ghg

greenhouse gas inventory

2000–2007

The University of Montana

table of contents

ghg inventory

Prepared by Jessie Davie,
ASUM Sustainability Coordinator

Assisted by GHG Inventory Team and Report Contributors:
Kendra Kallevig, Sky Orndoff, Erika Fredrickson, JJ Vandette
Faculty Advisor: Phil Condon, Associate Professor, EVST

The University of Montana

executive summary

As a public research institution, The University of Montana at Missoula attracts over 12,000 undergraduate and graduate students every year. Located in the Missoula Valley in Western Montana, at the base of Mt. Sentinel and by the banks of the Clark Fork River, UM is intrinsically tied to its landscape and setting. But as wildfires increase in our forests, temperatures reach record highs, and mountaintop glaciers continue to melt, we are watching Montana feel the initial effects of climate change—effects that are harming the natural features that make this state and this University unique and great. Global warming is the most pressing issue of our time, and we no longer can put off taking action as something to be done down the road. The time is now.

In response to such growing concerns about the impacts of global warming, in February 2007, President Dennison became a charter signatory to the American College and University Presidents' Climate Commitment (ACUPCC). In signing this commitment, President Dennison pledged to make The University of Montana more sustainable and to "ultimately neutralize greenhouse gas emissions on campus."[1] This commitment was a great milestone for the University and for the many students, faculty members and administrators who had dedicated many efforts to promote sustainability initiatives on campus. But a pledge is meaningless without action. Therefore, this report is one of the many steps outlined by the ACUPCC that an educational institution must take in order to demonstrate real progress.

This report summarizes the findings of UM's first-ever greenhouse gas inventory. The purpose of the inventory is three-fold:

1) To comply with ACUPCC's implementation schedule;
2) To identify and remedy the various complexities and obstacles involved in conducting an inventory at UM;
3) To formulate a baseline from which UM can create realistic reduction targets.

The findings in this report represent the most comprehensive set of data available at this time for the UM at Missoula. We were only able to track data from 2000 through 2007. Data was collected and inventoried from five sectors—on-campus stationary sources (steam plant), electricity purchases, transportation, solid waste, and agriculture. The results of the report show one common trend—greenhouse gas emissions at The University of Montana have steadily increased since 2000. The following report details GHG emissions associated with each sector, offers recommendations on possible reduction strategies, and serves as guide and blueprint for conducting future inventories.

acknowledgements

This inventory was truly the result of a campus-wide cooperative effort. There were many people involved, and we would like to offer all efforts—large or small—our greatest appreciation.

There are a few people in particular who we would like to thank and acknowledge. The work of the Greenhouse Gas Inventory interns—Kendra Kallevig, Sky Orndoff, JJ Vandette, and Erika Fredrickson—was invaluable and this inventory would not be where it is today without their hard work. Environmental Studies Assistant Professor, Robin Saha, dedicated many hours assisting with graphing projects. Research scientist in the College of Forestry and Conservation, Faith Ann Heinsch, shared her expertise and helped review this inventory. Laura Howe and Peggy Schalk in Facilities Services dedicated many hours providing data for this inventory as well as patiently answering many questions and providing lots of clarification. Kay Lamphiear from Business Services was a key player in data collection and we look forward to continue working with her. All members of UM's Sustainable Campus Committee (SCC) participated in guiding this project. Emily Peters, Facilities Services Sustainability Coordinator, and Dustin Leftridge, 2007/2008 ASUM President, both offered great support. Finally, Environmental Studies Associate Professor and SCC member, Phil Condon, acted as the project's advisor and his work, support, and guidance made this project possible.

other thanks:

