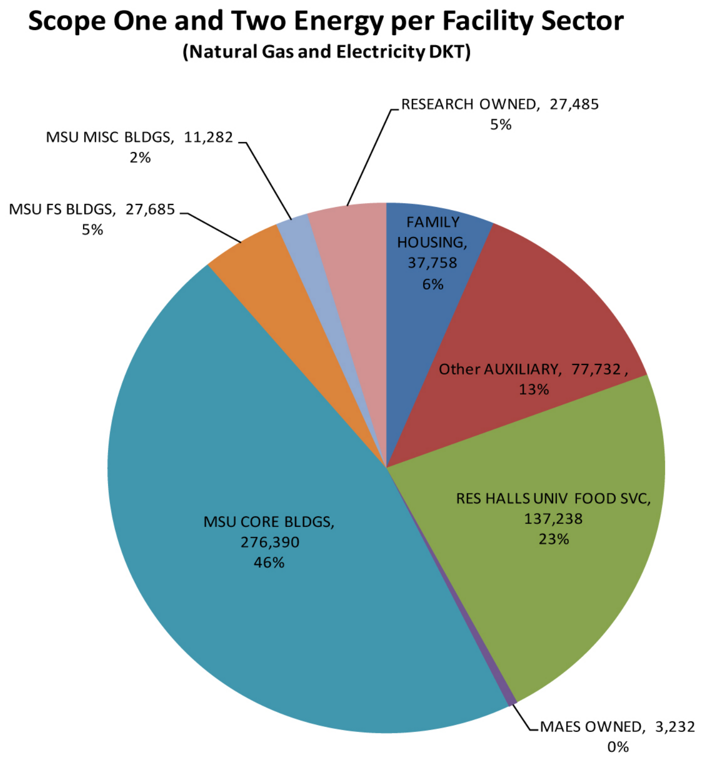

Figure 3.3 Energy Consumption / GHG Emissions Per Building Sectors

Climate Action Planning and Predictive Modeling

The baseline emission and mitigation strategy calculations were calculated using The Clean Air-Cool Planet Campus Carbon Calculator. This Excel workbook-based tool is designed to conduct greenhouse gas emissions inventories, project emissions into the future, and evaluate a portfolio of carbon reduction projects. The spreadsheets are based on workbooks provided by the Inter-governmental Panel on Climate Change (IPCC) for national-level inventories. The IPCC data has been adapted for institutional level assessment.

A strategy of phased projects and programs, focused on maximizing MSU's ability to reduce energy consumption and reclaim energy streams presently dissipated, is presented within this document. This strategy prepares systems for the eventual integration of renewable energy systems that compliment conservation and reclamation tactics. A multitude of Scope 3 reductions focused on reducing commuter travel emissions are discussed and an annual goal is projected.

Many of the mitigation tactics identified for Scopes 1 and 2 have been determined to interact and/or have mutual benefit. For this reason, both Scopes are considered for each of the following tactics. The preliminary assessment has been categorized in two phases based on implementation timeline, characteristics, and complexity. Phase One tactics are presently in design, construction, or implementation. The cost and economic performance of these projects are either known, or projected with a relatively high level of confidence. Phase Two tactics are identified as similar, conservation-based projects that can be implemented by applying readily available technology or that which is emerging, yet highly probable of cost effective success. Some of these tactics, such as the Leon Johnson Energy Retrofit, Northwest Campus Core District Energy Plant, and the Auxiliary Energy Performance project are presently being planned and developed. The costs, economic performance, and emissions reductions are more conceptual. The implementation of these tactics is further away and the accuracy of these key performance indicators is less than for Phase One. Continual reassessment of project scope and performance will promote the cost effectiveness of these efforts to meet the above guidelines. The Campus Lighting, Envelope, and HVAC Improvements are programmatic in nature. The indicated capital costs, economic performance, and emissions reductions are based strictly on benchmarks extrapolated from project historical performance, forecasted technology advances, and diminished "low hanging fruit" conventional conservation opportunities. These programs are intended to indicate mid-range planning goals, and do not indicate financial obligations to specific work.

Beyond these two phases are long range tactics that will require extensive study and development but levy significant impact on MSU-Bozeman's GHG emissions. These future phased tactics rely on advances in conservation based systems, substantial infrastructure innovation, and the implementation of large-scale renewable energy strategies. Due to the extensive analysis required to assess the viability of these options, quantitative analysis has not been completed at this time.

Controlling Energy Usage Escalation

Development of a sustainability-oriented culture and strong stewardship are crucial to mitigating the historical energy escalation at MSU (1.3 percent natural gas and 1.6 percent electrical average annual growth for the last 20 years). In Phase One, an Energy Conservation Culture Program is proposed. Phase Two will focus on maintaining efficient operation of the physical plant through continuous commissioning and continuous improvement efforts. New facilities will be required to meet sustainability standards as determined by the State of Montana. By internalizing efforts to maintain or improve energy efficiency and implementing strict standards for the energy performance of MSU's building stock, the average escalation of campus energy usage is forecasted to be reduced by over 1 percent annually. This is reflected in this analysis by a reduction of the escalating business-as-usual energy trend to a 0.25 percent trend. MSU-Bozeman's efforts to control the energy usage escalation rate will be continuously adapted to achieve a maximum of 0.25 percent annual growth rate in total energy (including Scope 3) with an annual goal of holding a flat, or negative growth trend. Achieving this will let the technical and power procurement mitigation tactics achieve and retain maximum effectiveness.

4.1 Scope One and Two — Phase One Mitigation Tactics

In the course of energy planning, energy conservation through demand-side management is often considered the most cost effective means of managing energy costs. Energy conservation's potential is much higher. It also can be the lowest cost energy resource for the utility to acquire generation, transmission, and distribution capacity through load relief. In State governments, energy conservation savings can relieve utility budgets, allowing funds to be allocated to cash strapped programs. Many utilities, including Montana's Northwestern Energy realize this and are reinvesting in energy conservation through rebates, auditing services, and infusing capital to improve the energy strategies on projects.

Phase One tactics identified are focused on the implementation of energy conservation projects

Phase One Mitigation Tactics (Completed Projects)					
Project/Program Identifier	Status	Capital Cost	Average Discounted Annual Cash Flow	Discounted Payback Time (years)	Annual Reductions (MTCO2e)
Resource Conservation Culture Program	Contracted program to be internalized 2011				
Student Union Building Lighting & HVAC Retrofit	Constructed	$ (232,497)	$ 23,795	9.8	(179)
Engineering/Phys Science Lighting & HVAC Retrofit	Constructed	$ (260,000)	$ 33,716	5.3	(306)
Wilson HVAC Retrofit	Completion Spring 2011	$ (1,161,347)	$ 20,301	24.0	(287)
Cobleigh HVAC Retrofit	Completion Spring 2011	$ (1,591,250)	$ 26,533	23.0	(433)
Exterior Pole Mount Lighting Retrofit	First round of deployment Summer 2011	$ (660,000)	$ 25,836	15.0	(186)
Exterior Building Lighting Retrofit	First round of deployment Summer 2011	$ (150,000)	$ 20,468	7.3	(141)
Phase One Lighting Retrofits	Eight competed in 2010, seven to be completed in 2011	$ (797,749)	$ 53,301	13.5	(446)

Figure 4.1 Phase One GHG Emission Mitigation Tactics

Phase Two Mitigation Tactics (Projects in Process)					
Project/Program Identifier	Status	Capital Cost	Average Discounted Annual Cash Flow	Discounted Payback Time (years)	Annual Reductions (MTCO2e)
Leon Johnson Energy Retrofit	Completion scheduled for Fall 2012.	$ (2,500,000)	$ 40,000	13	-558
NW District Energy Plant	Pending Concept Assessment	$ (2,200,000)	$ 44,490	19	-1400
Auxiliary Services Energy Performance Contract (Phase One)	Investment Grade Audit	$ (9,000,000)	$ 561,000	15	-5150

Figure 4.2 Phase Two GHG Emission Mitigation Tactics

on a variety of State owned facilities and limited work on Auxiliary facilities. The projects that are included in the Phase One implementation are listed in Figure 4.1. Many of these projects are presently being designed, constructed, or otherwise initiated.

This phase of work consists of lighting and HVAC improvement projects and the initiation of a Resource Conservation Culture Program. A Resource Conservation Specialist will be hired to further develop the interface with the campus community, establish benchmarks and measurement techniques, and act as liaison to the more technical energy conservation efforts.

These projects were initiated before the climate action planning process began, and in some cases, the primary project driver was not energy conservation, rather; deferred maintenance, safety, or system performance improvement. This group of projects is indicative of future phases of work that can be completed with conventional approaches and available technology.

While these projects are necessary and some perform well overall financially, they result in less than a 4 percent reduction of overall 2009 GHG emissions. At this stage of climate planning, it becomes apparent that we are not going to conserve our way out of a carbon intensive operation. Rather a dramatic evolution in the way that MSU's campus is heated, cooled, and powered is needed. It is imperative that a successful plan considers this from the inception of the effort to coordinate the phases and numerous tactics stretched out over several decades that will be required to achieve the set goals.

4.2 Scope One and Two — Phase Two Mitigation Tactics

The conventional technologies that enabled the conservation based projects of Phase One are coupled with near-term emerging technologies to define the scope of Phase Two. Several Phase Two efforts such as the Leon Johnson Energy Retrofit, Northwest Campus Core District Energy Plant, and Auxiliary Performance Contract, have significant momentum and definition. Other projected areas are defined programmatically only. These future programs include future lighting, envelope, and HVAC upgrades that have been conceptually defined with budget estimates and potential savings/reductions by applying forecasts for advanced conservation-based projects. Economic and energy benchmarks were applied to arrive at planning goals. Figure 4.2 provides an estimate of Phase Two tactics.

The need to address deteriorating existing systems coupled with the advancement of energy technologies will continue to present opportunities for Phase Two project development. Systems such as lighting will continue to evolve with lower energy consumption and longer life. Control technology continues to present conservation opportunities while HVAC systems will continue to require extensive upgrade to address deferred maintenance and to improve energy. It will be crucial that all HVAC retrofits implemented in the near and mid-term be complementary to long term energy strategies described in Phase Three.

MSU is presently engaged in the early stages of an Energy Performance Contract with McKinstry focused on the Auxiliary Services portions of Campus. This unique project delivery method employs increasingly detailed audit analysis to identify and aggregate high performing energy savings measures. Presently, the energy performance contractor is in the process of developing an investment grade audit of between 300 and 400 Facility Improvement Measures. This analysis will identify those projects with the highest energy, operational, and economic effectiveness. Pending Board of Regents authority, this single effort may result in several million dollars of investment in energy savings, precipitating the single largest GHG reduction in the present CAP. Figure 4.3 presents GHG emissions projections at MSU-Bozeman with Phase One and Two mitigation tactics, focusing on the 20 percent reduction by 2025.

4.3 Scope One and Two — Phase Three Mitigation Tactics

While Phases One and Two combined are forecast to generate about a 20 percent reduction in MSU's 2009 baseline greenhouse gas emissions (Figure 4.3), cost and technical barriers will dramatically impede the ability to achieve significant additional savings with the same tactics.

Phase Three focuses on the strategic integration of renewable energy systems, and possibly carbon sequestration tactics, with the conservation driven work of Phases One and Two. The key to a successfully integrated approach to carbon management at MSU is continual systems thinking. The building level retrofits of the earlier

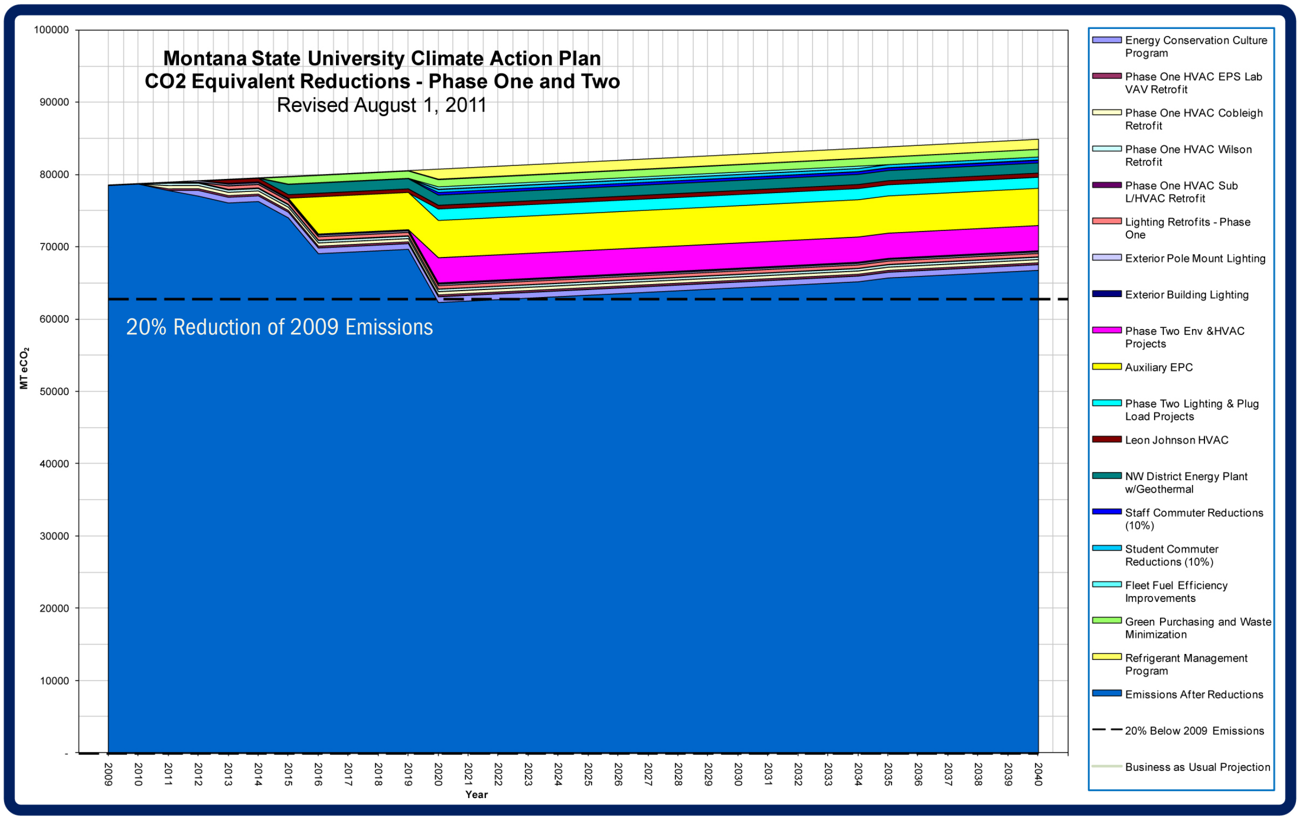

Figure 4.3

phases must be completed in a manner that allows a district approach to building power, heat, and cooling to be achieved. The district systems need to be arranged to facilitate the acquisition of low carbon power sources that may be provided at the utility level. Flexibility of the developed on sight resources is critical to allow the off-site electrical generation to be sources from a range of possibilities. Strategic alignment of the tactics described in Phase Three will minimize dependence upon carbon intensive sources of Scope One and Two energy streams.

The first two phases of this plan set the scene for implementation of on-site renewably based energy systems. HVAC retrofits will have been designed and constructed with distribution systems capable of accepting energy from low temperature heat sources such as heat recovery, geothermal, and solar thermal. The primary task of Phase Three is to re-power these HVAC systems with a portfolio of reclaimed and renewable energy sources. The system concept will be inherently flexible.

The future energy system at MSU will be a decentralized model developed around a core water loop designed to transport energy from building to building while having the capability of accepting energy from, or depositing energy to, a variety of sources. Initially this core water loop would be established and likely provided heating energy via heat injection from the central heating system (existing). As buildings are retrofit, in a range of ways discuss below, they are then connected to this district system to allow energy to be exchanged with it only after the building's energy balance has been met. Additional core water systems may be established in outlying areas of campus, including Family Housing.

Building Retrofits

The recovery and transportation of otherwise waste heat must be intrinsic to systems selected for all building retrofits that will interface with the future core water system at MSU. Specific building types are discussed below. System types that may apply include, but are not limited to:

1. Unitary water source heat pump,
2. Central, or sector defined, heat pump energy plants simultaneously producing heating and cooling energy streams,
3. Variable refrigerant volume with water cooled condensers,
4. Direct use of core water in system condensers/coolers (refrigeration)

Historical Classroom and Office Buildings

The diverse building set at MSU will require innovative approaches to retrofit depending on the particular buildings characteristics. Many of the older buildings are presently directly heated with steam and cooled only with natural ventilation with the exception of split systems or once-through water systems both of which are resource inefficient and provide no opportunity for heat reclamation. These buildings will require a great deal of creativity by the design team to maintain historical integrity while implementing system design that will properly condition the space at an optimal energy efficiency and enable heat removed from the building to be reclaimed into the core water system for use elsewhere in the system. This retrofit may occur through the integration of a unitary water source heat pump design, variable refrigerant volume with water cooled condenser, or possibly through central heat pump design for either the entire building or sectors.

Laboratories

The more complex buildings on campus, such as laboratory and research facilities, present the challenge of optimizing the heat recovery of laboratory exhaust volumes. Presently, run-around loop heat recovery systems are common at MSU, but the effectiveness of these systems on an annual basis is quite low as they are driven to work best under the highest temperature differences. Most of the year, the mild conditions in Bozeman do not allow these systems to operate efficiently so the heat goes unrecovered. Due to the inappropriate application of unitary (recirculation) equipment in some labs, the most likely retrofit for this building set may be centralized heat pumps that would simultaneously generate chilled water and heating water rather than treating the opposite energy stream as a waste byproduct, as is conventionally done. This system type would allow low temperature water, from the chilled water/heat recovery side of the process, to maximize the heat recovery from laboratory exhaust streams.

Residence Halls

The high domestic hot water loads, space heat requirements, and, in some cases, collocated kitchen/dining service loads make residence halls an intriguing opportunity for integration into the core water system. Substantial heat streams from kitchens, such as refrigeration and space cooling complement the need for large quantities of domestic hot water. A unitary approach to a water source heat pump conversion would allow each zone to be conditioned with the resulting heat (cooling) being made available for other uses. A residence hall with an efficient HVAC/envelope design should be in a net cooling mode to low ambient temperatures (about 10-20° F). The excess heat can be injected into process and domestic loads.

Establishing the Core Water Loop

The true power of a district-wide heat recovery and transportation system is in the ability to maximize the reuse of all the energy entering all of the buildings interconnected. Not only the energy introduced by building mechanical systems, but also the heat that results from light, people, plug loads, and passive solar. The ability to collect this heat, move it into a transport medium (water), and share it with other buildings establishes a base load energy source for all buildings that can minimize the net energy input to that required by the entire system. Since this core water loop would operate at about room temperature, it can be established in a non-insulated piping system that would be installed in the existing tunnel system. The tunnel system, which was established in the 1990's, is an incredibly vital component of the system (Figure 4.4). Approximately 1.6 miles of underground tunnel, with room for piping expansion exist around the perimeter of the core campus. Without the visionary planning that resulted in this valuable infrastructure, the concept of central core water would be impractical.

Developing the initial resources required to provide energy to the core water loop would preferably occur concurrently with core water loop development.

While sporadic geothermal resources exist in close proximity to MSU, e.g., Bozeman Hot Springs and Fish Hatchery at Bridger Canyon, the conceptual implementation of geothermal on campus does not depend on developing active resources. Rather it is based on the more conservative approach of establishing extensive well fields on campus of closed loop wells, manifolded together. These "daisy chained" closed-loop wells would not draw water from the earth, rather the heat transfer fluid would circulate through the U-shaped heat exchanger and back to the core water

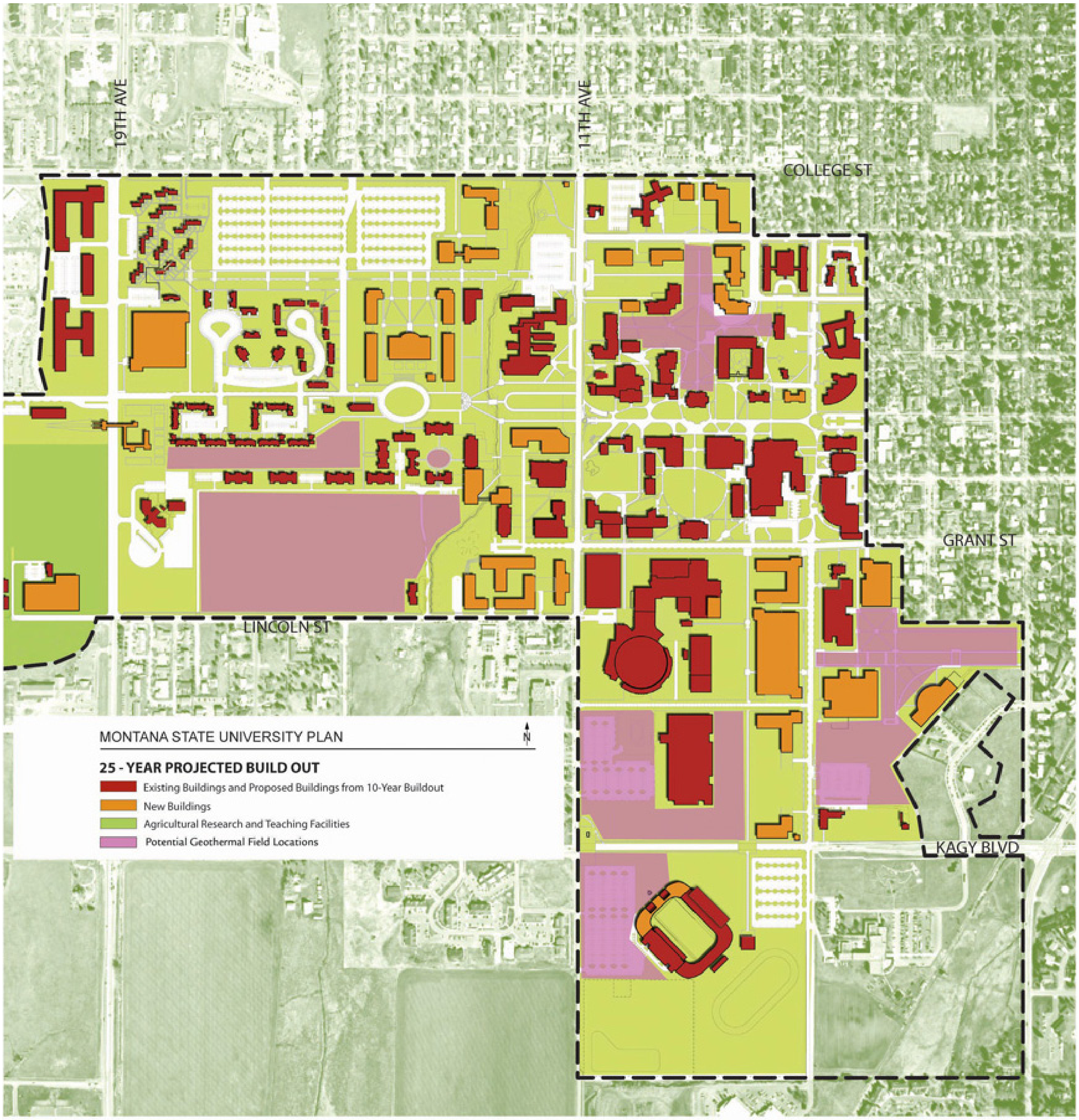

Figure 4.4 Implementing Renewable Heat Sources

loop at ground temperature. Well field locations would need to be identified and coordinated with the long range master plan.

The analysis of this concept is at the very earliest stages and extensive study and testing needs to be completed to test technical, economic, and environmental feasibility. Early indications of the systems spatial requirements and technical feasibility are positive. The economics of this project are complex as the project, while quite capital-intensive, may be timed to address substantial deferred maintenance at the time of implementation.

Conceptual Results – All Scope All Phases

The following GHG projections, or 'wedge' diagram (Figure 4.5) provides a conceptual view of the results of implementing the Phases Discussed above, as well as Scope 3 mitigation tactics discussed in that section. The long range tactics of Phase Three are conceptual and no commitment will be made to continue their development until extensive analysis is completed and funding is secured. With inclusion of these concepts, it is possible that MSU may be able to approach, and possibly surpass 50 percent reduction of 2009 GHG emissions. Rather than assigning this milestone to a date, it may be more appropriate to focus on technical and economic feasibility triggers. Later versions of this process will begin to solidify an approach and timelines can be more accurately considered then.

4.4 Scope Three Mitigation Tactics

Strategies to implement GHG reductions for transportation are more difficult than modifying a building (i.e., installing energy efficient windows, new heating/cooling systems, etc.), as transportation choices are based on individual choices/behaviors. Several strategies for reducing commuter emissions, including increasing online course offerings, incentivizing the use of low emission transportation choices, promoting on-, or near-campus living, and increased education and outreach. The transportation section of the Climate Action Plan looks at possible actions, including these, to reduce transportation impacts of MSU while integrating MSU transportation strategies into the broader community. With 69 percent of MSU's students, faculty and staff

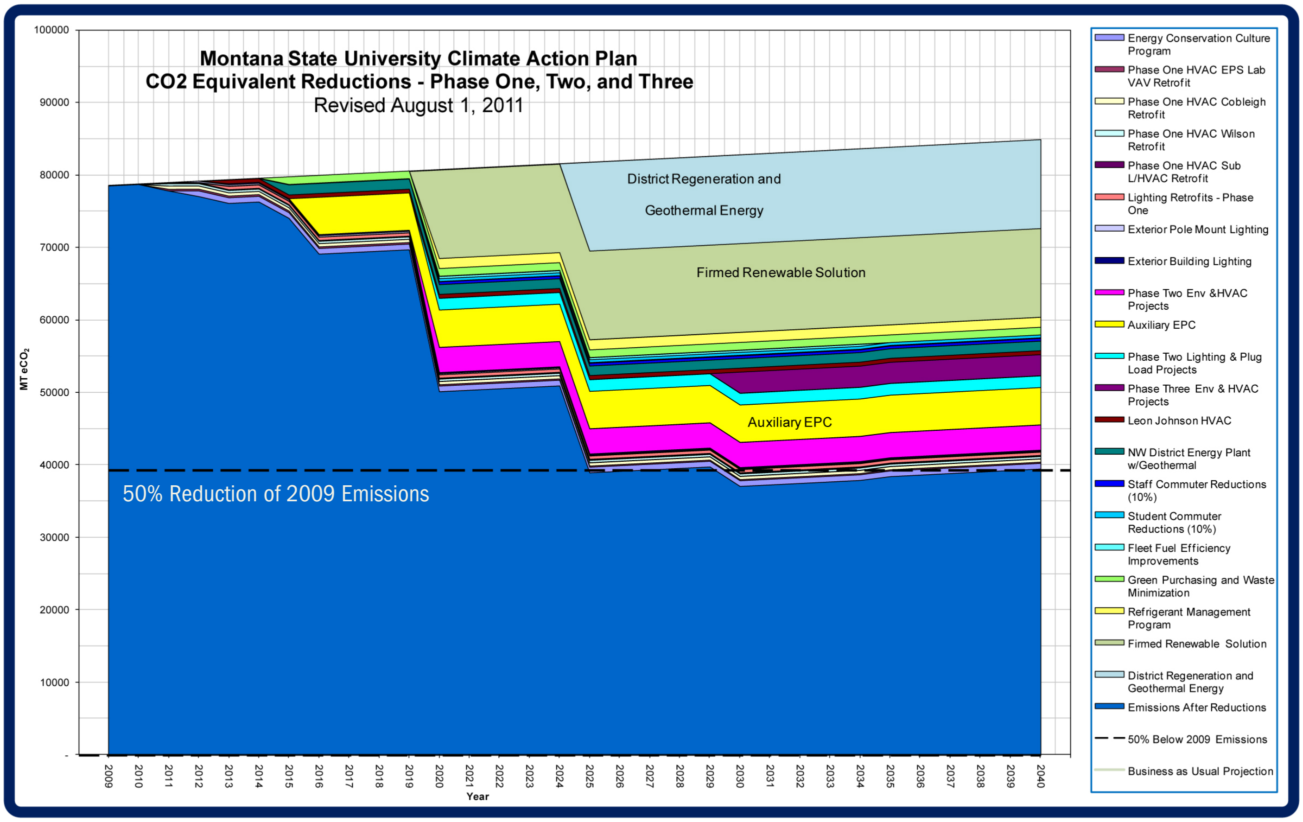

Figure 4.5

living within five miles of campus, it is important that MSU work with the City of Bozeman to implement transportation options. Further, 31 percent of students, faculty and staff live more than five miles from campus, therefore, the University must work with other partners, including Gallatin County, as well.

4.4.1 Transportation

Introduction

Transportation, in the form of the campus vehicle fleets, commuting and air travel, are relevant to the climate action plan because these activities produce a significant amount (38 percent) of MSU's net emissions. These Green House Gas (GHG) emissions are based on travel to and from, or on behalf of the University. However, it should be noted that the inventory used as a foundation for this Climate Action Plan does not include student travel beyond their daily commute to MSU. Therefore, student trips for employment, shopping purposes, or activities are not captured. These trips by students may create as much, or more, GHG emissions than their commutes to MSU, and should be calculated in the future.

Strategies to implement GHG reductions for transportation are more difficult than modifying a building, as transportation choices are based on individual choices/behaviors. Montana State University, the City of Bozeman, and surrounding area have made progress on alternative transportation modes that give individuals options other than driving their own vehicle (single-occupancy vehicle or SOV).

In its Greenhouse Gas Inventory Report (04-21-10) on Montana State University, McKinstry noted several strategies for reducing commuter emissions, including:

- Offer more online courses
- Increase parking fees
- Subsidize public transportation passes
- Carpool parking priority
- Restrict student cars and/or parking to upper classmen
- Installation of more bike racks and bike paths
- Subsidize on-campus housing to minimize off-campus living
- Education to campus about carbon footprint goals and the impact of individual commuter choices
- Convert parking lots to green spaces

The following sections discuss possibilities, including these, to reduce transportation impacts of MSU while integrating MSU transportation strategies into the broader community. It is important in discussing transportation plans that MSU not be viewed as an "island." Unless someone is living on campus, a person is traveling in and through Bozeman, and perhaps even one or two counties, to get to class or employment at MSU. Therefore, it is important that the transportation component of MSU's Climate Action Plan integrate with the City's and other transportation plans/climate action plans.

As of the adoption of this Climate Action Plan, the City of Bozeman was finalizing its Climate Action Plan. The following seven transportation recommendations were included in the City's plan:

1. Support policies for long-term integrated transportation and land use planning for a 20–30 year horizon
2. Promote a bike friendly community
3. Promote an electric car friendly community
4. Promote and provide incentives for clean fuels
5. Develop educational resources for the community on transportation options
6. Reduce vehicle miles traveled and fuel emissions
7. Air travel (examine emissions from Gallatin Field and its effects)

As noted in the following sections, MSU's Climate Action Plan includes similar transportation recommendations. As MSU and the City of Bozeman adopt and implement their Climate Action Plans, the two entities should work together as closely as possible to take advantage of funding opportunities and other synergies that may exist. A full analysis of transportation emissions, with comprehensive recommendations is supplied in Appendix 3 of this CAP. A shortened summary of findings and recommendations is supplied below.

While the majority of transportation cost and savings is based on the individual, not the University, if enough individuals stop driving to campus, there would be potential to reduce the number of parking spaces/lots that the University maintains. Financial savings to the University by reducing parking lot and University street maintenance would be somewhat offset by a reduction in the number of parking permits sold. However, there would be a reduction in green house gas emissions. Trees could be planted in parking lots that are no longer needed, which would also help to obtain a credit for Green House Gas emissions.

Campus Fleet (MSU Vehicles)

Montana State University owns 372 motor vehicles that are used by various departments for various purposes. There are three basic strategies to reduce GHG emissions from these vehicles. These strategies are modernizing the fleet, using electric vehicles, and using human powered vehicles.

As the fleet ages, MSU must update vehicles with more modern, fuel efficient and cleaner vehicles. In addition to purchasing more efficient vehicles, MSU must analyze the purpose for each vehicle, so that the proper size vehicle can be purchased. For example, heavy or light gasoline or diesel powered trucks may not be necessary if an electric or human-powered vehicle can accomplish the same task. For the short distances within the campus, electric vehicles could be used for many of the tasks that require some sort of vehicle, and should be strongly considered. However, to reduce the campus carbon footprint, the source of the electricity to power the vehicles needs to be considered as well. MSU already supplies bicycles for campus employees traveling short distances in and around campus. Utilitarian tricycles with trailers to haul tools and other equipment are used for campus landscaping. MSU should continue to maximize the use of these human powered vehicles in the future.

Campus Commuting

Objectives to reduce the Green House Gas emissions related to faculty, staff and students commuting to campus include eliminating or shortening the commute, or allowing a more efficient (less GHG emissions) commute. Policies should provide incentives or alternatives to SOVs, and disincentives to SOV enablers (like convenient and inexpensive parking). Strategies to achieve these objectives are discussed below, and in greater detail in Appendix 3.

Eliminating the Commute

More housing near campus

Similar to the City of Bozeman's recommendation for integrated transportation and land use planning, this strategy would provide more housing opportunities near campus, to reduce the need to drive to campus. Housing within close proximity to campus would allow the vast majority of people to be able to walk or bike to campus.

Online classes, meetings and training

With options for students to take classes online, the need to commute to campus may be greatly reduced. This would take an investment by MSU to have the technologies in place so that as many classes as possible are delivered via the Internet, or other electronic means. While it is recognized that numerous classes require hands-on (on campus) learning, commuting GHG emissions could be reduced by maximizing the number of online classes. Faculty, staff and students also commute to campus for meetings and/or trainings. If these meetings and trainings could be supported online, these commutes could also be eliminated.

Walking

The City of Bozeman, the Montana Department of Transportation and others have been working to provide pedestrian connections to MSU. The Greater Bozeman Area Transportation Plan (2007 update) places a strong emphasis on integrating pedestrian facilities into the transportation network. It identifies gaps in the pedestrian networks and recommends improvements.

The existing number of MSU students and employees who walk to campus is not well documented, though two recent studies provide insight. A 2007 study evaluation used employee and student addresses from the 2005 fall semester, showing approximately 3,900 individuals lived within one mile of campus and about 7,400 lived within three miles (MSU, 2007). Assuming MSU has 12,500 students and 3,500 employees, approximately 46 percent of MSU employees and students live within three miles of campus. While the geographic distribution of students and employees will vary from year to year, the geographic concentration should not change considerably without significant housing additions in close proximity to MSU.

An online transportation survey of MSU students and employees conducted in 2010 identified a random sample of 1500 MSU employees and students and had approximately 500 respondents. Approximately 53 percent of respondents reported living within three miles of campus, which is similar to the 46 percent estimated from the 2007 evaluation. The 2010 transportation survey indicated:

- 22.9 percent (112 people) reported walking as their primary travel mode to campus in the spring and fall (September, October, March, April and May).

- 27.6 percent (135 people) reported walking as their primary mode from November through February.
- Approximately 27 percent of respondents reported living within one mile of campus.

Specific strategies and recommendations for increasing walking are supplied in Appendix 3. Proposed solutions include raising awareness of walking access, and the financial and health benefits, with widely disseminated maps and targeted advertising. MSU's wellness program already gives points for employees who walk or bike to campus.

Bicycling

Bicycle facilities vary significantly and may include items such as wayfinding signs, separated paved pathways, covered bike parking, or end-of-trip facilities such as showers. Consistent with pedestrian facilities, the City of Bozeman and others have been working to provide bicycling connections to MSU. The City rebuilt West Babcock Street in 2005, adding bicycle lanes and sidewalks, which resulted in an increase of 256 percent in bicycle and pedestrian users (City of Bozeman, 2007). The Greater Bozeman Area Transportation Plan (2007 update) places a strong emphasis on integrating bicycle facilities into the transportation network. It recommends specific locations for bike lanes, bike routes, expanded shoulders and shared-use paths. Further bicycle-friendly infrastructure improvements are recommended.

There is significant interest at MSU in increasing bicycle commuting. MSU recently removed its ban on bikes on campus and installed a significant number of new bike racks in convenient locations around campus. The ASMSU sustainability center is researching options for a commuter/cruiser bike share/rental program in partnership with ASMSU Outdoor Recreation Center. Some campus buildings have end of trip facilities for bicycle commuters such as showers, lockers and changing rooms. The transportation survey of MSU students and employees conducted in 2010 indicates:

- 18.2 percent (89 people) reported bicycling as their primary travel mode to campus in the spring and fall (September, October, March, April and May).
- 3.5 percent (17 people) reported bicycling as their primary mode from November through February.
- Approximately 53 percent of respondents reported living within three miles of campus.

Specific strategies and recommendations related to increasing bicycle commuting are supplied in Appendix 3.

Transit (commuter and fixed route)

Transit refers to public transportation options within the community and college campus. A year-round transit system, Streamline, was introduced to the greater Bozeman area in August 2006. One added benefit of transit is that it can extend the trip length of other modes such as walking and biking. All Streamline buses are fitted with racks to accommodate up to 3 bicycles to facilitate this.

Funding for this service comes from a number of sources, including ASMSU and MSU. The service operates year-round, Monday-Friday, with limited service on Saturdays. The current Streamline service, and the paratransit service, GALAVAN, cost approximately $1.3 million to operate. Ridership on the Streamline system has continued to grow, with daily ridership averaging 750-800 rides per day, with over 1,000 rides per day in the winter months. This ridership is significantly higher than the initial estimates of 286 rides per day.

Given that transit fares are typically less that the cost of operating a car, and that Streamline is currently fare-free, individuals who use Streamline can save a significant amount of money. While MSU would receive little, if any, financial savings, MSU does accrue the reduction in GHG emissions by promoting its students, faculty and staff to utilize public transportation to commute to campus.

Adding additional routes and/or greater route frequency may be a way to increase ridership and reduce MSU's Scope 3 emissions. Beginning in August 2011, Streamline will provide half-hour frequency on its main Bozeman routes during peak morning and afternoon commute periods (7–9 am and 4–6 pm). Funds from the Federal Transit Administration, which are administered by the Montana Department of Transportation, help support Streamline, and reduce the amount of local funding necessary to operate the system. Typically, local funds pay for approximately half of the cost of adding another route, or to add more frequency to existing routes.

Car pooling

Montana State University made the ability to car pool easier when it switched its parking permits from a "sticker" to a "hang tag." Multiple vehicles can be registered to a single hang tag/parking permit. This allows multiple individuals to act as the "driver" of a car pool, using a single hang tag/ parking permit. The University does not actively promote car pooling, however. There is no formal process (software, etc.) for individuals who are interested in car pooling to find a "match" for a ride. Any car pools that exist are based on personal relationships, and people knowing other faculty/staff who live near them. As with transit, the cost savings accrued through car pooling are primarily to the individuals involved.

There are several programs to increase the use of car pooling. Most of them focus on using software to allow for students, faculty and staff to find other people interested in car pooling.

- www.memphis.edu/greencampus/carpooling.php
- www.campuslifeservices.ucsf.edu/transportation/rideshare/carpool
- www.zimride.com
- www.greenride.com/Solutions/Connect/Description

If Montana State University were to actively promote car pooling, marketing could be accomplished through the MSU News email, campus newspaper, and providing links from various MSU websites to a car pool software. Also, priority parking close to campus for car pool vehicles would be an incentive.

Implementing and promoting car pooling is estimated to cost between $10,000 and $20,000 per year. MSU may be able to work with the City of Bozeman and/or other large employers in the area to help pay for the car pooling software and incentives, and to increase the number of people participating in car pools. Based on a partnership between the Western Transportation Institute and the Human Resource Development Council District IX, Inc., with support from the Montana Department of Transportation and Montana Department of Public Health and Human Services, a statewide ridesharing software program should be implemented by October 2011.

Van pooling

There are no existing van pools (or van pool programs) in the Bozeman area. Van pools are similar to car pools, but are more formalized arrangements, typically with the vehicle (van) supplied by an employer or other entity, and a set cost for those who participate in the van pool. Monthly prices for participants can range from $80-$150/month depending upon several factors, including the distance traveled and how many people are participating in the van pool. Like a car pool, participants utilize a van pool to reduce the cost of commuting (alone).

Supporting/other strategies

In order to transition students, faculty and staff from a single occupancy vehicle (SOV) to another mode, supporting strategies are needed, which can be thought of as incentives and disincentives.

Incentives

A Guaranteed Ride Home (GRH) provides commuters who regularly vanpool, carpool, bike, walk, or take transit with a reliable ride home when unexpected emergencies arise. Many large employers with transportation programs offer commuters a GRH for personal emergencies and unscheduled overtime. In Bozeman, the GRH would take the form of a voucher that a commuter could use at a local taxi service to get home if something unexpected occurred (say a child getting sick at school). The employee could use a GRH voucher to pay for the trip, and the University would only have to pay for the GRH vouchers that get used. Employers using GRH typically provide two to four vouchers per year. GRH is designed for commuters who worry about how they'll get home when an emergency arises. Knowing there's a guaranteed ride home allows one to use commute with peace of mind and confidence.

Raise awareness of the financial and health benefits of commuting rather than SOV driving. Some promotion and encouragement activities could include:

- Incentives/giveaways in exchange for choosing a transportation alternative (e.g. discounts at local businesses)
- Discounts at local businesses to people who don't drive to campus
- Discounts at the MSU Bookstore or MSU Food Services to people who don't drive to campus
- A "pay not to park" incentive

Disincentives

Disincentives (or policies) can be put in place to make it less desirable to drive an SOV, and can lead people to look for alternative modes of transportation. Disincentives should be used in conjunction with incentives to make driving an SOV more expense, or take more time than an alternative mode. Given the fact that the

University primarily controls parking on campus, disincentives could include:

- Increased parking costs (for all parking spaces/permits)
- Distance based parking fees (so those who live closer to campus have to pay more for a parking permit, since they have more alternatives available)
- Parking meters on campus so people have to pay each time they park.

Parking meter disincentive is based on the concept that the first time a person purchases a semester or year-long parking permit, a cost is incurred, but after that, parking is "free." Placing parking meters at all spots on campus changes the paradigm, so that it costs money every time one parks on campus.

Air Travel

Directly financed air travel, study abroad air travel, and other directly financed travel accounted for 16, 9, and 3 percent of MSU's net emissions, respectively. Note that faculty, staff and student commuting only accounted for 10 percent of MSU's net emissions. While the alternatives for the student travel abroad are to not travel, or purchase offsets, there is another alternative related to other directly financed air travel.

As a major research university, many faculty, staff and students are traveling to be part of conferences to learn of research, or to present research findings. Until many of these conferences embrace video-conferencing, or holding virtual conferences, there will still be a tremendous need to travel by air to these meetings/conferences. In that situation, MSU will be able to purchase offsets to compensate for this travel.

In instances where air travel is taking place for meetings, project updates, or other instances when a conference call, webinar, or video conference is adequate, MSU should have policies and procedures in place so that faculty, staff and students can determine when air travel is justified, and when an alternative should be selected.

Emission Reductions

The shorter the distance someone commutes to campus, the more alternatives are available. For example, if someone lives within one mile of the MSU campus, alternatives such a walking and biking are viable options. However, if someone lives ten miles from campus, it is unreasonable to expect that they would walk or bike. The survey that was used to develop the baseline inventory indicated that the majority of faculty, staff and students live within a relatively close proximity to campus (Table 1).

Distance from Campus	Percentage of Respondents	Cumulative Percentage
Less than 1 mile	27.4%	27.4%
1.1-3 miles	25.4%	52.8%
3.1-5 miles	16.2%	69.0%
5.1 to 10 miles	14.7%	83.7%
10.1-15 miles	8.5%	92.2%
15.1-20 miles	3.3%	95.5%
20.1-30 miles	3.3%	98.8%
30.1-40 miles	0.5%	99.3%
40.1-50 miles	0.5%	99.8%
50.1 miles or more	0.3%	100.1%

Figure 4.6: Faculty, staff and student commute distances

The data indicates that roughly half of the campus population lives within a distance (three miles or less) where non-motorized options could be utilized. Further, only 4.5 percent of faculty, staff and students live more than 20 miles from campus, a distance which tends to add to the cost of options such as van pools and transit.

Figure 4 shows that a majority of housing in Bozeman is within three miles (the blue line) of campus. Driving from Belgrade to campus is approximately twelve miles.