President Dennison, Vice President Foley, Vice President Duringer, Provost Engstrom, Hugh Jesse, Jordan Hess, Mark LoParco, Perry Brown, Curtis Noonan, Lisa Swallow, Kelly Chadwick, Paul Williamson, Vicki Watson, Mike Panisko, Nancy Wilson, Brad Evanger, Bonnie Holzworth, Tony Tomsu, Ginna Reesman, Mona Weer, Rita Tucker, David Weis, Jennifer McCall, Jane Fisher, Judy Maseman, John Baldridge, Jim Sylvester, Edward Wingard, James O'Day, Sandy Shook, Kathy Benson, Bob Peterson, Gerald "Frenchy" Michaud, Max Bauer, Tom Welch, Greg Plants, Dan Corti, Rich Chaffee, Tom Burt, Richard Erving, Josh Slotnick, Lisa Gerloff

intro

introduction

By now we know that humans play a role in changing the Earth's climate. We know that the longer we wait in reducing Greenhouse Gases (GHGs) in our atmosphere, the higher the probability that climatic change will affect our lives in more extreme and unpredictable ways. According to the latest scientific assessment by the International Panel on Climate Change (IPCC), the burning of fossil fuels like coal, oil, and gas is the primary source of increasing carbon dioxide (CO2) emissions. Earth's oceans and plants absorb approximately half of these emissions, but the rest remains in the atmosphere for centuries. It is projected that twenty percent of 2007's CO2 emissions from fossil fuels will remain in the atmosphere for thousands of years.[2]

Like many places throughout the world, Montana has been experiencing record high temperatures and other symptoms of what could be long-term climate changes. Climate change has had, and will continue to have an impact on our environment, our lifestyles and future generations.[3] For this reason, the choice to take action on climate change is ethical at its core, and the solutions we employ must be both fair and effective.

The University of Montana is committed to developing and implementing sustainable initiatives allowing our campus to mitigate its impact on climate change. The Montana state government's energy bill in 2007 was $27.5 million, and just the cost for heating and lighting the state's university system was responsible for 58% of that bill.[4] The University of Montana alone incurred energy costs of roughly $3.3 million.

In 2007, in response to these energy costs and to the impending threats of climate change, President George Dennison signed the American College & University Presidents Climate Commitment (ACUPCC). In a recent newspaper article President Dennison referred to climate change as "the leading global issue of our time."[5] By signing the ACUPCC, he officially dedicated UM to reduce its carbon emissions to zero—a key part of making the campus a model for sustainability.

why greenhouse gases?

The greenhouse effect occurs when greenhouse gases (GHGs) in the atmosphere absorb infrared—long wave—radiation from the Earth's surface, and re-radiate it back to Earth. Greenhouse gases are distinguishable by their molecular structures, which allow them to absorb the energy of long wave radiation, preventing it from radiating into space. Without the natural greenhouse effect, the average temperature of the Earth's surface would be below the freezing point of water, and life as we know it would be impossible. However, human activities such as burning fossil fuels and deforestation have intensified the concentration of GHGs in the atmosphere, allowing it to trap an increasing percentage of the earth's infrared radiation. This series of interactions leads to global warming. According to the IPCC, there are six main greenhouse gases, each varying in its ability to efficiently absorb radiation. Carbon dioxide (CO2) is of most concern because it is the primary by-product of anthropogenic activities, including fossil fuel combustion and land-use change. Also high on the list of GHG culprits are methane (CH4) and nitrous oxide (N2O), both of which are released through anthropogenic activities like agriculture.

Gas	Formula	Global Warming Potential over 100 yrs	Current Atmospheric Concentration
Carbon Dioxide	(CO2)	1	379 ppm
Methane	(CH4)	25	1774 ppb
Nitrous oxide	(N2O)	298	319 ppb
Hydrofluorocarbons	(HFCs)	14,800	17.5 ppt
Perfluorocarbons	(PFCs)	12,200	3 ppt
Sulphur hexafluoride	(SF6)	22,800	4.2 ppt

Table 1[6]