The GHG inventory based its calculations on 9,124,603 automobile miles and 189,376 bus miles of commuting by faculty and staff, and 9,826,713 automobile miles and 411,168 bus miles of commuting by students. The GHG inventory did not capture student travel for other purposes (working, shopping, etc.).

While an analysis has not been completed to the level of detail that would allow for a decision that implementing van pooling, for instance, would reduce commuter traffic by 10 percent, Figure 4.7 provided data on the GHG emission savings based on the reduction of commuter mileage.

It should be noted that if MSU faculty, staff and students ride the bus (Streamline) it does not increase GHG emissions, as the buses are operating anyhow. However, to get a reduction of commuter mileage beyond 10 percent, an additional bus route, or more frequent bus service, may be required. The reduction table above does

	Car miles	Bus miles	Energy Use MMBtu	CO2 kg	CH4 kg	N2O kg	eCO2 Metric Tonnes
2009 Baseline							
facutly/staff	9,124,603	189,376	51,924.5	3,642,451.6	721.8	248.7	3,732.7
students	9,826,713	411,168	56,640.7	3,974,894.2	780.3	269.2	4,072.5
5% reduction							
faculty/staff	8,668,373	189,376	49,381.1	3,464,032.0	686.4	236.5	3,549.9
students	9,335,377	411,168	53,922.4	3,784,131.4	742.9	256.3	3,877.1
10% reduction							
faculty/staff	8,212,143	189,376	46,837.6	3,285,612.4	651.1	224.3	3,367.0
students	8,844,042	411,168	51,204.1	3,593,368.5	705.4	243.4	3,681.6
15% reduction							
faculty/staff	7,755,913	246,189	44,610.9	3,129,410.8	620.1	213.7	3,206.9
students	8,352,706	534,518	49,168.2	3,450,496.9	677.4	233.7	3,535.2
20% reduction							
faculty/staff	7,299,682	246,189	42,067.5	2,950,991.3	584.8	201.5	3,024.1
students	7,861,370	534,518	46,449.9	3,259,734.1	639.9	220.8	3,339.8

Figure 4.7: Potential GHG savings for commuter reductions

reflect an increase in bus miles, but that may not necessarily reflect the true picture.

It is recommended that Montana State University work with the City of Bozeman to promote currently available alternative modes to reduce commuting miles. These existing alternatives include walking, biking, car pooling and utilizing public transportation. Alternatives such as car pooling could be enhanced through the use of software for ride matching, and by MSU implementing incentives, such as preferential parking for car pool vehicles. In addition, incentives, such as giveaways or other promotions, could increase the use of transit. MSU could use additional surveys to gauge the interest in new options such as van pools, to see if those options are worthy of future investment.

4.4.2 Waste Minimization

Greenhouse gas emissions are associated with the production and disposal of each product used at MSU. Emissions associated with landfilled solid waste accounted for 2,132 MT CO_2e in MSU's inaugural GHG inventory. Emissions from production (mining, manufacture, shipping, etc.) were not included in inventory. Nevertheless, it should be acknowledged that the university holds some responsibility in this area because university purchasing decisions impact upstream production. As such, landfill diversion, source reduction, and purchasing practices must all be considered as part of a holistic strategy of sustainability and resource conservation at MSU.

Furthermore, the Montana Integrated Waste Management Act of 1991 stipulates that all State agencies and the university system shall prepare, implement, and maintain a source reduction and recycling plan that includes at minimum, "provisions for composting yard wastes and recycling office paper, cardboard, used motor oil and other materials for which recycling markets exist or may be developed."

4.4.2.1 Landfill Diversion

As their contents decompose under anaerobic conditions, landfills emit CO_2 as well as methane, an even more potent greenhouse gas. According to the EPA, municipal solid waste landfills were the second largest source of human-related methane emissions in the US in 2006.

In FY10 MSU disposed of 1,866 tons of material at the Logan Landfill. A waste stream analysis performed by Facilities Services in 1990 indicated that recyclable materials made up at least 45 percent of the waste stream from MSU's academic buildings and between 15-25 percent of waste from auxiliaries sources. Organic (compostable) materials made up 20 percent of waste from residential and food service areas. While these figures are 20 years old, they suggest a baseline of what can be done to reduce MSU's waste and divert reclaimable material.

An effective program to divert all reclaimable materials from landfill-bound trash will reduce

MSU's GHG emissions as well as demonstrate the University's commitment as a steward of Montana's environment and public resources.

Current Diversion Activities:

- Recycling - Operated by ASMSU and funded by student fees, recycling activities in FY10 diverted 118 tons of aluminum, steel, plastics, paper and cardboard, or about 6 percent of MSU's waste that year. Utilizing the EPA's WARM calculator the diversion of this material from landfill accounted for a net prevention of 424 MT CO_2e in combined downstream and upstream emissions. With adequate funding and resources the proportion of recyclables diverted from MSU's trash could be increased dramatically.
- E-scrap - Safety & Risk Management operates an E-scrap program (implemented Jan 2009) that is funded by a fee charged on all university computer purchases (2.5 percent of the purchase price). For this reason the program currently accepts only MSU-owned property, however electronics left behind at year end from dorms and family housing is also taken care of through the E-scrap program. Reusable equipment is either redistributed within the university or another educational facility, or donated to non-profit organizations. Over 500 units have been redistributed. Data is destroyed from Unusable computers then shipped to E.C.S. recycling facility. E.C.S. Headquarters is located in Santa Clara. This company also has 3 refineries located in the U.S. To date the E-Scrap program has shipped 32 tons of electronic material to recycling.
- Composting - University Food Services is in the process of researching the feasibility of composting food residuals in the dining halls. In Fall 2010 a one-semester pilot project was conducted, which separated compostable waste at one UFS kitchen and took it to a commercial composter in Amsterdam, Mont. Data from this pilot will be used to inform plans to expand the program. A Bokashi-based cold composting pilot project for both the salad bar and for Harrison dining hall is presently being set up to start beginning the Fall semester of 2011. Diversion of up to 26,000 lbs/yr with the closed loop system is anticipated.
- Property Surplus - University Business Services' Surplus Property program collects unwanted furnishings and equipment from campus departments and offices and makes those items available to other university entities.
- Various - Facilities Services has historically recycled/reused: crankcase oil, batteries, antifreeze, parts cleaners, used tires, scrap metals, light tubes, refrigerants, concrete, asphalt, road sand, and yard waste. Further research needs to be done to quantify these activities and their GHG and waste diversion benefits.

Strategies to Increase Landfill Diversion:

- Conduct an updated waste stream analysis to determine goals and benchmarks for increasing MSU's recycling and material diversion rates.
- Expand and promote recycling campus-wide. Increase access to and convenience of recycling in all buildings and at all university events. Make recycling as easy — or easier — than throwing something away.
- Establish an on-campus recycling facility to allow more efficient material handling and operations. A facility with a baler for cardboard and office paper might increase cost efficiency of the program and the volume it could handle.
- Explore ways for the various campus waste management programs/services to coordinate, collaborate, and share resources (i.e. trash, recycling, composting, and e-waste programs, which are currently operated separately).
- Reconsider how costs for trash services are budgeted and assessed campus wide and evaluate whether mechanisms can be developed to incentivize recycling/waste reduction. (For example, some campuses have increased fees for trash removal while providing recycling services free of charge, thus encouraging occupants to maximize recycling efforts.)
- Fund the E-scrap program so that it may accept e-waste from students and on-campus residences as well as MSU departments. Consider opportunities to partner with the City/County to collect e-scrap from the community at large as well.
- Expand the composting pilot program to all University eating establishments. Explore possibilities for partnering with off campus entities (City of Bozeman, County, or local businesses) to achieve economies of scale.

The holistic goal is 80 percent diversion from the landfill by 2050. This will be accomplished by achieving a series of lesser but sequential goals – 25 percent reduction by 2020, 50 percent reduction by 2030, 65 percent reduction by 2040. The tools and strategies of waste minimization, diversion, source reduction and responsible purchasing can be used to attain these interim and long-term goals, and will require further research and stakeholder input as they evolve.

4.4.2.2 Source Reduction and Responsible Purchasing:

Source reduction is generally accomplished by focusing on systems and behaviors, identifying where waste-intensive practices can be changed. Reducing unnecessary waste at the source will allow MSU to mitigate the inefficient use of resources and decrease disposal costs (both trash and recycling). By reducing total trash generated, source reduction will also reduce some of the GHG emissions associated with solid waste.

Responsible purchasing is an approach to procurement of goods and services that prioritizes choices which minimize negative social and environmental impacts throughout the product lifecycle, including production, distribution, use, and disposal. Responsible purchasing can be a tool for source reduction, for example selecting products or services that generate less waste (i.e. packaging). It is also a means by which the university can utilize its purchasing power to support production practices that have a lower environmental impact. For example when MSU buys goods made with recycled content this not only reduces waste, but also helps to ensure a continued market for the recyclable materials we sell through our recycling program.

The bulk of GHG emissions benefits associated with source reduction and responsible purchasing will be "upstream," corresponding to reduced demand on traditional manufacturing, mining, etc. Upstream emissions are not included in MSU's GHG Inventory, however this does not diminish the value of these actions as part of an overall sustainability strategy. In promoting and implementing source reduction and responsible purchasing practices, MSU will demonstrate its leadership in resource conservation and the creation of an environmentally sound production system.

Current Source Reduction and Responsible Purchasing Activities:

- University Food Service offers 20 percent discount on certain beverages when a reusable cup is used.
- University Food Service eliminated trays from all dining halls, reducing consumption, food waste, and resources used to wash trays.
- All ITC Global Student Computer Labs are automatically set to print double sided (duplex) to conserve paper.
- ITC offers refilled/remanufactured toner cartridges and collects spent cartridges for reuse.
- The Montana Department of Environmental Quality currently requires all State departments to purchase recycled content paper. It is a goal of the Montana Integrated Waste Management Act that 95 percent of all state paper purchases will be recycled content. Data for paper purchasing was not available at the time of MSU's inaugural GHG Inventory, and it is recommended that this be monitored in the future.
- Corporate Express, an online interface for ordering office supplies per State contract prices, automatically suggests "green" product alternatives to buyers. Efficacy and participation will need to be evaluated to optimize future participation.
- Some large contracts between MSU and outside vendors contain sustainability clauses or related requirements. MSU will continue to encourage such negotiations with large purchasing contracts.
- The Montana Made program spends 12 percent of University Food Service's budget on food products that are grown/processed in Montana. This supports the vitality of the local food economy and provides meals with a lower carbon footprint.

Strategies to Increase Source Reduction and Responsible Purchasing:

The following suggestions have been successfully implemented at other campuses in America, and it is recommended MSU integrate as many of them as is feasible, based upon further research and stakeholder input.

- Extend the reusable mug discount to all beverages. Provide refillable beverage containers to all employees/students and create a highly visible campaign/incentive program to reduce drink container waste. Programs like these integrate environmental practices into campus culture and have been shown to reduce disposable cup waste by 30 percent.
- Eliminate the sale of bottled water on campus and instead provide refill stations at water fountains and in dining halls. Remove

MSU branding from bottled water (MSU's endorsement sends a conflicting message).

- Eliminate the use of non-recyclable neon/deep-dyed (astrobright) paper in campus communications and Printing Services because it is not recyclable, contaminates the recycling stream, and has been linked to health effects from heavy metals used in its production.
- Change practices from one campus communication document per faculty/staff mailbox, to one announcement per department, and email notification.
- Discontinue printing of annual campus telephone directories in favor of the online searchable directory. If necessary, make directories available via an on-demand print option (for a fee), to accommodate those who strongly prefer a printed directory.
- Take steps to monitor and reduce excess print overruns of course catalogs, admissions materials, athletics schedules and similar campus publications.
- Reduce number of Bozeman Daily Chronicle, Exponent, and Local Advertising issues delivered to dining halls. (Many are not even read before they are recycled.)
- Maximize opportunities to digitize university processes and services, reducing reliance on paper records and communications.
- Create a comprehensive program to publicize and encourage responsible purchasing strategies and provide information and guidelines (preferred products, etc.) to department procurement officers. Note: Because procurement is decentralized at MSU (except for contracts and purchases over $5000), campus-wide purchasing policies will be difficult to enforce. These practices could instead be encouraged through education and by developing and offering cost-effective opportunities for department administrators to make responsible purchasing decisions.
- Establish requirements and/or guidelines to ensure MSU is meeting the DEQ mandate for purchasing recycled content paper.
- Develop boilerplate criteria for all competitive bids/contracts that address campus sustainability concerns and goals and require bidders to disclose their environmental practices/impacts for consideration. Include environmental and waste impacts in comparative cost assessments of bids.

5. EDUCATION AND CIVIC ENGAGEMENT

The ACUPCC requires signatories to demonstrate and articulate plans for "actions to make climate neutrality and sustainability a part of the curriculum and other educational experience for all students." This requirement is well-aligned with MSU-Bozeman's land-grant institutional mission, and will continue to be integral to future education and civic engagement activities.

Developing an interdisciplinary undergraduate program focused on sustainability

At MSU-Bozeman, the high level of research activity underway in environmental areas complements a growing interest in climate change, adaptation, and sustainability among our students and faculty. MSU is therefore building upon the research and education activities already underway at MSU (including the new EPSCoR Track 1 infrastructure grant) by developing an interdisciplinary undergraduate program in sustainability. This program will draw on our diverse strengths in research and education; our unique network of partners in government, non-profit organizations, and business; and our inspiring location in the Greater Yellowstone Ecosystem.

We envision a cross-college program, leading to an undergraduate certificate. The program will provide support for sustainability educational initiatives in all colleges; facilitate relevant training and in-service experiences, and offer critical mentoring, career advising, and job placement to students in this interdisciplinary area. Our goal is to instill in students a sense of wonder about Montana's wildlands and managed lands, while at the same time inviting them seek solutions to pressing environmental challenges and join efforts to build sustainable communities and ecosystems. This interdisciplinary program will draw on the strengths of our faculty and external partners by focusing on topics ranging from clean energy, water, and air; sustainable food production; climate change impacts; rural human health; community sustainability; clean energy development, and sustainable business practices.

Sustainability education is already underway in various centers, colleges and departments at MSU. However, we need better coordination and facilitation if we are to inspire and train Montana's and the nation's brightest students and help them pursue meaningful careers. The proposed Montana University System Institute on Ecosystems (IoE) would seem to be a logical home for this interdisciplinary education initiative. As a statewide consortium, the Institute will leverage existing capacity across the entire Montana University System, through focal administrative hubs at MSU-Bozeman and the University of Montana-Missoula.

The IoE will provide (1) a new framework that will increase state and national visibility for Montana University System environmental research and educational activities; (2) increased capacity to recruit and retain nationally competitive faculty and graduate and undergraduate students in interdisciplinary environmental and sustainability areas; (3) new opportunities for Montana University System students through support and coordination for education programs focused on the environment and sustainability; (4) a statewide community of scholars who share common interests in addressing complex environmental questions and supporting development of solutions for sustainable human and ecosystem well being; (5) access to services and facilities through the two-hubs comprising the Institute; (6) coordination of strategically allocated funding, including but not limited to the current EPSCoR RII Track 1 grant; (6) new connections with partners from other universities, tribal colleges, state and federal agencies, NGOs, small businesses, and communities that will foster innovative opportunities for collaboration; and (7) improved engagement with communities and stakeholders to support informed decision-making and development of solutions to environmental challenges.

5.1 Undergraduate and Graduate Education

MSU-Bozeman offers a wide-variety of CAP-related curricula and individual courses across campus. While every academic college, school and outreach entity at MSU is in some way integrating sustainability and climate neutrality into their operations, extensive inventorying and structuring is presently in progress. Current flagship programs include the College of Business, and the Sustainable Food and Bioenergy Systems (SFBS) interdisciplinary degree program. The College of Business presently offers a sustainable business course and is developing other courses to foster leaders and change agents in the area of corporate sustainability. In 2009, the first cross-college, interdisciplinary degree program focused wholly on sustainability, the Sustainable Food and Bioenergy Systems Program, was established. This two-college, four-departmental program currently has over 80 student majors. The program explores sustainable food and bioenergy from production through consumption, linking ecological, economic and social aspects of these systems. A student run farm serves as an experiential classroom for students in the program as well as for students from other programs and majors.

Sustainability and climate neutrality are also being integrated into all MSU curricula as evidenced by new courses and new content within existing courses. In the spring of 2010, over 150 faculty from across the MSU-Bozeman campus came together to explore their common interest and desire to improve the integration of sustainability and climate-change science across the university curriculum. As a result, inventorying current courses in sustainability (including CAP-related courses) is presently in progress, and will be available through the IoE, and in the next MSU CAP. The newly funded IoE is chartered to serve as a campus hub for undergraduate education focused on sustainability, facilitating improved integration of perspectives from many disciplines. The IoE will coordinate climate neutrality and sustainability education, outreach and research efforts amongst undergraduate and graduate students and staff/faculty across campus and within the community.

Sustainability and climate neutrality are increasingly being integrated into all MSU curricula as evidenced by new courses and new content within existing courses. For example:

- The Creative Research Lab in the College of Arts and Architecture is focused on environmental and human sustainability in architectural design through several collaborative projects including its "EcoSmart House Project."
- The College of Business is expanding its course offerings relative to sustainable business practices.
- A cross-college Water Resources Minor is in development, enhancing undergraduate exposure to science, engineering and policy topics related to sustaining water resources.

5.2 MSU Native Community

"As natives, we are part of the world's longest longitudinal study and climate change research project. The findings of this project are only now entering the academic world and Native scientists/students are critical to the appropriate sharing, use, translation and perpetuation of this work." —Lisa Lone Fight, Mandan, Hidatsa, Arikara, Graduate Researcher in LRES.

American Indians have long been celebrated as conservationists throughout the last century and into this one. This image became popularized by the Crying Indian commercial for the "Keep America Beautiful" campaign in 1971. Also in 1971, former Secretary of the Interior Stewart Udall published *The Indians: First Americans, First Ecologists.* While the label First Ecologists has been debated, the sentiment remains inescapably Native.

Native people of the Americas have long believed that it was a sacred duty to be good stewards of the environment. Wilma Mankiller, former Chief of the Cherokee Nation, observed: "In Iroquois society, leaders are encouraged to remember seven generations in the past and consider seven generations in the future when making decisions that affect the people."

The MSU-Bozeman campus is host to a diversity of people and cultures, internationally as well as from within Montana. MSU Native American and Native Alaskan students, staff and faculty represent numerous tribes from all seven reservations in Montana, in addition to elsewhere across North America. In Montana, the Native American (American Indian) population is estimated at 68,000. This constitutes approximately 7 percent of the general population in the state. The twelve tribes of Montana have a long history of living on, and with the land.

MSU-Bozeman strives to partner in cross-cultural education to promote sustainability and climate neutrality. Coordinated by the Native American Studies (NAS) program, numerous programs integrate sustainability, and ultimately climate neutrality, as can be learned from and taught to the Native American perspective.

Indigenous Science and Traditional Native Knowledge Resources

MSU-Bozeman lies within the traditional bioregion, or ecoregion, of a number of Native American Nations. These nations have developed a sophisticated yet seldom externally accessed body of knowledge regarding methods of living sustainably in this environment. While this plan currently deals primarily with "technical" solutions, indigenous people have long stated that there are not only technical and practical but also "conceptual" solutions to climate change embedded in indigenous science, traditional knowledge and world view. The incorporation of these conceptual tools includes, but is not limited to: seven generation planning; indigenous architectural and landscape ecology models; indigenous conceptions of the nature of human/environment interfaces and interactions; traditional ecological knowledge, and indigenous science. Such tools offered by indigenous peoples are unique resources from which MSU is well positioned to benefit.

MSU's CAP also benefits from indigenous scientists/students/staff performing primary work in these areas and can be at the forefront of such research and application. These sources of knowledge, resources, and tools must be actively sought and deliberately included as components of MSU's CAP. From this perspective, the CAP embraces an expansive view that conceives of MSU not as an island or fixed point but as an intersection of multiple corridors extending actively and reciprocally into indigenous communities and systems throughout the region.

The Department of Native American Studies (NAS)

The NAS Department is an academic department that offers a non-teaching undergraduate minor, a graduate certificate and a Masters in Native American Studies. The Department offers courses that conform to the Diversity criteria in the University Core Curriculum.

One of the areas of focus and interest in the Core courses is contemporary issues in Indian Country. Students study land tenure, coal gasification on and near reservations, and the impact of development (of many sorts) on the culture and sustainability of reservation life.

In the Masters program, graduate students can focus their studies on a diverse number of topics related to Native American Studies. One of the strong emphases of study is natural resource development and conservation on reservations. In support of that area, students often take NASX 525, Indigenous Philosophies of Sacred Ecologies, a course available, too, to any graduate student. The course description follows:

> Examination of indigenous philosophies of sacred ecologies, contrasting Native views with those held by Europeans regarding the natural world. The course also traces the impact of historical colonialism in the environment up to contemporary conflicts over sacred sites and environmental resources.

Native American Student Center

Montana State University has been granted approval to begin raising funds to build a Native American Student Center to house programs and services to enhance and improve Native student academic performance, retention and graduation. This building will feature an architectural design that reflects Native cultures of the state as a visible reminder of the importance of Native peoples to the uniqueness of this region.

In recognition of the importance of preserving resources for the future, the proposed Native American Student Center will be constructed as a "green" building. The building will seek an appropriate LEED rating and will foster the sustainability goals of our campus. The Center will include substantial natural light, cutting down on energy used in the facility for lighting and will include mechanically-assisted natural ventilation. The Center will be constructed with certified sustainable wood products and local stone and brick. The building will be designed to maximize solar energy of its location.

American Indian Council

Montana State University has a Native student population of approximately 400. The major student organization for Native students, and non-Indian students interested in American Indians, is the American Indian Council (AIC). Their major mission is to encourage healthy choices and promote Native culture. As a student organization, AIC attempts to engage in activities related to environmental awareness including recycling, highway clean-ups, and participating in campus-wide sustainability actions.

American Indian Research Opportunities

American Indian Research Opportunities (AIRO, www.montana.edu/wwwai) is a consortium of Montana's seven Tribal Colleges (Blackfeet Community College, Chief Dull Knife College, Fort Belknap College, Fort Peck Community College, Little Big Horn College, Salish Kootenai College, and Stone Child College) and Montana State University-Bozeman, dedicated to providing opportunities for American Indian students in career fields where they are significantly under-represented. The advisory board to the AIRO consortium consists of representatives from each of the seven tribal colleges and Montana State University-Bozeman. Specific goals of AIRO include recruiting, retaining and graduating American Indians (and other minorities/disadvantage students) with associate, baccalaureate, master's and doctoral degrees in Science, Engineering and Mathematics (SEM), as well as promoting SEM fields to American Indian students, parents, teachers, and the Indian community. These goals integrate the American Indian perspective and culture of conservation, with scientific understanding of human impacts on ecology and global climate change, which is carried back to American Indian communities at all levels from children to elders.

Designing Our Community

Designing Our Community (DOC, www.coe.montana.edu/doc) was founded with a multi-year grant from the William and Flora Hewlett Foundation — Engineering Schools of the West Initiative. The vision of DOC is to become firmly established as the premier institution of choice for Native American students in engineering, engineering technology, and computer science, and to be a successful partner with Native American communities in developing the future workforce. As with AIRO, improving access to the Native American communities in the sciences and engineering, results in greater science literacy relevant to understanding global climate change and engineering solutions in these underrepresented communities.

5.3 MSU Extension Services

The MSU Extension Service is an educational resource dedicated to improving the quality of people's lives by providing research-based knowledge to strengthen the social, economic and environmental well-being of families, communities and agriculture enterprises throughout Montana.

MSU Extension Services supplies various outreach and training opportunities to Montana residents and businesses relevant to climate change. At the MSU/Montana Weatherization Training Center (www.msuextension.org/category.cfm?Cid=14), training and certification is supplied to Montana and regional contractors dealing with home energy auditing/diagnostics, and cost effective installation of weatherization and home energy management systems. The Exploring Energy Efficiency and Alternatives — E3A program is a comprehensive training program for educators and contractors dealing with all aspects of home, farm, and ranch energy alternatives and building efficiency practices. E3A training covers wind, solar, weatherization, bio-fuels, methane digesters, hydro-power, geo-thermal, energy alternatives. The WxTV Training Network (www.wxtvonline.org) is a free, publically available online weatherization training platform for the nation's 900 weatherization agencies. Other clean energy subjects, such as solar and wind home usage are also covered, with the creation of up to 40 episodes annually. Additionally, MSU Extension Services operates the Montana Materials Exchange (www.montana.edu/mme). This is an online reuse platform for reuse of commercial and industrial materials to substantially reduce GHGs associated with transportation of waste, importation of excess new materials, and landfill operations.

An associate's degree program is being developed by MSU extension services in "Residential Building Performance," scheduled to start in the Fall of 2012. This will supply more comprehensive training than the above training programs for improving energy efficiency and designing/constructing clean energy solutions regionally compatible with residential buildings.

5.4 Other Outreach and Civic Engagement Activities

As a land-grant university, MSU-Bozeman is especially focused on community outreach and education. Various outreach endeavors at MSU are particularly relevant to climate education and greenhouse gas reduction, as listed below:

Student Organizations

Numerous student-led initiatives and academic programs already exist at MSU and the demand for such opportunities is growing among students and faculty. Some current and successful activities are listed below.

Network of Environmentally Conscious Organizations (NECO): NECO is a student-run organization focused on outreach, education and student initiated projects that promote sustainability on campus and in the community. Recent projects have included: establishing recycling in the residence halls, instituting composting at MSU, promoting conscientious sustainable behavior, and lobbying for PV solar panel retrofits on campus. NECO also advertises and sponsors lectures, films, and events that promote sustainable practices on campus and in the surrounding community, in addition to direct public outreach. Interested persons can learn more about NECO at the following website: www.bozoneco.com/get-involved

ASMSU Sustainability Center: Through self-initiated student fees, ASMSU established and operates the Sustainability Center. The ASMSU Sustainability Center is a student-funded program of the Associated Students of MSU (www.montana.edu/greenasmsu). ASMSU operates a student-run Recycling program, plans programs and events, coordinates campus recycling, waste and water-use reduction programs, hands-on student community projects, and collaborates with various campus partners to develop initiatives that enhance sustainability at MSU and engage students in the process. Programs run by the ASMSU Sustainability Center include:

- ASMSU Recycling: a student-funded program with services performed by student employees.
- Sustainability Luncheons: held twice each semester, the Sustainability Luncheon series brings the campus community together for a presentation or conversation on a sustainability topic with free refreshments featuring local Montana Made products.
- Take Back the Tap: The Sustainability Center has partnered with the City of Bozeman and University Food Service in joining this nationwide campaign to raise awareness of the environmental and health concerns related to bottled water.
- Gallatin Earth Celebration: The Sustainability Center is a co-sponsor of this annual Earth Week series of events hosted by MSU and the City of Bozeman each year.
- MSU Climate Action Plan: The Sustainability Center will facilitate continuing student involvement in the development of subsequent editions of this campus Climate Action Plan (CAP).
- Independent Research Project Opportunities: The Sustainability Center welcomes independent student research projects (for stipend, or credit, or simply volunteer) in areas consistent with its mission. An updated list of past and current research is maintained at www.montana.edu/greenasmsu/Research.html

Engineers Without Borders (EWB): MSU-Bozeman has a student chapter of EWB, a nationwide non-profit organization with over 180 student chapters. The mission of EWB-USA and its chapters is: "EWB-USA supports community-driven development programs worldwide by collaborating with local partners to design and implement sustainable engineering projects, while creating transformative experiences and responsible leaders." (www.ewb-usa.org/mission.php). EWB-USA encourages a strong sense of stewardship, outreach, and sustainable (environmentally and culturally) engineering solutions for communities in need, both in the USA and around the world.

Faculty/Staff-run Organizations

Burns Technology Center (BTC, http://eu.montana.edu/btc): The BTC was created in 1993 by MSU and the Montana Board of Regents to develop and demonstrate cost-effective telecommunications applications and distant learning strategies. The BTC successfully incorporates technology into traditional teaching and learning, as well as extends the university into the homes and communities of every Montanan. In addition, the center's distance learning programs reach people and communities across the United States and beyond. The BTC satisfies several goals of the CAP by increasing science literacy throughout Montana and beyond, and allowing distance education learning to decrease travel-related energy costs. Additionally, the BTC has made publicly available the free, downloadable unit: Hydrogen and the Environment: The quest for alternative fuels (http://hydrogen.montana.edu). Other materials will continue to develop through the BTC in the future.

Wind for Schools (WfS, www.coe.montana.edu/wind/skystream/locations.html): Wind for Schools is a parallel program with a primary objective to engage rural American in wind-related projects. By facilitating installation of small wind turbines at rural K-12 schools, the WfS program provides a knowledge base for alternative energy. The amount of supplemental power delivered to the primarily rural school facilities is relatively small, but the educational benefits are great.

The Integrated Design Lab | Bozeman (www.idlbozeman.com): The Integrated Design Lab is funded by the Northwest Energy Efficiency Alliance. Services include energy and lighting analysis for Montana architects and engineers who wish to become more aware of the environmental impacts of energy consumption. IDL serves as a Montana contact for energy and daylighting information, education, and tools for assessing integrated design decisions. MSU Faculty Director: Thomas Wood

Big Sky Carbon Sequestration Partnership (BSCSP, www.bigskyco2.org): The BSCSP is one of the U.S. Department of Energy's seven regional carbon sequestration partnerships. The partnerships engage key stakeholders to create a nationwide network that will help determine the best approaches for capturing and permanently storing greenhouse gases that contribute to climate change. The BSCSP region extends beyond Montana, encompassing Wyoming, Idaho, South Dakota, eastern Washington and Oregon as well. Its membership includes universities, national laboratories, private companies, state agencies and Native American tribes. The BSCSP relies on existing technologies from the fields of engineering, geology, chemistry, biology, geographic information systems (GIS) and economics to develop novel approaches for both geologic and terrestrial carbon storage in our region. The BSCSP engages in cutting-edge carbon sequestration research and development; economic and regulatory analyses; public education and outreach; and regional demonstration projects to deploy new technologies.

6. RESEARCH AND CREATIVE ACTIVITIES

In support of the MSU-Bozeman 2011 climate action plan, this section details ongoing and developing research activities related to energy and climate change (both on and off campus). First discussed is an overview of MSU's research mission and infrastructure. This is followed by an inventory of CAP-related research activities and plans to expand same.

6.1 Research Mission and Infrastructure

The integration of learning and discovery is a hallmark of the undergraduate experience at Montana State University, which offers every student a hands-on research or creative project in his or her sophomore year. MSU has become a model university for combining these two critical aspects of higher education. With outdoor laboratories as close as Yellowstone National Park, MSU students have ample opportunities to pursue exciting projects throughout their college careers. Not limited to the sciences, those projects also include such artistic endeavors as original musical compositions, paintings and architectural designs.

Those hands-on opportunities make MSU a leader in the number of prestigious Goldwater Scholarships for undergraduate excellence in science and math. MSU is among the nation's top tier of research universities, as recognized by the Carnegie Foundation for the Advancement of Teaching. The Foundation recently ranked MSU as one of 96 research universities with "very high research activity."

MSU faculty are recipients of National Science Career Awards, Presidential Early Career Awards for Scientists and Engineers (PECASE), a Technology Review magazine "young innovator" award and a McArthur Foundation Award. Faculty and student take advantage of the ability to conduct pioneering research in a unique learning environment. MSU's expenditures from sponsored research programs reached $109.5 million in fiscal year 2010 and continued growth is expected.

MSU-Bozeman is committed to reducing energy needs and greenhouse gas emissions through its continually expanding research. Present greenhouse gas reduction research areas include fuel cells, wind energy, harvesting transportation fuel from algae, microorganisms with biofuel-producing capabilities, biofuel from seed crops, and the storage of carbon dioxide deep underground, known as carbon sequestration. In environmental research, MSU covers everything from invasive weeds that threaten livestock grazing, to how climate change will change the frequency of wildfires, to lower GHG producing agricultural practices. Contributions through research will continue to benefit not only the current student body and surrounding region, but ultimately result in products and strategies to ameliorate greenhouse gas emissions on a global level as developed technologies are implemented.

6.2 CAP-Related Research Inventory

Discovery and Creativity

Interdisciplinary discovery creates solutions for societal issues related to the environment and sustainability. In contrast to the disciplinary organizational structure within most universities, environmental research on topics, such as climate change, requires interdisciplinary solutions that engage natural and social scientists, engineers, applied mathematicians, land managers, policy makers and communities. The IoE will increase visibility and provide a collective voice in environmental sciences and sustainability to help us succeed in new interdisciplinary research areas. Currently, over 65 faculty have research focused on sustainability and the environment, and nearly one-third of current research grants target environmental themes and continued growth is expected. The university has made significant investments in faculty and resources in energy, natural resources, ecology, earth sciences, environmental sciences, environmental engineering, and computational sciences.

Recent hires bring new strengths in energy, climate change science, snow science, watershed modeling, biogeochemistry, land-atmosphere interactions, aquatic ecology, plant ecology, optical sensors, ecological and environmental statistics, environmental microbiology, and environmental education. Current research in environmental sciences accounts for about one third of MSU's annual research funding, and faculty have received national awards for excellence in environmental research and education. Research at MSU takes advantage of the unique opportunities and natural laboratories available in Montana and the Greater Yellowstone Ecosystem (e.g., we have more research in Yellowstone National Park than any university in the country), but our focus on the environment, energy, and sustainability extends to all continents. Current research centers and institutes focused on sustainability-related research (described in more detail below) include the Energy Research Institute; Zero Emissions Research and Technology (ZERT); Big Sky Carbon Capture and Sequestration; Center for Biofilm Engineering; Thermal Biology Institute; Creative Design Laboratory; Jabs Center for Entrepreneurship for the New West; Center for Bioinspired Nanomaterials; Western Transportation Institute, the Wind Applications Center, Center for Invasive Plant Management, and the REHAU Montana EcoSmart House.

6.2.1 Research Centers Inventory

There are several umbrella research centers at MSU, many of which include outreach, education, and research components relevant to the subjects of sustainability and greenhouse gas reduction. Below, are listed the research centers that most directly address issues surrounding greenhouse gas reduction:

Center for Biofilm Engineering (CBE, www.biofilm.montana.edu): At the Center for Biofilm Engineering (CBE), multidisciplinary research teams develop beneficial uses for microbial biofilms and find solutions to industrially relevant biofilm problems. The CBE was established at Montana State University, Bozeman, in 1990 as a National Science Foundation Engineering Research Center. As part of the MSU College of Engineering, the CBE gives students a chance to get a head start on their careers by working on research teams led by world-recognized leaders in the biofilm field. Biofuel production and CO_2 sequestration are but two of the CBE's present and ongoing research areas that contribute to greenhouse gas reduction strategies (www.biofilm.montana.edu/research-program.html).

Energy Research Institute (www.montana.edu/energy): The Montana State University Energy Research Institute is an umbrella for MSU's energy research and education programs, which account for roughly $15 million in research each year. The institute encompasses more than 170 faculty, staff and students spread across 11 university departments who are working in fields such as clean-coal technology, fuel cells, wind, coal-bed methane, biofuels, as well as carbon sequestration and climate change. Over the past several years, MSU has developed a number of programs focused on energy, making the university a significant contributor to national and international energy research and development.

Consortium for the Agricultural Soils Mitigation of Greenhouse Gases (CASMGS, www.montana.edu/sustainability/curriculum.html): The CASMGS is a consortium of nine universities and one national laboratory assembled to investigate the potential of agricultural soils to mitigate greenhouse gases.

Economics of Climate Change and Greenhouse Gas Mitigation (www.montana.edu/sustainability/curriculum.html): This research program investigates issues facing the agricultural sector due to climate change, including the impact of climate change on U.S. cropping systems, and focuses on how to design programs to sequester carbon in agricultural soils.

6.2.2 Specific CAP-related Research Subjects

Agricultural management research

Research programs by faculty in the Department of Land Resources and Environmental Sciences (LRES) are targeting energy use reduction in agricultural and focusing on cropping systems that sequester carbon. Research under a current USDA AFRI grant focuses on energetic, economic and environmental benefits of using legume green manures as a nitrogen fertilizer replacement strategy. Faculty: Perry Miller (PI), Clain Jones, Rick Engel.

Current research is also investigating Camelina as a low input crop with added value from its byproducts. Camelina oil can be used for production of insulation foams and as a component of carpets. Camelina meal can be used for fertilization or remediation of phenolic contaminants. Additionally, Camelina meal can be used to reduce soil borne diseases and insects as an alternative to chemical pesticides. Camelina can also be used for its oils in biofuels, or for solid biomass pellets. Faculty: David Sands, Department of Plant Sciences and Plant Pathology. Dr. Sands is also presently researching composting microbes to degrade bioplastics. (http://mbprogram.montana.edu/faculty.asp?per_id=16&in_id=12)

In addition to the above mentioned green manure research as an alternative to energetically expensive nitrogenous fertilizers, Perry Miller is presently conducting studies with various alternative crops aimed at finding economical ways of sustainable soil management (http://scarab.msu.montana.edu/CropSystems/). Geoffrey C. Poole, of the LRES Department is presently studying land management approaches to limit N_2O emissions from streams.

Department of Agricultural Economics and Economics:
Research within the department spans a wide array of topics. Subjects relevant to the goals of the MSU CAP include: climate change, resource and environmental economics, and public choice. The Department of Agricultural Economics and Economics also houses the CASMGS and the Economics of Climate Change and Greenhouse Gas Mitigation research centers described above.

Carbon Sequestration

Biological
Rick Lawrence: The Spatial Sciences Center remote sensing lab is engaged in two major research efforts related to carbon sequestration. The first effort is developing monitoring and validation methods for cropping practices that increase soil carbon and are eligible for carbon credits traded on the Chicago Carbon Exchange. The second effort relates to geologic carbon sequestration in coordination with Dr. Kevin Repasky and Dr. Joe Shaw in the Electrical Engineering Department to develop methods using remote sensing to monitor geologic sequestration sites for leakage.

Perry Miller: Dr. Miller is presently conducting two long-term cropping systems studies at MSU. The A.H. Post Research Farm address carbon sequestration, reduced N_2O emissions, and energy use efficiency. A long-term out-of-state project on 6 farms is specifically addressing carbon sequestration in agricultural soils.

Geological
Zero Emissions Research and Technology (ZERT, www.montana.edu/zert)
DOE partnership investigating geochemical CO_2 sequestration: The Zero Emission Research and Technology Center (ZERT) is a research collaborative focused on understanding the basic science of underground (geologic) carbon dioxide storage to mitigate greenhouse gasses from fossil fuel use and to develop technologies that can ensure the safety and reliability of that storage. ZERT is a partnership involving DOE laboratories (Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, National Energy Technology Laboratory, Lawrence Livermore National Laboratory, and Pacific Northwest National Laboratory) as well as universities (Montana State and West Virginia University).

Research Goals are to: 1) develop sophisticated, comprehensive computer modeling suites which predict the underground behavior of carbon dioxide; 2) investigate the fundamental geochemical and hydrological issues related to underground carbon dioxide storage; 3) develop measurement techniques to verify storage and investigate leakage; and 4) develop mitigation techniques and determination of best practices for reservoir management. Faculty: David W. Bowen (Modeling and Mapping), Kevin Repasky and John L. Carlsten (Monitoring and remote sensing), Al Cunningham, Robin Gerlach, Dr. Andrew Mitchell and Mark Skidmore (Mitigation: Subsurface Biofilm Barriers).

Multi-spectral imaging of vegetation to detect CO_2 leaking from underground carbon sequestration storage facilities. This is part of the Lasers and Lidar Group (www.physics.montana.edu/optics/jlc/index.html) within the ZERT research program. Faculty: Joe Shaw, Rick Lawrence, Kevin Repasky, J.L. Carlsten (www.coe.montana.edu/ee/jshaw/index.htm)

Climate Change Impacts

NSF-funded research investigating C, N and S cycling in coastal plain wetlands to understand population dynamics. Predicting the likely ecosystem carbon and nutrient cycling of coastal plain freshwaters into a saltier and increasingly uncertain hydrologic future requires significant improvements to the current understanding of freshwater ecosystems. Incorporating sulfur (from sea salt) dynamics into our understanding of how microbes alter carbon and nutrient cycling and utilizing simulation modeling to mesh dynamic hydrology together with microbial biogeochemistry is important to formalize the emerging conceptual understanding of wetland biogeochemistry into a flexible, easily adjusted modeling framework. Developing software models will test various hypotheses and understand how sulfate intrusion in wetlands impacts greenhouse gases released to the atmosphere.

The field site is representative of large areas of SE coastal plain agricultural landscapes that are being actively restored or abandoned. The economic and ecological 'success' of this project is closely watched by regulators and practitioners throughout the region. This research program will directly affect the potential for site owners to sell validated carbon and nutrient credits in emerging ecosystem service markets. Resulting research findings (together with their economic implications) will influence future patterns of mitigation and conservation investment throughout the southeastern coastal plain and will provide critical information that will facilitate climate adaptation planning throughout the region.

Faculty: E.S. Bernhardt, G.C. Poole, A.J. Burgin, and C.I. Izurieta

Biofuels

Algal BioFuels Group:
The Algal BioFuels Group at Montana State University (MSU) has a unique combination of expertise for the development and application of algal technologies for production of biofuels and renewable chemicals. Current projects encompass $2.3M in funding from DOE, DOD and State sources. Unique algal strains have been isolated and characterized from a variety of different environments. In-house analytical capabilities are being developed to characterize algal triacylglycerides (TAGs), hydrocarbons, as well as fuel potential (hydrocarbons and fatty acid methyl ester analysis) for screening new isolates and optimizing fuel output of algal cultures. Faculty: Ross Carlson, Barbara Cooksey, Keith Cooksey, Matthew Fields, Robin Gerlach, Brent Peyton (Algal biodiesel and Mycodiesel).

Biohydrogen
Robust Phototrophic Microorganisms for Biological Hydrogen Production: Optimization of light driven or mediated hydrogen production for alternative energy. MSU researchers are exploring hydrogen production in either algae or Cyanobacteria for optimal hydrogen production and attempting to identify the organisms with the highest hydrogen production potential, thus laying the groundwork for metabolic engineering to create organisms with enhanced hydrogen production capabilities. PI: John Peters (www.chemistry.montana.edu/john.peters/research.html)

Fuel Cells
Biomimetic Systems for Light Driven Hydrogen Production: In work supported by the Department of Energy, researchers are applying enzymes and enzyme mimics (with Trevor Douglas) to the production of hydrogen-producing materials for alternative energy solutions. The project involves novel patented solar to hydrogen materials strategies that can be potentially applied in a number of different ways. Since durability is one of the key aspects of enzymes that limit their effective use in many industrial processes, enzyme stability, thermal adaptation, and immobilization as mechanisms to promote the use of enzymes as materials is under investigation. PI: John Peters (www.chemistry.montana.edu/john.peters/research.html)

Solid Oxide Fuel Cells (SOFCs):
Operation of solid-oxide fuel cells (SOFCs) are being researched in combined-heat and power (CHP) mode for improved energy efficiency to ultimately avoid the use of power generated by steam power plants. Hybrid operation of SOFC-microturbines are also being researched for improved energy efficiency. PI: M. Hashem Nehrir (www.coe.montana.edu/ee/hnehrir)

Current research is also investigating the stability and corrosion of various fuel cell components in the humid environment of Solid Oxide Fuel Cells (SOFCs). Specifically, in steel current collectors of SOFC stacks, chromia is volatized from these plates. Insulation and fuel feed tubes used in SOFCs can also release silica in the moist SOFC environment. Both of these volatile species, chromia and silica, can enter the gas stream and poison the cell. Improved techniques for making these volatility measurements are also being developed. More stable anode materials for SOFCs running at higher operation temperatures (> 800°C) in a reversible mode are also being developed. These would be used on NASA missions to mars, and could lead to improved SOFCs for earth operation as well. A reversible cell would use solar energy during the day to generate hydrogen fuel. The hydrogen would be used at night to generate electrical energy. PI: Richard J. Smith (www.physics.montana.edu/people/facview.asp?id_PersonDetails=4)

Wind
MSU faculty Doug Cairns is currently working on manufacturing and testing new materials for wind turbine blade structures.