While methane and nitrous oxide are not as heavily concentrated in the atmosphere as carbon dioxide, their ability to absorb radiation is higher.[7] Another complication to the greenhouse effect is that once greenhouse gases become too prevalent, there are positive feedbacks that begin to take place. For instance, the evaporation of ocean and lakes adds water vapor into the air, which, in turn, further traps radiation and reflects more heat back to Earth. Sea ice also has a high albedo, which reflects radiation back into the atmosphere. However, warming causes a reduction of sea ice, turning it to water, which absorbs heat rather than reflecting it.[8]

Comparison of annual CO2 growth and lower troposphere temperature

Black: Moving Annual CO2 growth (Mauna Loa),

Blue: Lower troposphere temperature (MSU UAH)

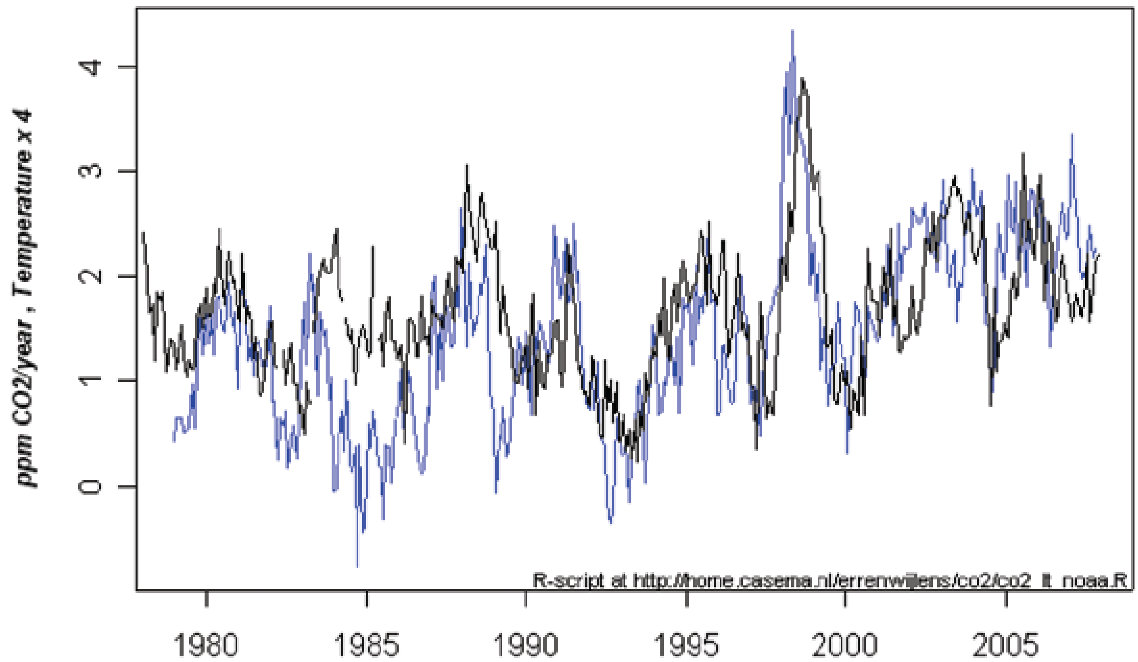


Figure 1: This graph compares the annual CO2 growth to the annual temperature rise.[9]

Evidence of Climate Change

In the past century there has been a rise of more than 0.7 degree (1.3 degrees F) in the average surface temperature of Earth, and in recent years global temperatures have spiked dramatically.[10] According to the analysis, the global average land-ocean temperature last year was 58.2 degrees Fahrenheit, slightly more than 1 degree above the average temperature between 1951 and 1980, which scientists use as a baseline.[11] While a 1-degree rise may not seem like much, it represents a major shift in a world where average temperatures over broad regions rarely vary more than a couple hundredths of a degree.

Eleven of the last twelve years (1995 – 2006) have ranked among the warmest years in the instrumented record. The likely rise in average global temperature by 2080-2099 relative to 1980-1999 could range anywhere from 2.0 to 11.5 degrees F.[12] This range reflects the uncertainties of how much GHGs human activity will put into the atmosphere from now until then, how positive feedback may play out, and other possibilities of tipping points where warming is increased due to unpredictable circumstances.