Composite material testing is presently being conducted in coordination with twelve industry partners for wind turbine blades to increase reliability and reduce the cost of wind energy. Research is on the durability of composite materials in a salt water environment is also being conducted for Marine Hydrokinetic (MHK) devices for water power generation such as tidal or ocean/river currents. Faculty: John Mandell, Prof. Emeritus (www.coe.montana.edu/composites/People/Faculty%20and%20Staff/John%20Mandel.htm)

Additionally, the Montana Wind Applications Center (WAC) is in place to offer wind energy educational opportunities to students at Montana State University, to support wind-related outreach efforts throughout Montana, and to assist the companion Montana Wind for Schools program. The WAC (www.coe.montana.edu/wind) was created in 2008 with startup funding provided by the U.S. Department of Energy National Renewable Energy Laboratory (DOE NERL). Faculty: Robb Larson.

Solar
Current research at MSU is focusing on methods for characterizing the temporal and spatial distribution of solar radiation across Montana. The placement and sizing of solar technologies is dependent on knowledge of the availability of solar radiation. The project aims to better understand the controls on solar radiation variability, to develop methods for representing the solar radiation characteristics, and to provide information useful for the efficacy of solar radiation technologies across Montana. The project will develop a system for communicating the availability and dependability of solar radiation across the state of Montana. The system will provide spatial maps of variables of importance to solar collector technologies, including: solar radiation means and extremes, frequency and duration of low radiation values, and runs of high radiation values. Faculty: Lucy Marshall.

Green Architecture and Construction:
REHAU MONTANA ecosmart house: Project research will specifically focus on sustainability, low energy usage, and disability design. A key objective of the research is to determine how the various building systems can best be integrated to optimize energy consumption, comfort, and life-cycle costs. (www.montanaecosmart.com/index.php)

Fly Ash Cement: Relative to sources of greenhouse gases, the United States and the rest of the world use a lot of concrete, and the production of the traditional Portland cement that goes into this concrete accounts for 7 percent of worldwide greenhouse gas emissions. Therefore, finding substitutes for Portland cement as the binding agent in concrete could have a significant impact on greenhouse gas emissions. In this regard, an innovative green concrete that uses no Portland cement is being researched. The solid constituents in this concrete are nearly 100 percent recycled or industrial by-products. Instead of Portland cement as the binding agent, fly ash, a by-product of burning coal to generate electricity is being used, and post consumer crushed glass, instead of sand and gravel for the filler material, is being used. Faculty: Michael Berry (member of Western Transportation Institute)

Other alternative energy research
Dr. M. Hashem Nehrir (www.coe.montana.edu/ee/hnehrir/) has multiple research endeavors relevant to the goals of MSU's CAP. He presently is researching near optimal operation of a hybrid wind-microturbine power generation system to minimize fuel (natural gas) consumption. He additionally is focusing on using residential electric thermal storage loads, such as electric water heaters, to store excess wind energy that may be available in a given area during high wind periods. Additional research includes control of electric loads to reduce the need for spinning reserve generation, hence reducing emission of undesired gases. Spinning reserve generators are often steam-based power generating units which are used in emergency cases. Additionally, Dr. Hehrir is researching power management of microgrids with hybrid alternative energy power generation sources. One objective in this work is the maximum use of renewable power generation resulting in minimum emission of undesired gases.

6.3 Future Research Directions

Separate from the Burns Technology Center, MSU-Bozeman is calling for proposals in order to expand access to MSU learning through development of online classes. President Cruzado noted that in the coming months and years, Montana State University will be expanding online distance education, a vehicle that enables us to reach out and meet the diverse educational needs of students in every corner of this state. In doing so, she proposed the designation of funds to give motivated faculty the time and support to develop online courses or transform existing ones into online programs reaching previously un-served or under-served learners. Faculty may request funds for time for program planning and course development and/or conversion. Priority will be given to programs able to launch in Fall 2011 or Spring 2012. Programs that require longer planning and approval time will also be considered, and there will be additional Requests for Proposals (RFPs) in future years. (eu.montana.edu/online/faculty/grow)

In addition, MSU is well positioned to coordinate and support primary research on

Native Communities, Indigenous Science and traditional knowledge related to climate change. The resources previously mentioned provide a foundation for this type of innovative, cross disciplinary endeavor.

7. FINANCIAL CONSIDERATIONS

Financial investment resulting in GHG emissions reductions will be prioritized according to the ability of options to cost effectively achieve multiple goals. For example, efforts that reduce emissions may also reduce deferred maintenance, address system deficiencies, interface with education and research, and/or achieve operational cost reductions. No funding is presently identified for implementation of mitigation tactics. All infrastructure investments made will consider these criteria and capitalize on funding opportunities by: 1) leveraging existing programs, such as the IoE for curricular and staffing opportunities; 2) pursuing the establishment of a Sustainability Endowment through the MSU Foundation funding structure; and 3) investigating external funding, through government and private grants, for CAP-related activities, including curriculum development, public outreach and partnering, infrastructure improvements, and research opportunities. To the extent possible, investments will be planned to complement the overall strategy of energy conservation and preparation of building systems for the integration of renewable energy sources.

8. COMMUNICATIONS AND ACTION ITEMS

This MSU CAP is a living document approved by the President and University Council, submitted to the American College and University Presidents Climate Commitment for posting on their website (www.presidentsclimatecommitment.org). It will be revised and resubmitted every two years. Suggested revisions for the 2013 submission can be made through the MSU Campus Sustainability Advisory Council.

A simple checklist can help guide decision-making at MSU to be in accordance with both its new Mission Statement (www.montana.edu/accreditation/MSU_Mission_and_Core_Themes_2011.pdf; accessed Nov 10, 2011) and the CAP.

Does the proposed action:

1) Decrease or hold neutral per capita greenhouse gas emissions?
2) Move towards use of renewable energy and material supplies?
3) Decrease or hold neutral per capita use of materials?
4) Decrease or hold neutral per capita waste stream?
5) Contribute to or provide knowledge and/or application dealing with sustainable practices for environment, society, and short and long term economics?
6) Contribute to the knowledge and experience base for students interested in sustainability?
7) Build towards more sustainable operations for MSU employees?
8) Push the envelope of sustainability for communities and organizations across Montana?
9) Acknowledge and honor the sense of place of Montana State University within the natural and human worlds?

To make concrete progress toward the goals of this CAP, immediate and near-term actions are recommended. The first such action taken toward satisfying the goals upon signing onto the ACUPCC was the establishment of CSAC at MSU. As the official advising council for MSU, regarding sustainable practices and meeting the signed objective of ultimate net-zero Carbon emissions, CSAC recommends the following:

1) Continued participation in the Uncommon Sense Business Leadership for a Sustainable Future program, which establishes methodologies for tracking, reporting, and improving practices in waste management, responsible purchasing, social and community investment, inventorying GHG emissions, and improving energy, water, and transportation efficiencies;
2) Creation of an Office of Sustainability. Such an office, with at least one FTE hire and physical office would supply a direct liaison between students, the IoE, advising on curricular choices toward the foreseen Sustainability Certificate, pairing students with identified research opportunities, and MSU Extension Services. This is a separate function from the ASMSU Sustainability center (described earlier), and would therefore require separate staff to perform these tasks.
3) Begin immediate changes in travel data acquisition in order to accurately track/audit air transportation mileage, commuter driving, and waste tracking. Specific changes in data acquisition are supplied in previous chapters of this CAP, and improved methods will be developed in the coming biennium through participation in the Uncommon Sense workshops.

Communications for the MSU CAP will be governed by MSU Communications via the CSAC website: www.montana.edu/sustainability.

Appendix 1: Greenhouse Gas Inventory

Greenhouse Gas Inventory Report

Montana State University

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Prepared by McKinstry

Prepared for Montana State University

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Greenhouse Gas Inventory Report

Montana State University

EXECUTIVE SUMMARY

Reporting university Greenhouse Gas (GHG) emissions is a critical step in planning for a sustainable campus and is a requirement for signatories of The American College & University President's Climate Commitment (ACUPCC). McKinstry Co was engaged by Montana State University (MSU) to assist in this process. It was determined that the total emissions for the 2009 reporting period were 77,375 Metric Tonnes Carbon Dioxide Equivalent (MT CO_2e), taking into account Scope 1, 2, and 3 emissions. This is a higher than average emissions value when compared to many ACUPCC institutions, but includes thorough data for Scope 3, emissions that are, at this time, omitted by many institutions.

INTRODUCTION

As a signatory to The ACUPCC, MSU has made an institutional commitment to reduce greenhouse gas emissions from campus operations and achieve a carbon neutral footprint. The initial step in achieving this goal is to complete a comprehensive GHG emissions inventory. In September of 2009, MSU contracted with McKinstry Co. to assist in compiling this information. The findings in this report are the result of a joint effort from McKinstry and multiple members of the MSU staff.

GHG accounting and reporting was based on the principles set forth in the World Resource Institute GHG Protocol. These are:

Relevance – Ensure the GHG Inventory appropriately reflects the GHG emissions of the university and serves the decision making needs of users – both internal and external to the university.

Completeness – Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.

Consistency – Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document and changes to the data, inventory boundary, methods, or any other relevant factors in the time series.

Transparency – Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.

Accuracy – Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

MSU's 2009 GHG inventory was based on university data for the 2008-2009 fiscal year (July 2008 – June 2009), and was calculated using the Clean Air Cool Planet Campus Carbon Calculator v6.4. Data was collected from a variety of sources, and some incomplete data was extrapolated to provide MSU with an estimate based on the best available data.

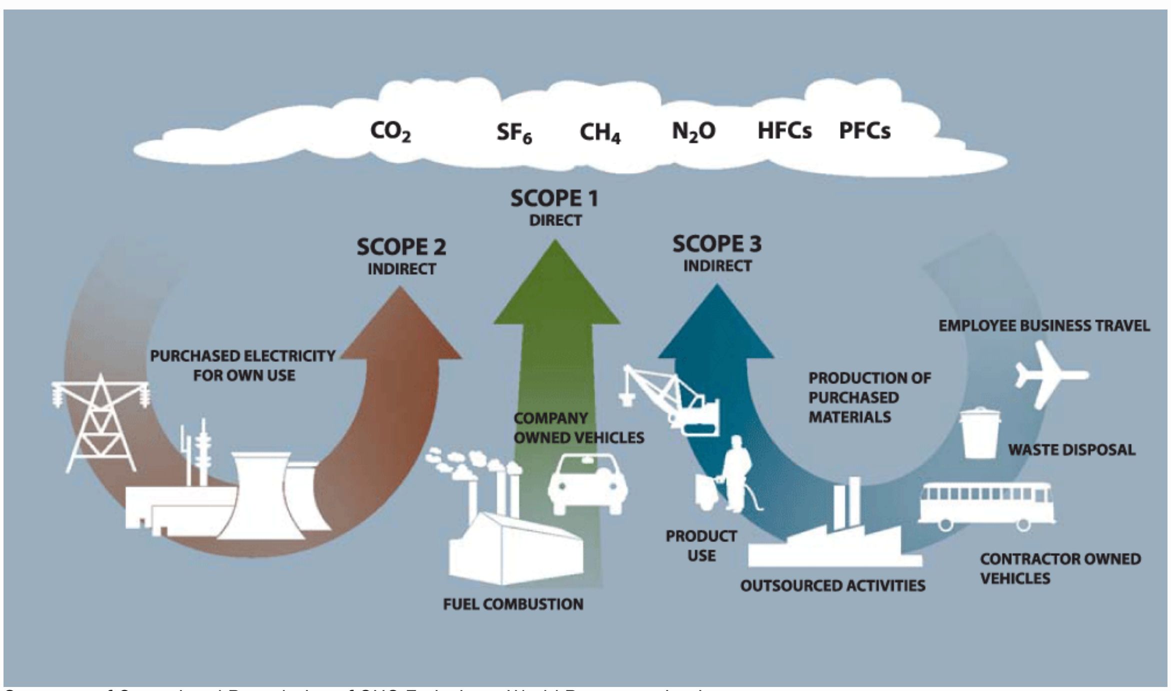
Reporting Boundaries

Through discussions with MSU, it was determined that the scope of this report would be limited to MSU activities at the Bozeman campus. Additionally, it was agreed that MSU would use the Operational Control Approach in determining organizational boundaries on the campus. Under this approach, MSU is accounting for GHG emissions from all operations under its operational control, which refers to the authority to introduce and implement operating policies, and is consistent with the ACUPCC reporting guidelines. The commitment requires that signatories report on and mitigate emissions only from Scope 1 and 2 sources, as well as commute and air travel from Scope 3. Comparing this inventory with peer institutions reveals that most inventories focus on required emissions sources. This inventory aims to document all MSU emissions, regardless of the required mitigation responsibilities.

It can be argued that many Scope 3 emissions are not under direct MSU control and should therefore be excluded. Holding the university accountable for personal commute choices and habits could be argued as outside the control of the reporting institution, and should not impact its footprint. MSU feels that it is important to accurately account for all emissions resulting from university existence, and this cannot exclude emissions from choices of the campus population, and are therefore included in this report.

Description of Emission Sources

Throughout this report, emissions are grouped into three different Scope categories. Scope 1 emissions are direct GHG emissions occurring from sources that are owned or controlled by the institution. Scope 2 emissions account for indirect GHG emissions that are a consequence of activities that take place within the organizational boundaries but that occur at sources owned or controlled by another entity, such as purchased electricity. Scope 3 emissions are all indirect emissions not covered in Scope 2, and focus on cultural emissions associated with travel, waste, and commuting habits of the university. By understanding where university emissions are concentrated, MSU will be better prepared to strategically approach reduction to meet the ACUPCC requirements of achieving a carbon neutral campus.

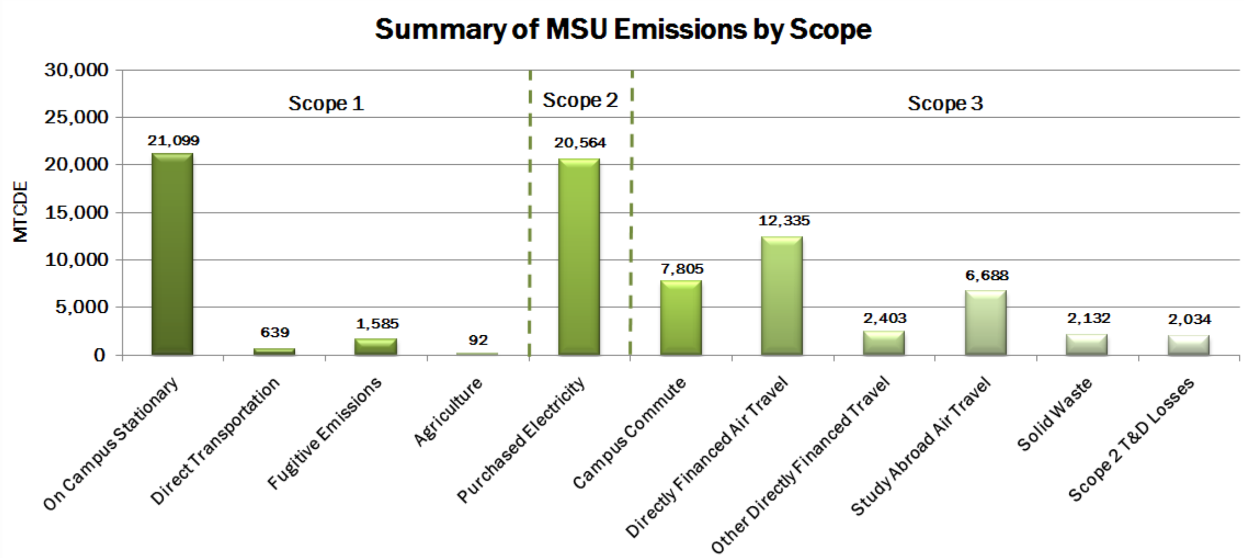


Summary of Operational Boundaries of GHG Emissions. World Resources Institute.

INVENTORY RESULTS

Well tracked data for Scope 1 and Scope 2 were typically available for the university, but some Scope 3 data, specifically other directly financed air and ground travel, were based upon best available data, recommended conversion factors, and supplemented by estimates from other ACUPCC universities. MSU's emissions presented in this report reflect a higher than average value than comparable universities on the ACUPCC website. It is important to note that many of these institutions have not reported on air travel, and many do not include comprehensive commute data. By omitting these Scope 3 emissions from the GHG reports, the university total emissions are considerably lower than the 77,375 MT CO_2e reported for MSU. MSU and McKinstry choose to report on all data collected by MSU, and make assumptions for unknown parameters (study abroad air miles) in order to present the most comprehensive footprint information available. Although not all of these emissions are required reporting for ACUPCC, it is recommended that MSU continues to view their GHG inventory holistically and report on full emissions. MSU acknowledges that their reported emissions are likely to change as they evolve their data collection protocols, and are not required to report on all emissions stated in compliance with ACUPCC. The table and graph below represent the total MSU GHG emissions by scope and source based on best available data.

2009	MT CO_2e	% of Net Emissions	ACUPCC required?
Co-gen Electricity	0	0%	yes
Co-gen Steam	0	0%	yes
Other On-Campus Stationary	21,099	27%	yes
Direct Transportation	639	1%	yes
Refrigerants & Chemicals	1,585	2%	yes
Agriculture	92	0%	yes
Purchased Electricity	20,564	27%	yes
Purchased Steam / Chilled Water	0	0%	yes
Faculty / Staff Commuting	3,733	5%	yes
Student Commuting	4,073	5%	yes
Directly Financed Air Travel	12,335	16%	yes
Other Directly Financed Travel	2,403	3%	recommended
Study Abroad Air Travel	6,688	9%	yes
Solid Waste	2,132	3%	yes
Wastewater	0	0%	recommended
Paper	0	0%	recommended
Scope 2 T&D Losses	2,034	3%	recommended
Additional	0	0%	recommended
Non-Additional	0	0%	recommended
Scope 1	23,415	30%	
Scope 2	20,564	27%	
Scope 3	33,397	43%	
All Scopes	77,375	100%	
All Offsets	0		
TOTAL EMISSIONS	77,375		



The baseline Greenhouse Gas Inventory for the MSU campus is estimated to be approximately 77,375 MT CO_2e /yr, including Scope 1, 2, and 3 metrics. Understanding where emissions are coming from will help MSU focus reduction goals and track their progress as they reduce emissions across all three scopes.

Data Collection Methodology

Below is a summary of how data for this report was collected, and any calculations or extrapolations used to generate the GHG inventory report. For a full list of assumptions and standard calculations, please reference the Assumptions and Calculations in Appendix 1.

General University Data

University Population – The MSU "Quick Facts 2008-2009" report was used for the university population. For faculty and staff, full time equivalent (FTE) employee numbers were used.

Scope 1 Emissions

Stationary Combustion –This accounts for the total direct emissions from stationary combustion on the MSU campus. Stationary combustion refers to the burning of fuels to produce electricity, steam, heat, or power using equipment in a fixed location such as boilers, burners, heaters, furnaces, incinerators, kilns, ovens, dryers, and engines. Any biogenic carbon dioxide emissions that result from the combustion of biomass or biomass-based fuel are not included in Scope 1. Complete records of all utility bills were provided by Patti Yasbek and the facilities group.

Mobile Combustion from Direct Transportation – Accounts for the total direct emissions from mobile combustion in MSU-owned fleet such as cars, trucks, tractors, and buses. These emissions were captured from MSU fuel records from motor pool and Gas Island fuel sales for campus fleet vehicles supplied by Patti Yasbek and Laura Humberger at MSU.

Fugitive Emissions – Data for emissions due to the intentional or unintentional release of GHGs in the production, processing, transmission, storage, and use of fuels and other substances were supplied by Dan Stevenson at MSU. This includes releases of hydro fluorocarbon during the use of refrigeration and air conditioning equipment and methane leakage from natural gas transport. The CACP calculator identifies specific emissions factors for each type of refrigerant used on campus based on the Global Warming Potential (GWP) for the individual refrigerant. For refrigerants not in the CACP calculator, MSDS sheet values for GWP were used.

Agricultural Emissions – This captures emissions from on-campus fertilizer application.

Scope 2 Emissions

Purchased Electricity – This captures the total indirect GHG emissions resulting from the generation of electricity purchased and used by MSU. Default eGRID region and sub-region emissions coefficients for Bozeman, Montana (supplied in the Clean Air-Cool Planet Campus Carbon Calculator v6.4) were used for all electricity emissions calculations.

Purchased Steam – MSU does not purchase any steam or chilled water.

Scope 3 Emissions

Commute Transportation – A commute survey was created and administered by Gretchen Hooker with ASMSU. This survey was distributed to faculty, staff and students on the MSU campus. Results from this survey were used to calculate emissions from student, faculty, and staff commuting. Extracting usable data required query sorting of the survey responses, and is explained in the following bullets. A total of nine sorted reports were used to populate commute data for the GHG inventory.

CACP methodology for calculating commuting data bases calculations on FTE student population, giving part-time students equivalent of one-half a full-time student. This may not accurately capture the complex commute patterns of students going to and from campus, but until more accurate tracking is established, the CACP protocol will be used for MSU calculation.

- Commute Preferences – To determine primary commute patterns for students, faculty and staff, each group was sorted individually. Responses to question four of the survey would then show the primary commute habits of each group (bus, SOV, carpool etc). Because the survey separated out commute choices by season, averages were calculated for the GHG Inventory inputs. For faculty and staff, full-year averages were used because they are employed on a 12 month pattern. For student averages, spring/fall and winter response averages were used to determine % utilizing each mode of transportation as their primary commute choice during the school year.

- Driving Distance – To determine the average trip distance for drive-alone commuters, each response group was filtered to sort by status (student, faculty or staff), and to those that selected “drive-alone” as their primary commute choice. The survey allowed respondents to specify distance they lived from campus. An average of these values was calculated for each group to enter into the CACP workbook. Any extreme outlier responses were omitted.

- Bus Distance – To determine the average trip distance for bus commuters, each response group was filtered to sort by status (student, faculty or staff), and to those that selected “bus” as their primary commute choice. The survey allowed respondents to specify distance they lived from campus. An average of these values was calculated for each group to enter into the CACP workbook.

- Weeks Worked/Trips Per Week – Values entered for the number of weeks commuting were assumed based on MSU data for employee benefits and academic calendars. It was assumed that all employees and students were commuting five days per week, to and from campus.

Air Travel – Air travel accounts for a large portion of most universities GHG emissions. Reported emissions from air travel for MSU are estimates based on best available data and extrapolations. The following bullets explain the methodology to calculate these Scope 3 emissions from MSU.

- Athletic Air Travel – Athletic air travel was tracked by MSU for the 2008-2009 academic year. This data was provided in dollars spent for each trip. The CACP input requires air miles, so to extrapolate air miles from these dollar values, the recommended ATA conversion factor[1]. It is entered into the CACP workbook as student air travel.

- Faculty and Staff Air Travel – MSU air travel spending is automatically tracked through the university purchasing card records and expense reports. The total spent on university air travel related to research and other travel was converted to air miles using the ATA conversion used throughout all MSU air travel calculations; this is equivalent to approximately 12,756,878 air passenger miles.

- Study Abroad Air Travel – At this time, MSU does not track or record air miles associated with study abroad travel. Rather than leave this value at zero, the reporting team used estimated study abroad miles based on other reporting universities based on air miles per student. This estimate will be refined in future reports at MSU develops tracking protocol to capture study abroad travel.

Other Transportation – Reported emissions from air travel for MSU are estimates based on best available data and extrapolations. The following bullets explain the methodology to calculate these Scope 3 emissions from MSU research travel.

- Reimbursement for Mileage– Calculated from total dollar value reported by MSU using 2007-2008 standards reimbursement rates per mile.

- Fuel Costs – Calculated based on total reported fuel expenditures at $2.50 per gallon.

- Bus Mileage – Bus data was only available specifically for athletic teams. For bus-only trips, MapQuest.com round trip distances between MSU and the opponent city were used for mileage. For trips where busses and airlines were used, it was assumed that each bus on the trip traveled 150 miles. Number of busses were based on number of participants (provided by MSU Athletic Department) and bus capacity of 49 passengers.

Solid Waste – This captures the total indirect GHG emissions resulting from the incineration or decomposition of MSU's solid waste.

Offsets – MSU does not currently purchase any offsets for their GHG emissions.

Report Omissions

Various inputs were omitted from this report due to a lack of data availability. MSU acknowledges these omissions impact the accuracy of this report, and are working to collect these data for future reports. The future inclusion of these inputs may or may not significantly change MSU's GHG footprint.

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[1] The ACUPCC Instructions for Submitting a Greenhouse Gas Report states that 'for guidance on calculating air travel emissions, you may consult "Guidance on Scope 3 Emissions, pt 2: Air Travel" on the AASHE Blog. The AASHE Blog states that you can use statistics on the average price per passenger air mile from the Air Transportation Association of America to convert the total air travel expenditure into passenger air miles. Since the figures from the ATA exclude taxes, AASHE recommends adjusting the cost per passenger mile up by 20 percent to take taxes into account. The ATA data indicates that the nominal domestic yield in dollars per passenger mile was $0.1384 in 2008. Adjusting this cost up by 20 percent per AASHE recommendations results in a cost of $0.16608 per passenger mile.

Paper – MSU data not available.

Wastewater – MSU data not available.

Recommended Inventory Improvements

Through the process of collecting, compiling, and reporting the 2009 GHG Inventory, gaps in current data collection processes were identified. The most critical improvements need to be addressed in accurate data collection for air travel miles and commute transportation patterns.

It is recommended that for future commute transportation surveys, MSU consider alternative methods that will reach more respondents. It is also recommended that the question "How many miles do you live from campus?" be rephrased "How many miles is your daily commute?" It was found that some faculty not on campus responded with 100's of miles from campus (probably not their daily commute) which could skew averages if outliers had not been omitted. This change would more accurately capture what the emissions impact from daily commuting is for MSU employees and students.

The commuter survey did not account for commuting via light rail or commuter rail. If and when this becomes an option for campus commuters, it should be added to the response options.

For future accurate reporting, MSU should establish protocol for tracking air miles for faculty and staff travel, for-credit study abroad, and athletics. The most accurate reporting would come from direct collection of passenger miles (ground or air) rather than dollar amounts. In the current athletics tracking system, some recommended improvements would include miles driven on each bus and rental car. From the data provided, it is difficult to accurately convert dollars spent to miles driven. As MSU refines their data collection methods, future GHG Inventories will represent more accurate Scope 3 emissions.

Potential GHG Reduction Strategies

The first step in determining potential GHG reduction strategies is to understand the various emission sources that make up a university's GHG Inventory. Looking at the summary of MSU emissions by scope reveals that electricity use and Scope 3 transportation make up the most significant contribution to MSU's footprint. Strategic approach to reduction of these key areas will have the most dramatic reduction potential for the university.

Scopes 1 & 2 Reduction

The majority of Scope 1 & Scope 2 emissions come from on campus stationary sources and purchased electricity. These emissions are a direct result of energy use at the facilities on campus. In order to reduce these emissions a number of steps can be taken. The first step is to look into the behavior of the students, faculty, and staff. Are lights being left on? Are thermostats turned up in the winter? The next step would be to conduct a comprehensive facility audit. This audit would allow MSU to evaluate any potential Facility Improvement Measures (FIMs) that would save energy, reduce energy cost, and reduce the emissions inventory.

After all FIMs are analyzed, an implementation strategy would be put into place that would help MSU prioritize the FIMs based on areas such as carbon reduction, first cost, payback, capital / maintenance need, etc. Once an implementation plan is put in place for the FIMs, the university would then look at renewables as a method to further reduce its Scope 1 and Scope 2 emissions. This would include evaluating technologies such as solar, wind, and biomass. These technologies are still fairly expensive and would likely only make sense on a large scale after all FIMs are pursued. Finally, MSU could look into carbon offsets for the remainder of the emissions.

Scope 3 Reduction

Reducing Scope 3 emissions will require that MSU adopt additional policies and programs to incentivize options that will reduce emissions. Since MSU's Scope 3 emissions are impacted most heavily by air travel and campus commuting, programs focused on education and increasing viability of alternative options will have the greatest impact on Scope 3 of the campus footprint. Waste reduction would also have an impact and should be considered in a more comprehensive action plan.

Commuter Reductions – To further reduce emissions from commuters, it is recommended that MSU expand on current programs, as well as implement new ones. It is important to the MSU continue promoting any benefits it is already offering to faculty, staff and students. Increasing awareness about these programs has dramatic potential to boost participation. Additional strategies for further reducing commuter emissions include:

- Offer more online courses
- Increase parking fees
- Subsidized public transportation passes
- Carpool priority parking
- Restrict student cars and/or parking to upper classmen
- Installation of more bike racks and bike paths
- Subsidize on-campus housing to minimize off-campus living
- Education to campus about carbon footprint goals and the impact of individual commute choices
- Convert parking lots to green space

Air Travel Reductions – Air travel reductions are challenging because many programs are viewed as beneficial and valuable as part of the college experience. Student air travel is calculated from air miles from for-credit study abroad programs and athletics. To reduce air miles for study abroad activities, the university could look at having students purchase offsets for their trips or encourage destinations nearer to Seattle. The athletics department should look at the possibility of driving to more local athletic events rather than flying. Air travel from faculty and staff could be reduced by cutting air travel budgets, and encouraging them to select only the most important events to attend.

As a signatory to the ACUPCC, the next step for MSU is to create a Climate Action Plan. This plan will take a closer look at these and other strategies to reduce MSU's carbon footprint.

Conclusion

This report captures the 2009 GHG Inventory for MSU based upon the most accurate campus data available. As signatories to the ACUPCC, MSU is striving to benchmark their greenhouse gas emissions and begin the process to achieve carbon neutrality. This benchmark value will help MSU better understand their current emission sources so that they can approach carbon reduction in the most strategic manner possible. As MSU works towards carbon neutrality, their development of a climate action plan will need to address both campus emissions concerns from both an operations and cultural standpoint to truly achieve the results they are seeking.

APPENDIX

SECTION 1: EMISSION FACTORS AND CARBON RISK

Understanding the potential range of emission values important for MSU when they analyze their footprint, and when comparing it to other universities across the nation. MSU and McKinstry opted to use the most commonly accepted option, the NREC eGRID sub-regional mix published by the United State Environmental Protection Agency (EPA). The ACUPCC recommended Clean Air Cool Planet Campus Carbon Calculator (used in this GHG inventory), and automatically defaults to this sub-regional value. Institutions do have the option of entering "custom" local mixes, but these values may not be widely accepted for comparison to other reporting institutions.

While this value does represent the current regional average, these regions have been known to change. The NERC regions substantially changed between 2002 and 2006, consequently altering the eGRID sub-regions to order to reflect these changes. Below are two maps that reflect these changes. The first map shows the pre-2006 eGRID regions; the second shows the current eGRID regions. It is important to note that this change resulted in larger electricity emission factor in 2006, and that anyone using the eGRID numbers would show a corresponding increase in their carbon footprint.

Another reasonable option for selecting an electricity emissions factor would be to use the national average. This number would be higher than the regional number and the number based on the local fuel mix. It is speculated by many people in the industry that the national average emissions factor could become the standard used in all carbon calculations if the United States goes to a Cap and Trade system or a Carbon Tax. By adopting a national average for calculation of MSU's GHG Inventory, it is likely to increase with the addition of more carbon intensive energy sources (such as coal) from the East Coast.

Many universities are currently reporting on only minimal data, and using local "custom" fuel mixes showing potentially inflated values for low-carbon source electricity. As more rigid requirements for standard reporting are developed, these universities footprints are likely to increase more significantly than MSU's due to MSU's comprehensive reporting methodology presented in this report.

MSU Custom Mix Analysis

When MSU compared their GHG inventory calculated using the recommended eGRID sub regions verses the university "custom" mix, the result showed a very minor difference. The custom mix of electricity that the university purchases is made up of very similar components represented by the eGRID sub region. In this situation, either mix would have provided a similar emissions total from the university, but it is recommended that they continue to report with emissions based on eGRID for consistency.

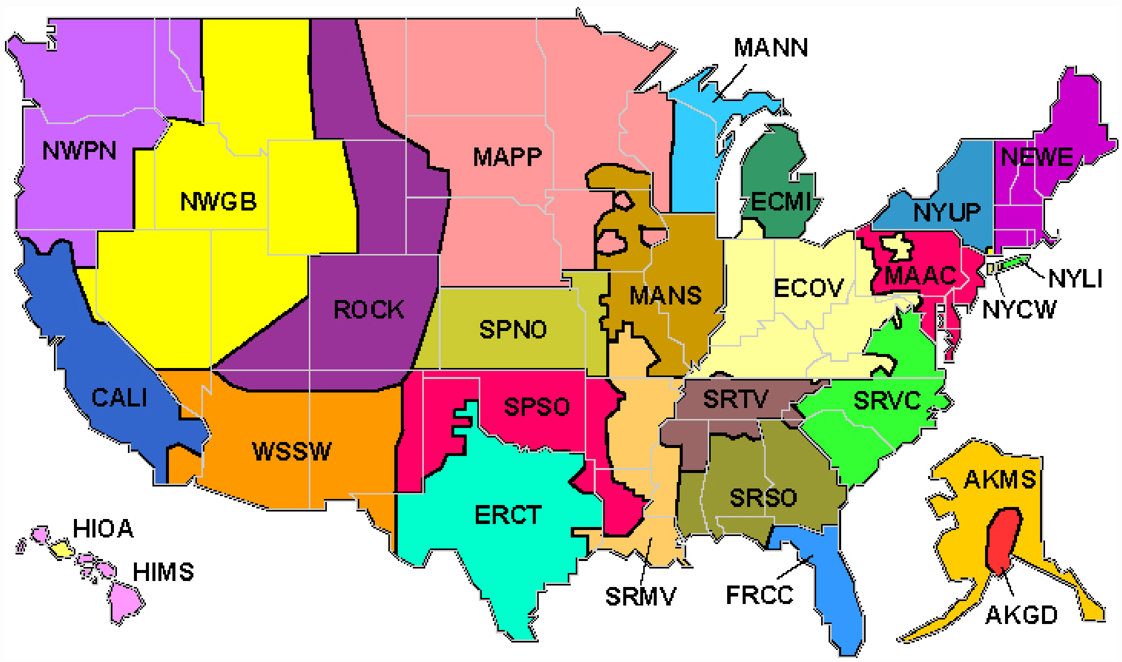
The difference in emissions from purchased electricity (Scope 2) was only 1,082.3 CO_2e.

MSU emissions with eGRID factors - Scope 2: 20,563.5 MT CO_2e (77,375.2 total)

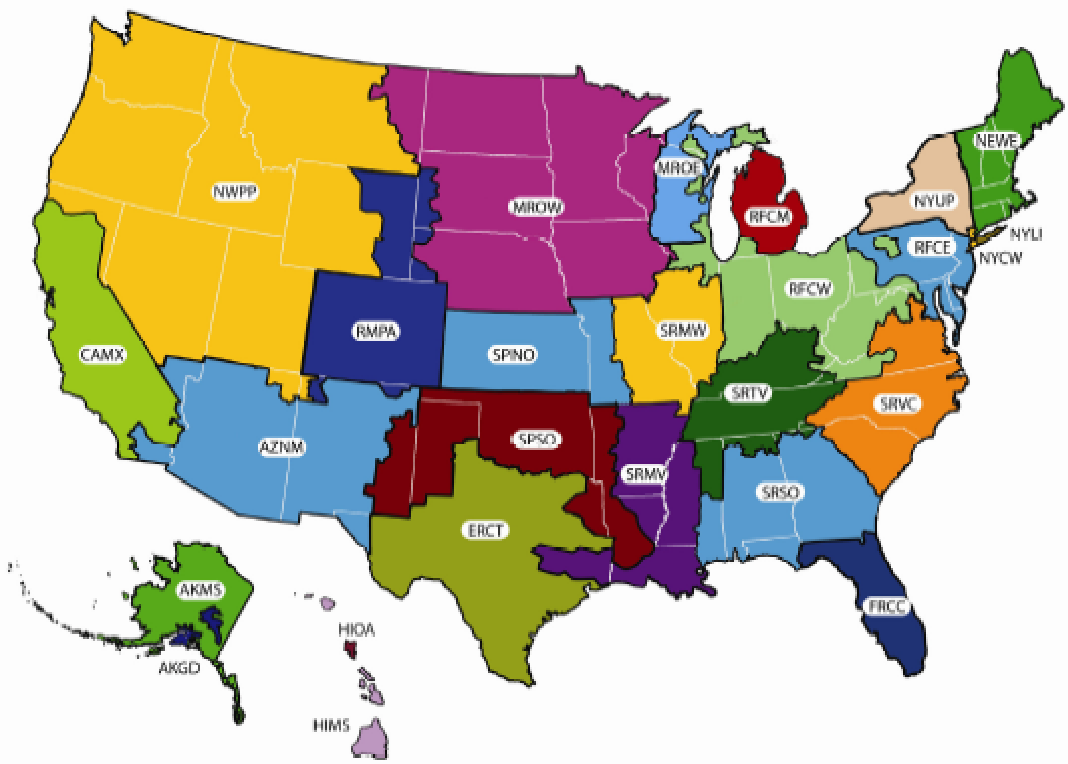
MSU emissions with custom mix – Scope 2: 21,548.4 MT CO_2e (78,457.5 total)

The following maps show the history of eGRID regional emissions areas changes between 2002 and 2006, illustrating an example of how redefining sub-region boundaries can influence fuel emission factors.

eGRID 2002 Regional Map



eGRID 2006 Regional Map



Comparison: MSU Local Mix Calculation

On this worksheet: Summary information from an inventoried year.

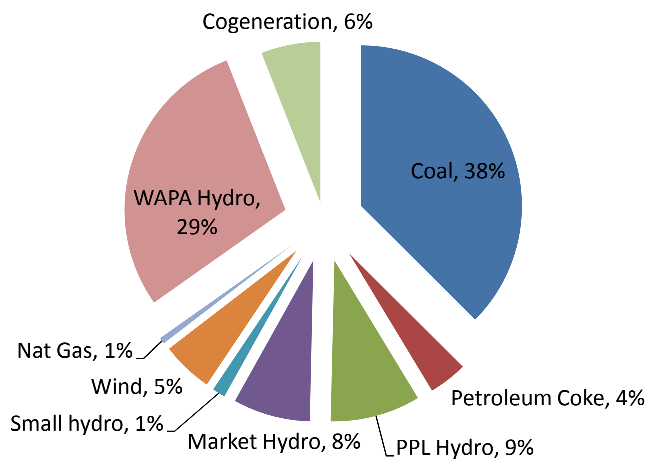
MODULE	**Summary**
WORKSHEET	**Overview of Annual Emissions**
UNIVERSITY	**Montana State University**

Select Year -->	**2009**	**Energy Consumption**	**CO_2**	**CH_4**	**N_2O**	**eCO_2**
		MMBtu	kg	kg	kg	Metric Tonnes
Scope 1	Co-gen Electricity	-	-	-	-	-
	Co-gen Steam	-	-	-	-	-
	Other On-Campus Stationary	398,684.1	21,038,005.7	2,105.8	42.3	21,099.0
	Direct Transportation	8,863.8	625,539.3	106.6	37.5	639.1
	Refrigerants & Chemicals	-	-	-	-	1,585.3
	Agriculture	-	-	-	309.7	91.7
Scope 2	Purchased Electricity	505,416.3	21,436,253.4	244.0	359.8	21,548.4
	Purchased Steam / Chilled Water	-	-	-	-	-
Scope 3	Faculty / Staff Commuting	51,924.5	3,642,451.6	721.8	248.7	3,732.7
	Student Commuting	56,640.7	3,974,894.2	780.3	269.2	4,072.5
	Directly Financed Air Travel	62,602.4	12,291,201.6	121.0	139.1	12,335.2
	Other Directly Financed Travel	33,431.8	2,344,459.9	468.0	161.1	2,402.9
	Study Abroad Air Travel	33,942.0	6,664,081.2	65.6	75.4	6,687.9
	Solid Waste	-	-	92,682.9	-	2,131.7
	Wastewater	-	-	-	-	-
	Paper	-	-	-	-	-
	Scope 2 T&D Losses	49,986.2	2,120,069.0	24.1	35.6	2,131.2
Offsets	Additional					-
	Non-Additional					-
Totals	Scope 1	407,547.9	21,663,545.0	2,212.4	389.5	23,415.0
	Scope 2	505,416.3	21,436,253.4	244.0	359.8	21,548.4
	Scope 3	288,527.6	31,037,157.5	94,863.7	929.2	33,494.1
	All Scopes	1,201,491.8	74,136,956.0	97,320.1	1,678.5	78,457.5
	All Offsets					-
					Net Emissions:	**78,457.5**

MSU Local Electricity Mix

So - Where Does MSU's Electricity Come from?

Based on 2008 Northwestern Energy Portfolio, MSU Self-generation, and MSU procured Hydro contract
Information provided by MSU Facilities Services



MSU's Electric Portfolio (Combined NWE,WAPA, and CoGen)	% MSU Portfolio	% NWEn Portfolio
NW Energy	**65%**	100%
Coal	38%	58%
Petroleum Coke	4%	6%
PPL Hydro	9%	14%
Market Hydro	8%	12%
Small hydro	1%	2%
Wind	5%	8%
Nat Gas	1%	1%
WAPA Hydro	**29%**	
Cogeneration	**6%**	

CACP Inputs

coal and petroleum coke	42%	44%
hydro	47%	50%
natural gas	1%	1%
wind	5%	6%
cogen accounted for in scope 1		

multiple hydro sources combined in CACP
coal and petroum coke combined in CACP (same emissions factor)
cogeneration was already accounted for and therefore omitted

provided by MSU

Northwestern Energy
2008 Montana Electric & Gas CO2 Emissions Estimate

Electric Business

Assumptions

1. Electric market and PPL contract purchases are allocated according to an estimated Montana resource mix of 60% coal / 40% hydro.
2. Total resource procurement includes transmission losses.

	2008 MWh	*% of Portfolio*
2008 Retail Sales	5,969,702	
2008 Required Procurement to Serve Load	6,522,929	
Resources by Type		
Coal		
Colstrip 4	943,910	*14%*
QF Coal	293,305	*4%*
PPL Contract 60%	1,365,840	*21%*
Market 60%	1,164,938	*18%*
	3,767,993	*58%*
Petroleum Coke		
QF BGI	405,625	*6%*
Natural Gas		
Basin Creek	45,845	*1%*
Non-Emitting		
PPL Contract 40%	910,560	*14%*
QF Wind	8,987	*0%*
QF Hydro	60,871	*1%*
Tiber Hydro	43,901	*1%*
Judith Gap Wind Farm	502,522	*8%*
Market 40%	776,625	*12%*
	2,303,466	*35%*
Total Resource Procurement Including Losses	**6,522,929**	***100%***

Metric Tons CO_2 Emissions / MWh	Metric Tons CO_2 / MWh	
Coal	1.13	4,272,101
Petroleum Coke	1.13	459,892
Natural Gas	0.40	18,338
Total Metric Tons CO_2 Emissions		**4,750,331**

Gas Business

	2008
Lbs CO_2 / Dkt	117
2008 Montana Retail Sales (Dkt)	20,495,762
Total Metric Tons CO_2 Emissions	**1,087,530**
Emissions as % of Total Retail Sales	**5%**

Following calculations by MSU Facilities Services:

LB CO2/KWH CALCULATION USING RETAIL SALES MWH

2204.62262	lb/metric ton	x		4,750,331	metric tons	=	10472687110	lbs co2	
10472687110	lbs co2	/	(	5,969,702	Net MWH	x	1000	kwh/mwh	)
						=	**1.754**	**lbCO2/KWH**	

LB CO2/KWH CALCULATION USING PROCUREMENT TO SERVE LOAD (MWH)

2204.62262	lb/metric ton	x		4,750,331	metric tons	=	10472687110	lbs co2	
10472687110	lbs co2	/	(	6,522,929	Net MWH	x	1000	kwh/mwh	)
						=	**1.606**	**lbCO2/KWH**	

SECTION 2: MSU GHG ASSUMPTIONS AND CALCULATIONS

General Assumptions:

All inputs were entered in the Clean Air Cool Planet Campus Carbon Calculator v6.4.
It was assumed that MSU provided complete and accurate data capturing all travel for the Bozeman campus activities.
Data provided was accurate for the 2008-2009 academic year.