Other circumstantial evidence for climate change according to the IPCC report includes:

- Dramatic melting of ice on both land and sea. By mid-century, ice in the Arctic may disappear completely each summer.

- The growing season has lengthened over much of the Northern Hemisphere, and in higher latitudes it has lengthened by over two weeks.
- Birds and insects are being pushed to new altitudes and latitudes due to warming. Arctic communities report seeing birds like robins appearing in areas when they haven't before.
- Drought has been increasing in most warm places, especially in the tropics.
- Ocean temperatures across the globe are rising significantly.
- Permafrost in both Alaska and Greenland that has been built on for hundreds or thousands of years has been melting to the point where entire towns are having to relocate, and crops that were not previously able to grow, now can.
- There has been a consistent, worldwide trend of lower water levels in streams and lakes, with decreasing summer stream flows over the past few decades.
- There is evidence that marshlands are turning into open water as precipitation in those areas continues to increase.

Significant evidence points to anthropogenic climate change. According to the IPCC, CO_2 concentrations in the atmosphere have increased since the industrial revolution, and can be correlated with the increase in combustion of fossil fuels, which produces CO_2. Human land use that produces CO_2, including deforestation, has also been increasing during this time. We know that CO_2 alters the amount of outgoing radiation by re-emitting it back to Earth and producing a warming. When fed into a climate change computer model, natural climate change can only explain a portion of our current and rapid warming trend since the industrial revolution. When human-produced CO_2 is added to that model, the model's prediction aligns with current warming trends.[13]

global ethical implications

The most important problem we face today is figuring out how to fairly and effectively make a technological transition – to a point where we not only stabilize atmospheric GHGs, but also begin reducing them. This will require solutions that will both mitigate climate change and provide ways to adapt to it quickly. The warming of the planet and the rise of sea level will likely push people away from coastlines, and since two-thirds of the global population live within 250 miles of the coast, it will be a major geographic shift. In general, places that are wet are projected to get wetter, while places that are dry are projected to get drier.[14]

In a recently updated IPCC report Rajendra Pachauri, Chairman of the IPCC, told reporters, "it is the poorest of the poor in the world, and this includes poor people even in prosperous societies, who are going to be the worst hit." This is a test for civilized society, because solutions (or lack thereof) will have a great impact on other people. The "fair" part will be difficult because of its vague definition, because of the number of people we have to consider and because currently our economic and political systems are not fair. In addition, those who are dealing most with the costs of climate change never really reaped the benefits of the consumer lifestyle that caused those costs, which also makes the situation unfair.

"Efficiency" will be difficult for some of the same reasons and mostly because climate change is a global problem with systemic issues, yet efficiency is often attained best at a local level. Global treaties are often watered down to fit everybody's needs, and in this case we may need to have a strong, uncompromising solution to change the momentum of climate change quickly enough to avoid unpredictable disasters.

The problems that we face now do not have much to do with science. The science of climate change can continue to be improved upon, but it will never give us a 100% certain projection of what will happen if we do nothing. So far, we have been given substantial evidence that climate change is happening now, and that we are playing a significant role in that change. Considering the current scientific consensus on climate change,[15] the climate model projections and regional observations that may be related to climate change, we have enough evidence to make a decision to act. And considering that current projections indicate that inaction will directly contribute to more intense devastation, and a reduction in solution opportunities, we have an ethical obligation to act. Translating knowledge of our obligation into action is the hard part. However, if we know that climate change is at least partly human-caused, and we understand that the likely consequences could have detrimental effects on humanity, habitats and wildlife, then we have a moral obligation to make changes, and we are definitely culpable if we do nothing. The University of Montana's commitment to reduce its carbon footprint is a great starting point in this effort.