SCOPE 1:

1. Data provided by MSU for on campus stationary.
2. Campus directly financed transportation fuel values were proved for fuel purchased on fuel cards and at the MSU fuel island. It was confirmed with the accounting department that these values were not double counted with other travel in Scope 3.
3. Values for refrigerant used were provided by MSU. For GWP values not found in the CACP calculator, "other" was specified and GWP from MSDS sheets for those refrigerants were used.

SCOPE 2:

1. Data provided by MSU for purchases electricity was based on utility data for the Bozeman campus between July 2008 and June 2009.
2. Default CACP emissions values (eGRID sub region NWPP WECC Northwest) were used for calculating emissions.

SCOPE 3:

Data feeding inputs for Scope 3 Directly Financed Travel were provided by the MSU Accounting Department. Totals from MSU records provided in the Travel Info Provided to McKinstry 2-20-2010.exl document were used to calculate input miles based on the following assumptions. A summary of final inputs can be found in the *MSU GHG Travel Inputs.xls*. A copy is located in the appendix.

Air Travel:

Faculty/Staff/Athletics Air Passenger Miles

1. Air miles were based on total cost – provided by accounting department at MSU
2. Converted to miles based on $0.16608 per mile (ATA recommendation)

Study abroad Air Miles

1. Miles estimated based on averages per student population from other ACUPCC reporting institutions
2. Study abroad air miles based on MSU full-time student population only
3. Likely to change as MSU develops better tracking systems for their students

Directly Financed Ground Transportation:

General Ground Transportation

1. Based on total cost – provided by accounting department at MSU
2. Assumed that bus travel only occurred in athletics dept records, all other ground transportation was taxi service
3. All athletics costs were captured on both Athletics department records and Accounting records
4. Subtracted off total bus (MSU athletics) costs from total ground transportation (provided by MSU accounting) to obtain total non-bus travel costs
5. All non-bus travel costs were converted to miles based on the following assumptions:

a. 40% of ground transportation costs were fuel
b. Fuel costs $2.50 per gallon
c. Average fuel efficiency 22 mpg

Bus Transportation (from Athletics only)

1. Bus travel miles were estimated through the following assumptions:
    a. Distances were estimated based on provided between cities specified by MSU athletics department records entered into Mapquest.com
    b. Bus capacity 49 passengers, # of busses on each trip based on size of team (provided by athletics department)
    c. Athletic trips with air travel as primary source of travel assumed 150 miles per bus on the trip

Personal Mileage Reimbursement

1. Based on total cost provided by MSU accounting department records
2. Based on high (no motor pool available) and low (motor pool available and opted for personal use) standard mileage reimbursement rates as follows:
    a. 2008 mileage rates
        i. high = $0.585 per mile
        ii. low = $0.265 per mile
    b. 2009 mileage rates
        i. high = $0.55 per mile
        ii. low = $0.28 per mile
3. Assumed 50% of personal mileage reimbursement at each high and low level, working out to an average of $0.42 per mile
4. Assumed personal mileage reimbursements had even distribution throughout 2008-2009 fiscal year at MSU

Motor Pool

1. Motor pool total expenditures captured both fuel and rental costs
2. 40% of motor pool costs were fuel
3. Fuel costs $2.50 per gallon
4. Average fuel efficiency 22 mpg

"Other" Data

1. "Other" data was available on costs associated with travel through the MSU Accounting department files. These expenditures accounted for various travel expenses including but not limited to: meals, lodging, ground transportation, registration fees, car rentals, fuel, airfare, mileage and miscellaneous expenses. Due to the ambiguity of the expenses in this category, all "other" expenditures were omitted from any calculations for the 2009 GHG inventory.

Commuting:

1. Student, staff and faculty commute data was collected by MSU in a survey.
2. It was assumed that this survey accurately captures the average commute habits of the Bozeman campus population.
3. Commute data does not account for student travel beyond their daily commute. All personal travel while at MSU and to and from their permanent address are not within the scope of the MSU GHG footprint.

SECTION 3: MSU SUPPORTING DATA

The following pages contain background data provided by MSU for the compilation of their 2009 GHG Inventory.

1. 2008-2009 UTILITIES
2. REFRIGERANT USAGE
3. REFRIGERANT GWP DATA – R414B HOT SHOT
4. REFRIGERANT GWP DATA – R-502
5. MSU PROVIDED TRAVEL INFORMATION
6. TRAVEL INPUTS
7. COMMUTE SURVEY SUMMARY
8. FUEL USE SUMMARY

ELECTRICITY RECONCILIATION BY VENDOR

QRY: GGIEGROSS

GROSS PURCHASED ELECTRICITY	Month	Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Total
Purchased Units (no cogen)	KW Units	8,170	8,165	8,723	8,934	8,529	8,310	7,999	8,147	8,172	8,706	8,215	8,131	100,201
Purchased Units (no cogen)	KWH Units	4,346,153	4,258,003	4,426,655	4,669,994	4,411,055	4,570,559	4,494,153	4,287,124	4,555,619	4,523,891	4,144,651	3,962,902	52,650,759
$$ paid to WAPA & NWE	KW$	$58,742	$58,686	$61,144	$62,009	$65,733	$63,528	$60,741	$63,577	$64,172	$68,062	$57,497	$57,206	$741,099
$$ paid to WAPA & NWE	KWH$$	$193,719	$216,921	$241,501	$214,267	$176,816	$171,130	$169,528	$165,017	$178,908	$181,544	$189,347	$188,658	$2,287,355
$$ paid to WAPA & NWE	Total $$	$252,461	$275,607	$302,645	$276,276	$242,549	$234,658	$230,270	$228,594	$243,080	$249,606	$246,844	$245,865	$3,028,454

ELEC09etc & ELEC10etc.xlsx & QRY: GGICOGEN

SOUTH SIDE SUBSTATION		Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Total	
Portion of SSS supplied by NWE (per NWE)	KW Units	5,560	5,568	5,896	6,078	4,860	4,569	4,269	4,452	4,477	5,041	5,607	5,605	61,982	
Portion of SSS supplied by WAPA (per NWE)	KW Units	2,022	2,027	2,113	2,113	3,072	2,987	3,021	2,942	3,001	3,072	1,942	1,912	30,224	**33%**
Total KW Units	**KW Units**	**7,582**	**7,595**	**8,009**	**8,191**	**7,932**	**7,556**	**7,290**	**7,394**	**7,478**	**8,113**	**7,549**	**7,517**	**92,206**	
Portion of SSS supplied by NWE (per NWE)	KWH Units	2,276,164	2,727,504	3,443,461	3,034,761	2,326,816	2,208,840	2,113,392	2,030,130	2,284,153	2,423,488	2,833,278	2,721,767	30,423,754	
Portion of SSS supplied by WAPA (per NWE)	KWH Units	1,733,728	1,243,429	581,095	1,123,961	1,541,623	1,567,428	1,635,286	1,629,552	1,634,330	1,554,048	976,775	915,307	16,136,562	**35%**
Total KWH Units	**KWH Units**	**4,009,892**	**3,970,933**	**4,024,556**	**4,158,722**	**3,868,439**	**3,776,268**	**3,748,678**	**3,659,682**	**3,918,483**	**3,977,536**	**3,810,053**	**3,637,074**	**46,560,316**	
NWE Charges to supply & deliver NWE elec	KW$	$30,939	$30,983	$32,808	$33,821	$27,044	$25,424	$23,039	$23,597	$23,731	$26,719	$29,720	$29,709	$337,534	
NWE Charges to deliver WAPA Elec	KW$	$11,251	$11,279	$11,757	$11,757	$17,094	$16,621	$16,304	$15,593	$15,907	$16,283	$10,294	$10,135	$164,275	
WAPA Charges	KW$	$11,424	$11,453	$11,938	$11,938	$17,357	$16,877	$17,069	$20,006	$20,407	$20,890	$13,206	$13,002	$185,565	
Total KW$$	**KW$**	**$53,614**	**$53,715**	**$56,503**	**$57,516**	**$61,495**	**$58,922**	**$56,412**	**$59,196**	**$60,045**	**$63,892**	**$53,220**	**$52,846**	**$687,374**	
NWE Charges to supply & deliver NWE elec	KWH$	$147,140	$176,457	$206,347	$175,942	$131,865	$123,568	$122,213	$116,791	$129,687	$133,112	$154,487	$154,068	$1,771,677	
NWE Charges to deliver WAPA Elec	KWH$	$7,068	$5,069	$2,369	$4,582	$6,285	$6,390	$6,667	$6,644	$6,663	$6,336	$3,982	$3,732	$65,789	
WAPA Charges	KWH$	$12,606	$12,496	$12,654	$13,041	$18,583	$19,210	$18,871	$21,865	$23,409	$22,685	$14,048	$13,330	$202,798	
Total KWH$$	**KWH$**	**$166,814**	**$194,022**	**$221,370**	**$193,566**	**$156,733**	**$149,169**	**$147,751**	**$145,300**	**$159,759**	**$162,133**	**$172,518**	**$171,129**	**$2,040,264**	
NWE Charges to supply & deliver NWE elec	**Total SSS $**	**$178,079**	**$207,440**	**$239,155**	**$209,763**	**$158,909**	**$148,992**	**$145,252**	**$140,388**	**$153,418**	**$159,831**	**$184,207**	**$183,777**	**$2,109,211**	
NWE Charges to deliver WAPA Elec	**Total SSS $**	**$18,319**	**$16,348**	**$14,126**	**$16,339**	**$23,379**	**$23,011**	**$22,971**	**$22,237**	**$22,570**	**$22,619**	**$14,276**	**$13,867**	**$230,064**	
WAPA Charges	**Total SSS $**	**$24,030**	**$23,948**	**$24,592**	**$24,980**	**$35,940**	**$36,087**	**$35,940**	**$41,871**	**$43,816**	**$43,574**	**$27,254**	**$26,331**	**$388,363**	
Total $$	**Total SSS $**	**$220,428**	**$247,737**	**$277,873**	**$251,082**	**$218,228**	**$208,090**	**$204,163**	**$204,496**	**$219,804**	**$226,025**	**$225,737**	**$223,975**	**$2,727,638**	

TOTAL ELECTRICITY		Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Total	
Elec supplied by NWE (per NWE)	KW Units	6,148	6,138	6,428	6,593	5,346	5,101	4,783	4,979	4,974	5,543	6,122	6,130	68,285	68%
Elec supplied by WAPA (per NWE)	KW Units	2,022	2,027	2,113	2,113	3,072	2,987	3,021	2,942	3,001	3,072	1,942	1,912	30,224	30%
Elec supplied by Cogen	KW Units	-	-	182	228	111	222	195	226	197	91	151	89	1,692	2%
Total	**KW Units**	**8,170**	**8,165**	**8,723**	**8,934**	**8,529**	**8,310**	**7,999**	**8,147**	**8,172**	**8,706**	**8,215**	**8,131**	**100,201**	100%
Elec supplied by NWE (per NWE)	KWH Units	2,612,425	3,014,574	3,706,882	3,312,801	2,597,613	2,506,363	2,406,743	2,295,829	2,544,110	2,696,661	3,067,162	2,964,115	33,725,278	64%
Elec supplied by WAPA (per NWE)	KWH Units	1,733,728	1,243,429	581,095	1,123,961	1,541,623	1,567,428	1,635,286	1,629,552	1,634,330	1,554,048	976,775	915,307	16,136,562	31%
Elec supplied by Cogen	KWH Units	-	-	138,678	233,232	271,819	496,768	452,124	361,743	377,179	273,182	100,714	83,480	2,788,919	5%
Total	**KWH Units**	**4,346,153**	**4,258,003**	**4,426,655**	**4,669,994**	**4,411,055**	**4,570,559**	**4,494,153**	**4,287,124**	**4,555,619**	**4,523,891**	**4,144,651**	**3,962,902**	**52,650,759**	100%
NWE Charges to supply & deliver NWE elec	KW$	$36,067	$35,954	$37,449	$38,313	$31,282	$30,031	$27,369	$27,978	$27,859	$30,890	$33,997	$34,070	$391,259	53%
NWE Charges to deliver WAPA Elec	KW$	$11,251	$11,279	$11,757	$11,757	$17,094	$16,621	$16,304	$15,593	$15,907	$16,283	$10,294	$10,135	$164,275	
WAPA Charges	KW$	$11,424	$11,453	$11,938	$11,938	$17,357	$16,877	$17,069	$20,006	$20,407	$20,890	$13,206	$13,002	$185,565	47%
Total $	**KW$**	**$58,742**	**$58,686**	**$61,144**	**$62,009**	**$65,733**	**$63,528**	**$60,741**	**$63,577**	**$64,172**	**$68,062**	**$57,497**	**$57,206**	**$741,099**	100%
NWE Charges to supply & deliver NWE elec	KWH$	$174,045	$199,356	$226,478	$196,643	$151,948	$145,529	$143,990	$136,508	$148,836	$152,523	$171,316	$171,597	$2,018,769	88%
NWE Charges to deliver WAPA Elec	KWH$	$7,068	$5,069	$2,369	$4,582	$6,285	$6,390	$6,667	$6,644	$6,663	$6,336	$3,982	$3,732	$65,789	
WAPA Charges	KWH$	$12,606	$12,496	$12,654	$13,041	$18,583	$19,210	$18,871	$21,865	$23,409	$22,685	$14,048	$13,330	$202,798	12%
Total $	**KWH$**	**$193,719**	**$216,921**	**$241,501**	**$214,267**	**$176,816**	**$171,130**	**$169,528**	**$165,017**	**$178,908**	**$181,544**	**$189,347**	**$188,658**	**$2,287,355**	100%
NWE Charges to supply & deliver NWE elec	**Total $**	**$210,112**	**$235,310**	**$263,927**	**$234,957**	**$183,230**	**$175,559**	**$171,359**	**$164,486**	**$176,695**	**$183,413**	**$205,314**	**$205,667**	**$2,410,027**	80%
NWE Charges to deliver WAPA Elec	**Total $**	**$18,319**	**$16,348**	**$14,126**	**$16,339**	**$23,379**	**$23,011**	**$22,971**	**$22,237**	**$22,570**	**$22,619**	**$14,276**	**$13,867**	**$230,064**	
WAPA Charges	**Total $**	**$24,030**	**$23,948**	**$24,592**	**$24,980**	**$35,940**	**$36,087**	**$35,940**	**$41,871**	**$43,816**	**$43,574**	**$27,254**	**$26,331**	**$388,363**	20%
Total $	**Total $**	**$252,461**	**$275,607**	**$302,645**	**$276,276**	**$242,549**	**$234,658**	**$230,270**	**$228,594**	**$243,080**	**$249,606**	**$246,844**	**$245,865**	**$3,028,454**	100%

Electricity Cost for Bldgs Excluded (general bldg tab/exclude)	**$26,440**
Total Included	**$3,002,014**

MSU Refrigerant Usage

TACMO	TACYR	TQTYHR	TITMNO	TDESC	CACP INPUT	GWP
		105.50	PL2555 Total	FREON HOT SHOT R414	none (enter as "other")	1400
		75.00	PL2570 Total	FREON #R404 A	HFC-404a	CACP default
		1,572.00	PL2602 Total	FREON #22	HCFC-22	CACP default
		101.00	PL2603 Total	FREON #R134 A	HFC-134	CACP default
		51.50	PL2606 Total	FREON #502	none (enter as "other")	6200
Grand Total		1,905.00				

** All Quantities reflect pounds used.

Provided by MSU
cutsheets for "other" refrigerants are included in the following pages

TABLE 1 (continued). Physical, safety, and environmental data for refrigerants (sorted by ASHRAE Standard 34 designations).

Refrigerant		Physical data							Safety data					Environmental data		
Number	Chemical formula or blend composition, common name	Molecular mass	NBP (°C)	NBP (°F)	T_c (°C)	T_c (°F)	P_c (MPa)	P_c (psia)	OEL (PPMv)	LFL (%)	HOC (MJ/kg)	HOC (Btu/lb)	ASHRAE 34 safety group	Atmospheric life, τ_{atm} (yr)	ODP	GWP 100 yr
411A	R-1270/22/152a (1.5/87.5/11.0), G2018A	82.36	-39.5	-39.1	99.1	210.4	4.95	718	1000	5.5			A2		0.044	1600
411B	R-1270/22/152a (3.0/94.0/3.0), G2018B	83.07	-41.6	-42.9	96.0	204.8	4.95	718	1000	7.0	6.5	2794	A2		0.047	1700
----	R-1270/22/152a (3.0/95.5/1.5), G2018C	83.44	-41.8	-43.2	95.5	203.9	4.95	718		none					0.048	1700
412A	R-22/218/142b (70.0/5.0/25.0), Arcton TP5R	92.17	-38.0	-36.4	107.2	225.0	4.90	711	1000	8.7			A2		0.053	2300
413A	R-218/134a/600a (9.0/88.0/3.0), Isceon MO49	103.95	-33.4	-28.1	96.6	205.9	4.02	583		8.8			A2		0	2100
414A	R-22/124/600a/142b (51.0/28.5/4.0/16.5), GHG-X4	96.93	-33.0	-27.4	112.7	234.9	4.68	679	1000	none	3.6	1548	A1		0.043	1500
414B	R-22/124/600a/142b (50.0/39.0/1.5/9.5), Hot Shot	101.59	-32.9	-27.2	111.0	231.8	4.59	666		none			A1		0.039	1400
415A	R-22/152a (82.0/18.0)	81.91	-37.2	-35.0	102.0	215.6	4.96	719		5.6	2.7	1161	A2		0.041	1500
415B	R-22/152a (25.0/75.0), THR01b	70.19	-26.9	-16.4	111.4	232.5	4.65	674	1000	wff			A2		0.013	550
416A	R-134a/124/600 (59.0/39.5/1.5), FR-12	111.92	-24.0	-11.2	107.0	224.6	3.98	577		none	7.8	3353	A1		0.008	1100
417A	R-125/134a/600 (46.6/50.0/3.4), Isceon MO59 and NU-22	106.75	-39.1	-38.4	87.3	189.1	4.05	587	1000	none			A1		0	2300
418A	R-290/22/152a (1.5/96.0/2.5), THR03b	84.60	-41.7	-43.1	96.2	205.2	4.98	722		8.9	1.7	731	A2		0.048	1700
419A	R-125/134a/E170 (77.0/19.0/4.0), FX-90	109.34	-42.6	-44.7	79.3	174.7	3.71	538		none	10.0	4299	A2		0	3000
420A	R-134a/142b (88.0/12.0)	101.84	-24.9	-12.8	104.8	220.6	4.09	593	1000	none			A1		0.008	1500
----	R-134a/142b (80.6/19.4), RB-276	101.73	-24.2	-11.6	107.2	225.0	4.10	595		none					0.014	1600
421A	R-125/134a (58.0/42.0)	111.75	-40.7	-41.3	82.9	181.2	3.93	570	1000	none			A1		0	2600
421B	R-125/134a (85.0/15.0)	116.93	-45.6	-50.1	72.5	162.5	3.75	544	1000	none	-0.5	-215	A1		0	3200
422A	R-125/134a/600a (85.1/11.5/3.4), One Shot and Isceon MO79	113.60	-46.5	-51.7	71.8	161.2	3.75	544	1000	none			A1		0	3100
422B	R-125/134a/600a (55.0/42.0/3.0)	108.52	-41.3	-42.3	83.4	182.1	3.97	576	1000	none			A1		0	2500
422C	R-125/134a/600a (82.0/15.0/3.0)	113.40	-45.9	-50.6	73.2	163.8	3.78	548	1000	none	2.6	1118	A1		0	3100
422D	R-125/134a/600a (65.1/31.5/3.4), Isceon MO29	109.93	-43.2	-45.8	79.8	175.6	3.92	569	1000	none			A1		0	2700
423A	R-134a/227ea (52.5/47.5), Isceon 39TC	125.96	-24.1	-11.4	99.5	211.1	3.59	521	1000	none			A1		0	2300
424A	R-125/134a/600a/600/601a (50.5/47.0/0.9/1.0/0.6), RS-44	108.41	-39.7	-39.5	86.3	187.3	4.02	583	1000	none			A1		0	2400
425A	R-32/134a/227ea (18.5/69.5/12.0), THR03a	90.31	-38.1	-36.6	93.9	201.0	4.50	653	1000	none	5.1	2193	A1		0	1500

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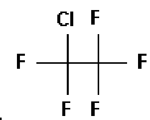

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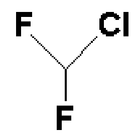

R-502502

Other names and brand names: CFC-502, Freon-502 Genetron-502, Forane-502

Freon is a registered trade name for E. I. DuPont. Genetron is a registered trade name for Allied Signal Corporation. Forane is a registered trade name for Elf Atochem.

General Information

Chemical Formula	CAS Registry #	Color & Odor	Refrigerant Applications
Azeotropic Blend of R-22 and R-115	75-461-6 and 76-15-3	Colorless Pressurized liquid with slight ether like odor	Medium and low temperature refrigeration

Physical Data

Molecular Mass	Boiling Point C°	Boiling Point F°	Critical Temperature C°	Critical Temperature F°	Critical Pressure MPa	Critical Pressure psia
111.63	-45.3	-49.5	80.7	177.3	4.02	583

Toxicity & Global Warming Data

TLV-TWA	Years of Atmospheric Lifetime	Ozone Depletion Potential	Global Warming Potential
1,000		0.221	6200

Packaging Information

Packaged in	Volumes available in pounds	Color of Container
Pressurized cylinders	30, 50, 125, 875, 1,750	Light purple (lavender)

Shipping Information

MSU Bozeman and agencies travel expenses not including **identifiable** lodging, meals, and non pertinent expenses like registrations, parking fees, etc.

CACP grouping	McKinstrey	Sum of Amount	
Athletics	Air Travel	741,964.00	
	Fuel	24,363.54	
	Ground Transport	19,836.28	
	Mileage Reimbursement	18.00	
	Motorpool	2,403.79	*Includes charge for vehicle and fuel*
	Other	399,412.17	*Includes reimb for any expenses related to travel that were not paid directly to a vendor (meals, lodging, ground transportation, registration fees, car rentals, fuel, airfare, mileage and miscellaneous could be included)*
Athletics Total		**1,187,997.78**	
Other	Air Travel	1,896,871.13	
	Fuel	226,362.21	
	Ground Transport	76,795.13	
	Mileage Reimbursement	453,347.50	
	Motorpool	208,705.31	*Includes charge for vehicle and fuel*
	Other	2,511,167.43	*Includes reimb for any expenses related to travel that were not paid directly to a vendor (meals, lodging, ground transportation, registration fees, car rentals, fuel, airfare, mileage and miscellaneous could be included)*
Other Total		**5,373,248.71**	
Grand Total		**6,561,246.49**	

Mileage Reimbursement Rates 1st half of FY 2009 high rate $0.585, low $0.28; 2nd half high $0.55, low $0.265

average = 0.42

Source: MSU, Jeana Henley

File Name: *Travel Info provided to McKinstry 2-20-2010*

MSU Travel Inputs for CACP, 2009 Footprint

file: MSU GHG Travel Inputs.xls

Miles

		Staff Air Travel	Student (Athletics) Air Travel	Taxi/Ferry/Rental Car	Bus	Personal Reimbursement
CACP TOTAL	INPUT	**11,421,430**	**4,467,510**	**4,855,041**	**25,739**	**1,079,442**
Athletics 09 Workbook					25,739	
Total Travel TRND (PC air out) Athletics	airfare		4,467,510			
	fuel			2,119,950		
	ground transportation			X		
	mileage					43
	Motor Pool			8,461		
	rental car					
Total Travel TRND (PC air out) Research	airfare	11,421,430				
	fuel			1,991,987		
	ground transportation			X		
	mileage					1,079,399
	Motor Pool			734,643		
	rental car					
	combined ground transport - busses			111,138		

Dollars - totals pulled by MSU accounting dept on Travel info for McKinstry 2-20-2010

		Staff Air Travel	Student (Athletics)	Taxi/Ferry/Rental	Bus	Personal
Total Travel Athletics	airfare		$741,964			
	fuel			$240,903		
	ground transportation			$19,836		
	mileage					$18
	Motor Pool			$2,404		
	rental car					
Total Travel Other	airfare	$1,896,871				
	fuel			$226,362		
	ground transportation			$76,795		
	mileage					$453,348
	Motor Pool			$208,705		
	rental car					

MSU Commute Survey Results and CACP Inputs

	CACP Input	Final Value for 2009	Units	Sourced from Survey	Calculations
student car	# students	10,930.0	#	from CACP *MSU Quick Facts 2008-2009	
	% personal vehicle	37.0	%	from student filter of results	fall/spring/winter average
	% carpool	7.0	%	from student filter of results	fall/spring/winter average
	trips/week	10.0	#	assumed	5 day class week
	weeks/year	30.0	#	assumed	15 week semesters (2 semesters/year)
	miles/trip	7.4	miles	from Student SOV Commute Distance filter	average of 95 off campus SOV primary students
student bus	% bus	3.8	%	from student filter of results	fall/spring/winter average
	trips/week	10.0	#	assumed	5 day class week
	weeks/year	30.0	weeks	assumed	15 week semesters (2 semesters/year)
	miles/trip	3.3	miles	student bus filter	average of student bus riders in school year
faculty car	# faculty	898.6	#	MSU Quick Facts 2008-2009	
	% personal vehicle	51.6	%	faculty filter	total year average
	% carpool	8.3	%	faculty filter	total year average
	trips/week	10.0	#	assumed	5 day work week
	weeks/year	46.0	weeks	assumed	based on accural of 14 hours per month and 11 holidays
	miles/trip	18.3	miles	faculty SOV filter, question 2 responses	average of 97 responses
faculty bus	% bus	1.7	%	faculty filter	total year average
	trips/week	10.0	#	assumed	5 day work week
	weeks/year	46.0	weeks		based on accural of 14 hours per month and 11 holidays
	miles/trip	2.6	miles	faculty bus filter	average distance to campus with bus as primary
staff car	# staff	1,781.2	#	MSU Quick Facts 2008-2009	
	% personal vehicle	59.3	%	staff commute filter	total year average
	% carpool	10.2	%	staff commute filter	total year average
	trips/week	10.0	#	assumed	5 day work week
	weeks/year	47.0	weeks	assumed	baesd on accural of 10 hours per month and 11 holidays
	miles/trip	9.1	miles	staff SOV filter	average distance to campus with SOV as primary
staff bus	% bus	2.8	%	staff commute filter	total year average
	trips/week	10.0	#	estimate	5 day work week
	weeks/year	47.0	weeks		baesd on accural of 10 hours per month and 11 holidays
	miles/trip	7.3	miles	staff bus distance filter	average distance to campus with bus as primary

FY2009 - 1st pass for Greenhouse Gas Inventory - FUEL

Other Dept owned own Vehicles	**Vendor**	**Gallons Sold**	**Sale Amount**	**Miles**	**Hours**	
Gasoline	Gas Island -Story Distr	17,777.8	$48,116.66	not avail	not avail	Posts to Banner as "Jan Sales OFS Mech Tool" to Account Code 62216 Gasoline
Diesel	Gas Island -Story Distr	678.2	$1,859.75	not avail	not avail	
Total Other Depts		**18,456.0**	**$49,976.41**			
Facilities Vehicles/Equip with Hour Meters						
Gasoline	Gas Island -Story Distr	822.2	$2,724.02	n/a	1,181	Posts to Banner as "Jan Sales OFS Mech Tool" to Account Code 62216 Gasoline
Diesel	Gas Island -Story Distr	4,596.4	$12,675.80	n/a	6,455	
Total		**5,418.6**	**$15,399.82**	**-**	**7,636**	
Facilities Vehicles/Equip with Odometers						
Gasoline	Gas Island -Story Distr	19,442.6	$50,888.42	164,417	n/a	Posts to Banner as "Jan Sales OFS Mech Tool" to Account Code 62216 Gasoline
Diesel	Gas Island -Story Distr	7,639.4	$20,429.13	33,077	n/a	
Total		**27,082.0**	**$71,317.55**	**197,494**	**-**	
Sub-total	**Gas Island -Story Distr**	**50,956.6**	**136,693.8**	**197,494**	**7,636**	
Motor Pool RENTAL VEHICLES						
Gasoline	Gas Island -Story Distr	10,493.3	$29,104.30	223,539	n/a	
Gasoline	Fuel Card	8,497.3	$22,719.08	181,018	n/a	Posts to Banner as "Jan Sales Motor Pool" to Travel Account Code 62405 or 62415 and is bundled with Vehicle Rental Charge
Total Motor Pool		**18,990.6**	**$51,823.38**	**404,557**		
	Gas Island GAS	48,535.9	130,833.40			
	Gas Island DIESEL	12,914.0	34,964.68	165,798		
	Fuel Card GAS	8,497.3	22,719.08			
	Total Sales	**69,947.2**	**188,517.2**			

SECTION 4: CACP EXAMPLE PAGES

MSU GHG Inventory Input Page from CACP

On this Worksheet: Enter data related to emissions. If a column does not apply or the data is unavailable, leave it blank.

MODULE
WORKSHEET
UNIVERSITY Montana State University

Fiscal Year																																		
																						--- Scope 2 Emissions Sourc	--- Scope 3 Emissions Sources ---											
										Direct Transportation Sources					**Refrigerants & Chemicals**						**Agriculture Sources**		**Purchased Electricity, Steam, and Chilled Water**	Commuting - click here to enter data				**Directly Financed Outsourced Travel**					**Study Abroad Travel**	
	Population						Physical Size			University Fleet					Refrigerants & Chemicals						Fertilizer Application		Electricity	Faculty / Staff Commuting		Student Commuting		Air Travel						Landfilled Waste
Fiscal Year	Full Time Students	Part-Time Students	Summer School	Faculty	Staff	Total Building	Natural Gas	LPG (Propane)	Other	Gasoline Fleet	Diesel Fleet	Natural Gas Fleet	Other Fleet	Electric Fleet	HFC-404a	HCFC-22	HFC-134	Other	Other	Other	Synthetic	% Nitrogen	CLICK TO SET eGRID	Automobile	Bus	Automobile	Bus	Faculty / Staff	Students	Taxi / Ferry / Rental Car	Bus	Personal Mileage Reimbursement	Air	No CH4 Recovery
	#	#	#	#	#	Square feet	MMBtu/decatherms	Gallons	MMBtu	Gallons	Gallons	MMBtu	MMBtu	kWh	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	%	kWh	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Short Tons
1990																								-	-	-	-							
1991																								-	-	-	-							
1992																								-	-	-	-							
1993																								-	-	-	-							
1994																								-	-	-	-							
1995																								-	-	-	-							
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2006																								-	-	-	-							
2007																								-	-	-	-							
2008																								-	-	-	-							
2009	9,490	2,879	3,318	899	1,781	4,132,010	398,167	6,000		57,033	12,914				75	1,572	101	52	106		60,000	36.67%	49,861,840	9,124,603	189,376	9,826,713	411,168	11,421,430	4,467,510	4,855,041	25,739	1,079,442	8,614,714	1,966
2010																								-	-	-	-							

note: unused columns have been hidden for purposes of this print-out

values entered for travel can be found in the excel MSU GHG Travel Inputs.xls

On this worksheet: Summary information from an inventoried year.

MODULE	**Summary**
WORKSHEET	**Overview of Annual Emissions**
UNIVERSITY	**Montana State University**

Select Year -->	**2009**	**Energy Consumption**	**CO_2**	**CH_4**	**N_2O**	**eCO_2**
		MMBtu	kg	kg	kg	Metric Tonnes
Scope 1	Co-gen Electricity	-	-	-	-	-
	Co-gen Steam	-	-	-	-	-
	Other On-Campus Stationary	398,684.1	21,038,005.7	2,105.8	42.3	21,099.0
	Direct Transportation	8,863.8	625,539.3	106.6	37.5	639.1
	Refrigerants & Chemicals	-	-	-	-	1,585.3
	Agriculture	-	-	-	309.7	91.7
Scope 2	Purchased Electricity	244,277.3	20,405,917.1	244.3	513.4	20,563.5
	Purchased Steam / Chilled Water	-	-	-	-	-
Scope 3	Faculty / Staff Commuting	51,924.5	3,642,451.6	721.8	248.7	3,732.7
	Student Commuting	56,640.7	3,974,894.2	780.3	269.2	4,072.5
	Directly Financed Air Travel	62,602.4	12,291,201.6	121.0	139.1	12,335.2
	Other Directly Financed Travel	33,431.8	2,344,459.9	468.0	161.1	2,402.9
	Study Abroad Air Travel	33,942.0	6,664,081.2	65.6	75.4	6,687.9
	Solid Waste	-	-	92,682.9	-	2,131.7
	Wastewater	-	-	-	-	-
	Paper	-	-	-	-	-
	Scope 2 T&D Losses	24,159.3	2,018,167.6	24.2	50.8	2,033.8
Offsets	Additional					-
	Non-Additional					-
Totals	Scope 1	407,547.9	21,663,545.0	2,212.4	389.5	23,415.0
	Scope 2	244,277.3	20,405,917.1	244.3	513.4	20,563.5
	Scope 3	262,700.7	30,935,256.2	94,863.7	944.4	33,396.7
	All Scopes	914,525.9	73,004,718.3	97,320.4	1,847.3	77,375.2
	All Offsets					-
					Net Emissions:	**77,375.2**

Appendix 2: Commuter Questionnaire Data

MSU Transportation Survey

What is your status at Montana State University?	Response Percent	Response Count
Full-time Student	**45.6%**	**229**
Part-time Student	5.8%	29
Faculty	19.5%	98
Staff	29.1%	146
	answered question	**502**
	skipped question	**0**

MSU Transportation Survey

Where do you live?			
		Response Percent	Response Count
On Campus		15.3%	77
Off Campus. How many miles do you live from campus?		**84.7%**	**425**
	answered question		**502**
	skipped question		**0**

Off Campus. How many miles do you live from campus?		
1	7	Jan 13, 2010 11:59 PM
2	4	Jan 13, 2010 11:59 PM
3	1	Jan 13, 2010 11:59 PM
4	0.25	Jan 14, 2010 12:00 AM
5	0.5	Jan 14, 2010 12:00 AM
6	6	Jan 14, 2010 12:01 AM
7	6	Jan 14, 2010 12:01 AM
8	10	Jan 14, 2010 12:02 AM
9	3.9	Jan 14, 2010 12:03 AM
10	.5	Jan 14, 2010 12:03 AM
11	210	Jan 14, 2010 12:03 AM
12	1	Jan 14, 2010 12:03 AM
13	6	Jan 14, 2010 12:03 AM
14	.5	Jan 14, 2010 12:04 AM
15	3	Jan 14, 2010 12:05 AM
16	3 miles	Jan 14, 2010 12:05 AM
17	5	Jan 14, 2010 12:05 AM
18	1	Jan 14, 2010 12:05 AM
19	1.5	Jan 14, 2010 12:06 AM
20	3.5	Jan 14, 2010 12:07 AM
21	5	Jan 14, 2010 12:07 AM
22	0.5	Jan 14, 2010 12:08 AM
23	1/2	Jan 14, 2010 12:09 AM
24	3	Jan 14, 2010 12:09 AM
25	2	Jan 14, 2010 12:09 AM
26	2	Jan 14, 2010 12:10 AM
27	12	Jan 14, 2010 12:10 AM
28	1	Jan 14, 2010 12:12 AM
29	8.5	Jan 14, 2010 12:12 AM

MSU Transportation Survey

What is your PRIMARY mode of transportation to campus in the following seasons? (check one per row)								
	Bicycle	Walk	Drive alone	Carpool	Streamline Bus	Other Mode (*specify below*)	N/A (not working/not in class)	Re C
Fall & Spring (Sept – Oct. & March – May)	18.2% (89)	22.9% (112)	**44.7% (219)**	8.2% (40)	2.2% (11)	3.3% (16)	0.6% (3)	
Winter (Nov. – Feb.)	3.5% (17)	27.6% (135)	**51.8% (254)**	9.0% (44)	4.5% (22)	2.0% (10)	1.6% (8)	
Summer (June – Aug.)	24.5% (120)	13.9% (68)	**36.9% (181)**	4.9% (24)	1.2% (6)	3.5% (17)	15.1% (74)	
*Specify "Other Mode", from above (ex. motorcycle, etc.):								
	answered question							
	skipped question							

*Specify "Other Mode", from above (ex. motorcycle, etc.):		
1	Motorcycle - although I'm only 0.25 mi from campus my office is 1 mile from my house (I do not work on campus & make 3-5 trips to campus a week)	Jan 14, 2010 12:03 AM
2	It depends on my schedule and circumstances. Sometimes I walk, many times I ride the bus. On the mornings I teach at 8:10 am, I take my car and park as close as possible to the campus.	Jan 14, 2010 12:07 AM
3	In Fall, Spring and Summer, try to take the bus to, walk home or ride my bike	Jan 14, 2010 12:17 AM
4	plane	Jan 14, 2010 12:18 AM
5	motorcycle	Jan 14, 2010 1:46 AM
6	Commercial air on a packed plane	Jan 14, 2010 1:53 AM
7	Simetimes walk.	Jan 14, 2010 2:51 AM
8	NA	Jan 14, 2010 2:57 AM
9	In the winter I bike, walk, carpool or drive alone depending on the weather	Jan 14, 2010 4:25 AM
10	Scooter	Jan 14, 2010 7:45 AM
11	when the snow melts I bike about half the time; but mostly walk	Jan 14, 2010 1:56 PM
12	carpool 2 days a week the other days drive alone	Jan 14, 2010 2:30 PM
13	I live on campus so this is my transportation around town.	Jan 14, 2010 3:02 PM
14	I walk or drive depending on daylight and weather.	Jan 14, 2010 3:20 PM
15	work off campus-live about 4 miles from work	Jan 14, 2010 3:59 PM
16	motorcycle	Jan 14, 2010 4:58 PM
17	Drive 10 miles and walk the last mile to campus	Jan 14, 2010 7:06 PM
18	motorcycle	Jan 14, 2010 7:35 PM
19	motorcycle	Jan 14, 2010 9:14 PM
20	80% Streamline - 20% drive alone	Jan 14, 2010 10:04 PM

*Specify "Other Mode", from above (ex. motorcycle, etc.):		
21	Skateboard	Jan 15, 2010 4:31 PM
22	Motorcycle	Jan 15, 2010 7:44 PM
23	motorscooter	Jan 15, 2010 9:54 PM
24	this is to my extension office, always carpool to MSU if we must go to campus which is 90 miles, but only go 3 to 4 times per year	Jan 19, 2010 4:03 PM
25	Drive w/my children (drop them at school)	Jan 20, 2010 3:50 PM
26	State Vehicle	Jan 20, 2010 5:55 PM
27	I am doing distance learning during the Spring and Fall	Jan 20, 2010 7:11 PM
28	motorcycle	Jan 21, 2010 4:58 AM
29	Longboarding	Jan 21, 2010 6:13 PM
30	MOTORCYCLE	Jan 27, 2010 2:00 AM

MSU Transportation Survey

If you CARPOOL to campus, on average how many passengers travel together, including the driver? (Skip this question if it does not apply to you.)				
		Response Average	Response Total	Response Count
Number in Carpool:		2.07	178	86
			answered question	86
			skipped question	416

MSU Transportation Survey

If you DRIVE or CARPOOL to campus, approximately what is the vehicle's gas mileage (city driving) in miles per gallon (MPG)? (Skip this question if it does not apply to you)			
		Response Percent	**Response Count**
10-15 MPG		8.2%	27
15-20 MPG		28.6%	94
20-25 MPG		**35.3%**	**116**
25-35 MPG		24.6%	81
35-50 MPG		2.7%	9
50 MPG or more		0.6%	2
		answered question	**329**
		skipped question	**173**

MSU Transportation Survey

Please estimate how many TOTAL MILES you travel round trip between your permanent residence and Bozeman in a typical year. (Include trips home for break and/or holidays; ignore fields that don't apply.)				
		Response Average	Response Total	Response Count
By Car		3,771.65	841,077	223
By Carpool		1,028.20	89,453	87
By Plane		**3,779.29**	**359,033**	95
By Rail		66.67	3,000	45
Other		230.53	10,374	45
			answered question	**250**
			skipped question	**252**

By Car		
1		Jan 14, 2010 12:02 AM
2	2400	Jan 14, 2010 12:05 AM
3	1000	Jan 14, 2010 12:08 AM
4	15000	Jan 14, 2010 12:08 AM
5	2000	Jan 14, 2010 12:09 AM
6	180	Jan 14, 2010 12:10 AM
7		Jan 14, 2010 12:11 AM
8	3500	Jan 14, 2010 12:11 AM
9	360	Jan 14, 2010 12:11 AM
10	0	Jan 14, 2010 12:11 AM
11	600	Jan 14, 2010 12:12 AM
12		Jan 14, 2010 12:12 AM
13	0	Jan 14, 2010 12:13 AM
14	3000	Jan 14, 2010 12:14 AM
15	1500	Jan 14, 2010 12:16 AM
16	2100	Jan 14, 2010 12:17 AM
17		Jan 14, 2010 12:17 AM
18	7000	Jan 14, 2010 12:19 AM
19	400	Jan 14, 2010 12:19 AM
20	3000	Jan 14, 2010 12:20 AM
21	1500	Jan 14, 2010 12:21 AM
22		Jan 14, 2010 12:23 AM
23	2200	Jan 14, 2010 12:23 AM
24	3600	Jan 14, 2010 12:23 AM

MSU Transportation Survey

Amtrak is considering re-opening passenger rail service along the North Coast Hiawatha Route. This would connect Seattle and Chicago and offer services to Billings, Bozeman, Helena, Butte, and Missoula with possible spurs to Dillon, Great Falls, and Whitefish. If this service existed would it replace any of your existing trips by other means?			
		Response Percent	Response Count
Yes, all.		13.6%	34
Yes, some.		**60.0%**	**150**
No, none.		26.4%	66
	answered question		**250**
	skipped question		**252**

Appendix 3: Western Transportation Institute ACUPCC Climate Action Plan Transportation Analysis

Montana State University

American College and University Presidents Climate Commitment

Climate Action Plan – Transportation Component

by

David Kack
Rebecca Gleason

Western Transportation Institute
College of Engineering
Montana State University

A report prepared for the
Montana State University
CSAC

December 7, 2011

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1. INTRODUCTION

Transportation, in the form of the campus vehicle fleets, commuting and air travel, are relevant to the climate action plan because these activities produce a significant amount (38 percent) of MSU's net emissions. The Green House Gas (GHG) emissions are based on travel to, or on behalf of the University. However, it should be noted that the inventory used as a foundation for this Climate Action Plan does not include student travel beyond their daily commute to MSU. Therefore, student trips for employment, shopping purposes, or activities are not captured herein. These trips by the students may create as much or perhaps even more GHG emissions than their commutes to MSU, and should be calculated in the future.

Strategies to implement GHG reductions for transportation are more difficult than modifying a building (i.e., installing energy efficient windows, new heating/cooling systems, etc.), as transportation choices are based on individual choices/behaviors. Montana State University, the City of Bozeman, and surrounding area have made progress on alternative transportation modes that give individuals options other than driving their own vehicle (single-occupancy vehicle or SOV).

In its Greenhouse Gas Inventory Report (04-21-10) on Montana State University, McKinstry noted several strategies for reducing commuter emissions, including:

- Offer more online courses
- Increase parking fees
- Subsidize public transportation passes
- Carpool parking priority
- Restrict student cars and/or parking to upper classmen
- Installation of more bike racks and bike paths
- Subsidize on-campus housing to minimize off-campus living
- Education to campus about carbon footprint goals and the impact of individual commuter choices
- Convert parking lots to green spaces

The following sections discuss possibilities, including these, to reduce transportation impacts of MSU while integrating MSU transportation strategies into the broader community. It is important in discussing transportation plans that MSU not be viewed as an "island". Unless someone is living on campus, a person is traveling in and through Bozeman, and perhaps even one or two counties, to get to class or employment at MSU. Therefore, it is important that the transportation component of MSU's Climate Action Plan integrate with the City's and other transportation plans/climate action plans.

As of the adoption of this Climate Action Plan, the City of Bozeman was finalizing its Climate Action Plan. The following seven transportation recommendations were included in the City's plan:

1. Support policies for long-term integrated transportation and land use planning for a 20-30 year horizon
2. Promote a bike friendly community
3. Promote an electric car friendly community
4. Promote and provide incentives for clean fuels

5. Develop educational resources for the community on transportation options
6. Reduce vehicle miles traveled and fuel emissions
7. Air travel (examine emissions from Gallatin Field and its effects)

As noted in the following sections, MSU's Climate Action Plan includes similar transportation recommendations. As MSU and the City of Bozeman adopt and implement their Climate Action Plans, the two entities should work together as closely as possible to take advantage of funding opportunities and other synergies that may exist.