climate impacts on montana

Montana is known for its natural ecosystems and national parks. These features attract outdoor recreation enthusiasts, college students studying an array of sciences, farmers, and tourists, among others, and provide both intrinsic values for communities and economic returns for the state. Climate change appears to already be affecting these features with longer fire seasons and lower streams levels. Milder winters with decreasing days of frost and earlier growing seasons may also become a trend. While an extended growing season may seem beneficial to agriculture in Montana, water issues will likely sabotage those benefits in the long-run. By 2050, global climate models project Montana to be 5 degrees F warmer in summer but receive 10% less rainfall, leading to increased water management and irrigation problems. Intense fire seasons, low snow-pack and other biological changes in the ecosystem could impact critical plants and wildlife in national parks. It is expected that Montana will lose all glaciers in Glacier National Park by 2030.[16]

One piece of climate change evidence in Montana is an increase in temperature over the last decade, correlating with global climate change. July 2007 was a record breaking month, providing the hottest state temperature on record at 107 degrees F.[17] But that's not the only record it broke. July 2007 also gave us:

- the warmest night on state record at 71 degrees F.
- the highest average July temperature at 78.1 degrees, which is 11.2 degrees above average and breaks the old record by 3.3 degrees.
- the most number of 100 degree F days (11 days) on record, breaking the old 1936 record which was set at 6 days.
- the most number of nights at 60 degrees F and above (18 nights), breaking the old 1985 record, which was 10 days.

If these record breaking temperatures become a long-term trend, we can deduce that long-term changes in Montana's climate will include a number of related impacts including:

- **Shorter, milder winters.** Milder winters could have severe effects on both economy and ecology. Recreation areas that require large amounts of snow for skiing and other winter activities will face the challenges of lower levels of snow.

- **Growing seasons.** Earlier snowmelt will provide earlier springs with the result of longer growing seasons. However, the benefits of longer growing seasons may be suppressed by lower precipitation and drier summers.[19] Decreasing summer stream flows may also put strains on irrigation and water availability in general.

- **The melting of glaciers.** Glaciers in parks like Glacier National Park are already being impacted by climate change. While snow melt is a seasonal impact, the melting of glaciers is a long term change in glacial ecosystems. There are also obvious implications for the tourist aspect of a national park called "Glacier" if it has no glaciers.

March snowlevel at Snowbowl Ski Area

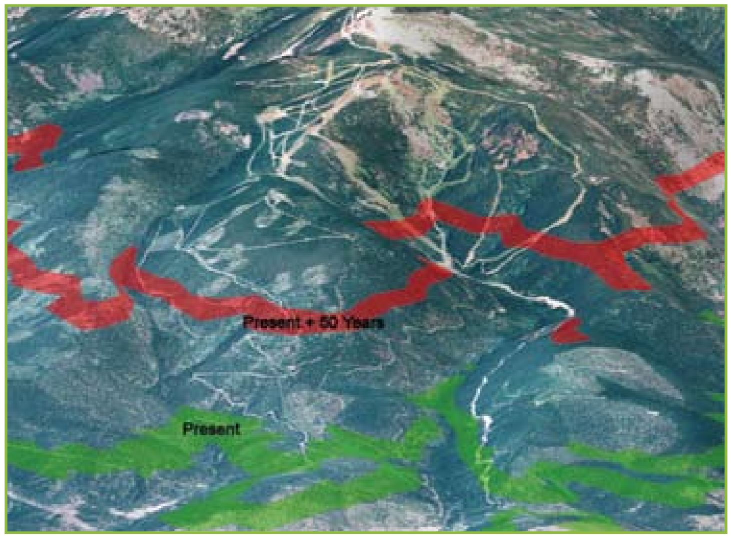


Figure 2: Saxon Holbrook, http://www.ntsg.umt.edu/

2005 (in green) and predicted level for 2055 (in red)[18]