2. CAMPUS FLEET (MSU VEHICLES)

Montana State University owns 372 vehicles that are used by various departments for various purposes. There are three basic strategies to reduce GHG emissions to the extent possible in relation to these vehicles. These strategies are modernizing the fleet, using electric vehicles, and using human powered vehicles.

2.1. Modernize fleet

As the fleet ages, MSU must update vehicles with more modern, fuel efficient and cleaner vehicles. In addition to simply purchasing more efficient vehicles, MSU must analyze the purpose for each vehicle, so that the proper size vehicle can be purchased. For example, heavy or light gasoline or diesel powered trucks may not need to be purchased, if an electric or human-powered vehicle can accomplish the same task. Facilities Services has been in the process of reducing the physical size of maintenance vehicles. They have six gator- like vehicles used by Landscape and Grounds Maintenance Staff and seven mini- utility vehicles (Vantage and C-Mag). These smaller, more maneuverable vehicles are able to access more areas without disturbing the surrounding environment and can effectively transport personnel and their tools/materials. Facilities and Campus Departments have 9 carts, and 5 ATVs. An analysis should be conducted of each vehicle the University owns, and the purpose of the vehicle. The analysis could then be used to determine what vehicles should be purchased in the future.

2.2. Electric vehicles (consider source of electricity)

Electric vehicles do not produced green house gasses, although the source of electricity that powers them may. MSU Facilities Services evaluated an electric mini utility vehicle in winter 2010 over a 30 day period. While handling and power were good; the batteries did not last through-out the day especially with the heat/defrost on. Because the electrical mini utility vehicle is unable to support our on demand transportation requirement at this time its integration into the fleet will occur when the battery technology improves. In general, with the short distances within the campus, electric vehicles could be used for many of the tasks that require some sort of vehicle. Whether it is delivering supplies, people, or small equipment among the various campus buildings, electric vehicles may be able to accomplish the majority of the transportation needs on campus. As MSU analyzes and updates its vehicle fleet, the use of electric vehicles should be strongly considered. As noted herein, however, to reduce the campus carbon footprint, the source of the electricity to power the vehicles needs to be considered, as well.

2.3. Bicycles or other "human powered" vehicles

Bicycles are already used by campus employees for traveling short distances in and around campus. Utilitarian tricycles with trailers to haul tools and other equipment are used for campus landscaping. MSU should maximize the use of these human powered vehicles to decrease emissions and increase physical activity. In summer 2011, MSU main campus had 33 bicycles for Facilities Services and University Police to use. Four additional bicycles were available to Student Union building staff.

3. CAMPUS COMMUTING

Objectives to reduce the Green House Gas emissions related to faculty, staff and students commuting to campus include eliminating or shortening the commute, or allowing a more efficient (less GHG emissions) commute. These strategies integrate alternatives to single occupancy vehicles (SOVs) through campus policies related to walking, bicycling, transit, carpooling, vanpooling. Policies should provide incentives to alternatives to SOVs and disincentives to SOV enablers such as convenient and inexpensive parking. Strategies to achieve these objectives are discussed in more detail within this section.

3.1. Eliminating the Commute

3.1.1. More housing near campus

Similar to the City of Bozeman's recommendation for integrated transportation and land use planning, this strategy would provide more housing opportunities near campus, so that faculty, staff and students would not need to drive to campus. Housing with a close proximity to campus would allow the vast majority of people to be able to walk or bike to campus.

3.1.2. Online classes

With options for students to take classes online, the need to commute to campus may be eliminated. This would take an investment by MSU to have the technologies in place so that as many classes as possible are delivered via the Internet, or other electronic means. While it is recognized that there are numerous classes that require hands-on (on campus) learning, commuting GHG emissions could be reduced by maximizing the number of classes taught online.

3.1.3. Web based meetings/trainings

Faculty, staff and students also frequently commute to campus for meetings and/or trainings. If these meetings and trainings could be supported in an online basis, these commutes could be eliminated. As noted with the online classes, MSU would need to invest in the technology to support online meetings and trainings.

- Cost savings to University/to individuals

As noted earlier, the majority of the cost of transportation is based on the individual, not the University. Therefore, the maximum savings in reducing commuting to campus would be accrued to individuals. If enough individuals stop driving to campus, there would be potential to reduce the number of parking spaces/lots that the University maintains. However, the savings to the University by reducing parking lot maintenance could be offset by a reduction in the number of parking permits sold. If this were the case, there would be no cost savings to the University, as the revenue would be reduced, and there would be no savings. However, there would be a reduction in green house gas emissions.

- Examples of other programs- weblinks

An increasing number of universities are offering online courses or degrees. Following are links to more information about a few of these programs

http://learn.berkeley.edu/

http://www.worldcampus.psu.edu/

http://www.online.uillinois.edu/

- Marketing/education/promotion

The online courses and the meetings/trainings would be marketed/promoted to both students, and faculty/staff.

- Potential partners (funding, advertising, in-kind support)

There may be the potential to establish online meeting/training systems that could be used by other entities (businesses and other organizations).

- How could this fit MSU curriculum, student research, departments

Departments would need to decide what courses, trainings and meetings could occur online versus in person. Research could be conducted to determine the efficiency and effectiveness of online courses, training and meetings versus the in-person alternative. Further, research could be conducted to determine how much carbon savings is accrued due to an increase in these online activities.

- Timeline

While it would take longer to develop online courses, meetings and trainings could be transitioned online almost instantly. With systems such as GoToMeeting and Webex, meetings and trainings could occur within a week or two of a policy being implemented.

3.2. Walking

3.2.1. Existing status and cost

Basic elements of a pedestrian network are sidewalks, pathways, crosswalks and curb ramps. These elements should form a connected network that is functional and safe. The City of Bozeman, the Montana Department of Transportation and others have been working to provide pedestrian connections to MSU. The Greater Bozeman Area Transportation Plan (2007 update) places a strong emphasis on integrating pedestrian facilities into the transportation network. It identifies gaps in the pedestrian networks and recommends improvements. Construction started on one of the recommended improvements in the fall of 2010. This recent improvement is a separated pathway along the south side of College Street between South 11th street and Huffine Lane; a key non-motorized connection between MSU and neighborhoods on the west side of town. The City passed a “complete streets” policy in 2010 which ensures that streets are “complete” and safe for all users, including motorists, pedestrians, transit users, bicyclists, children, the elderly and people with disabilities.

The existing number of MSU students and employees who walk to campus is not well documented, though two recent studies provide insight. A 2007 study evaluated how far from campus MSU employees and students live. For the 2007 study, MSU and the City of Bozeman mapped the geographical distribution of students and employees in relation to the MSU campus. The evaluation used employee and student addresses from the 2005 fall semester, showing approximately 3,900 individuals lived within one mile of campus and about 7,400 lived within three miles (MSU, 2007). Assuming MSU has 12,500 students and 3,500 employees, this data suggests approximately 46 percent of MSU employees and students live within three miles of campus. (cite literature on distances most people are willing to walk). While the geographic distribution of students and employees will vary from year to year, the geographic concentration should not change considerably without significant housing additions in close proximity to MSU.

A transportation survey of MSU students and employees conducted in 2010 suggests walking to campus is common. This online survey identified a random sample of 1500 MSU employees and students and had approximately 500 respondents. Approximately 53 percent of respondents reported living within three miles of campus, which is similar to the 46 percent estimated from the 2007 evaluation. The 2010 transportation survey indicated:

- 22.9 percent (112 people) reported walking as their primary travel mode to campus in the spring and fall (September, October, March, April and May).
- 27.6 percent (135 people) reported walking as their primary mode from November through February.
- Approximately 27 percent of respondents reported living within one mile of campus.

In comparison, the 2009 National Household Travel Survey reports walking trips accounted for 10.9 percent of all trips reported, while one percent of all trips reported were taken by bike (FHWA and PBIC 2010).

3.2.2. Description of alternative/TDM plan and cost

- Cost savings to University/ to individuals

It is unlikely that increasing walking alone has the potential to significantly reduce University costs related to commuter transportation. An integrated approach of linking pedestrian, bicycling and transit travel along with carpools and vanpools has potential to reduce parking needs and costs of parking lot maintenance. Individuals who walk instead of drive save money by reducing fuel use. They may reduce health care costs by improving their health through increased regular physical activity. While these costs are difficult to quantify, walking is the lowest cost transportation option available for short trips.

- Examples of other programs- weblinks

Using maps and guides that show walking and biking infrastructure options are an effective method to encourage people to walk and bike. The Bozeman Area Bicycle Advisory Board (BABAB) is in the process of revising a city bicycling map that could form a basis for a map that integrates recommended walking and transit options as well.

The City of Boulder is a University town in a mountain setting and has a wallet size pedestrian map.

http://www.bouldercolorado.gov/files/GOBoulder/maps/bike_ped_walletmap_09.pdf

Boulder has examples of other maps showing transit, bicycle and pedestrian options at:

http://www.bouldercolorado.gov/index.php?option=com_content&view=article&id=8853&Itemid=2979

Create a "Drive Less, Live More" Campaign as shown in the Greater Bozeman Area Transportation Plan (page 6-6-23). This is a media campaign and website intended to educate drive alone commuters of other options.

http://www.drivelesslivemore.org

http://www.divelesslivemore.com

http://Drivelesssavemore.com

Create a commuter calculator to raise awareness of the true costs of commuting. Place this in a prominent location on MSU's website.

http://www.drivelesslivemore.org/ComputeYourCommute.asp

- Marketing/education/promotion

Many people are in the habit of driving and simply don't think about other options such as walking, biking and/or transit, carpooling or vanpools. Identifying what motivates people to change their behavior (finances, health, environment, fun…) can help MSU created targeted marketing campaigns to initiate changes in travel modes. Raise awareness of the health benefits of active travel such as walking and bicycling on a regular basis. MSU's wellness program already gives points for employees who walk or bike to campus. Employees who track their healthful behaviors are rewarded annually with a $100 check. Provide more incentives to walk to school or work on a regular basis. Reward students and employees and recognize them for their efforts. MSU could market alternative transportation options at events such as Catapalooza, freshman convocation, new student and staff orientations, employee and student wellness programs and other campus events. Alternative transportation materials such as walking and biking maps could by widely distributed on MSU's website, at the Ask-Us Desk, MSU bookstore and other high traffic campus locations.

- Potential partners (funding, advertising, in-kind support)

There is significant interest from the public health community to increase physical activity through daily commuting. Health organizations associated with MSU insurance programs, the County Health Department and the MSU Wellness program are likely partners to support active travel options. The City of Bozeman's pedestrian and traffic safety committee is a good connection. Local businesses may provide sponsorships for active transportation options in return for advertisements on maps or other materials. MSU could partner with the City to improve the existing City of Bozeman Bike Map or create new pedestrian and bicycle maps that could be widely distributed to campus commuters.

- How could this fit MSU curriculum, student research, departments

Two interdisciplinary university-level courses have been developed to explore the core concepts of pedestrian and bicycle design and strategies to create comprehensive bicycle and pedestrian plans and programs. The two courses are:

- Pedestrian and Bicycling Information Center (PBIC) Bicycle and Pedestrian Planning Course for Graduate Students
- Federal Highway Administration (FHWA) University Course on Bicycle and Pedestrian Transportation

Students taking either course will recognize the legitimacy of the bicycle and pedestrian modes, understand how policy, planning, and engineering practices can be improved to create a more balanced transportation system, and become familiar with basic policies, practices, tools, and design principles that can be used to create bicycle and pedestrian-friendly communities (PBIC 2010). Course information may be found online at www.walkinginfo.org/training/university-courses/.

With regard to research, public administration students could assess policies and public participation processes related to alternative transportation options (complete streets, commuter tax credit for example). Graphic design students could assist in designing and updating local pedestrian, bicycling and transit maps. Students in GIS courses could improve on the existing evaluation/mapping of student and employee residence proximity to MSU, proximity to transit, bike and walking infrastructure. Engineering students could research innovative solutions to improve pedestrian and bicyclist safety (more on this in bicycle section that follows). Students interested in health promotion or public health could study relationships between travel behavior and health. Denver's new public bicycle sharing program launched in April 2010 is the focus of an ongoing study into population-wide health interventions aimed at increasing physical activity (Duvall, 2010).

- Timeline

The Bozeman Area Bicycle Advisory Board is in the process of updating the City's bike map. A pedestrian oriented map could likely be produced within 3 to 4 months with appropriate funding. A commuter calculator could be implemented very quickly online, but connecting people to these resources will occur over time and as mentioned above may be coordinated with campus events.

3.3. Bicycling

3.3.1. Existing status and cost

Bicycle facilities vary significantly and may include items such as wayfinding signs, separated paved pathways, covered bike parking, or end of trip facilities such as showers. Consistent with pedestrian facilities, the City of Bozeman and others have been working to provide bicycling connections to MSU. The City rebuilt West Babcock Street in 2005, adding bicycle lanes and sidewalks, which resulted in an increase of 256 percent in bicycle and pedestrian users (City of Bozeman, 2007). The Greater Bozeman Area Transportation Plan (2007 update) places a strong emphasis on integrating bicycle facilities into the transportation network. It recommends specific locations for bike lanes, bike routes, expanded shoulders and shared-use paths. The City installed 320 bike route signs in 2005 and created a bicycle map. Recent bicycle facilities that improve connections to campus include Kagy Boulevard bicycle lanes, a separated pathway along College St. between 11th and Huffine Lane and bicycle lanes along S. 19th. These are just a few of many examples.

There is significant interest at MSU in increasing bicycle commuting. MSU recently removed its ban on bikes on campus and installed a significant number of new bike racks in convenient locations around campus. The ASMSU sustainability center is researching options for a commuter/cruiser bike share/rental program in partnership with ASMSU Outdoor Recreation Center. Some campus buildings have end of trip facilities for bicycle commuters such as showers, lockers and changing rooms. A transportation survey of MSU students and employees conducted in 2010 indicates:

- 18.2 percent (89 people) reported bicycling as their primary travel mode to campus in the spring and fall (September, October, March, April and May).
- 3.5 percent (17 people) reported bicycling as their primary mode from November through February.
- Approximately 53 percent of respondents reported living within three miles of campus.

3.3.1. Description of alternative/TDM plan and cost

There are many ways MSU could encourage students and employees to replace driving commutes with bicycling. The "Five Es" are a common measure of bicycle friendliness based on The League of American Bicyclists categories (LAB, 2008):

1. *Engineering* refers to what has been built to promote cycling the existence and connectivity of well-designed bike lanes and multi-use paths.

2. *Education* includes teaching cyclists how to ride safely and teaching motorists how to share the road safely with cyclists.

3. *Encouragement* refers to how bicycling is promoted and encouraged. This can occur through Bike Month and Bike to Work Week events, creating community bike maps, route finding signage, community bike rides and commuter incentive programs.
4. *Enforcement* refers to connections between cycling and law enforcement. A few examples include whether or not law enforcement has a liaison with the cycling community and if there are bicycle divisions of the law enforcement.
5. *Evaluation* refers to systems to evaluate current programs and plan for the future. Evaluation focuses on measuring the amount of cycling taking place, crash and fatality rates, and ways to reduce these numbers.

Even where the engineering component (safe biking infrastructure) exists; education, encouragement, enforcement and evaluation are needed to change behavior and create a bike friendly culture. MSU should collaborate with the City to implement the Greater Bozeman Area Transportation Plan's bicycling and pedestrian recommendations and with the Bozeman Area Bicycle Advisory Board (BABAB), which now has space for an MSU student representative. Applications can be downloaded from the City of Bozeman Bike Advisory Board web page and submitted to Aimee Kissel (at City Hall), the Citizen Advisory Board Coordinator: akissel@bozeman.net. The following sections describe cost savings and activites MSU can implement to create a more bike friendly culture, organized by the "5 Es".

- Cost savings to University/ to individuals

It is unlikely that increased bicycling alone has the potential to significantly reduce University costs related to commuter transportation. An integrated approach of linking pedestrian, bicycling and transit travel along with carpools and vanpools has potential to reduce single occupancy vehicles (SOV) at MSU. Significant reductions in SOVs can reduce parking needs and costs of parking lot maintenance.

- Examples of other programs- weblinks

Engineering

Provide covered bike parking on campus and at transit stops. Provide bike lockers for regular commuters. Collaborate with the City and BABAB to make bicycle facility improvements recommended in the City's transportation plan.

Education

The bike buddy campaign pairs less experience cyclists with a trained cycling mentor who assists them in route selection, training rides, reading bike maps and gear questions to lower barriers to using a bicycle for transportation. (Bozeman Transportation Plan Pg 6-17)

http://www.bicyclealliance.org/commutte/bikebuddy.html

http://www.bicycling.511.org/buddy.htm

The League of American Bicyclists offer courses in bicycle education and safety. Bike rodeos are fun events aimed at teaching kids basic skills and safety rules. These events could be adapted to target university students and employees.

http://www.bikeleague.org/programs/education/courses.php

http://www.bicyclinglife.com/Safetyskills/bicyclerodeo.hgm

http://www.saferoutestoschools.org/pdfs/lessonplans/rodeomanual_june2006.pdf

Training courses on biking in cold climates would be relevant and fun for MSU students, faculty and staff. Bozeman's Bike Kitchen would be a good source for guidance on cold weather biking training. The following websites present good cold weather biking information.

http://www.allweathersports.com/winter/winter.html

http://dingdingletsride.com/topics/bike-winter/

Figure 1: Fat tires for fun winter biking.

Encouragement

Ripon College in Wisconsin and the University of New England (UNE) are leading the way in encouraging biking. In fall 2008, UNE launched its alternative transportation program by offering free bicycles or Zipcar usage to first-year resident students who promised not to bring cars to campus. Considered one of the most comprehensive programs of its kind in the country, the program, featured in the New York Times, was a resounding success and will be offered again to the first one hundred and twenty five first year resident students who opt into the program. **Since the alternative transportation program was initiated at UNE, the University has been able to close and convert a parking lot into recreation space without the need for additional parking.**

http://www.ripon.edu/velorution/bike.html

http://www.une.edu/news/2010/unebicycleprogram.cfm

Distribute the City of Bozeman's Bicycling map to encourage more biking. BABAB is currently revising the City of Bozeman Bicycle Map anticipated to be complete by April 2011. MSU should work with BABAB to broadly distribute this map to students, faculty and staff.

Pilot light is currently sponsored by BABAB to increase night biking safety by providing bicycle front and rear lights to those who need them. BABAB is working with the international student office and local law enforcement to distribute lights. This program could be expanded and improved by incorporating recommendations on pages 6-21 and 6-22 of the Bozeman Transportation Plan (use well designed graphic ads, enforce bike light laws, partner with local cycling groups and conduct media outreach).

http://www.portlandonline.com/transportation/index.cfm

Encourage multi-modal connections. Streamline buses already have bike racks on them that carry three bikes. Encourage bicycle-transit connections by placing a bus bike rack on campus with directions on how to use the rack. This allows people to practice using bus bike racks without the intimidation of standing in front of a running bus.

Bike to work week or month occurs the second week of May in coordination with the National bike to work week. MSU could tailor a bike to school week during the academic school year. The League of American Bicyclists has a bike month guide on their website below. www.bikecommutechallenge.com/

http://www.bikeleague.org/programs/bikemonth/

Figure 2: How to use bus bike racks
(Denver Bike-n-Ride example)

Incorporate bicycling into MSU's existing parking and transportation programs. UC Davis has an example bike transportation program at the website.

www.taps.ucdavis.edu/bicycle/

Stanford has created a guide for getting around without a car. MSU could do the same.

http://transportation.stanford.edu/pdf/thriving-at-stanford.pdf

Start a bike share or loan program at MSU. As mentioned previously, MSU's sustainability director has initiated this process. Some examples of bike sharing at other universities are shown in the web links below.

http://www.parking.uci.edu/zotwheels/main.cfm

http://parking.duke.edu/alternative_transportation/bicycling/duke_bikes/

Expand the Bicycle Benefits (BB) program to campus. Bicycle Benefits, initiated in Bozeman in 2008, rewards individuals and businesses for their commitment to cleaner air, personal health, and pedaling. More than 50 Bozeman businesses are already members. Individuals purchase helmet stickers and bike to BB Businesses (identified by a storefront window decal and online listings) and receive a discount. The BB website (www.bicyclebenefits.org) has BB Business Members and discounts. BABAB is managing the Bozeman BB program beginning in spring 2010. BABAB buys helmet stickers from BB for $1.25/each and sells them to businesses at $2.50/each or to individuals for $5/each. Funds from stickers go to promote safe biking in Bozeman. MSU's Ask Us desk or the bookstore would be good distribution points for faculty, staff and students who want to purchase the reflective BB helmet stickers.

Enforcement

Speed limit enforcement creates a safer environment for bicyclists and pedestrians and motorists. MSU should work with law enforcement for targeted enforcement of speed limits near school and in response to bicycling and pedestrian complaints.

http://transportation.stanford.edu/alt_transportation/BikingAtStanford.shtml

On-bike officers are an excellent tool for community and neighborhood and special event policing. Central Point, Oregon has a sample program:

http://www.bta4bikes.org/btablog/2008/01/30/alice-award-nominee-chief-jon-zeliff/

Evaluation

It is important to evaluate how changes in policies and programs can affect bicycle and pedestrian mode share. MSU should implement a transportation survey similar to the 2010 survey, to students, faculty and staff on an annual basis. MSU may also participate in the National Bicycle and Pedestrian Documentation Project, which is a developing project to create a consistent method to track bicycle and pedestrian volumes nationwide. Methods are described online at: http://bikepeddocumentation.org/

- Marketing/education/promotion

In addition to methods described in the sections above, the Greater Bozeman Area Transportation Plan recommends the following activities for an MSU Bike orientation:

- Bike maps and information to incoming and returning students at the beginning of the year through school information packets.
- Flat tire clinics, bike legal clinics and guided rides, advertise through flyers, email and bulletin boards and campus newspaper.
- Information tabling at campus events and prominent locations during the first few weeks of school.
- A bikes at MSU web page with links and more information
- At-cost or low-cost bike lights (from BABAB) or sold at tabling events and through the campus bookstore.
- Potential partners (funding, advertising, in-kind support)

Health organizations associated with MSU insurance programs, the County Health Department and the MSU Wellness program are likely partners to support active travel options. The City's

Bozeman Area Bicycle Advisory Board has already created maps and a website and can provide information about local bicycling events and activities. The Bozeman Bike Kitchen is a non-profit organization and while the Bike Kitchen cannot provide funding, they may be a valuable partner for activities such as bike maintenance.

- How could this fit MSU curriculum, student research, departments

Statistics students could create a travel mode survey to consistently track MSU student and employee travel habits and transportation mode share. This could build upon the transportation survey conducted in 2010. Business/marketing students could develop innovative methods to promote alternative transportation. Civil engineering students could research and evaluate emerging practices in bicycle transportation such as bike boxes, bicycle preferred streets, bike signals, colorized pavement and other options that can improve bicycle networks (see http://www.nacto.org/citiesforcycling.html).

- Timeline

Unlike major infrastructure improvements, many of the education and encouragement programs require minimal funding and could be implemented as time and interest allow. Student groups such as NECO and others could use volunteers to move forward on many of these concepts.

3.4. Transit (commuter and fixed route)

Transit refers to public transportation options within a community and college campus. As noted herein, Montana State University and the Associated Students of Montana State University contribute to the Streamline system, which operates in the greater Bozeman area. Transit also can extend the trip length of other modes such as walking and biking (see Figure 3).

Figure 3: MSU student loading her bike on a Streamline bus

3.4.1. Existing status and cost

The Associated Students of Montana State University (ASMSU) actually had one of the early public transit systems in Bozeman, when Bobcat Transit was introduced in 1977. However, that service lasted only fourteen days, and it was not until 1987 that Bobcat Transit became more established in the community. While open to the public, Bobcat Transit only operated during the main MSU semesters, and had a limited schedule. A year-round transit system, Streamline, was introduced to the greater Bozeman area in August 2006. Funding for this service comes from a number of sources, including ASMSU and MSU.

The Streamline system includes three routes within Bozeman, a route connecting Bozeman and Belgrade, and a limited commuter run between Livingston and Bozeman. The service operates year-round, Monday-Friday, with limited service on Saturdays. The current Streamline service, and the paratransit service, GALAVAN, cost approximately $1.3 million to operate.

Ridership on the Streamline system has continued to grow, with daily ridership averaging 750-800 rides per day, with over 1,000 rides per day in the winter months. This ridership is significantly higher than the initial estimates of 286 rides per day.

A Civil Engineering Class project in the fall of 2009 analyzed the Streamline system, a few highlights of that report include:

- 48% of riders were 18-24 years old, 42% were 25-54 years old.
- 52% of riders were MSU students, 12% were MSU faculty or staff.
- 90% of riders walked to the bus stop.
- The top three expansion recommendations included: longer hours (Monday-Friday), service on Sundays, and more frequent service.
- Nearly 29% of the Bozeman area and around 50% of the Bozeman population is within a quarter mile of a Streamline stop.

3.4.2. Description of alternative/TDM plan and cost

As noted in the beginning of this section, transportation costs, especially commuting costs, are typically costs borne by the individual. Given that transit fares are typically less that the cost of operating a car, and given that Streamline is currently fare-free, individuals who use Streamline can save a significant amount of money. In addition, they are reducing their GHG emissions by not using their vehicle. The only cost savings to the University are that fewer parking spaces need to be maintained (or constructed), and there may be some savings in reduced maintenance to roads controlled by the University. The University does accrue the reduction in GHG emissions by promoting its students, faculty and staff to utilize public transportation to commute to campus, however.

The cost for the Streamline transit service is approximately $50 per hour. This rate does vary, however, based on a number of factors. In general, it costs approximately $150,000 per year to operate a route 12 hours per day, five days per week. If the University wanted to add another route in town to get more faculty, staff and students on the bus, it would cost approximately $150,000. It is important to note that additional funds from the Federal Transit Administration, which are administered by the Montana Department of Transportation, may be available to reduce this amount. Therefore, it may be possible to add another route, or add more frequency to existing routes, for approximately half of the full-cost. This is to say that MSU may only need to pay one-half of the cost for additional service, with Federal funds paying for the other half.

- Examples of other programs

CyRide, a collaboration between the city of Ames, Iowa State University, and ISU's Student Body Government, is frequently cited as a model for transit within a college community.

http://www.cyride.com/

The University of Colorado at Boulder has services on its campus that link with other routes that connect the campus with Boulder and the greater Boulder-Denver area.

http://www.colorado.edu/parking/index.html

- Marketing/education/promotion

Streamline is marketed through primarily newspaper ads, and the brochures (schedules and maps). The buses themselves serve as advertisements, as they are very visible, and there are three to four buses parked in front of the Strand Union each hour, as the buses pulse on their schedule.

- Potential partners (funding, advertising, in-kind support)

Streamline already has obtained funding through a mix of partners, including federal funds administered by the Montana Department of Transportation. Local partners include Montana State University, the Associated Students of Montana State University, the City of Bozeman, Gallatin County and the City of Belgrade. However, additional partners, including large employers in the area, could contribute to Streamline, allowing the expansion of operations.

- How could this fit MSU curriculum, student research, departments

An engineering class uses Streamline as part of its public transportation program, by conducting a review/analysis of the transit system. Other classes could examine the potential to use alternative fueled vehicles, how to better market the system, or other analysis of the Streamline service.

- Timeline

Streamline services can be modified quickly, with the limiting factor being the number of vehicles available. For example, it would be relatively easy to start service on Sundays, or have existing routes run longer into the evening. More frequent service would likely require additional vehicles, which could take up to 18 months to procure. Programs to increase the marketing of Streamline to the MSU community could start immediately, however.

3.5. Car pooling

3.5.1. Existing status and cost

Montana State University made the ability to car pool easier when it switched its parking permits from a “sticker” to a “hang tag”. If individuals want to car pool, they can register a number of vehicles to a single hang tag/parking permit. This allows multiple individuals to act as the “driver” of a car pool, and allows a car pool to use a single hang tag/parking permit. With that being said, the University does not actively promote car pooling. There is no formal process (software, etc.) for individuals who are interested in car pooling to find a "match" for a ride. Any car pools that exist are based on personal relationships, and people knowing other faculty/staff who live near them, and may want to share a ride.

3.5.2. Description of alternative/TDM plan and cost

- Cost savings to University/ to individuals

As with transit, the cost savings accrued through car pooling are primarily to the individuals involved. While there are no set formulas for how to share costs in a car pool, most car pools focus on the cost of the fuel. Therefore, if two people are in a car pool (the driver and a passenger), the cost of fuel is cut in half. This savings can be significant, however. If someone were to commute from Livingston or Three Forks to campus, it would be roughly a 70 mile roundtrip. If they commuted to campus 200 days per year, that is a total of 14,000 miles. With a fuel economy of 25 miles per gallon, the driver would purchase 560 gallons of fuel for the commute. That would equate to $1,607.20 at $2.87/gallon, or $2,380 at $4.25/gallon. Therefore, by car pooling with only one other person, a driver could save anywhere from $803.60/year to $1,190/year depending upon fuel costs. Car pooling with three or four people (total) would save even more money.

The savings to the University would be the need to maintain (or build) less parking, and less maintenance on University streets. Trees could be planted in parking lots that are no longer needed, which would also help to obtain a credit for Green House Gas emissions.

- Examples of other programs

There are several programs to increase the use of car pooling. Most of them focus on using software to allow for students, faculty and staff to find other people interested in car pooling.

http://www.memphis.edu/greencampus/carpooling.php

http://www.campuslifeservices.ucsf.edu/transportation/rideshare/carpool/

http://www.zimride.com/

http://www.greenride.com/Solutions/Connect/Description

- Marketing/education/promotion

If Montana State University were to actively promote car pooling, marketing could be accomplished through the MSU News e-mail, campus newspaper, and providing links from various MSU websites to a car pool software. Also, priority parking close to campus for car pool vehicles would also be an incentive.

- Potential partners (funding, advertising, in-kind support)

The cost for implementing and promoting car pooling is estimated to cost between $10,000 and $20,000 per year. MSU may be able to work with the City of Bozeman and/or other large employers in the area to help pay for the car pooling software and incentives, and to increase the number of employees (people) to be part of a car pool. In addition, local businesses may be willing to donate prizes that could be used to promote the car pool concept.

- How could this fit MSU curriculum, student research, departments

Similar to the transit service, MSU classes could research car pooling, including how to get more people to car pool, and the types of people who participate.

- Timeline

Software could be procured and operating within weeks, and a marketing campaign could begin almost immediately, as well. In a discussion with Amy Fox from Zimride, the target is to have 10-20 percent of students, faculty and staff signed up within the first six months of the ridesharing campaign.

3.6. Van pooling

3.6.1. Existing status and cost

There are no existing van pools (or van pool programs) in the Bozeman area. Van pools are somewhat similar to car pools, but are more formalized arrangements, typically with the vehicle (van) supplied by an employer or other entity, and a set cost for those who participate in the van pool. One person in the van pool typically becomes the driver, and usually doesn't pay the monthly cost of participating in the van pool. The monthly cost for each participant is set to cover fuel, insurance, maintenance and capital costs. Monthly prices for participants can range from $80-$150/month depending upon several factors, including the distance traveled and how many people are participating in the van pool. Ideally, nine to twelve people participate in each van pool.

3.6.2. Description of alternative/TDM plan and cost

- Cost savings to University/ to individuals

Like a car pool, participants utilize a van pool to reduce the cost of commuting (alone). Utilizing alternatives such as transit, car pools or van pools can sometimes mean a family can have mobility with only one car, or possibly no cars. The cost savings to the University would be in the form of having less parking spaces to maintain (or build).

- Examples of other programs

The closest (physically) example of a van pool program is in the greater Missoula area, through the Missoula Ravalli Transportation Management Association (MR TMA) http://www.mrtma.org/Vanpool.htm

VPSI provides vans and van pool services to a number of organizations: http://www.vpsi.org/mysitecaddy/site3/index.htm

The University of Iowa has over 70 vans in its van pool program:

http://www.uiowa.edu/~commprog/vanpool_home.html

The University of California at San Francisco has a number of mobility options, including van pooling:

http://campuslifeservices.ucsf.edu/transportation/rideshare/vanpool/

- Marketing/education/promotion

As with a car pool program, the promotion of a van pool program would be to encourage students, faculty and staff to sign up for the program. In addition to saving money from reduced commuting costs, van pool vehicles could be given priority parking spaces on campus. The University could provide “giveaways” or prizes to people who participate in van pools, such as gift certificates to the Bookstore, or could pay for one month of the van pool expenses for winners.

- Potential partners

The University could partner with the Streamline transit system to operate the van pool program, which would allow individuals who are not affiliated with the University to participate in the program. The University could solicit support from other business for prizes or incentives that could be used to encourage use of the van pool program.

- How could this fit MSU curriculum, student research, departments

A van pool program could be viewed from many different angles for research projects. Marketing students could design and implement marketing programs, sociology/psychology students could analyze what makes an individual more likely to participate in a van pool, and engineering students could analyze factors that influence where to place van pools, and the GHG savings they produce.

- Timeline

A van pool program could be started quickly with leased vehicles, while it could take a year or so to procure vans if the vehicles were to be purchased. While software could be used to manage the van pool program, basic software (Microsoft Excel or Word) could be used to manage the system. Initially, van pools would be focused in areas with concentrations of students and staff, such as the Three Forks/Manhattan or Livingston areas. Working with other large employers, such as Bozeman Deaconess Health, van pools could be extended to other areas.

3.7. Supporting/other strategies

In order to transition students, faculty and staff from a single occupancy vehicle (SOV) to alternative forms of mobility, supporting strategies will need to be implemented. These supporting strategies can be thought of in terms of incentives and disincentives.

3.7.1. Guaranteed Ride Home

A Guaranteed Ride Home (otherwise known as GRH) provides commuters who regularly vanpool, carpool, bike, walk, or take transit with a reliable ride home when one of life's unexpected emergencies arises. Many public transportation agencies, or large employers with transportation programs, offer commuters a GRH for personal emergencies and unscheduled overtime. In an area such as Bozeman, the GRH would take the form of a voucher that a commuter could use on the local taxi service to get home if something unexpected occurred (say a child getting sick at school). The employee could call the taxi company for the ride, and use a GRH voucher to pay for the trip. The University would only have to pay for the GRH vouchers that are used. Some employers will provide up to four vouchers in a year, while others limit the vouchers to two per year. GRH is designed to rescue commuters who are worried about how they’ll get home when an emergency arises. Knowing there’s a guaranteed ride home allows one to use commuting options like transit and carpools with peace of mind and confidence.

3.7.2. Education Activities

Each strategy herein has discussed educational activities not only in terms of education about how to safely bicycle in traffic or load a bike on a bus, but also in terms of how alternative transportation activities could be integrated into student class projects or research. Whether it is planning for better transportation-land use linkages, analyzing the use and efficiency of alternatives, determining how to get more people to use alternative transportation modes, or analyzing the reduction in green house gas emissions from the increased use of alternative modes, there are many educational activities that can be part of the transportation component of Montana State University's Climate Action Plan.

3.7.3. Evaluation Activities

The evaluation activities would include analyzing how many people (students, faculty, staff) switched from an SOV to an alternative mode (walk, bike, car or van pool, or use transit). Institutionalizing a transportation survey, similar to the 2010 survey, would help MSU track changes. In addition, an analysis could look at the use of each mode, and what could be done to further increase the use of alternative modes for the commute to/from the University.

Further evaluation activities could include determining the cost/benefit ratio of each alternative mode, and van pool and transit routes could be evaluated as well.

3.7.4. Promotion and Encouragement Activities

The promotion and encouragement activities could be thought of the "carrot" or incentives to get people to change their transportation behaviors. There is a host of activities that could be included herein, some of which were mentioned in sections related to specific transportation alternatives. However, some of the promotion and encouragement activities could include:

- Incentives/giveaways to people who don't drive to campus
- Discounts at local businesses to people who don't drive to campus
- Discounts at the MSU Bookstore or MSU Food Services to people who don't drive to campus
- A "pay not to park" incentive

Encouragement could include competitions between colleges/departments within MSU for the highest percentage of staff (or students) that do not drive to campus. MSU sports teams could ride the bus, car pool or ride bikes to campus with other students, faculty and staff to promote riding the bus. News articles or other media events can highlight how using alternatives to the single-occupancy vehicle saves money and reduces green house gas emissions.

3.7.5. Disincentives

If promotion and encouragement activities are viewed as a "carrot", the disincentives are certainly the "stick." These activities (or policies) would be put in place to make it less desirable to commute to campus in a single-occupancy vehicle, and should lead people to look for alternative modes of transportation. In general, disincentives should not be used exclusively to get people to modify their transportation behavior, but should be used in conjunction with incentives, as well.

In general, disincentives make traveling in a single-occupancy vehicle more expense, or take more time than an alternative mode. Given the fact that the University primarily controls parking on campus, disincentives could include:

- Increased parking costs (for all parking spaces/permits)
- Distance based parking fees (so those who live closer to campus have to pay more for a parking permit, since they have more alternatives available)
- Parking meters on campus so people have to pay each time they park.

The parking meter concept is based on the concept that the first time a person purchases a semester or year-long parking permit; that is when the cost is incurred. The rest of the time a person parks, it is "free." Having parking meters at all spots on campus changes the paradigm, so that it costs someone ever time they park on campus.

4. AIR TRAVEL

4.1.1. Existing status and cost

Directly financed air travel contributed 16 percent of MSU's net emissions. Air travel for students studying abroad contributed another 9 percent of MSU's net emissions. This is significant, as faculty, staff and student commuting only accounted for 10 percent of MSU's net emissions. While the alternatives for the student travel abroad are to not travel, or purchase offsets, there is another alternative related to other directly financed air travel.

4.1.2. Description of alternative/TDM plan and cost

As a major research university, many faculty, staff and students are traveling to be part of conferences to learn of research, or to present research findings. Until many of these conferences embrace video-conferencing, or holding virtual conferences, there will still be a tremendous need to travel by air to these meetings/conferences. In that situation, MSU will be able to purchase offsets to compensate for this travel.

In instances where air travel is taking place for meetings, project updates, or other instances when a conference call, webinar, or video conference is adequate, MSU should have policies and procedures in place so that faculty, staff and students can determine when air travel is justified, and when an alternative should be selected.

5. EMISSION REDUCTIONS

As noted previously, the Green House Gas inventory for Montana State University did not include student trips for purposes other than commuting to classes at MSU. The commuting activities to campus for student, faculty and staff accounted for 10 percent of MSU's net emissions. Directly financed air travel, study abroad air travel, and other directly financed travel accounted for 16%, 9%, and 3% of MSU's net emissions, respectively.

The main strategy noted herein for air travel and "other" travel was to purchase offsets, while there were various strategies identified herein for reducing commuting impacts. The shorter the distance someone commutes to campus, the more alternatives are available. For example, if someone lives within one mile of the MSU campus, alternatives such a walking and biking are viable options. However, if someone lives ten miles from campus, it is unreasonable to expect that they would walk or bike. The survey that was used to develop the baseline inventory indicated that the majority of faculty, staff and students live within a relatively close proximity to campus (Table 1).

Table 1: Faculty, staff and student commute distances

Distance from Campus	Percentage of Respondents	Cumulative Percentage
Less than 1 mile	27.4%	27.4%
1.1-3 miles	25.4%	52.8%
3.1-5 miles	16.2%	69.0%
5.1 to 10 miles	14.7%	83.7%
10.1-15 miles	8.5%	92.2%
15.1-20 miles	3.3%	95.5%
20.1-30 miles	3.3%	98.8%
30.1-40 miles	0.5%	99.3%
40.1-50 miles	0.5%	99.8%
50.1 miles or more	0.3%	100.1%

The data indicates that roughly half of the campus population lives within a distance (three miles or less) where non-motorized options could be utilized. Further, only 4.5 percent of faculty, staff and students live more than 20 miles from campus, a distance which tends to add to the cost of options such as van pools and transit.

Figure 4 shows that a majority of housing in Bozeman is within three miles (the blue line) of campus. Driving from Belgrade to campus is approximately twelve miles.

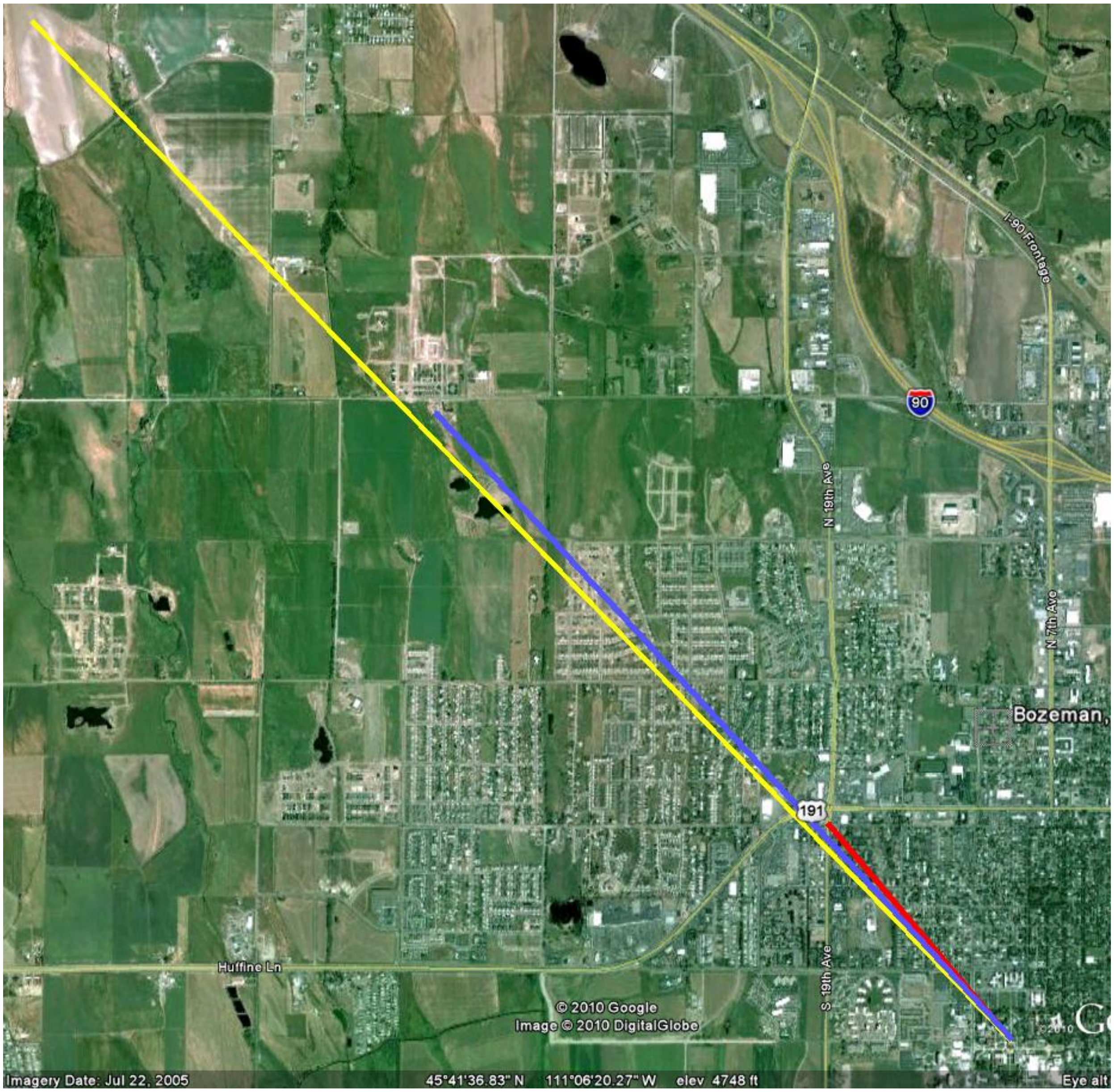

Figure 4: Distances from MSU Campus Source: Google Earth

The GHG inventory based its calculations on 9,124,603 automobile miles and 189,376 bus miles of commuting by faculty and staff, and 9,826,713 automobile miles and 411,168 bus miles of commuting by students. The GHG inventory did not capture student travel for other purposes (working, shopping, etc.).