Shepard Glacier Glacier National Park

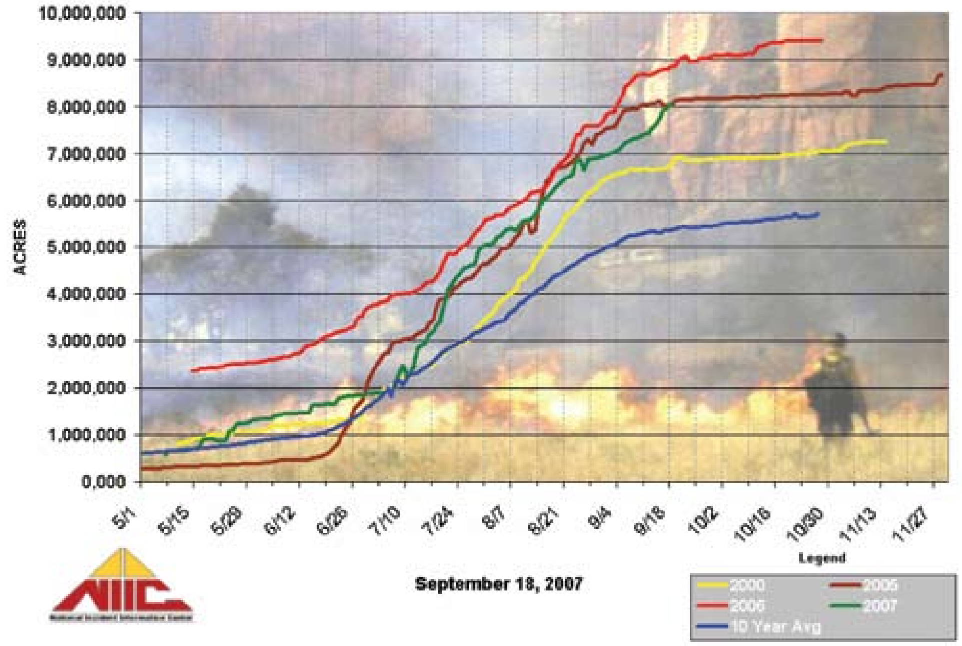
(Fagre, Dan. http://www.nrmsc.usgs.gov/staff/fagre.html)

Photo by W.C. Alden, USGS 1913

(Fagre, Dan. http://www.nrmsc.usgs.gov/staff/fagre.html)

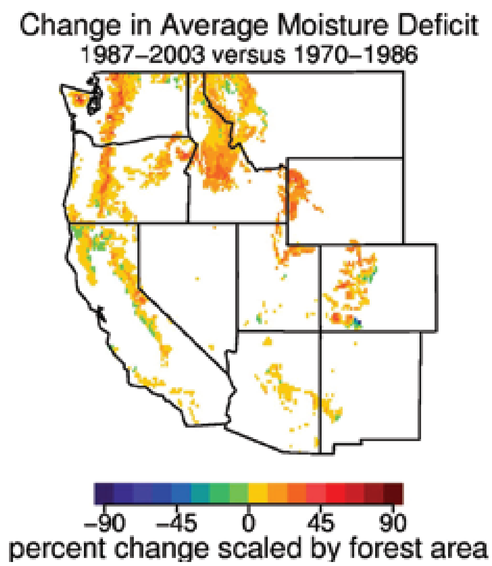
Photo by B. Reardon, USGS 2008

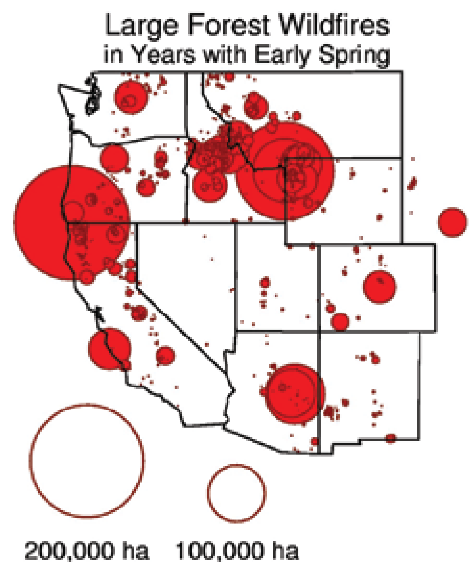
Wildland Acres Burned 2007



- **More drought and fire danger.** The number of wildland acres burned by wildfire over the last 10 years has risen significantly. Wildfires due to climate change are expected to continue increasing the amount of acreage burned, mostly because the intensity of wildfires is expected to increase.[20]