While an analysis has not been completed to the level of detail that would allow for a decision that implementing van pooling, for instance, would reduce commuter traffic by 10 percent, Table 2 provided data on the GHG emission savings based on the reduction of commuter mileage.

Table 2: Potential GHG savings for commuter reductions

	Car miles	Bus miles	Energy Use MMBtu	CO2 kg	CH4 kg	N2O kg	eCO2 Metric Tonnes
2009 Baseline							
facutly/staff	9,124,603	189,376	51,924.5	3,642,451.6	721.8	248.7	3,732.7
students	9,826,713	411,168	56,640.7	3,974,894.2	780.3	269.2	4,072.5
5% reduction							
faculty/staff	8,668,373	189,376	49,381.1	3,464,032.0	686.4	236.5	3,549.9
students	9,335,377	411,168	53,922.4	3,784,131.4	742.9	256.3	3,877.1
10% reduction							
faculty/staff	8,212,143	189,376	46,837.6	3,285,612.4	651.1	224.3	3,367.0
students	8,844,042	411,168	51,204.1	3,593,368.5	705.4	243.4	3,681.6
15% reduction							
faculty/staff	7,755,913	246,189	44,610.9	3,129,410.8	620.1	213.7	3,206.9
students	8,352,706	534,518	49,168.2	3,450,496.9	677.4	233.7	3,535.2
20% reduction							
faculty/staff	7,299,682	246,189	42,067.5	2,950,991.3	584.8	201.5	3,024.1
students	7,861,370	534,518	46,449.9	3,259,734.1	639.9	220.8	3,339.8

It should be noted that if MSU faculty, staff and students ride the bus (Streamline) it does not increase GHG emissions, as the buses are operating anyhow. However, to get a reduction of commuter mileage beyond 10 percent, an additional bus route, or more frequent bus service, may be required. The reduction table above does reflect an increase in bus miles, but that may not necessarily reflect the true picture.

It is recommended that Montana State University work with the City of Bozeman to promote currently available alternative modes to reduce commuting miles. These existing alternatives include walking, biking, car pooling and utilizing public transportation. Alternatives such as car pooling could be enhanced through the use of software for ride matching, and by MSU implementing incentives, such as preferential parking for car pool vehicles. In addition, incentives, such as giveaways or other promotions, could increase the use of transit. MSU could use additional surveys to gauge the interest in new options such as van pools, to see if those options are worthy of future investment.

6. REFERENCES

City of Bozeman, 2007. 2005-2006 West Babcock Street Pedestrian and Bicycle Monitoring Project. www.bozeman.net/planning

Duvall, Andrew 2010. Public Bicycle Sharing as a Population-Scale Health Intervention for Active Transportation Activity in Denver, Colorado. Unpublished Dissertation Prospectus. IGERT Fellow Center for Sustainable Urban Systems, University of Colorado, Denver.

FHWA and PBIC 2010. The National Bicycling and Walking Study: 15-Year Status Report.

League of American Bicyclists, 2008. LAB website at http://www.bikeleague.org/

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Appendix 1: Greenhouse Gas Inventory

Greenhouse Gas Inventory Report

Montana State University

04 21 10

Prepared by McKinstry

Prepared for Montana State University

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Greenhouse Gas Inventory Report

Montana State University

EXECUTIVE SUMMARY

Reporting university Greenhouse Gas (GHG) emissions is a critical step in planning for a sustainable campus and is a requirement for signatories of The American College & University President's Climate Commitment (ACUPCC). McKinstry Co was engaged by Montana State University (MSU) to assist in this process. It was determined that the total emissions for the 2009 reporting period were 77,375 Metric Tonnes Carbon Dioxide Equivalent (MT CO_2e), taking into account Scope 1, 2, and 3 emissions. This is a higher than average emissions value when compared to many ACUPCC institutions, but includes thorough data for Scope 3, emissions that are, at this time, omitted by many institutions.

INTRODUCTION

As a signatory to The ACUPCC, MSU has made an institutional commitment to reduce greenhouse gas emissions from campus operations and achieve a carbon neutral footprint. The initial step in achieving this goal is to complete a comprehensive GHG emissions inventory. In September of 2009, MSU contracted with McKinstry Co. to assist in compiling this information. The findings in this report are the result of a joint effort from McKinstry and multiple members of the MSU staff.

GHG accounting and reporting was based on the principles set forth in the World Resource Institute GHG Protocol. These are:

Relevance – Ensure the GHG Inventory appropriately reflects the GHG emissions of the university and serves the decision making needs of users – both internal and external to the university.

Completeness – Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.

Consistency – Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document and changes to the data, inventory boundary, methods, or any other relevant factors in the time series.

Transparency – Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.

Accuracy – Ensure that the quantification of GHG emissions is systematically neither over nor under actual emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

MSU's 2009 GHG inventory was based on university data for the 2008-2009 fiscal year (July 2008 – June 2009), and was calculated using the Clean Air Cool Planet Campus Carbon Calculator v6.4. Data was collected from a variety of sources, and some incomplete data was extrapolated to provide MSU with an estimate based on the best available data.

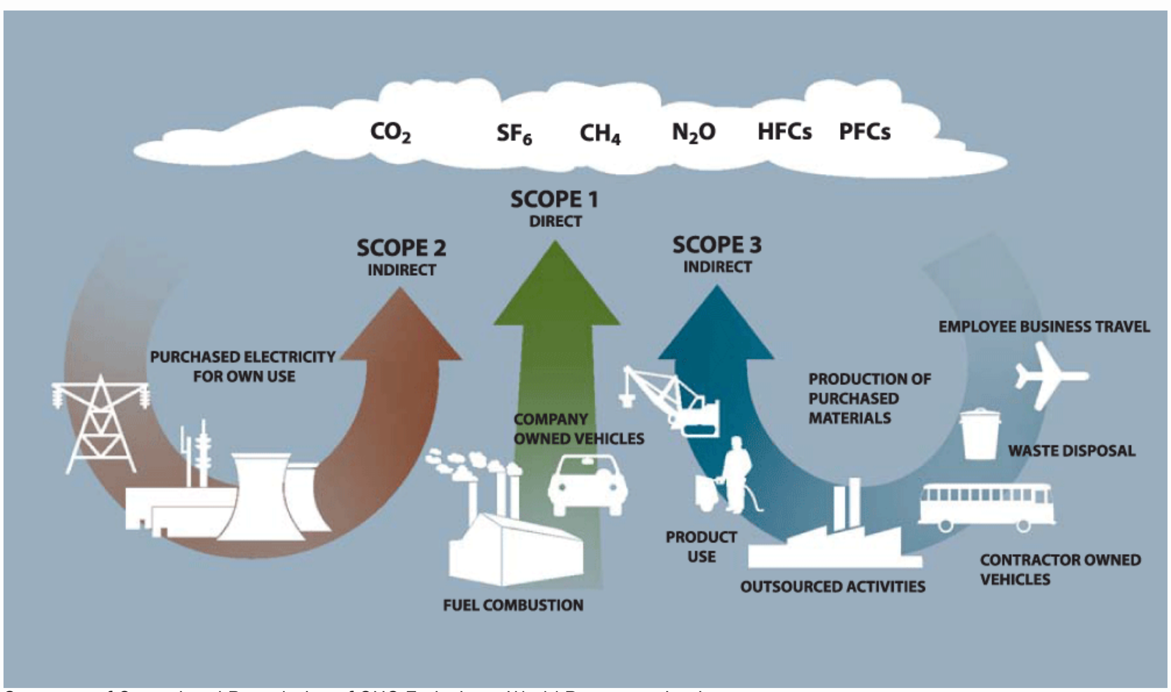
REPORTING BOUNDARIES

Through discussions with MSU, it was determined that the scope of this report would be limited to MSU activities at the Bozeman campus. Additionally, it was agreed that MSU would use the Operational Control Approach in determining organizational boundaries on the campus. Under this approach, MSU is accounting for GHG emissions from all operations under its operational control, which refers to the authority to introduce and implement operating policies, and is consistent with the ACUPCC reporting guidelines. The commitment requires that signatories report on and mitigate emissions only from Scope 1 and 2 sources, as well as commute and air travel from Scope 3. Comparing this inventory with peer institutions reveals that most inventories focus on required emissions sources. This inventory aims to document all MSU emissions, regardless of the required mitigation responsibilities.

It can be argued that many Scope 3 emissions are not under direct MSU control and should therefore be excluded. Holding the university accountable for personal commute choices and habits could be argued as outside the control of the reporting institution, and should not impact its footprint. MSU feels that it is important to accurately account for all emissions resulting from university existence, and this cannot exclude emissions from choices of the campus population, and are therefore included in this report.

DESCRIPTION OF EMISSION SOURCES

Throughout this report, emissions are grouped into three different Scope categories. Scope 1 emissions are direct GHG emissions occurring from sources that are owned or controlled by the institution. Scope 2 emissions account for indirect GHG emissions that are a consequence of activities that take place within the organizational boundaries but that occur at sources owned or controlled by another entity, such as purchased electricity. Scope 3 emissions are all indirect emissions not covered in Scope 2, and focus on cultural emissions associated with travel, waste, and commuting habits of the university. By understanding where university emissions are concentrated, MSU will be better prepared to strategically approach reduction to meet the ACUPCC requirements of achieving a carbon neutral campus.

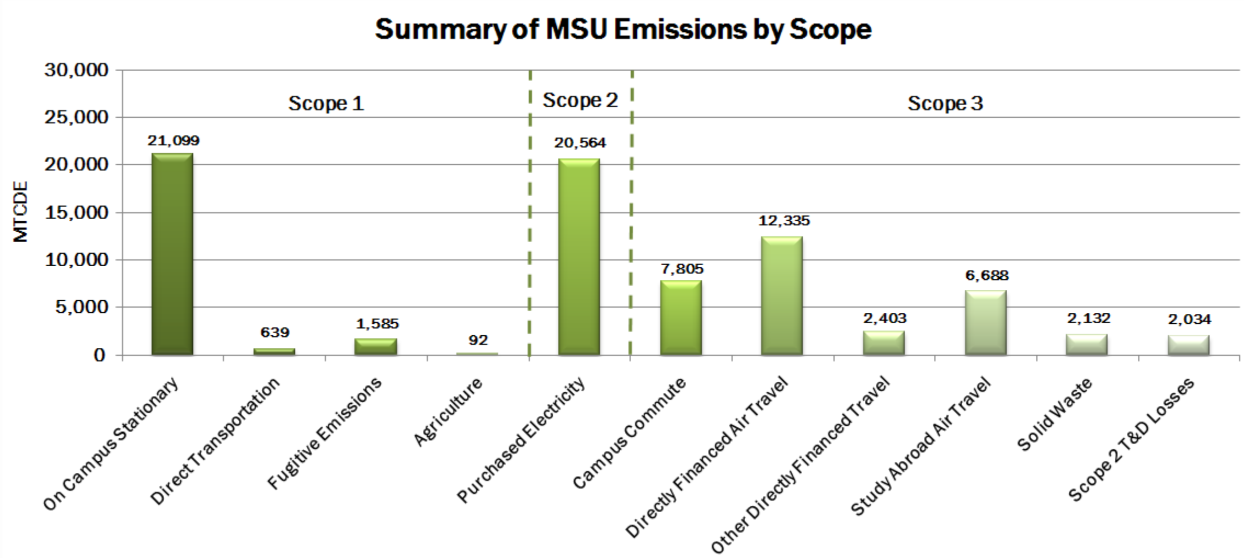


Summary of Operational Boundaries of GHG Emissions. World Resources Institute.

INVENTORY RESULTS

Well tracked data for Scope 1 and Scope 2 were typically available for the university, but some Scope 3 data, specifically other directly financed air and ground travel, were based upon best available data, recommended conversion factors, and supplemented by estimates from other ACUPCC universities. MSU's emissions presented in this report reflect a higher than average value than comparable universities on the ACUPCC website. It is important to note that many of these institutions have not reported on air travel, and many do not include comprehensive commute data. By omitting these Scope 3 emissions from the GHG reports, the university total emissions are considerably lower than the 77,375 MT CO_2e reported for MSU. MSU and McKinstry choose to report on all data collected by MSU, and make assumptions for unknown parameters (study abroad air miles) in order to present the most comprehensive footprint information available. Although not all of these emissions are required reporting for ACUPCC, it is recommended that MSU continues to view their GHG inventory holistically and report on full emissions. MSU acknowledges that their reported emissions are likely to change as they evolve their data collection protocols, and are not required to report on all emissions stated in compliance with ACUPCC. The table and graph below represent the total MSU GHG emissions by scope and source based on best available data.

2009	MT CO_2e	% of Net Emissions	ACUPCC required?
Co-gen Electricity	0	0%	yes
Co-gen Steam	0	0%	yes
Other On-Campus Stationary	21,099	27%	yes
Direct Transportation	639	1%	yes
Refrigerants & Chemicals	1,585	2%	yes
Agriculture	92	0%	yes
Purchased Electricity	20,564	27%	yes
Purchased Steam / Chilled Water	0	0%	yes
Faculty / Staff Commuting	3,733	5%	yes
Student Commuting	4,073	5%	yes
Directly Financed Air Travel	12,335	16%	yes
Other Directly Financed Travel	2,403	3%	recommended
Study Abroad Air Travel	6,688	9%	yes
Solid Waste	2,132	3%	yes
Wastewater	0	0%	recommended
Paper	0	0%	recommended
Scope 2 T&D Losses	2,034	3%	recommended
Additional	0	0%	recommended
Non-Additional	0	0%	recommended
Scope 1	23,415	30%	
Scope 2	20,564	27%	
Scope 3	33,397	43%	
All Scopes	77,375	100%	
All Offsets	0		
TOTAL EMISSIONS	77,375		



The baseline Greenhouse Gas Inventory for the MSU campus is estimated to be approximately 77,375 MT CO_2e /yr, including Scope 1, 2, and 3 metrics. Understanding where emissions are coming from will help MSU focus reduction goals and track their progress as they reduce emissions across all three scopes.

DATA COLLECTION METHODOLOGY

Below is a summary of how data for this report was collected, and any calculations or extrapolations used to generate the GHG inventory report. For a full list of assumptions and standard calculations, please reference the Assumptions and Calculations in Appendix 1.

General University Data

University Population – The MSU "Quick Facts 2008-2009" report was used for the university population. For faculty and staff, full time equivalent (FTE) employee numbers were used.

Scope 1 Emissions

Stationary Combustion –This accounts for the total direct emissions from stationary combustion on the MSU campus. Stationary combustion refers to the burning of fuels to produce electricity, steam, heat, or power using equipment in a fixed location such as boilers, burners, heaters, furnaces, incinerators, kilns, ovens, dryers, and engines. Any biogenic carbon dioxide emissions that result from the combustion of biomass or biomass-based fuel are not included in Scope 1. Complete records of all utility bills were provided by Patti Yasbek and the facilities group.

Mobile Combustion from Direct Transportation – Accounts for the total direct emissions from mobile combustion in MSU-owned fleet such as cars, trucks, tractors, and buses. These emissions were captured from MSU fuel records from motor pool and Gas Island fuel sales for campus fleet vehicles supplied by Patti Yasbek and Laura Humberger at MSU.

Fugitive Emissions – Data for emissions due to the intentional or unintentional release of GHGs in the production, processing, transmission, storage, and use of fuels and other substances were supplied by Dan Stevenson at MSU. This includes releases of hydro fluorocarbon during the use of refrigeration and air conditioning equipment and methane leakage from natural gas transport. The CACP calculator identifies specific emissions factors for each type of refrigerant used on campus based on the Global Warming Potential (GWP) for the individual refrigerant. For refrigerants not in the CACP calculator, MSDS sheet values for GWP were used.

Agricultural Emissions – This captures emissions from on-campus fertilizer application.

Scope 2 Emissions

Purchased Electricity – This captures the total indirect GHG emissions resulting from the generation of electricity purchased and used by MSU. Default eGRID region and sub-region emissions coefficients for Bozeman, Montana (supplied in the Clean Air-Cool Planet Campus Carbon Calculator v6.4) were used for all electricity emissions calculations.

Purchased Steam – MSU does not purchase any steam or chilled water.

Scope 3 Emissions

Commute Transportation – A commute survey was created and administered by Gretchen Hooker with ASMSU. This survey was distributed to faculty, staff and students on the MSU campus. Results from this survey were used to calculate emissions from student, faculty, and staff commuting. Extracting usable data required query sorting of the survey responses, and is explained in the following bullets. A total of nine sorted reports were used to populate commute data for the GHG inventory.

CACP methodology for calculating commuting data bases calculations on FTE student population, giving part-time students equivalent of one-half a full-time student. This may not accurately capture the complex commute patterns of students going to and from campus, but until more accurate tracking is established, the CACP protocol will be used for MSU calculation.

- Commute Preferences – To determine primary commute patterns for students, faculty and staff, each group was sorted individually. Responses to question four of the survey would then show the primary commute habits of each group (bus, SOV, carpool etc). Because the survey separated out commute choices by season, averages were calculated for the GHG Inventory inputs. For faculty and staff, full-year averages were used because they are employed on a 12 month pattern. For student averages, spring/fall and winter response averages were used to determine % utilizing each mode of transportation as their primary commute choice during the school year.

- Driving Distance – To determine the average trip distance for drive-alone commuters, each response group was filtered to sort by status (student, faculty or staff), and to those that selected “drive-alone” as their primary commute choice. The survey allowed respondents to specify distance they lived from campus. An average of these values was calculated for each group to enter into the CACP workbook. Any extreme outlier responses were omitted.

- Bus Distance – To determine the average trip distance for bus commuters, each response group was filtered to sort by status (student, faculty or staff), and to those that selected “bus” as their primary commute choice. The survey allowed respondents to specify distance they lived from campus. An average of these values was calculated for each group to enter into the CACP workbook.

- Weeks Worked/Trips Per Week – Values entered for the number of weeks commuting were assumed based on MSU data for employee benefits and academic calendars. It was assumed that all employees and students were commuting five days per week, to and from campus.

Air Travel – Air travel accounts for a large portion of most universities GHG emissions. Reported emissions from air travel for MSU are estimates based on best available data and extrapolations. The following bullets explain the methodology to calculate these Scope 3 emissions from MSU.

- Athletic Air Travel – Athletic air travel was tracked by MSU for the 2008-2009 academic year. This data was provided in dollars spent for each trip. The CACP input requires air miles, so to extrapolate air miles from these dollar values, the recommended ATA conversion factor[1]. It is entered into the CACP workbook as student air travel.

- Faculty and Staff Air Travel – MSU air travel spending is automatically tracked through the university purchasing card records and expense reports. The total spent on university air travel related to research and other travel was converted to air miles using the ATA conversion used throughout all MSU air travel calculations; this is equivalent to approximately 12,756,878 air passenger miles.

- Study Abroad Air Travel – At this time, MSU does not track or record air miles associated with study abroad travel. Rather than leave this value at zero, the reporting team used estimated study abroad miles based on other reporting universities based on air miles per student. This estimate will be refined in future reports at MSU develops tracking protocol to capture study abroad travel.

Other Transportation – Reported emissions from air travel for MSU are estimates based on best available data and extrapolations. The following bullets explain the methodology to calculate these Scope 3 emissions from MSU research travel.

- Reimbursement for Mileage– Calculated from total dollar value reported by MSU using 2007-2008 standards reimbursement rates per mile.

- Fuel Costs – Calculated based on total reported fuel expenditures at $2.50 per gallon.

- Bus Mileage – Bus data was only available specifically for athletic teams. For bus-only trips, MapQuest.com round trip distances between MSU and the opponent city were used for mileage. For trips where busses and airlines were used, it was assumed that each bus on the trip traveled 150 miles. Number of busses were based on number of participants (provided by MSU Athletic Department) and bus capacity of 49 passengers.

Solid Waste – This captures the total indirect GHG emissions resulting from the incineration or decomposition of MSU's solid waste.

Offsets – MSU does not currently purchase any offsets for their GHG emissions.

Report Omissions

Various inputs were omitted from this report due to a lack of data availability. MSU acknowledges these omissions impact the accuracy of this report, and are working to collect these data for future reports. The future inclusion of these inputs may or may not significantly change MSU's GHG footprint.

[1] The ACUPCC Instructions for Submitting a Greenhouse Gas Report states that 'for guidance on calculating air travel emissions, you may consult "Guidance on Scope 3 Emissions, pt 2: Air Travel" on the AASHE Blog. The AASHE Blog states that you can use statistics on the average price per passenger air mile from the Air Transportation Association of America to convert the total air travel expenditure into passenger air miles. Since the figures from the ATA exclude taxes, AASHE recommends adjusting the cost per passenger mile up by 20 percent to take taxes into account. The ATA data indicates that the nominal domestic yield in dollars per passenger mile was $0.1384 in 2008. Adjusting this cost up by 20 percent per AASHE recommendations results in a cost of $0.16608 per passenger mile.

Paper – MSU data not available.

Wastewater – MSU data not available.

Recommended Inventory Improvements

Through the process of collecting, compiling, and reporting the 2009 GHG Inventory, gaps in current data collection processes were identified. The most critical improvements need to be addressed in accurate data collection for air travel miles and commute transportation patterns.

It is recommended that for future commute transportation surveys, MSU consider alternative methods that will reach more respondents. It is also recommended that the question "How many miles do you live from campus?" be rephrased "How many miles is your daily commute?" It was found that some faculty not on campus responded with 100's of miles from campus (probably not their daily commute) which could skew averages if outliers had not been omitted. This change would more accurately capture what the emissions impact from daily commuting is for MSU employees and students.

The commuter survey did not account for commuting via light rail or commuter rail. If and when this becomes an option for campus commuters, it should be added to the response options.

For future accurate reporting, MSU should establish protocol for tracking air miles for faculty and staff travel, for-credit study abroad, and athletics. The most accurate reporting would come from direct collection of passenger miles (ground or air) rather than dollar amounts. In the current athletics tracking system, some recommended improvements would include miles driven on each bus and rental car. From the data provided, it is difficult to accurately convert dollars spent to miles driven. As MSU refines their data collection methods, future GHG Inventories will represent more accurate Scope 3 emissions.

Potential GHG Reduction Strategies

The first step in determining potential GHG reduction strategies is to understand the various emission sources that make up a university's GHG Inventory. Looking at the summary of MSU emissions by scope reveals that electricity use and Scope 3 transportation make up the most significant contribution to MSU's footprint. Strategic approach to reduction of these key areas will have the most dramatic reduction potential for the university.

Scopes 1 & 2 Reduction

The majority of Scope 1 & Scope 2 emissions come from on campus stationary sources and purchased electricity. These emissions are a direct result of energy use at the facilities on campus. In order to reduce these emissions a number of steps can be taken. The first step is to look into the behavior of the students, faculty, and staff. Are lights being left on? Are thermostats turned up in the winter? The next step would be to conduct a comprehensive facility audit. This audit would allow MSU to evaluate any potential Facility Improvement Measures (FIMs) that would save energy, reduce energy cost, and reduce the emissions inventory.

After all FIMs are analyzed, an implementation strategy would be put into place that would help MSU prioritize the FIMs based on areas such as carbon reduction, first cost, payback, capital / maintenance need, etc. Once an implementation plan is put in place for the FIMs, the university would then look at renewables as a method to further reduce its Scope 1 and Scope 2 emissions. This would include evaluating technologies such as solar, wind, and biomass. These technologies are still fairly expensive and would likely only make sense on a large scale after all FIMs are pursued. Finally, MSU could look into carbon offsets for the remainder of the emissions.

Scope 3 Reduction

Reducing Scope 3 emissions will require that MSU adopt additional policies and programs to incentivize options that will reduce emissions. Since MSU's Scope 3 emissions are impacted most heavily by air travel and campus commuting, programs focused on education and increasing viability of alternative options will have the greatest impact on Scope 3 of the campus footprint. Waste reduction would also have an impact and should be considered in a more comprehensive action plan.

Commuter Reductions – To further reduce emissions from commuters, it is recommended that MSU expand on current programs, as well as implement new ones. It is important to the MSU continue promoting any benefits it is already offering to faculty, staff and students. Increasing awareness about these programs has dramatic potential to boost participation. Additional strategies for further reducing commuter emissions include:

- Offer more online courses
- Increase parking fees
- Subsidized public transportation passes
- Carpool priority parking
- Restrict student cars and/or parking to upper classmen
- Installation of more bike racks and bike paths
- Subsidize on-campus housing to minimize off-campus living
- Education to campus about carbon footprint goals and the impact of individual commute choices
- Convert parking lots to green space

Air Travel Reductions – Air travel reductions are challenging because many programs are viewed as beneficial and valuable as part of the college experience. Student air travel is calculated from air miles from for-credit study abroad programs and athletics. To reduce air miles for study abroad activities, the university could look at having students purchase offsets for their trips or encourage destinations nearer to Seattle. The athletics department should look at the possibility of driving to more local athletic events rather than flying. Air travel from faculty and staff could be reduced by cutting air travel budgets, and encouraging them to select only the most important events to attend.

As a signatory to the ACUPCC, the next step for MSU is to create a Climate Action Plan. This plan will take a closer look at these and other strategies to reduce MSU's carbon footprint.

CONCLUSION

This report captures the 2009 GHG Inventory for MSU based upon the most accurate campus data available. As signatories to the ACUPCC, MSU is striving to benchmark their greenhouse gas emissions and begin the process to achieve carbon neutrality. This benchmark value will help MSU better understand their current emission sources so that they can approach carbon reduction in the most strategic manner possible. As MSU works towards carbon neutrality, their development of a climate action plan will need to address both campus emissions concerns from both an operations and cultural standpoint to truly achieve the results they are seeking.

APPENDIX

SECTION 1: EMISSION FACTORS AND CARBON RISK

Understanding the potential range of emission values important for MSU when they analyze their footprint, and when comparing it to other universities across the nation. MSU and McKinstry opted to use the most commonly accepted option, the NREC eGRID sub-regional mix published by the United State Environmental Protection Agency (EPA). The ACUPCC recommended Clean Air Cool Planet Campus Carbon Calculator (used in this GHG inventory), and automatically defaults to this sub-regional value. Institutions do have the option of entering "custom" local mixes, but these values may not be widely accepted for comparison to other reporting institutions.

While this value does represent the current regional average, these regions have been known to change. The NERC regions substantially changed between 2002 and 2006, consequently altering the eGRID sub-regions to order to reflect these changes. Below are two maps that reflect these changes. The first map shows the pre-2006 eGRID regions; the second shows the current eGRID regions. It is important to note that this change resulted in larger electricity emission factor in 2006, and that anyone using the eGRID numbers would show a corresponding increase in their carbon footprint.

Another reasonable option for selecting an electricity emissions factor would be to use the national average. This number would be higher than the regional number and the number based on the local fuel mix. It is speculated by many people in the industry that the national average emissions factor could become the standard used in all carbon calculations if the United States goes to a Cap and Trade system or a Carbon Tax. By adopting a national average for calculation of MSU's GHG Inventory, it is likely to increase with the addition of more carbon intensive energy sources (such as coal) from the East Coast.

Many universities are currently reporting on only minimal data, and using local "custom" fuel mixes showing potentially inflated values for low-carbon source electricity. As more rigid requirements for standard reporting are developed, these universities footprints are likely to increase more significantly than MSU's due to MSU's comprehensive reporting methodology presented in this report.

MSU Custom Mix Analysis

When MSU compared their GHG inventory calculated using the recommended eGRID sub regions verses the university "custom" mix, the result showed a very minor difference. The custom mix of electricity that the university purchases is made up of very similar components represented by the eGRID sub region. In this situation, either mix would have provided a similar emissions total from the university, but it is recommended that they continue to report with emissions based on eGRID for consistency.

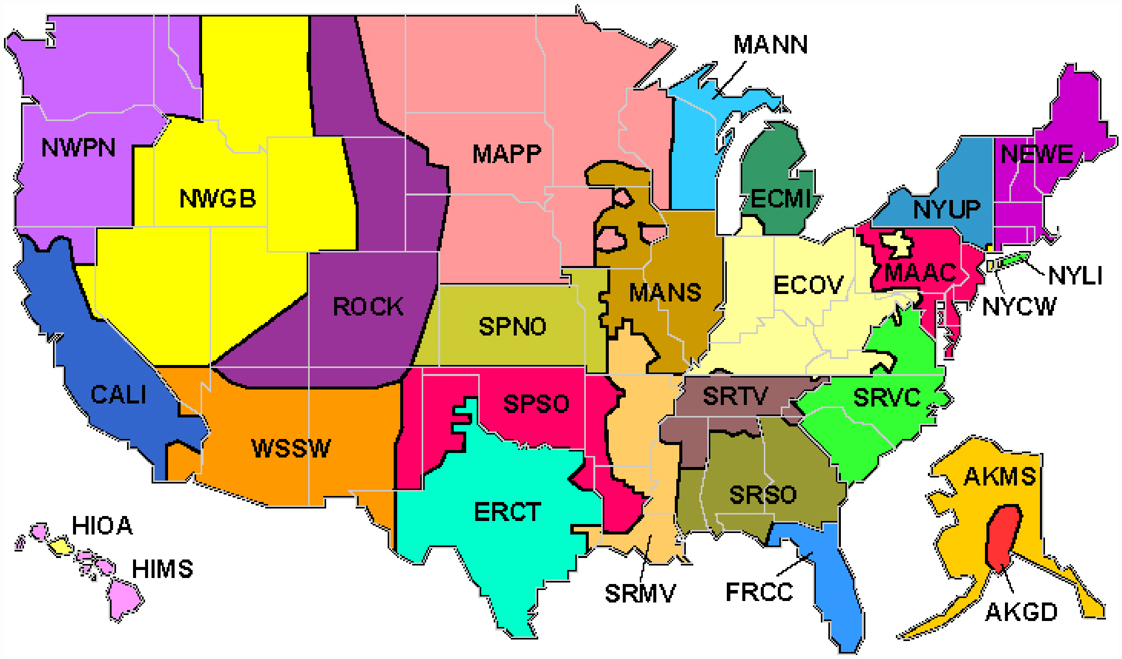
The difference in emissions from purchased electricity (Scope 2) was only 1,082.3 CO_2e.

MSU emissions with eGRID factors - Scope 2: 20,563.5 MT CO_2e (77,375.2 total)

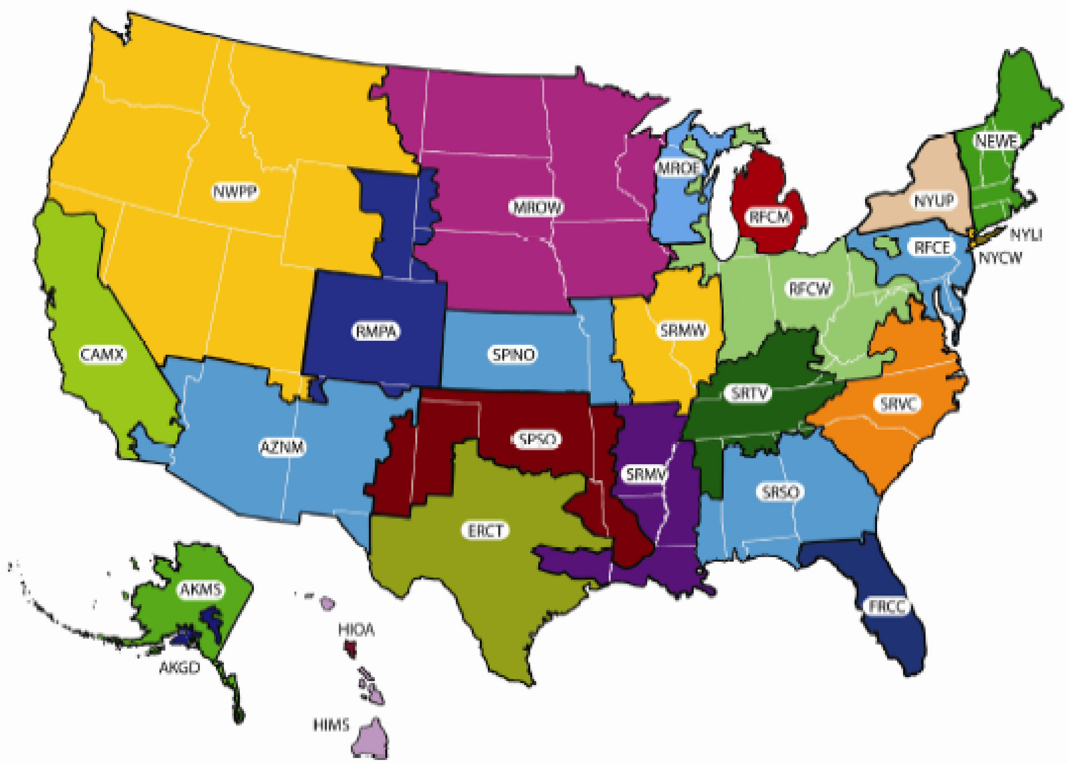
MSU emissions with custom mix – Scope 2: 21,548.4 MT CO_2e (78,457.5 total)

The following maps show the history of eGRID regional emissions areas changes between 2002 and 2006, illustrating an example of how redefining sub-region boundaries can influence fuel emission factors.

eGRID 2002 Regional Map



eGRID 2006 Regional Map



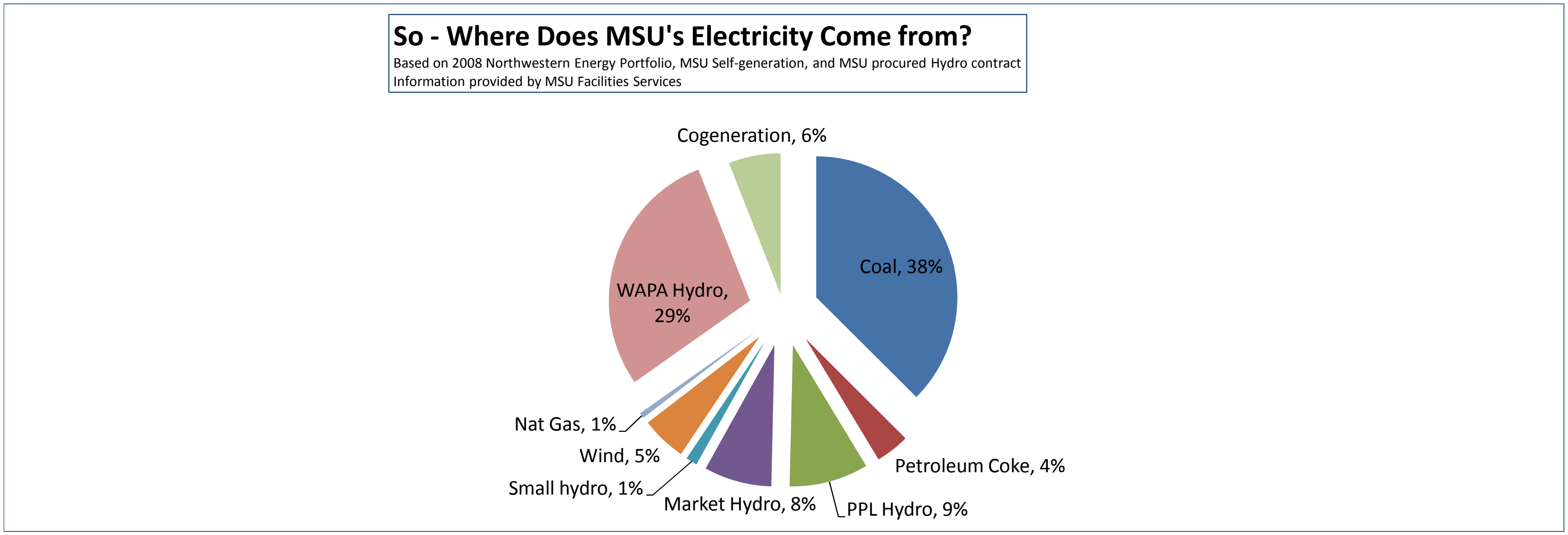
Comparison: MSU Local Mix Calculation

On this worksheet: Summary information from an inventoried year.

MODULE	**Summary**
WORKSHEET	**Overview of Annual Emissions**
UNIVERSITY	**Montana State University**

Select Year -->	**2009**	**Energy Consumption**	**CO_2**	**CH_4**	**N_2O**	**eCO_2**
		MMBtu	kg	kg	kg	Metric Tonnes
Scope 1	Co-gen Electricity	-	-	-	-	-
	Co-gen Steam	-	-	-	-	-
	Other On-Campus Stationary	398,684.1	21,038,005.7	2,105.8	42.3	21,099.0
	Direct Transportation	8,863.8	625,539.3	106.6	37.5	639.1
	Refrigerants & Chemicals	-	-	-	-	1,585.3
	Agriculture	-	-	-	309.7	91.7
Scope 2	Purchased Electricity	505,416.3	21,436,253.4	244.0	359.8	21,548.4
	Purchased Steam / Chilled Water	-	-	-	-	-
Scope 3	Faculty / Staff Commuting	51,924.5	3,642,451.6	721.8	248.7	3,732.7
	Student Commuting	56,640.7	3,974,894.2	780.3	269.2	4,072.5
	Directly Financed Air Travel	62,602.4	12,291,201.6	121.0	139.1	12,335.2
	Other Directly Financed Travel	33,431.8	2,344,459.9	468.0	161.1	2,402.9
	Study Abroad Air Travel	33,942.0	6,664,081.2	65.6	75.4	6,687.9
	Solid Waste	-	-	92,682.9	-	2,131.7
	Wastewater	-	-	-	-	-
	Paper	-	-	-	-	-
	Scope 2 T&D Losses	49,986.2	2,120,069.0	24.1	35.6	2,131.2
Offsets	Additional					-
	Non-Additional					-
Totals	Scope 1	407,547.9	21,663,545.0	2,212.4	389.5	23,415.0
	Scope 2	505,416.3	21,436,253.4	244.0	359.8	21,548.4
	Scope 3	288,527.6	31,037,157.5	94,863.7	929.2	33,494.1
	All Scopes	1,201,491.8	74,136,956.0	97,320.1	1,678.5	78,457.5
	All Offsets					-
					Net Emissions:	**78,457.5**

MSU Local Electricity Mix



MSU's Electric Portfolio (Combined NWE,WAPA, and CoGen)	% MSU Portfolio	% NWEn Portfolio
NW Energy	**65%**	100%
Coal	38%	58%
Petroleum Coke	4%	6%
PPL Hydro	9%	14%
Market Hydro	8%	12%
Small hydro	1%	2%
Wind	5%	8%
Nat Gas	1%	1%
WAPA Hydro	**29%**	
Cogeneration	**6%**	

provided by MSU

CACP Inputs		
coal and petroleum coke	42%	44%
hydro	47%	50%
natural gas	1%	1%
wind	5%	6%
cogen accounted for in scope 1		

multiple hydro sources combined in CACP
coal and petroum coke combined in CACP (same emissions factor)
cogeneration was already accounted for and therefore omitted

Northwestern Energy
2008 Montana Electric & Gas CO2 Emissions Estimate

Electric Business

Assumptions
1. Electric market and PPL contract purchases are allocated according to
   an estimated Montana resource mix of 60% coal / 40% hydro.
2. Total resource procurement includes transmission losses.

	2008 MWh	% of Portfolio
2008 Retail Sales	5,969,702	
2008 Required Procurement to Serve Load	6,522,929	
Resources by Type		
Coal		
Colstrip 4	943,910	14%
QF Coal	293,305	4%
PPL Contract 60%	1,365,840	21%
Market 60%	1,164,938	18%
	3,767,993	58%
Petroleum Coke		
QF BGI	405,625	6%
Natural Gas		
Basin Creek	45,845	1%
Non-Emitting		
PPL Contract 40%	910,560	14%
QF Wind	8,987	0%
QF Hydro	60,871	1%
Tiber Hydro	43,901	1%
Judith Gap Wind Farm	502,522	8%
Market 40%	776,625	12%
	2,303,466	35%
Total Resource Procurement Including Losses	**6,522,929**	**100%**

Metric Tons CO_2 Emissions / MWh	Metric Tons CO_2 / MWh	
Coal	1.13	4,272,101
Petroleum Coke	1.13	459,892
Natural Gas	0.40	18,338
Total Metric Tons CO_2 Emissions		**4,750,331**

Gas Business

	2008
Lbs CO_2 / Dkt	117
2008 Montana Retail Sales (Dkt)	20,495,762
Total Metric Tons CO_2 Emissions	**1,087,530**
Emissions as % of Total Retail Sales	**5%**

Following calculations by MSU Facilities Services:

LB CO2/KWH CALCULATION USING RETAIL SALES MWH

2204.62262	lb/metric ton	x		4,750,331	metric tons	=	10472687110	lbs co2	
10472687110	lbs co2	/	(	5,969,702	Net MWH	x	1000	kwh/mwh	)
						=	**1.754**	**lbCO2/KWH**	

LB CO2/KWH CALCULATION USING PROCUREMENT TO SERVE LOAD (MWH)

2204.62262	lb/metric ton	x		4,750,331	metric tons	=	10472687110	lbs co2	
10472687110	lbs co2	/	(	6,522,929	Net MWH	x	1000	kwh/mwh	)
						=	**1.606**	**lbCO2/KWH**	

SECTION 2: MSU GHG ASSUMPTIONS AND CALCULATIONS

General Assumptions:

All inputs were entered in the Clean Air Cool Planet Campus Carbon Calculator v6.4.
It was assumed that MSU provided complete and accurate data capturing all travel for the Bozeman campus activities.
Data provided was accurate for the 2008-2009 academic year.

SCOPE 1:

1. Data provided by MSU for on campus stationary.
2. Campus directly financed transportation fuel values were proved for fuel purchased on fuel cards and at the MSU fuel island. It was confirmed with the accounting department that these values were not double counted with other travel in Scope 3.
3. Values for refrigerant used were provided by MSU. For GWP values not found in the CACP calculator, “other” was specified and GWP from MSDS sheets for those refrigerants were used.

SCOPE 2:

1. Data provided by MSU for purchases electricity was based on utility data for the Bozeman campus between July 2008 and June 2009.
2. Default CACP emissions values (eGRID sub region NWPP WECC Northwest) were used for calculating emissions.

SCOPE 3:

Data feeding inputs for Scope 3 Directly Financed Travel were provided by the MSU Accounting Department. Totals from MSU records provided in the Travel Info Provided to McKinstry 2-20-2010.exl document were used to calculate input miles based on the following assumptions. A summary of final inputs can be found in the *MSU GHG Travel Inputs.xls*. A copy is located in the appendix.

Air Travel:

Faculty/Staff/Athletics Air Passenger Miles

1. Air miles were based on total cost – provided by accounting department at MSU
2. Converted to miles based on $0.16608 per mile (ATA recommendation)

Study abroad Air Miles

1. Miles estimated based on averages per student population from other ACUPCC reporting institutions
2. Study abroad air miles based on MSU full-time student population only
3. Likely to change as MSU develops better tracking systems for their students

Directly Financed Ground Transportation:

General Ground Transportation

1. Based on total cost – provided by accounting department at MSU
2. Assumed that bus travel only occurred in athletics dept records, all other ground transportation was taxi service
3. All athletics costs were captured on both Athletics department records and Accounting records
4. Subtracted off total bus (MSU athletics) costs from total ground transportation (provided by MSU accounting) to obtain total non-bus travel costs
5. All non-bus travel costs were converted to miles based on the following assumptions:

   a. 40% of ground transportation costs were fuel
   b. Fuel costs $2.50 per gallon
   c. Average fuel efficiency 22 mpg

Bus Transportation (from Athletics only)

1. Bus travel miles were estimated through the following assumptions:
   a. Distances were estimated based on provided between cities specified by MSU athletics department records entered into Mapquest.com
   b. Bus capacity 49 passengers, # of busses on each trip based on size of team (provided by athletics department)
   c. Athletic trips with air travel as primary source of travel assumed 150 miles per bus on the trip

Personal Mileage Reimbursement

1. Based on total cost provided by MSU accounting department records
2. Based on high (no motor pool available) and low (motor pool available and opted for personal use) standard mileage reimbursement rates as follows:
   a. 2008 mileage rates
      i. high = $0.585 per mile
      ii. low = $0.265 per mile
   b. 2009 mileage rates
      i. high = $0.55 per mile
      ii. low = $0.28 per mile
3. Assumed 50% of personal mileage reimbursement at each high and low level, working out to an average of $0.42 per mile
4. Assumed personal mileage reimbursements had even distribution throughout 2008-2009 fiscal year at MSU

Motor Pool

1. Motor pool total expenditures captured both fuel and rental costs
2. 40% of motor pool costs were fuel
3. Fuel costs $2.50 per gallon
4. Average fuel efficiency 22 mpg

“Other” Data

1. “Other” data was available on costs associated with travel through the MSU Accounting department files. These expenditures accounted for various travel expenses including but not limited to: meals, lodging, ground transportation, registration fees, car rentals, fuel, airfare, mileage and miscellaneous expenses. Due to the ambiguity of the expenses in this category, all “other” expenditures were omitted from any calculations for the 2009 GHG inventory.

Commuting:

1. Student, staff and faculty commute data was collected by MSU in a survey.
2. It was assumed that this survey accurately captures the average commute habits of the Bozeman campus population.
3. Commute data does not account for student travel beyond their daily commute. All personal travel while at MSU and to and from their permanent address are not within the scope of the MSU GHG footprint.

Section 3: MSU Supporting Data

The following pages contain background data provided by MSU for the compilation of their 2009 GHG Inventory.

1. 2008-2009 Utilities
2. Refrigerant Usage
3. Refrigerant GWP Data – R414B Hot Shot
4. Refrigerant GWP Data – R-502
5. MSU provided Travel Information
6. travel Inputs
7. Commute Survey Summary
8. Fuel Use Summary

ELECTRICITY RECONCILIATION BY VENDOR

QRY: GGIEGROSS

GROSS PURCHASED ELECTRICITY	Month	Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Total
Purchased Units (no cogen)	KW Units	8,170	8,165	8,723	8,934	8,529	8,310	7,999	8,147	8,172	8,706	8,215	8,131	100,201
Purchased Units (no cogen)	KWH Units	4,346,153	4,258,003	4,426,655	4,669,994	4,411,055	4,570,559	4,494,153	4,287,124	4,555,619	4,523,891	4,144,651	3,962,902	52,650,759
$$ paid to WAPA & NWE	KW$	$58,742	$58,686	$61,144	$62,009	$65,733	$63,528	$60,741	$63,577	$64,172	$68,062	$57,497	$57,206	$741,099
$$ paid to WAPA & NWE	KWH$$	$193,719	$216,921	$241,501	$214,267	$176,816	$171,130	$169,528	$165,017	$178,908	$181,544	$189,347	$188,658	$2,287,355
$$ paid to WAPA & NWE	Total $$	$252,461	$275,607	$302,645	$276,276	$242,549	$234,658	$230,270	$228,594	$243,080	$249,606	$246,844	$245,865	$3,028,454

ELEC09etc & ELEC10etc.xlsx & QRY: GGICOGEN

SOUTH SIDE SUBSTATION		Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Total	
Portion of SSS supplied by NWE (per NWE)	KW Units	5,560	5,568	5,896	6,078	4,860	4,569	4,269	4,452	4,477	5,041	5,607	5,605	61,982	
Portion of SSS supplied by WAPA (per NWE)	KW Units	2,022	2,027	2,113	2,113	3,072	2,987	3,021	2,942	3,001	3,072	1,942	1,912	30,224	**33%**
Total KW Units	**KW Units**	**7,582**	**7,595**	**8,009**	**8,191**	**7,932**	**7,556**	**7,290**	**7,394**	**7,478**	**8,113**	**7,549**	**7,517**	**92,206**	
Portion of SSS supplied by NWE (per NWE)	KWH Units	2,276,164	2,727,504	3,443,461	3,034,761	2,326,816	2,208,840	2,113,392	2,030,130	2,284,153	2,423,488	2,833,278	2,721,767	30,423,754	
Portion of SSS supplied by WAPA (per NWE)	KWH Units	1,733,728	1,243,429	581,095	1,123,961	1,541,623	1,567,428	1,635,286	1,629,552	1,634,330	1,554,048	976,775	915,307	16,136,562	**35%**
Total KWH Units	**KWH Units**	**4,009,892**	**3,970,933**	**4,024,556**	**4,158,722**	**3,868,439**	**3,776,268**	**3,748,678**	**3,659,682**	**3,918,483**	**3,977,536**	**3,810,053**	**3,637,074**	**46,560,316**	
NWE Charges to supply & deliver NWE elec	KW$	$30,939	$30,983	$32,808	$33,821	$27,044	$25,424	$23,039	$23,597	$23,731	$26,719	$29,720	$29,709	$337,534	
NWE Charges to deliver WAPA Elec	KW$	$11,251	$11,279	$11,757	$11,757	$17,094	$16,621	$16,304	$15,593	$15,907	$16,283	$10,294	$10,135	$164,275	
WAPA Charges	KW$	$11,424	$11,453	$11,938	$11,938	$17,357	$16,877	$17,069	$20,006	$20,407	$20,890	$13,206	$13,002	$185,565	
Total KW$$	**KW$**	**$53,614**	**$53,715**	**$56,503**	**$57,516**	**$61,495**	**$58,922**	**$56,412**	**$59,196**	**$60,045**	**$63,892**	**$53,220**	**$52,846**	**$687,374**	
NWE Charges to supply & deliver NWE elec	KWH$	$147,140	$176,457	$206,347	$175,942	$131,865	$123,568	$122,213	$116,791	$129,687	$133,112	$154,487	$154,068	$1,771,677	
NWE Charges to deliver WAPA Elec	KWH$	$7,068	$5,069	$2,369	$4,582	$6,285	$6,390	$6,667	$6,644	$6,663	$6,336	$3,982	$3,732	$65,789	
WAPA Charges	KWH$	$12,606	$12,496	$12,654	$13,041	$18,583	$19,210	$18,871	$21,865	$23,409	$22,685	$14,048	$13,330	$202,798	
Total KWH$$	**KWH$**	**$166,814**	**$194,022**	**$221,370**	**$193,566**	**$156,733**	**$149,169**	**$147,751**	**$145,300**	**$159,759**	**$162,133**	**$172,518**	**$171,129**	**$2,040,264**	
NWE Charges to supply & deliver NWE elec	**Total SSS $**	**$178,079**	**$207,440**	**$239,155**	**$209,763**	**$158,909**	**$148,992**	**$145,252**	**$140,388**	**$153,418**	**$159,831**	**$184,207**	**$183,777**	**$2,109,211**	
NWE Charges to deliver WAPA Elec	**Total SSS $**	**$18,319**	**$16,348**	**$14,126**	**$16,339**	**$23,379**	**$23,011**	**$22,971**	**$22,237**	**$22,570**	**$22,619**	**$14,276**	**$13,867**	**$230,064**	
WAPA Charges	**Total SSS $**	**$24,030**	**$23,948**	**$24,592**	**$24,980**	**$35,940**	**$36,087**	**$35,940**	**$41,871**	**$43,816**	**$43,574**	**$27,254**	**$26,331**	**$388,363**	
Total $$	**Total SSS $**	**$220,428**	**$247,737**	**$277,873**	**$251,082**	**$218,228**	**$208,090**	**$204,163**	**$204,496**	**$219,804**	**$226,025**	**$225,737**	**$223,975**	**$2,727,638**	

TOTAL ELECTRICITY		Jul 2008	Aug 2008	Sep 2008	Oct 2008	Nov 2008	Dec 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	May 2009	Jun 2009	Total	
Elec supplied by NWE (per NWE)	KW Units	6,148	6,138	6,428	6,593	5,346	5,101	4,783	4,979	4,974	5,543	6,122	6,130	68,285	68%
Elec supplied by WAPA (per NWE)	KW Units	2,022	2,027	2,113	2,113	3,072	2,987	3,021	2,942	3,001	3,072	1,942	1,912	30,224	30%
Elec supplied by Cogen	KW Units	-	-	182	228	111	222	195	226	197	91	151	89	1,692	2%
Total	**KW Units**	**8,170**	**8,165**	**8,723**	**8,934**	**8,529**	**8,310**	**7,999**	**8,147**	**8,172**	**8,706**	**8,215**	**8,131**	**100,201**	100%
Elec supplied by NWE (per NWE)	KWH Units	2,612,425	3,014,574	3,706,882	3,312,801	2,597,613	2,506,363	2,406,743	2,295,829	2,544,110	2,696,661	3,067,162	2,964,115	33,725,278	64%
Elec supplied by WAPA (per NWE)	KWH Units	1,733,728	1,243,429	581,095	1,123,961	1,541,623	1,567,428	1,635,286	1,629,552	1,634,330	1,554,048	976,775	915,307	16,136,562	31%
Elec supplied by Cogen	KWH Units	-	-	138,678	233,232	271,819	496,768	452,124	361,743	377,179	273,182	100,714	83,480	2,788,919	5%
Total	**KWH Units**	**4,346,153**	**4,258,003**	**4,426,655**	**4,669,994**	**4,411,055**	**4,570,559**	**4,494,153**	**4,287,124**	**4,555,619**	**4,523,891**	**4,144,651**	**3,962,902**	**52,650,759**	100%
NWE Charges to supply & deliver NWE elec	KW$	$36,067	$35,954	$37,449	$38,313	$31,282	$30,031	$27,369	$27,978	$27,859	$30,890	$33,997	$34,070	$391,259	53%
NWE Charges to deliver WAPA Elec	KW$	$11,251	$11,279	$11,757	$11,757	$17,094	$16,621	$16,304	$15,593	$15,907	$16,283	$10,294	$10,135	$164,275	
WAPA Charges	KW$	$11,424	$11,453	$11,938	$11,938	$17,357	$16,877	$17,069	$20,006	$20,407	$20,890	$13,206	$13,002	$185,565	47%
Total $	**KW$**	**$58,742**	**$58,686**	**$61,144**	**$62,009**	**$65,733**	**$63,528**	**$60,741**	**$63,577**	**$64,172**	**$68,062**	**$57,497**	**$57,206**	**$741,099**	100%
NWE Charges to supply & deliver NWE elec	KWH$	$174,045	$199,356	$226,478	$196,643	$151,948	$145,529	$143,990	$136,508	$148,836	$152,523	$171,316	$171,597	$2,018,769	88%
NWE Charges to deliver WAPA Elec	KWH$	$7,068	$5,069	$2,369	$4,582	$6,285	$6,390	$6,667	$6,644	$6,663	$6,336	$3,982	$3,732	$65,789	
WAPA Charges	KWH$	$12,606	$12,496	$12,654	$13,041	$18,583	$19,210	$18,871	$21,865	$23,409	$22,685	$14,048	$13,330	$202,798	12%
Total $	**KWH$**	**$193,719**	**$216,921**	**$241,501**	**$214,267**	**$176,816**	**$171,130**	**$169,528**	**$165,017**	**$178,908**	**$181,544**	**$189,347**	**$188,658**	**$2,287,355**	100%
NWE Charges to supply & deliver NWE elec	**Total $**	**$210,112**	**$235,310**	**$263,927**	**$234,957**	**$183,230**	**$175,559**	**$171,359**	**$164,486**	**$176,695**	**$183,413**	**$205,314**	**$205,667**	**$2,410,027**	80%
NWE Charges to deliver WAPA Elec	**Total $**	**$18,319**	**$16,348**	**$14,126**	**$16,339**	**$23,379**	**$23,011**	**$22,971**	**$22,237**	**$22,570**	**$22,619**	**$14,276**	**$13,867**	**$230,064**	
WAPA Charges	**Total $**	**$24,030**	**$23,948**	**$24,592**	**$24,980**	**$35,940**	**$36,087**	**$35,940**	**$41,871**	**$43,816**	**$43,574**	**$27,254**	**$26,331**	**$388,363**	20%
Total $	**Total $**	**$252,461**	**$275,607**	**$302,645**	**$276,276**	**$242,549**	**$234,658**	**$230,270**	**$228,594**	**$243,080**	**$249,606**	**$246,844**	**$245,865**	**$3,028,454**	100%

Electricity Cost for Bldgs Excluded (general bldg tab/exclude)	**$26,440**
Total Included	**$3,002,014**

MSU Refrigerant Usage

TACMO	TACYR	TQTYHR	TITMNO	TDESC	CACP INPUT	GWP
		105.50	PL2555 Total	FREON HOT SHOT R414	none (enter as "other")	1400
		75.00	PL2570 Total	FREON #R404 A	HFC-404a	CACP default
		1,572.00	PL2602 Total	FREON #22	HCFC-22	CACP default
		101.00	PL2603 Total	FREON #R134 A	HFC-134	CACP default
		51.50	PL2606 Total	FREON #502	none (enter as "other")	6200
Grand Total		1,905.00				

** All Quantities reflect pounds used.

Provided by MSU
cutsheets for "other" refrigerants are included in the following pages

TABLE 1 (continued). Physical, safety, and environmental data for refrigerants (sorted by ASHRAE Standard 34 designations).

Refrigerant		Physical data							Safety data					Environmental data		
Number	Chemical formula or blend composition, common name	Molecular mass	NBP (°C)	NBP (°F)	T_c (°C)	T_c (°F)	P_c (MPa)	P_c (psia)	OEL (PPMv)	LFL (%)	HOC (MJ/kg)	HOC (Btu/lb)	ASHRAE 34 safety group	Atmospheric life, τ_{atm} (yr)	ODP	GWP 100 yr
411A	R-1270/22/152a (1.5/87.5/11.0), G2018A	82.36	-39.5	-39.1	99.1	210.4	4.95	718	1000	5.5			A2		0.044	1600
411B	R-1270/22/152a (3.0/94.0/3.0), G2018B	83.07	-41.6	-42.9	96.0	204.8	4.95	718	1000	7.0	6.5	2794	A2		0.047	1700
----	R-1270/22/152a (3.0/95.5/1.5), G2018C	83.44	-41.8	-43.2	95.5	203.9	4.95	718		none					0.048	1700
412A	R-22/218/142b (70.0/5.0/25.0), Arcton TP5R	92.17	-38.0	-36.4	107.2	225.0	4.90	711	1000	8.7			A2		0.053	2300
413A	R-218/134a/600a (9.0/88.0/3.0), Isceon MO49	103.95	-33.4	-28.1	96.6	205.9	4.02	583		8.8			A2		0	2100
414A	R-22/124/600a/142b (51.0/28.5/4.0/16.5), GHG-X4	96.93	-33.0	-27.4	112.7	234.9	4.68	679	1000	none	3.6	1548	A1		0.043	1500
414B	R-22/124/600a/142b (50.0/39.0/1.5/9.5), Hot Shot	101.59	-32.9	-27.2	111.0	231.8	4.59	666		none			A1		0.039	1400
415A	R-22/152a (82.0/18.0)	81.91	-37.2	-35.0	102.0	215.6	4.96	719		5.6	2.7	1161	A2		0.041	1500
415B	R-22/152a (25.0/75.0), THR01b	70.19	-26.9	-16.4	111.4	232.5	4.65	674	1000	wff			A2		0.013	550
416A	R-134a/124/600 (59.0/39.5/1.5), FR-12	111.92	-24.0	-11.2	107.0	224.6	3.98	577		none	7.8	3353	A1		0.008	1100
417A	R-125/134a/600 (46.6/50.0/3.4), Isceon MO59 and NU-22	106.75	-39.1	-38.4	87.3	189.1	4.05	587	1000	none			A1		0	2300
418A	R-290/22/152a (1.5/96.0/2.5), THR03b	84.60	-41.7	-43.1	96.2	205.2	4.98	722		8.9	1.7	731	A2		0.048	1700
419A	R-125/134a/E170 (77.0/19.0/4.0), FX-90	109.34	-42.6	-44.7	79.3	174.7	3.71	538		none	10.0	4299	A2		0	3000
420A	R-134a/142b (88.0/12.0)	101.84	-24.9	-12.8	104.8	220.6	4.09	593	1000	none			A1		0.008	1500
----	R-134a/142b (80.6/19.4), RB-276	101.73	-24.2	-11.6	107.2	225.0	4.10	595		none					0.014	1600
421A	R-125/134a (58.0/42.0)	111.75	-40.7	-41.3	82.9	181.2	3.93	570	1000	none			A1		0	2600
421B	R-125/134a (85.0/15.0)	116.93	-45.6	-50.1	72.5	162.5	3.75	544	1000	none	-0.5	-215	A1		0	3200
422A	R-125/134a/600a (85.1/11.5/3.4), One Shot and Isceon MO79	113.60	-46.5	-51.7	71.8	161.2	3.75	544	1000	none			A1		0	3100
422B	R-125/134a/600a (55.0/42.0/3.0)	108.52	-41.3	-42.3	83.4	182.1	3.97	576	1000	none			A1		0	2500
422C	R-125/134a/600a (82.0/15.0/3.0)	113.40	-45.9	-50.6	73.2	163.8	3.78	548	1000	none	2.6	1118	A1		0	3100
422D	R-125/134a/600a (65.1/31.5/3.4), Isceon MO29	109.93	-43.2	-45.8	79.8	175.6	3.92	569	1000	none			A1		0	2700
423A	R-134a/227ea (52.5/47.5), Isceon 39TC	125.96	-24.1	-11.4	99.5	211.1	3.59	521	1000	none			A1		0	2300
424A	R-125/134a/600a/600/601a (50.5/47.0/0.9/1.0/0.6), RS-44	108.41	-39.7	-39.5	86.3	187.3	4.02	583	1000	none			A1		0	2400
425A	R-32/134a/227ea (18.5/69.5/12.0), THR03a	90.31	-38.1	-36.6	93.9	201.0	4.50	653	1000	none	5.1	2193	A1		0	1500

Continued on next page

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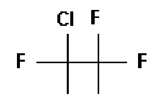

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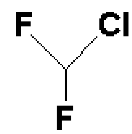

R-502502

Other names and brand names: CFC-502, Freon-502 Genetron-502, Forane-502

Freon is a registered trade name for E. I. DuPont. Genetron is a registered trade name for Allied Signal Corporation. Forane is a registered trade name for Elf Atochem.

General Information

Chemical Formula	CAS Registry #	Color & Odor	Refrigerant Applications
Azeotropic Blend of R-22 and R-115	75-461-6 and 76-15-3	Colorless Pressurized liquid with slight ether like odor	Medium and low temperature refrigeration

Physical Data

Molecular Mass	Boiling Point C°	Boiling Point F°	Critical Temperature C°	Critical Temperature F°	Critical Pressure MPa	Critical Pressure psia
111.63	-45.3	-49.5	80.7	177.3	4.02	583

Toxicity & Global Warming Data

TLV-TWA	Years of Atmospheric Lifetime	Ozone Depletion Potential	Global Warming Potential
1,000		0.221	6200

Packaging Information

Packaged in	Volumes available in pounds	Color of Container
Pressurized cylinders	30, 50, 125, 875, 1,750	Light purple (lavender)

Shipping Information

MSU Bozeman and agencies travel expenses not including **identifiable** lodging, meals, and non pertinent expenses like registrations, parking fees, etc.

CACP grouping	McKinstrey	Sum of Amount	
Athletics	Air Travel	741,964.00	
	Fuel	24,363.54	
	Ground Transport	19,836.28	
	Mileage Reimbursement	18.00	
	Motorpool	2,403.79	*Includes charge for vehicle and fuel*
	Other	399,412.17	*Includes reimb for any expenses related to travel that were not paid directly to a vendor (meals, lodging, ground transportation, registration fees, car rentals, fuel, airfare, mileage and miscellaneous could be included)*
Athletics Total		**1,187,997.78**	
Other	Air Travel	1,896,871.13	
	Fuel	226,362.21	
	Ground Transport	76,795.13	
	Mileage Reimbursement	453,347.50	
	Motorpool	208,705.31	*Includes charge for vehicle and fuel*
	Other	2,511,167.43	*Includes reimb for any expenses related to travel that were not paid directly to a vendor (meals, lodging, ground transportation, registration fees, car rentals, fuel, airfare, mileage and miscellaneous could be included)*
Other Total		**5,373,248.71**	
Grand Total		**6,561,246.49**	

Mileage Reimbursement Rates *1st half of FY 2009 high rate $0.585, low $0.28; 2nd half high $0.55, low $0.265*

average = 0.42

Source: MSU, Jeana Henley

File Name: *Travel Info provided to McKinstry 2-20-2010*

MSU Travel Inputs for CACP, 2009 Footprint

file: MSU GHG Travel Inputs.xls

Miles

		Staff Air Travel	Student (Athletics) Air Travel	Taxi/Ferry/Rental Car	Bus	Personal Reimbursement
CACP TOTAL	INPUT	**11,421,430**	**4,467,510**	**4,855,041**	**25,739**	**1,079,442**
Athletics 09 Workbook					25,739	
Total Travel TRND (PC air out) Athletics	airfare		4,467,510			
	fuel			2,119,950		
	ground transportation			X		
	mileage					43
	Motor Pool			8,461		
	rental car					
Total Travel TRND (PC air out) Research	airfare	11,421,430				
	fuel			1,991,987		
	ground transportation			X		
	mileage					1,079,399
	Motor Pool			734,643		
	rental car					
	combined ground transport - busses			111,138		

Dollars - totals pulled by MSU accounting dept on Travel info for McKinstry 2-20-2010

		Staff Air Travel	Student (Athletics)	Taxi/Ferry/Rental	Bus	Personal
Total Travel Athletics	airfare		$741,964			
	fuel			$240,903		
	ground transportation			$19,836		
	mileage					$18
	Motor Pool			$2,404		
	rental car					
Total Travel Other	airfare	$1,896,871				
	fuel			$226,362		
	ground transportation			$76,795		
	mileage					$453,348
	Motor Pool			$208,705		
	rental car					

MSU Commute Survey Results and CACP Inputs

	CACP Input	Final Value for 2009	Units	Sourced from Survey	Calculations
student car	# students	10,930.0	#	from CACP *MSU Quick Facts 2008-2009	
	% personal vehicle	37.0	%	from student filter of results	fall/spring/winter average
	% carpool	7.0	%	from student filter of results	fall/spring/winter average
	trips/week	10.0	#	assumed	5 day class week
	weeks/year	30.0	#	assumed	15 week semesters (2 semesters/year)
	miles/trip	7.4	miles	from Student SOV Commute Distance filter	average of 95 off campus SOV primary students
student bus	% bus	3.8	%	from student filter of results	fall/spring/winter average
	trips/week	10.0	#	assumed	5 day class week
	weeks/year	30.0	weeks	assumed	15 week semesters (2 semesters/year)
	miles/trip	3.3	miles	student bus filter	average of student bus riders in school year
faculty car	# faculty	898.6	#	MSU Quick Facts 2008-2009	
	% personal vehicle	51.6	%	faculty filter	total year average
	% carpool	8.3	%	faculty filter	total year average
	trips/week	10.0	#	assumed	5 day work week
	weeks/year	46.0	weeks	assumed	based on accural of 14 hours per month and 11 holidays
	miles/trip	18.3	miles	faculty SOV filter, question 2 responses	average of 97 responses
faculty bus	% bus	1.7	%	faculty filter	total year average
	trips/week	10.0	#	assumed	5 day work week
	weeks/year	46.0	weeks		based on accural of 14 hours per month and 11 holidays
	miles/trip	2.6	miles	faculty bus filter	average distance to campus with bus as primary
staff car	# staff	1,781.2	#	MSU Quick Facts 2008-2009	
	% personal vehicle	59.3	%	staff commute filter	total year average
	% carpool	10.2	%	staff commute filter	total year average
	trips/week	10.0	#	assumed	5 day work week
	weeks/year	47.0	weeks	assumed	baesd on accural of 10 hours per month and 11 holidays
	miles/trip	9.1	miles	staff SOV filter	average distance to campus with SOV as primary
staff bus	% bus	2.8	%	staff commute filter	total year average
	trips/week	10.0	#	estimate	5 day work week
	weeks/year	47.0	weeks		baesd on accural of 10 hours per month and 11 holidays
	miles/trip	7.3	miles	staff bus distance filter	average distance to campus with bus as primary

FY2009 - 1st pass for Greenhouse Gas Inventory - FUEL

Other Dept owned own Vehicles	Vendor	Gallons Sold	Sale Amount	Miles	Hours	
Gasoline	Gas Island -Story Distr	17,777.8	$48,116.66	not avail	not avail	Posts to Banner as "Jan Sales OFS Mech Tool" to Account Code 62216 Gasoline
Diesel	Gas Island -Story Distr	678.2	$1,859.75	not avail	not avail	
Total Other Depts		**18,456.0**	**$49,976.41**			
Facilities Vehicles/Equip with Hour Meters						
Gasoline	Gas Island -Story Distr	822.2	$2,724.02	n/a	1,181	Posts to Banner as "Jan Sales OFS Mech Tool" to Account Code 62216 Gasoline
Diesel	Gas Island -Story Distr	4,596.4	$12,675.80	n/a	6,455	
Total		**5,418.6**	**$15,399.82**	**-**	**7,636**	
Facilities Vehicles/Equip with Odometers						
Gasoline	Gas Island -Story Distr	19,442.6	$50,888.42	164,417	n/a	Posts to Banner as "Jan Sales OFS Mech Tool" to Account Code 62216 Gasoline
Diesel	Gas Island -Story Distr	7,639.4	$20,429.13	33,077	n/a	
Total		**27,082.0**	**$71,317.55**	**197,494**	**-**	
Sub-total	**Gas Island -Story Distr**	**50,956.6**	**136,693.8**	**197,494**	**7,636**	
Motor Pool RENTAL VEHICLES						
Gasoline	Gas Island -Story Distr	10,493.3	$29,104.30	223,539	n/a	
Gasoline	Fuel Card	8,497.3	$22,719.08	181,018	n/a	Posts to Banner as "Jan Sales Motor Pool" to Travel Account Code 62405 or 62415 and is bundled with Vehicle Rental Charge
Total Motor Pool		**18,990.6**	**$51,823.38**	**404,557**		
	Gas Island GAS	48,535.9	130,833.40			
	Gas Island DIESEL	12,914.0	34,964.68	165,798		
	Fuel Card GAS	8,497.3	22,719.08			
	Total Sales	**69,947.2**	**188,517.2**			

SECTION 4: CACP EXAMPLE PAGES

MSU GHG Inventory Input Page from CACP

On this Worksheet: Enter data related to emissions. If a column does not apply or the data is unavailable, leave it blank.

MODULE
WORKSHEET
UNIVERSITY Montana State University

Fiscal Year										Direct Transportation Sources				
	Population						Physical Size			University Fleet				
	Full Time Students	Part-Time Students	Summer School	Faculty	Staff	Total Building	Natural Gas	LPG (Propane)	Other	Gasoline Fleet	Diesel Fleet	Natural Gas Fleet	Other Fleet	Electric Fleet
	#	#	#	#	#	Square feet	MMBtu/decatherms	Gallons	MMBtu	Gallons	Gallons	MMBtu	MMBtu	kWh
1990														
1991														
1992														
1993														
1994														
1995														
1996														
1997														
1998														
1999														
2000														
2001														
2002														
2003														
2004														
2005														
2006														
2007														
2008														
2009	9,490	2,879	3,318	899	1,781	4,132,010	398,167	6,000		57,033	12,914			
2010														

Fiscal Year	Refrigerants & Chemicals						Agriculture Sources		--- Scope 2 Emissions Sources Purchased Electricity, Steam, and Chilled Water	--- Scope 3 Emissions Sources --- Commuting - click here to enter data				Directly Financed Outsourced Travel					Study Abroad Travel	
	Refrigerants & Chemicals						Fertilizer Application		Electricity	Faculty / Staff Commuting		Student Commuting		Air Travel						Landfilled Waste
	HFC-404a	HCFC-22	HFC-134	Other	Other	Other	Synthetic	% Nitrogen	CLICK TO SET eGRID	Automobile	Bus	Automobile	Bus	Faculty / Staff	Students	Taxi / Ferry / Rental Car	Bus	Personal Mileage Reimbursement	Air	No CH4 Recovery
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	%	kWh	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Short Tons
1990										-	-	-	-							
1991										-	-	-	-							
1992										-	-	-	-							
1993										-	-	-	-							
1994										-	-	-	-							
1995										-	-	-	-							
1996										-	-	-	-							
1997										-	-	-	-							
1998										-	-	-	-							
1999										-	-	-	-							
2000										-	-	-	-							
2001										-	-	-	-							
2002										-	-	-	-							
2003										-	-	-	-							
2004										-	-	-	-							
2005										-	-	-	-							
2006										-	-	-	-							
2007										-	-	-	-							
2008										-	-	-	-							
2009	75	1,572	101	52	106		60,000	36.67%	49,861,840	9,124,603	189,376	9,826,713	411,168	11,421,430	4,467,510	4,855,041	25,739	1,079,442	8,614,714	1,966
2010										-	-	-	-							

note: unused columns have been hidden for purposes of this print-out

values entered for travel can be found in the excel MSU GHG Travel Inputs.xls

On this worksheet: Summary information from an inventoried year.

MODULE	**Summary**
WORKSHEET	**Overview of Annual Emissions**
UNIVERSITY	**Montana State University**

Select Year -->	**2009**	**Energy Consumption**	**CO_2**	**CH_4**	**N_2O**	**eCO_2**
		MMBtu	kg	kg	kg	Metric Tonnes
Scope 1	Co-gen Electricity	-	-	-	-	-
	Co-gen Steam	-	-	-	-	-
	Other On-Campus Stationary	398,684.1	21,038,005.7	2,105.8	42.3	21,099.0
	Direct Transportation	8,863.8	625,539.3	106.6	37.5	639.1
	Refrigerants & Chemicals	-	-	-	-	1,585.3
	Agriculture	-	-	-	309.7	91.7
Scope 2	Purchased Electricity	244,277.3	20,405,917.1	244.3	513.4	20,563.5
	Purchased Steam / Chilled Water	-	-	-	-	-
Scope 3	Faculty / Staff Commuting	51,924.5	3,642,451.6	721.8	248.7	3,732.7
	Student Commuting	56,640.7	3,974,894.2	780.3	269.2	4,072.5
	Directly Financed Air Travel	62,602.4	12,291,201.6	121.0	139.1	12,335.2
	Other Directly Financed Travel	33,431.8	2,344,459.9	468.0	161.1	2,402.9
	Study Abroad Air Travel	33,942.0	6,664,081.2	65.6	75.4	6,687.9
	Solid Waste	-	-	92,682.9	-	2,131.7
	Wastewater	-	-	-	-	-
	Paper	-	-	-	-	-
	Scope 2 T&D Losses	24,159.3	2,018,167.6	24.2	50.8	2,033.8
Offsets	Additional					-
	Non-Additional					-
Totals	Scope 1	407,547.9	21,663,545.0	2,212.4	389.5	23,415.0
	Scope 2	244,277.3	20,405,917.1	244.3	513.4	20,563.5
	Scope 3	262,700.7	30,935,256.2	94,863.7	944.4	33,396.7
	All Scopes	914,525.9	73,004,718.3	97,320.4	1,847.3	77,375.2
	All Offsets					-
					Net Emissions:	**77,375.2**

Appendix 2: Commuter Questionnaire Data

MSU Transportation Survey

What is your status at Montana State University?	Response Percent	Response Count
Full-time Student	**45.6%**	**229**
Part-time Student	5.8%	29
Faculty	19.5%	98
Staff	29.1%	146
answered question		**502**
skipped question		**0**

MSU Transportation Survey

Where do you live?			
		Response Percent	Response Count
On Campus		15.3%	77
Off Campus. How many miles do you live from campus?		**84.7%**	**425**
	answered question		**502**
	skipped question		**0**

Off Campus. How many miles do you live from campus?		
1	7	Jan 13, 2010 11:59 PM
2	4	Jan 13, 2010 11:59 PM
3	1	Jan 13, 2010 11:59 PM
4	0.25	Jan 14, 2010 12:00 AM
5	0.5	Jan 14, 2010 12:00 AM
6	6	Jan 14, 2010 12:01 AM
7	6	Jan 14, 2010 12:01 AM
8	10	Jan 14, 2010 12:02 AM
9	3.9	Jan 14, 2010 12:03 AM
10	.5	Jan 14, 2010 12:03 AM
11	210	Jan 14, 2010 12:03 AM
12	1	Jan 14, 2010 12:03 AM
13	6	Jan 14, 2010 12:03 AM
14	.5	Jan 14, 2010 12:04 AM
15	3	Jan 14, 2010 12:05 AM
16	3 miles	Jan 14, 2010 12:05 AM
17	5	Jan 14, 2010 12:05 AM
18	1	Jan 14, 2010 12:05 AM
19	1.5	Jan 14, 2010 12:06 AM
20	3.5	Jan 14, 2010 12:07 AM
21	5	Jan 14, 2010 12:07 AM
22	0.5	Jan 14, 2010 12:08 AM
23	1/2	Jan 14, 2010 12:09 AM
24	3	Jan 14, 2010 12:09 AM
25	2	Jan 14, 2010 12:09 AM
26	2	Jan 14, 2010 12:10 AM
27	12	Jan 14, 2010 12:10 AM
28	1	Jan 14, 2010 12:12 AM
29	8.5	Jan 14, 2010 12:12 AM

MSU Transportation Survey

What is your PRIMARY mode of transportation to campus in the following seasons? (check one per row)								
	Bicycle	Walk	Drive alone	Carpool	Streamline Bus	Other Mode (*specify below*)	N/A (not working/not in class)	Re C
Fall & Spring (Sept – Oct. & March – May)	18.2% (89)	22.9% (112)	**44.7% (219)**	8.2% (40)	2.2% (11)	3.3% (16)	0.6% (3)	
Winter (Nov. – Feb.)	3.5% (17)	27.6% (135)	**51.8% (254)**	9.0% (44)	4.5% (22)	2.0% (10)	1.6% (8)	
Summer (June – Aug.)	24.5% (120)	13.9% (68)	**36.9% (181)**	4.9% (24)	1.2% (6)	3.5% (17)	15.1% (74)	
*Specify "Other Mode", from above (ex. motorcycle, etc.):								
	answered question							
	skipped question							

*Specify "Other Mode", from above (ex. motorcycle, etc.):		
1	Motorcycle - although I'm only 0.25 mi from campus my office is 1 mile from my house (I do not work on campus & make 3-5 trips to campus a week)	Jan 14, 2010 12:03 AM
2	It depends on my schedule and circumstances. Sometimes I walk, many times I ride the bus. On the mornings I teach at 8:10 am, I take my car and park as close as possible to the campus.	Jan 14, 2010 12:07 AM
3	In Fall, Spring and Summer, try to take the bus to, walk home or ride my bike	Jan 14, 2010 12:17 AM
4	plane	Jan 14, 2010 12:18 AM
5	motorcycle	Jan 14, 2010 1:46 AM
6	Commercial air on a packed plane	Jan 14, 2010 1:53 AM
7	Simetimes walk.	Jan 14, 2010 2:51 AM
8	NA	Jan 14, 2010 2:57 AM
9	In the winter I bike, walk, carpool or drive alone depending on the weather	Jan 14, 2010 4:25 AM
10	Scooter	Jan 14, 2010 7:45 AM
11	when the snow melts I bike about half the time; but mostly walk	Jan 14, 2010 1:56 PM
12	carpool 2 days a week the other days drive alone	Jan 14, 2010 2:30 PM
13	I live on campus so this is my transportation around town.	Jan 14, 2010 3:02 PM
14	I walk or drive depending on daylight and weather.	Jan 14, 2010 3:20 PM
15	work off campus-live about 4 miles from work	Jan 14, 2010 3:59 PM
16	motorcycle	Jan 14, 2010 4:58 PM
17	Drive 10 miles and walk the last mile to campus	Jan 14, 2010 7:06 PM
18	motorcycle	Jan 14, 2010 7:35 PM
19	motorcycle	Jan 14, 2010 9:14 PM
20	80% Streamline - 20% drive alone	Jan 14, 2010 10:04 PM

*Specify "Other Mode", from above (ex. motorcycle, etc.):		
21	Skateboard	Jan 15, 2010 4:31 PM
22	Motorcycle	Jan 15, 2010 7:44 PM
23	motorscooter	Jan 15, 2010 9:54 PM
24	this is to my extension office, always carpool to MSU if we must go to campus which is 90 miles, but only go 3 to 4 times per year	Jan 19, 2010 4:03 PM
25	Drive w/my children (drop them at school)	Jan 20, 2010 3:50 PM
26	State Vehicle	Jan 20, 2010 5:55 PM
27	I am doing distance learning during the Spring and Fall	Jan 20, 2010 7:11 PM
28	motorcycle	Jan 21, 2010 4:58 AM
29	Longboarding	Jan 21, 2010 6:13 PM
30	MOTORCYCLE	Jan 27, 2010 2:00 AM

MSU Transportation Survey

If you CARPOOL to campus, on average how many passengers travel together, including the driver? (Skip this question if it does not apply to you.)				
		Response Average	Response Total	Response Count
Number in Carpool:		2.07	178	86
			answered question	86
			skipped question	416

MSU Transportation Survey

If you DRIVE or CARPOOL to campus, approximately what is the vehicle's gas mileage (city driving) in miles per gallon (MPG)? (Skip this question if it does not apply to you)			
		Response Percent	**Response Count**
10-15 MPG		8.2%	27
15-20 MPG		28.6%	94
20-25 MPG		**35.3%**	**116**
25-35 MPG		24.6%	81
35-50 MPG		2.7%	9
50 MPG or more		0.6%	2
		answered question	**329**
		skipped question	**173**

MSU Transportation Survey

Please estimate how many TOTAL MILES you travel round trip between your permanent residence and Bozeman in a typical year. (Include trips home for break and/or holidays; ignore fields that don't apply.)				
		Response Average	Response Total	Response Count
By Car		3,771.65	841,077	223
By Carpool		1,028.20	89,453	87
By Plane		**3,779.29**	**359,033**	95
By Rail		66.67	3,000	45
Other		230.53	10,374	45
			answered question	250
			skipped question	252

By Car		
1		Jan 14, 2010 12:02 AM
2	2400	Jan 14, 2010 12:05 AM
3	1000	Jan 14, 2010 12:08 AM
4	15000	Jan 14, 2010 12:08 AM
5	2000	Jan 14, 2010 12:09 AM
6	180	Jan 14, 2010 12:10 AM
7		Jan 14, 2010 12:11 AM
8	3500	Jan 14, 2010 12:11 AM
9	360	Jan 14, 2010 12:11 AM
10	0	Jan 14, 2010 12:11 AM
11	600	Jan 14, 2010 12:12 AM
12		Jan 14, 2010 12:12 AM
13	0	Jan 14, 2010 12:13 AM
14	3000	Jan 14, 2010 12:14 AM
15	1500	Jan 14, 2010 12:16 AM
16	2100	Jan 14, 2010 12:17 AM
17		Jan 14, 2010 12:17 AM
18	7000	Jan 14, 2010 12:19 AM
19	400	Jan 14, 2010 12:19 AM
20	3000	Jan 14, 2010 12:20 AM
21	1500	Jan 14, 2010 12:21 AM
22		Jan 14, 2010 12:23 AM
23	2200	Jan 14, 2010 12:23 AM
24	3600	Jan 14, 2010 12:23 AM

MSU Transportation Survey

Amtrak is considering re-opening passenger rail service along the North Coast Hiawatha Route. This would connect Seattle and Chicago and offer services to Billings, Bozeman, Helena, Butte, and Missoula with possible spurs to Dillon, Great Falls, and Whitefish. If this service existed would it replace any of your existing trips by other means?		Response Percent	Response Count
Yes, all.		13.6%	34
Yes, some.		**60.0%**	**150**
No, none.		26.4%	66
		answered question	**250**
		skipped question	**252**

Appendix 3: Western Transportation Institute ACUPCC Climate Action Plan Transportation Analysis

Montana State University

American College and University Presidents Climate Commitment

Climate Action Plan – Transportation Component

by

David Kack

Rebecca Gleason

Western Transportation Institute

College of Engineering

Montana State University

A report prepared for the

Montana State University

CSAC

December 7, 2011

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1. INTRODUCTION

Transportation, in the form of the campus vehicle fleets, commuting and air travel, are relevant to the climate action plan because these activities produce a significant amount (38 percent) of MSU's net emissions. The Green House Gas (GHG) emissions are based on travel to, or on behalf of the University. However, it should be noted that the inventory used as a foundation for this Climate Action Plan does not include student travel beyond their daily commute to MSU. Therefore, student trips for employment, shopping purposes, or activities are not captured herein. These trips by the students may create as much or perhaps even more GHG emissions than their commutes to MSU, and should be calculated in the future.

Strategies to implement GHG reductions for transportation are more difficult than modifying a building (i.e., installing energy efficient windows, new heating/cooling systems, etc.), as transportation choices are based on individual choices/behaviors. Montana State University, the City of Bozeman, and surrounding area have made progress on alternative transportation modes that give individuals options other than driving their own vehicle (single-occupancy vehicle or SOV).

In its Greenhouse Gas Inventory Report (04-21-10) on Montana State University, McKinstry noted several strategies for reducing commuter emissions, including:

- Offer more online courses
- Increase parking fees
- Subsidize public transportation passes
- Carpool parking priority
- Restrict student cars and/or parking to upper classmen
- Installation of more bike racks and bike paths
- Subsidize on-campus housing to minimize off-campus living
- Education to campus about carbon footprint goals and the impact of individual commuter choices
- Convert parking lots to green spaces

The following sections discuss possibilities, including these, to reduce transportation impacts of MSU while integrating MSU transportation strategies into the broader community. It is important in discussing transportation plans that MSU not be viewed as an "island". Unless someone is living on campus, a person is traveling in and through Bozeman, and perhaps even one or two counties, to get to class or employment at MSU. Therefore, it is important that the transportation component of MSU's Climate Action Plan integrate with the City's and other transportation plans/climate action plans.

As of the adoption of this Climate Action Plan, the City of Bozeman was finalizing its Climate Action Plan. The following seven transportation recommendations were included in the City's plan:

1. Support policies for long-term integrated transportation and land use planning for a 20-30 year horizon
2. Promote a bike friendly community
3. Promote an electric car friendly community
4. Promote and provide incentives for clean fuels

5. Develop educational resources for the community on transportation options
6. Reduce vehicle miles traveled and fuel emissions
7. Air travel (examine emissions from Gallatin Field and its effects)

As noted in the following sections, MSU's Climate Action Plan includes similar transportation recommendations. As MSU and the City of Bozeman adopt and implement their Climate Action Plans, the two entities should work together as closely as possible to take advantage of funding opportunities and other synergies that may exist.

2. CAMPUS FLEET (MSU VEHICLES)

Montana State University owns 372 vehicles that are used by various departments for various purposes. There are three basic strategies to reduce GHG emissions to the extent possible in relation to these vehicles. These strategies are modernizing the fleet, using electric vehicles, and using human powered vehicles.

2.1. Modernize fleet

As the fleet ages, MSU must update vehicles with more modern, fuel efficient and cleaner vehicles. In addition to simply purchasing more efficient vehicles, MSU must analyze the purpose for each vehicle, so that the proper size vehicle can be purchased. For example, heavy or light gasoline or diesel powered trucks may not need to be purchased, if an electric or human-powered vehicle can accomplish the same task. Facilities Services has been in the process of reducing the physical size of maintenance vehicles. They have six gator- like vehicles used by Landscape and Grounds Maintenance Staff and seven mini- utility vehicles (Vantage and C-Mag). These smaller, more maneuverable vehicles are able to access more areas without disturbing the surrounding environment and can effectively transport personnel and their tools/materials. Facilities and Campus Departments have 9 carts, and 5 ATVs. An analysis should be conducted of each vehicle the University owns, and the purpose of the vehicle. The analysis could then be used to determine what vehicles should be purchased in the future.

2.2. Electric vehicles (consider source of electricity)

Electric vehicles do not produced green house gasses, although the source of electricity that powers them may. MSU Facilities Services evaluated an electric mini utility vehicle in winter 2010 over a 30 day period. While handling and power were good; the batteries did not last through-out the day especially with the heat/defrost on. Because the electrical mini utility vehicle is unable to support our on demand transportation requirement at this time its integration into the fleet will occur when the battery technology improves. In general, with the short distances within the campus, electric vehicles could be used for many of the tasks that require some sort of vehicle. Whether it is delivering supplies, people, or small equipment among the various campus buildings, electric vehicles may be able to accomplish the majority of the transportation needs on campus. As MSU analyzes and updates its vehicle fleet, the use of electric vehicles should be strongly considered. As noted herein, however, to reduce the campus carbon footprint, the source of the electricity to power the vehicles needs to be considered, as well.

2.3. Bicycles or other “human powered” vehicles

Bicycles are already used by campus employees for traveling short distances in and around campus. Utilitarian tricycles with trailers to haul tools and other equipment are used for campus landscaping. MSU should maximize the use of these human powered vehicles to decrease emissions and increase physical activity. In summer 2011, MSU main campus had 33 bicycles for Facilities Services and University Police to use. Four additional bicycles were available to Student Union building staff.

3. CAMPUS COMMUTING

Objectives to reduce the Green House Gas emissions related to faculty, staff and students commuting to campus include eliminating or shortening the commute, or allowing a more efficient (less GHG emissions) commute. These strategies integrate alternatives to single occupancy vehicles (SOVs) through campus policies related to walking, bicycling, transit, carpooling, vanpooling. Policies should provide incentives to alternatives to SOVs and disincentives to SOV enablers such as convenient and inexpensive parking. Strategies to achieve these objectives are discussed in more detail within this section.

3.1. Eliminating the Commute

3.1.1. More housing near campus

Similar to the City of Bozeman’s recommendation for integrated transportation and land use planning, this strategy would provide more housing opportunities near campus, so that faculty, staff and students would not need to drive to campus. Housing with a close proximity to campus would allow the vast majority of people to be able to walk or bike to campus.

3.1.2. Online classes

With options for students to take classes online, the need to commute to campus may be eliminated. This would take an investment by MSU to have the technologies in place so that as many classes as possible are delivered via the Internet, or other electronic means. While it is recognized that there are numerous classes that require hands-on (on campus) learning, commuting GHG emissions could be reduced by maximizing the number of classes taught online.

3.1.3. Web based meetings/trainings

Faculty, staff and students also frequently commute to campus for meetings and/or trainings. If these meetings and trainings could be supported in an online basis, these commutes could be eliminated. As noted with the online classes, MSU would need to invest in the technology to support online meetings and trainings.

- Cost savings to University/to individuals

As noted earlier, the majority of the cost of transportation is based on the individual, not the University. Therefore, the maximum savings in reducing commuting to campus would be accrued to individuals. If enough individuals stop driving to campus, there would be potential to reduce the number of parking spaces/lots that the University maintains. However, the savings to the University by reducing parking lot maintenance could be offset by a reduction in the number of parking permits sold. If this were the case, there would be no cost savings to the University, as the revenue would be reduced, and there would be no savings. However, there would be a reduction in green house gas emissions.

- Examples of other programs- weblinks

An increasing number of universities are offering online courses or degrees. Following are links to more information about a few of these programs

http://learn.berkeley.edu/

http://www.worldcampus.psu.edu/

http://www.online.uillinois.edu/

- Marketing/education/promotion

The online courses and the meetings/trainings would be marketed/promoted to both students, and faculty/staff.

- Potential partners (funding, advertising, in-kind support)

There may be the potential to establish online meeting/training systems that could be used by other entities (businesses and other organizations).

- How could this fit MSU curriculum, student research, departments

Departments would need to decide what courses, trainings and meetings could occur online versus in person. Research could be conducted to determine the efficiency and effectiveness of online courses, training and meetings versus the in-person alternative. Further, research could be conducted to determine how much carbon savings is accrued due to an increase in these online activities.

- Timeline

While it would take longer to develop online courses, meetings and trainings could be transitioned online almost instantly. With systems such as GoToMeeting and Webex, meetings and trainings could occur within a week or two of a policy being implemented.

3.2. Walking

3.2.1. Existing status and cost

Basic elements of a pedestrian network are sidewalks, pathways, crosswalks and curb ramps. These elements should form a connected network that is functional and safe. The City of Bozeman, the Montana Department of Transportation and others have been working to provide pedestrian connections to MSU. The Greater Bozeman Area Transportation Plan (2007 update) places a strong emphasis on integrating pedestrian facilities into the transportation network. It identifies gaps in the pedestrian networks and recommends improvements. Construction started on one of the recommended improvements in the fall of 2010. This recent improvement is a separated pathway along the south side of College Street between South 11th street and Huffine Lane; a key non-motorized connection between MSU and neighborhoods on the west side of town. The City passed a “complete streets” policy in 2010 which ensures that streets are “complete” and safe for all users, including motorists, pedestrians, transit users, bicyclists, children, the elderly and people with disabilities.

The existing number of MSU students and employees who walk to campus is not well documented, though two recent studies provide insight. A 2007 study evaluated how far from campus MSU employees and students live. For the 2007 study, MSU and the City of Bozeman mapped the geographical distribution of students and employees in relation to the MSU campus. The evaluation used employee and student addresses from the 2005 fall semester, showing approximately 3,900 individuals lived within one mile of campus and about 7,400 lived within three miles (MSU, 2007). Assuming MSU has 12,500 students and 3,500 employees, this data suggests approximately 46 percent of MSU employees and students live within three miles of campus. (cite literature on distances most people are willing to walk). While the geographic distribution of students and employees will vary from year to year, the geographic concentration should not change considerably without significant housing additions in close proximity to MSU.

A transportation survey of MSU students and employees conducted in 2010 suggests walking to campus is common. This online survey identified a random sample of 1500 MSU employees and students and had approximately 500 respondents. Approximately 53 percent of respondents reported living within three miles of campus, which is similar to the 46 percent estimated from the 2007 evaluation. The 2010 transportation survey indicated:

- 22.9 percent (112 people) reported walking as their primary travel mode to campus in the spring and fall (September, October, March, April and May).
- 27.6 percent (135 people) reported walking as their primary mode from November through February.
- Approximately 27 percent of respondents reported living within one mile of campus.

In comparison, the 2009 National Household Travel Survey reports walking trips accounted for 10.9 percent of all trips reported, while one percent of all trips reported were taken by bike (FHWA and PBIC 2010).

3.2.2. Description of alternative/TDM plan and cost

- Cost savings to University/ to individuals

It is unlikely that increasing walking alone has the potential to significantly reduce University costs related to commuter transportation. An integrated approach of linking pedestrian, bicycling and transit travel along with carpools and vanpools has potential to reduce parking needs and costs of parking lot maintenance. Individuals who walk instead of drive save money by reducing fuel use. They may reduce health care costs by improving their health through increased regular physical activity. While these costs are difficult to quantify, walking is the lowest cost transportation option available for short trips.

- Examples of other programs- weblinks

Using maps and guides that show walking and biking infrastructure options are an effective method to encourage people to walk and bike. The Bozeman Area Bicycle Advisory Board (BABAB) is in the process of revising a city bicycling map that could form a basis for a map that integrates recommended walking and transit options as well.

The City of Boulder is a University town in a mountain setting and has a wallet size pedestrian map.

http://www.bouldercolorado.gov/files/GOBoulder/maps/bike_ped_walletmap_09.pdf

Boulder has examples of other maps showing transit, bicycle and pedestrian options at:

http://www.bouldercolorado.gov/index.php?option=com_content&view=article&id=8853&Itemid=2979

Create a "Drive Less, Live More" Campaign as shown in the Greater Bozeman Area Transportation Plan (page 6-6-23). This is a media campaign and website intended to educate drive alone commuters of other options.

http://www.drivelesslivemore.org

http://www.divelesslivemore.com

http://Drivelesssavemore.com

Create a commuter calculator to raise awareness of the true costs of commuting. Place this in a prominent location on MSU's website.

http://www.drivelesslivemore.org/ComputeYourCommute.asp

- Marketing/education/promotion

Many people are in the habit of driving and simply don't think about other options such as walking, biking and/or transit, carpooling or vanpools. Identifying what motivates people to change their behavior (finances, health, environment, fun…) can help MSU created targeted marketing campaigns to initiate changes in travel modes. Raise awareness of the health benefits of active travel such as walking and bicycling on a regular basis. MSU's wellness program already gives points for employees who walk or bike to campus. Employees who track their healthful behaviors are rewarded annually with a $100 check. Provide more incentives to walk to school or work on a regular basis. Reward students and employees and recognize them for their efforts. MSU could market alternative transportation options at events such as Catapalooza, freshman convocation, new student and staff orientations, employee and student wellness programs and other campus events. Alternative transportation materials such as walking and biking maps could by widely distributed on MSU’s website, at the Ask-Us Desk, MSU bookstore and other high traffic campus locations.

- Potential partners (funding, advertising, in-kind support)

There is significant interest from the public health community to increase physical activity through daily commuting. Health organizations associated with MSU insurance programs, the County Health Department and the MSU Wellness program are likely partners to support active travel options. The City of Bozeman’s pedestrian and traffic safety committee is a good connection. Local businesses may provide sponsorships for active transportation options in return for advertisements on maps or other materials. MSU could partner with the City to improve the existing City of Bozeman Bike Map or create new pedestrian and bicycle maps that could be widely distributed to campus commuters.

- How could this fit MSU curriculum, student research, departments

Two interdisciplinary university-level courses have been developed to explore the core concepts of pedestrian and bicycle design and strategies to create comprehensive bicycle and pedestrian plans and programs. The two courses are:

- Pedestrian and Bicycling Information Center (PBIC) Bicycle and Pedestrian Planning Course for Graduate Students
- Federal Highway Administration (FHWA) University Course on Bicycle and Pedestrian Transportation

Students taking either course will recognize the legitimacy of the bicycle and pedestrian modes, understand how policy, planning, and engineering practices can be improved to create a more balanced transportation system, and become familiar with basic policies, practices, tools, and design principles that can be used to create bicycle and pedestrian-friendly communities (PBIC 2010). Course information may be found online at www.walkinginfo.org/training/university-courses/.

With regard to research, public administration students could assess policies and public participation processes related to alternative transportation options (complete streets, commuter tax credit for example). Graphic design students could assist in designing and updating local pedestrian, bicycling and transit maps. Students in GIS courses could improve on the existing evaluation/mapping of student and employee residence proximity to MSU, proximity to transit, bike and walking infrastructure. Engineering students could research innovative solutions to improve pedestrian and bicyclist safety (more on this in bicycle section that follows). Students interested in health promotion or public health could study relationships between travel behavior and health. Denver’s new public bicycle sharing program launched in April 2010 is the focus of an ongoing study into population-wide health interventions aimed at increasing physical activity (Duvall, 2010).

- Timeline

The Bozeman Area Bicycle Advisory Board is in the process of updating the City's bike map. A pedestrian oriented map could likely be produced within 3 to 4 months with appropriate funding. A commuter calculator could be implemented very quickly online, but connecting people to these resources will occur over time and as mentioned above may be coordinated with campus events.

3.3. Bicycling

3.3.1. Existing status and cost

Bicycle facilities vary significantly and may include items such as wayfinding signs, separated paved pathways, covered bike parking, or end of trip facilities such as showers. Consistent with pedestrian facilities, the City of Bozeman and others have been working to provide bicycling connections to MSU. The City rebuilt West Babcock Street in 2005, adding bicycle lanes and sidewalks, which resulted in an increase of 256 percent in bicycle and pedestrian users (City of Bozeman, 2007). The Greater Bozeman Area Transportation Plan (2007 update) places a strong emphasis on integrating bicycle facilities into the transportation network. It recommends specific locations for bike lanes, bike routes, expanded shoulders and shared-use paths. The City installed 320 bike route signs in 2005 and created a bicycle map. Recent bicycle facilities that improve connections to campus include Kagy Boulevard bicycle lanes, a separated pathway along College St. between 11th and Huffine Lane and bicycle lanes along S. 19th. These are just a few of many examples.

There is significant interest at MSU in increasing bicycle commuting. MSU recently removed its ban on bikes on campus and installed a significant number of new bike racks in convenient locations around campus. The ASMSU sustainability center is researching options for a commuter/cruiser bike share/rental program in partnership with ASMSU Outdoor Recreation Center. Some campus buildings have end of trip facilities for bicycle commuters such as showers, lockers and changing rooms. A transportation survey of MSU students and employees conducted in 2010 indicates:

- 18.2 percent (89 people) reported bicycling as their primary travel mode to campus in the spring and fall (September, October, March, April and May).
- 3.5 percent (17 people) reported bicycling as their primary mode from November through February.
- Approximately 53 percent of respondents reported living within three miles of campus.

3.3.1. Description of alternative/TDM plan and cost

There are many ways MSU could encourage students and employees to replace driving commutes with bicycling. The "Five Es" are a common measure of bicycle friendliness based on The League of American Bicyclists categories (LAB, 2008):

1. *Engineering* refers to what has been built to promote cycling the existence and connectivity of well-designed bike lanes and multi-use paths.
2. *Education* includes teaching cyclists how to ride safely and teaching motorists how to share the road safely with cyclists.

3. *Encouragement* refers to how bicycling is promoted and encouraged. This can occur through Bike Month and Bike to Work Week events, creating community bike maps, route finding signage, community bike rides and commuter incentive programs.
4. *Enforcement* refers to connections between cycling and law enforcement. A few examples include whether or not law enforcement has a liaison with the cycling community and if there are bicycle divisions of the law enforcement.
5. *Evaluation* refers to systems to evaluate current programs and plan for the future. Evaluation focuses on measuring the amount of cycling taking place, crash and fatality rates, and ways to reduce these numbers.

Even where the engineering component (safe biking infrastructure) exists; education, encouragement, enforcement and evaluation are needed to change behavior and create a bike friendly culture. MSU should collaborate with the City to implement the Greater Bozeman Area Transportation Plan's bicycling and pedestrian recommendations and with the Bozeman Area Bicycle Advisory Board (BABAB), which now has space for an MSU student representative. Applications can be downloaded from the City of Bozeman Bike Advisory Board web page and submitted to Aimee Kissel (at City Hall), the Citizen Advisory Board Coordinator: akissel@bozeman.net. The following sections describe cost savings and activites MSU can implement to create a more bike friendly culture, organized by the "5 Es".

- Cost savings to University/ to individuals

It is unlikely that increased bicycling alone has the potential to significantly reduce University costs related to commuter transportation. An integrated approach of linking pedestrian, bicycling and transit travel along with carpools and vanpools has potential to reduce single occupancy vehicles (SOV) at MSU. Significant reductions in SOVs can reduce parking needs and costs of parking lot maintenance.

- Examples of other programs- weblinks

Engineering

Provide covered bike parking on campus and at transit stops. Provide bike lockers for regular commuters. Collaborate with the City and BABAB to make bicycle facility improvements recommended in the City's transportation plan.

Education

The bike buddy campaign pairs less experience cyclists with a trained cycling mentor who assists them in route selection, training rides, reading bike maps and gear questions to lower barriers to using a bicycle for transportation. (Bozeman Transportation Plan Pg 6-17)

http://www.bicyclealliance.org/commutte/bikebuddy.html

http://www.bicycling.511.org/buddy.htm

The League of American Bicyclists offer courses in bicycle education and safety. Bike rodeos are fun events aimed at teaching kids basic skills and safety rules. These events could be adapted to target university students and employees.

http://www.bikeleague.org/programs/education/courses.php

http://www.bicyclinglife.com/Safetyskills/bicyclerodeo.hgm

http://www.saferoutestoschools.org/pdfs/lessonplans/rodeomanual june2006.pdf

Training courses on biking in cold climates would be relevant and fun for MSU students, faculty and staff. Bozeman's Bike Kitchen would be a good source for guidance on cold weather biking training. The following websites present good cold weather biking information.

http://www.allweathersports.com/winter/winter.html

http://dingdingletsride.com/topics/bike-winter/

Figure 1: Fat tires for fun winter biking.

Encouragement

Ripon College in Wisconsin and the University of New England (UNE) are leading the way in encouraging biking. In fall 2008, UNE launched its alternative transportation program by offering free bicycles or Zipcar usage to first-year resident students who promised not to bring cars to campus. Considered one of the most comprehensive programs of its kind in the country, the program, featured in the New York Times, was a resounding success and will be offered again to the first one hundred and twenty five first year resident students who opt into the program. **Since the alternative transportation program was initiated at UNE, the University has been able to close and convert a parking lot into recreation space without the need for additional parking.**

http://www.ripon.edu/velorution/bike.html

http://www.une.edu/news/2010/unebicycleprogram.cfm

Distribute the City of Bozeman's Bicycling map to encourage more biking. BABAB is currently revising the City of Bozeman Bicycle Map anticipated to be complete by April 2011. MSU should work with BABAB to broadly distribute this map to students, faculty and staff.

Pilot light is currently sponsored by BABAB to increase night biking safety by providing bicycle front and rear lights to those who need them. BABAB is working with the international student office and local law enforcement to distribute lights. This program could be expanded and improved by incorporating recommendations on pages 6-21 and 6-22 of the Bozeman Transportation Plan (use well designed graphic ads, enforce bike light laws, partner with local cycling groups and conduct media outreach).

http://www.portlandonline.com/transportation/index.cfm

Encourage multi-modal connections. Streamline buses already have bike racks on them that carry three bikes. Encourage bicycle-transit connections by placing a bus bike rack on campus with directions on how to use the rack. This allows people to practice using bus bike racks without the intimidation of standing in front of a running bus.

Figure 2: How to use bus bike racks
(Denver Bike-n-Ride example)

Bike to work week or month occurs the second week of May in coordination with the National bike to work week. MSU could tailor a bike to school week during the academic school year. The League of American Bicyclists has a bike month guide on their website below. www.bikecommutechallenge.com/

http://www.bikeleague.org/programs/bikemonth/

Incorporate bicycling into MSU's existing parking and transportation programs. UC Davis has an example bike transportation program at the website.

www.taps.ucdavis.edu/bicycle/

Stanford has created a guide for getting around without a car. MSU could do the same.

http://transportation.stanford.edu/pdf/thriving-at-stanford.pdf

Start a bike share or loan program at MSU. As mentioned previously, MSU's sustainability director has initiated this process. Some examples of bike sharing at other universities are shown in the web links below.

http://www.parking.uci.edu/zotwheels/main.cfm

http://parking.duke.edu/alternative_transportation/bicycling/duke_bikes/

Expand the Bicycle Benefits (BB) program to campus. Bicycle Benefits, initiated in Bozeman in 2008, rewards individuals and businesses for their commitment to cleaner air, personal health, and pedaling. More than 50 Bozeman businesses are already members. Individuals purchase helmet stickers and bike to BB Businesses (identified by a storefront window decal and online listings) and receive a discount. The BB website (www.bicyclebenefits.org) has BB Business Members and discounts. BABAB is managing the Bozeman BB program beginning in spring 2010. BABAB buys helmet stickers from BB for $1.25/each and sells them to businesses at $2.50/each or to individuals for $5/each. Funds from stickers go to promote safe biking in Bozeman. MSU's Ask Us desk or the bookstore would be good distribution points for faculty, staff and students who want to purchase the reflective BB helmet stickers.

Enforcement

Speed limit enforcement creates a safer environment for bicyclists and pedestrians and motorists. MSU should work with law enforcement for targeted enforcement of speed limits near school and in response to bicycling and pedestrian complaints.

http://transportation.stanford.edu/alt_transportation/BikingAtStanford.shtml

On-bike officers are an excellent tool for community and neighborhood and special event policing. Central Point, Oregon has a sample program:

http://www.bta4bikes.org/btablog/2008/01/30/alice-award-nominee-chief-jon-zeliff/

Evaluation

It is important to evaluate how changes in policies and programs can affect bicycle and pedestrian mode share. MSU should implement a transportation survey similar to the 2010 survey, to students, faculty and staff on an annual basis. MSU may also participate in the National Bicycle and Pedestrian Documentation Project, which is a developing project to create a consistent method to track bicycle and pedestrian volumes nationwide. Methods are described online at: http://bikepeddocumentation.org/

- Marketing/education/promotion

In addition to methods described in the sections above, the Greater Bozeman Area Transportation Plan recommends the following activities for an MSU Bike orientation:

- Bike maps and information to incoming and returning students at the beginning of the year through school information packets.
- Flat tire clinics, bike legal clinics and guided rides, advertise through flyers, email and bulletin boards and campus newspaper.
- Information tabling at campus events and prominent locations during the first few weeks of school.
- A bikes at MSU web page with links and more information
- At-cost or low-cost bike lights (from BABAB) or sold at tabling events and through the campus bookstore.
- Potential partners (funding, advertising, in-kind support)

Health organizations associated with MSU insurance programs, the County Health Department and the MSU Wellness program are likely partners to support active travel options. The City's

Bozeman Area Bicycle Advisory Board has already created maps and a website and can provide information about local bicycling events and activities. The Bozeman Bike Kitchen is a non-profit organization and while the Bike Kitchen cannot provide funding, they may be a valuable partner for activities such as bike maintenance.

- How could this fit MSU curriculum, student research, departments

Statistics students could create a travel mode survey to consistently track MSU student and employee travel habits and transportation mode share. This could build upon the transportation survey conducted in 2010. Business/marketing students could develop innovative methods to promote alternative transportation. Civil engineering students could research and evaluate emerging practices in bicycle transportation such as bike boxes, bicycle preferred streets, bike signals, colorized pavement and other options that can improve bicycle networks (see http://www.nacto.org/citiesforcycling.html).

- Timeline

Unlike major infrastructure improvements, many of the education and encouragement programs require minimal funding and could be implemented as time and interest allow. Student groups such as NECO and others could use volunteers to move forward on many of these concepts.

3.4. Transit (commuter and fixed route)

Transit refers to public transportation options within a community and college campus. As noted herein, Montana State University and the Associated Students of Montana State University contribute to the Streamline system, which operates in the greater Bozeman area. Transit also can extend the trip length of other modes such as walking and biking (see Figure 3).

Figure 3: MSU student loading her bike on a Streamline bus

3.4.1. Existing status and cost

The Associated Students of Montana State University (ASMSU) actually had one of the early public transit systems in Bozeman, when Bobcat Transit was introduced in 1977. However, that service lasted only fourteen days, and it was not until 1987 that Bobcat Transit became more established in the community. While open to the public, Bobcat Transit only operated during the main MSU semesters, and had a limited schedule. A year-round transit system, Streamline, was introduced to the greater Bozeman area in August 2006. Funding for this service comes from a number of sources, including ASMSU and MSU.

The Streamline system includes three routes within Bozeman, a route connecting Bozeman and Belgrade, and a limited commuter run between Livingston and Bozeman. The service operates year-round, Monday-Friday, with limited service on Saturdays. The current Streamline service, and the paratransit service, GALAVAN, cost approximately $1.3 million to operate.

Ridership on the Streamline system has continued to grow, with daily ridership averaging 750-800 rides per day, with over 1,000 rides per day in the winter months. This ridership is significantly higher than the initial estimates of 286 rides per day.

A Civil Engineering Class project in the fall of 2009 analyzed the Streamline system, a few highlights of that report include:

- 48% of riders were 18-24 years old, 42% were 25-54 years old.
- 52% of riders were MSU students, 12% were MSU faculty or staff.
- 90% of riders walked to the bus stop.
- The top three expansion recommendations included: longer hours (Monday-Friday), service on Sundays, and more frequent service.
- Nearly 29% of the Bozeman area and around 50% of the Bozeman population is within a quarter mile of a Streamline stop.

3.4.2. Description of alternative/TDM plan and cost

As noted in the beginning of this section, transportation costs, especially commuting costs, are typically costs borne by the individual. Given that transit fares are typically less that the cost of operating a car, and given that Streamline is currently fare-free, individuals who use Streamline can save a significant amount of money. In addition, they are reducing their GHG emissions by not using their vehicle. The only cost savings to the University are that fewer parking spaces need to be maintained (or constructed), and there may be some savings in reduced maintenance to roads controlled by the University. The University does accrue the reduction in GHG emissions by promoting its students, faculty and staff to utilize public transportation to commute to campus, however.

The cost for the Streamline transit service is approximately $50 per hour. This rate does vary, however, based on a number of factors. In general, it costs approximately $150,000 per year to operate a route 12 hours per day, five days per week. If the University wanted to add another route in town to get more faculty, staff and students on the bus, it would cost approximately $150,000. It is important to note that additional funds from the Federal Transit Administration, which are administered by the Montana Department of Transportation, may be available to reduce this amount. Therefore, it may be possible to add another route, or add more frequency to existing routes, for approximately half of the full-cost. This is to say that MSU may only need to pay one-half of the cost for additional service, with Federal funds paying for the other half.

- Examples of other programs

CyRide, a collaboration between the city of Ames, Iowa State University, and ISU's Student Body Government, is frequently cited as a model for transit within a college community.

http://www.cyride.com/

The University of Colorado at Boulder has services on its campus that link with other routes that connect the campus with Boulder and the greater Boulder-Denver area.

http://www.colorado.edu/parking/index.html

- Marketing/education/promotion

Streamline is marketed through primarily newspaper ads, and the brochures (schedules and maps). The buses themselves serve as advertisements, as they are very visible, and there are three to four buses parked in front of the Strand Union each hour, as the buses pulse on their schedule.

- Potential partners (funding, advertising, in-kind support)

Streamline already has obtained funding through a mix of partners, including federal funds administered by the Montana Department of Transportation. Local partners include Montana State University, the Associated Students of Montana State University, the City of Bozeman, Gallatin County and the City of Belgrade. However, additional partners, including large employers in the area, could contribute to Streamline, allowing the expansion of operations.

- How could this fit MSU curriculum, student research, departments

An engineering class uses Streamline as part of its public transportation program, by conducting a review/analysis of the transit system. Other classes could examine the potential to use alternative fueled vehicles, how to better market the system, or other analysis of the Streamline service.

- Timeline

Streamline services can be modified quickly, with the limiting factor being the number of vehicles available. For example, it would be relatively easy to start service on Sundays, or have existing routes run longer into the evening. More frequent service would likely require additional vehicles, which could take up to 18 months to procure. Programs to increase the marketing of Streamline to the MSU community could start immediately, however.

3.5. Car pooling

3.5.1. Existing status and cost

Montana State University made the ability to car pool easier when it switched its parking permits from a “sticker” to a “hang tag”. If individuals want to car pool, they can register a number of vehicles to a single hang tag/parking permit. This allows multiple individuals to act as the “driver” of a car pool, and allows a car pool to use a single hang tag/parking permit. With that being said, the University does not actively promote car pooling. There is no formal process (software, etc.) for individuals who are interested in car pooling to find a "match" for a ride. Any car pools that exist are based on personal relationships, and people knowing other faculty/staff who live near them, and may want to share a ride.

3.5.2. Description of alternative/TDM plan and cost

- Cost savings to University/ to individuals

As with transit, the cost savings accrued through car pooling are primarily to the individuals involved. While there are no set formulas for how to share costs in a car pool, most car pools focus on the cost of the fuel. Therefore, if two people are in a car pool (the driver and a passenger), the cost of fuel is cut in half. This savings can be significant, however. If someone were to commute from Livingston or Three Forks to campus, it would be roughly a 70 mile roundtrip. If they commuted to campus 200 days per year, that is a total of 14,000 miles. With a fuel economy of 25 miles per gallon, the driver would purchase 560 gallons of fuel for the commute. That would equate to $1,607.20 at $2.87/gallon, or $2,380 at $4.25/gallon. Therefore, by car pooling with only one other person, a driver could save anywhere from $803.60/year to $1,190/year depending upon fuel costs. Car pooling with three or four people (total) would save even more money.

The savings to the University would be the need to maintain (or build) less parking, and less maintenance on University streets. Trees could be planted in parking lots that are no longer needed, which would also help to obtain a credit for Green House Gas emissions.

- Examples of other programs

There are several programs to increase the use of car pooling. Most of them focus on using software to allow for students, faculty and staff to find other people interested in car pooling.

http://www.memphis.edu/greencampus/carpooling.php

http://www.campuslifeservices.ucsf.edu/transportation/rideshare/carpool/

http://www.zimride.com/

http://www.greenride.com/Solutions/Connect/Description

- Marketing/education/promotion

If Montana State University were to actively promote car pooling, marketing could be accomplished through the MSU News e-mail, campus newspaper, and providing links from various MSU websites to a car pool software. Also, priority parking close to campus for car pool vehicles would also be an incentive.

- Potential partners (funding, advertising, in-kind support)

The cost for implementing and promoting car pooling is estimated to cost between $10,000 and $20,000 per year. MSU may be able to work with the City of Bozeman and/or other large employers in the area to help pay for the car pooling software and incentives, and to increase the number of employees (people) to be part of a car pool. In addition, local businesses may be willing to donate prizes that could be used to promote the car pool concept.

- How could this fit MSU curriculum, student research, departments

Similar to the transit service, MSU classes could research car pooling, including how to get more people to car pool, and the types of people who participate.

- Timeline

Software could be procured and operating within weeks, and a marketing campaign could begin almost immediately, as well. In a discussion with Amy Fox from Zimride, the target is to have 10-20 percent of students, faculty and staff signed up within the first six months of the ridesharing campaign.

3.6. Van pooling

3.6.1. Existing status and cost

There are no existing van pools (or van pool programs) in the Bozeman area. Van pools are somewhat similar to car pools, but are more formalized arrangements, typically with the vehicle (van) supplied by an employer or other entity, and a set cost for those who participate in the van pool. One person in the van pool typically becomes the driver, and usually doesn't pay the monthly cost of participating in the van pool. The monthly cost for each participant is set to cover fuel, insurance, maintenance and capital costs. Monthly prices for participants can range from $80-$150/month depending upon several factors, including the distance traveled and how many people are participating in the van pool. Ideally, nine to twelve people participate in each van pool.

3.6.2. Description of alternative/TDM plan and cost

- Cost savings to University/ to individuals

Like a car pool, participants utilize a van pool to reduce the cost of commuting (alone). Utilizing alternatives such as transit, car pools or van pools can sometimes mean a family can have mobility with only one car, or possibly no cars. The cost savings to the University would be in the form of having less parking spaces to maintain (or build).

- Examples of other programs

The closest (physically) example of a van pool program is in the greater Missoula area, through the Missoula Ravalli Transportation Management Association (MR TMA) http://www.mrtma.org/Vanpool.htm

VPSI provides vans and van pool services to a number of organizations: http://www.vpsi.org/mysitecaddy/site3/index.htm

The University of Iowa has over 70 vans in its van pool program:

http://www.uiowa.edu/~commprog/vanpool_home.html

The University of California at San Francisco has a number of mobility options, including van pooling:

http://campuslifeservices.ucsf.edu/transportation/rideshare/vanpool/

- Marketing/education/promotion

As with a car pool program, the promotion of a van pool program would be to encourage students, faculty and staff to sign up for the program. In addition to saving money from reduced commuting costs, van pool vehicles could be given priority parking spaces on campus. The University could provide “giveaways” or prizes to people who participate in van pools, such as gift certificates to the Bookstore, or could pay for one month of the van pool expenses for winners.

- Potential partners

The University could partner with the Streamline transit system to operate the van pool program, which would allow individuals who are not affiliated with the University to participate in the program. The University could solicit support from other business for prizes or incentives that could be used to encourage use of the van pool program.

- How could this fit MSU curriculum, student research, departments

A van pool program could be viewed from many different angles for research projects. Marketing students could design and implement marketing programs, sociology/psychology students could analyze what makes an individual more likely to participate in a van pool, and engineering students could analyze factors that influence where to place van pools, and the GHG savings they produce.

- Timeline

A van pool program could be started quickly with leased vehicles, while it could take a year or so to procure vans if the vehicles were to be purchased. While software could be used to manage the van pool program, basic software (Microsoft Excel or Word) could be used to manage the system. Initially, van pools would be focused in areas with concentrations of students and staff, such as the Three Forks/Manhattan or Livingston areas. Working with other large employers, such as Bozeman Deaconess Health, van pools could be extended to other areas.

3.7. Supporting/other strategies

In order to transition students, faculty and staff from a single occupancy vehicle (SOV) to alternative forms of mobility, supporting strategies will need to be implemented. These supporting strategies can be thought of in terms of incentives and disincentives.

3.7.1. Guaranteed Ride Home

A Guaranteed Ride Home (otherwise known as GRH) provides commuters who regularly vanpool, carpool, bike, walk, or take transit with a reliable ride home when one of life's unexpected emergencies arises. Many public transportation agencies, or large employers with transportation programs, offer commuters a GRH for personal emergencies and unscheduled overtime. In an area such as Bozeman, the GRH would take the form of a voucher that a commuter could use on the local taxi service to get home if something unexpected occurred (say a child getting sick at school). The employee could call the taxi company for the ride, and use a GRH voucher to pay for the trip. The University would only have to pay for the GRH vouchers that are used. Some employers will provide up to four vouchers in a year, while others limit the vouchers to two per year. GRH is designed to rescue commuters who are worried about how they’ll get home when an emergency arises. Knowing there’s a guaranteed ride home allows one to use commuting options like transit and carpools with peace of mind and confidence.

3.7.2. Education Activities

Each strategy herein has discussed educational activities not only in terms of education about how to safely bicycle in traffic or load a bike on a bus, but also in terms of how alternative transportation activities could be integrated into student class projects or research. Whether it is planning for better transportation-land use linkages, analyzing the use and efficiency of alternatives, determining how to get more people to use alternative transportation modes, or analyzing the reduction in green house gas emissions from the increased use of alternative modes, there are many educational activities that can be part of the transportation component of Montana State University's Climate Action Plan.

3.7.3. Evaluation Activities

The evaluation activities would include analyzing how many people (students, faculty, staff) switched from an SOV to an alternative mode (walk, bike, car or van pool, or use transit). Institutionalizing a transportation survey, similar to the 2010 survey, would help MSU track changes. In addition, an analysis could look at the use of each mode, and what could be done to further increase the use of alternative modes for the commute to/from the University.

Further evaluation activities could include determining the cost/benefit ratio of each alternative mode, and van pool and transit routes could be evaluated as well.

3.7.4. Promotion and Encouragement Activities

The promotion and encouragement activities could be thought of the "carrot" or incentives to get people to change their transportation behaviors. There is a host of activities that could be included herein, some of which were mentioned in sections related to specific transportation alternatives. However, some of the promotion and encouragement activities could include:

- Incentives/giveaways to people who don't drive to campus
- Discounts at local businesses to people who don't drive to campus
- Discounts at the MSU Bookstore or MSU Food Services to people who don't drive to campus
- A "pay not to park" incentive

Encouragement could include competitions between colleges/departments within MSU for the highest percentage of staff (or students) that do not drive to campus. MSU sports teams could ride the bus, car pool or ride bikes to campus with other students, faculty and staff to promote riding the bus. News articles or other media events can highlight how using alternatives to the single-occupancy vehicle saves money and reduces green house gas emissions.

3.7.5. Disincentives

If promotion and encouragement activities are viewed as a "carrot", the disincentives are certainly the "stick." These activities (or policies) would be put in place to make it less desirable to commute to campus in a single-occupancy vehicle, and should lead people to look for alternative modes of transportation. In general, disincentives should not be used exclusively to get people to modify their transportation behavior, but should be used in conjunction with incentives, as well.

In general, disincentives make traveling in a single-occupancy vehicle more expense, or take more time than an alternative mode. Given the fact that the University primarily controls parking on campus, disincentives could include:

- Increased parking costs (for all parking spaces/permits)
- Distance based parking fees (so those who live closer to campus have to pay more for a parking permit, since they have more alternatives available)
- Parking meters on campus so people have to pay each time they park.

The parking meter concept is based on the concept that the first time a person purchases a semester or year-long parking permit; that is when the cost is incurred. The rest of the time a person parks, it is “free.” Having parking meters at all spots on campus changes the paradigm, so that it costs someone ever time they park on campus.

4. AIR TRAVEL

4.1.1. Existing status and cost

Directly financed air travel contributed 16 percent of MSU’s net emissions. Air travel for students studying abroad contributed another 9 percent of MSU’s net emissions. This is significant, as faculty, staff and student commuting only accounted for 10 percent of MSU’s net emissions. While the alternatives for the student travel abroad are to not travel, or purchase offsets, there is another alternative related to other directly financed air travel.

4.1.2. Description of alternative/TDM plan and cost

As a major research university, many faculty, staff and students are traveling to be part of conferences to learn of research, or to present research findings. Until many of these conferences embrace video-conferencing, or holding virtual conferences, there will still be a tremendous need to travel by air to these meetings/conferences. In that situation, MSU will be able to purchase offsets to compensate for this travel.

In instances where air travel is taking place for meetings, project updates, or other instances when a conference call, webinar, or video conference is adequate, MSU should have policies and procedures in place so that faculty, staff and students can determine when air travel is justified, and when an alternative should be selected.

5. EMISSION REDUCTIONS

As noted previously, the Green House Gas inventory for Montana State University did not include student trips for purposes other than commuting to classes at MSU. The commuting activities to campus for student, faculty and staff accounted for 10 percent of MSU’s net emissions. Directly financed air travel, study abroad air travel, and other directly financed travel accounted for 16%, 9%, and 3% of MSU’s net emissions, respectively.

The main strategy noted herein for air travel and “other” travel was to purchase offsets, while there were various strategies identified herein for reducing commuting impacts. The shorter the distance someone commutes to campus, the more alternatives are available. For example, if someone lives within one mile of the MSU campus, alternatives such a walking and biking are viable options. However, if someone lives ten miles from campus, it is unreasonable to expect that they would walk or bike. The survey that was used to develop the baseline inventory indicated that the majority of faculty, staff and students live within a relatively close proximity to campus (Table 1).

Table 1: Faculty, staff and student commute distances

Distance from Campus	Percentage of Respondents	Cumulative Percentage
Less than 1 mile	27.4%	27.4%
1.1-3 miles	25.4%	52.8%
3.1-5 miles	16.2%	69.0%
5.1 to 10 miles	14.7%	83.7%
10.1-15 miles	8.5%	92.2%
15.1-20 miles	3.3%	95.5%
20.1-30 miles	3.3%	98.8%
30.1-40 miles	0.5%	99.3%
40.1-50 miles	0.5%	99.8%
50.1 miles or more	0.3%	100.1%

The data indicates that roughly half of the campus population lives within a distance (three miles or less) where non-motorized options could be utilized. Further, only 4.5 percent of faculty, staff and students live more than 20 miles from campus, a distance which tends to add to the cost of options such as van pools and transit.

Figure 4 shows that a majority of housing in Bozeman is within three miles (the blue line) of campus. Driving from Belgrade to campus is approximately twelve miles.

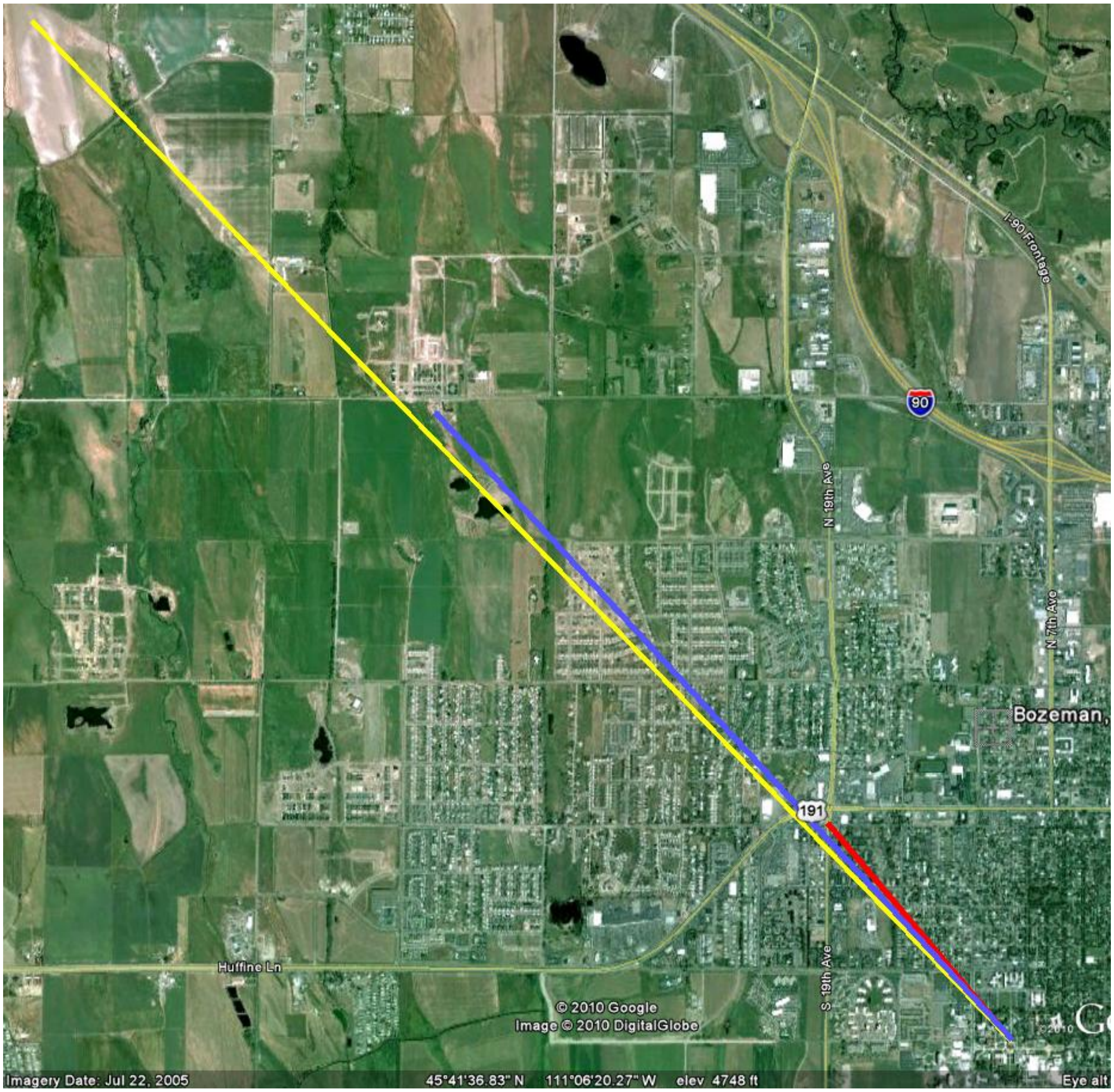

Figure 4: Distances from MSU Campus Source: Google Earth

The GHG inventory based its calculations on 9,124,603 automobile miles and 189,376 bus miles of commuting by faculty and staff, and 9,826,713 automobile miles and 411,168 bus miles of commuting by students. The GHG inventory did not capture student travel for other purposes (working, shopping, etc.).

While an analysis has not been completed to the level of detail that would allow for a decision that implementing van pooling, for instance, would reduce commuter traffic by 10 percent, Table 2 provided data on the GHG emission savings based on the reduction of commuter mileage.

Table 2: Potential GHG savings for commuter reductions

	Car miles	Bus miles	Energy Use MMBtu	CO2 kg	CH4 kg	N2O kg	eCO2 Metric Tonnes
2009 Baseline							
facutly/staff	9,124,603	189,376	51,924.5	3,642,451.6	721.8	248.7	3,732.7
students	9,826,713	411,168	56,640.7	3,974,894.2	780.3	269.2	4,072.5
5% reduction							
faculty/staff	8,668,373	189,376	49,381.1	3,464,032.0	686.4	236.5	3,549.9
students	9,335,377	411,168	53,922.4	3,784,131.4	742.9	256.3	3,877.1
10% reduction							
faculty/staff	8,212,143	189,376	46,837.6	3,285,612.4	651.1	224.3	3,367.0
students	8,844,042	411,168	51,204.1	3,593,368.5	705.4	243.4	3,681.6
15% reduction							
faculty/staff	7,755,913	246,189	44,610.9	3,129,410.8	620.1	213.7	3,206.9
students	8,352,706	534,518	49,168.2	3,450,496.9	677.4	233.7	3,535.2
20% reduction							
faculty/staff	7,299,682	246,189	42,067.5	2,950,991.3	584.8	201.5	3,024.1
students	7,861,370	534,518	46,449.9	3,259,734.1	639.9	220.8	3,339.8

It should be noted that if MSU faculty, staff and students ride the bus (Streamline) it does not increase GHG emissions, as the buses are operating anyhow. However, to get a reduction of commuter mileage beyond 10 percent, an additional bus route, or more frequent bus service, may be required. The reduction table above does reflect an increase in bus miles, but that may not necessarily reflect the true picture.

It is recommended that Montana State University work with the City of Bozeman to promote currently available alternative modes to reduce commuting miles. These existing alternatives include walking, biking, car pooling and utilizing public transportation. Alternatives such as car pooling could be enhanced through the use of software for ride matching, and by MSU implementing incentives, such as preferential parking for car pool vehicles. In addition, incentives, such as giveaways or other promotions, could increase the use of transit. MSU could use additional surveys to gauge the interest in new options such as van pools, to see if those options are worthy of future investment.

6. REFERENCES

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