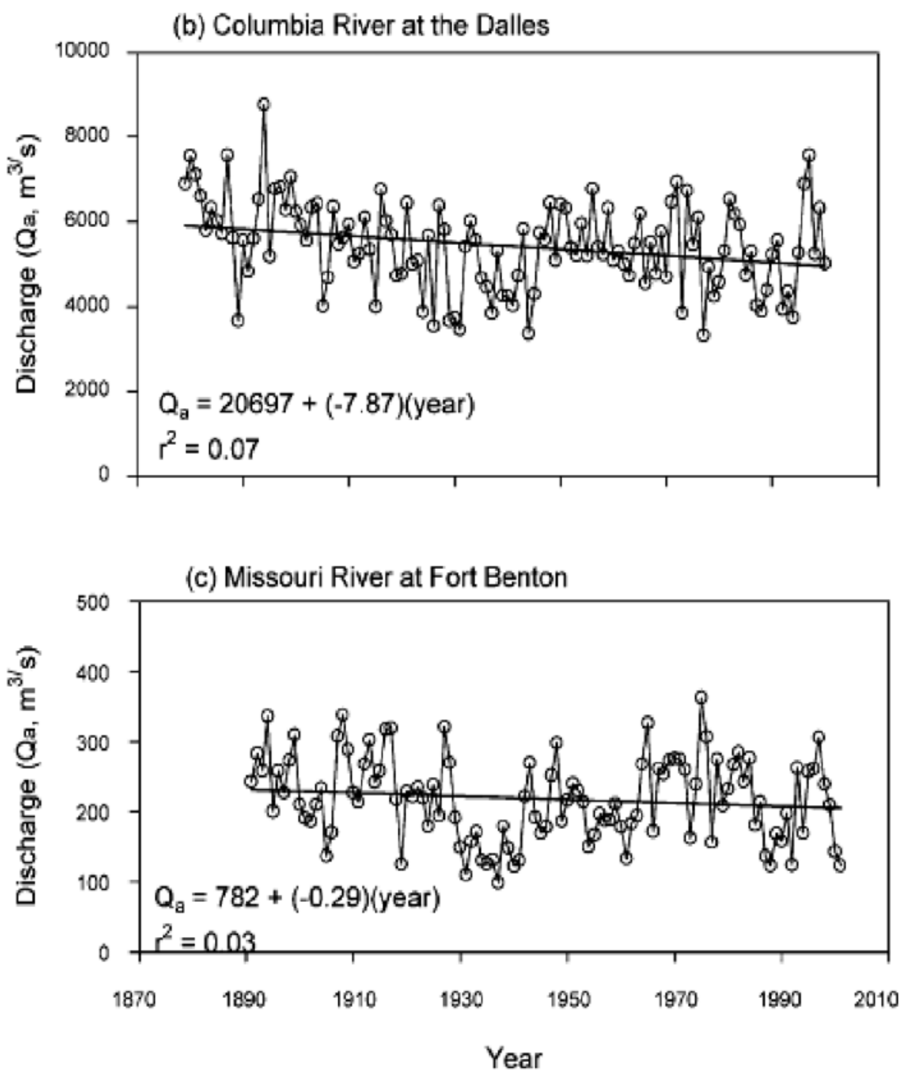
- In the Western US, including Montana, precipitation deficits and early springs have led to larger forest fires than usual. Precipitation changes will occur with climate change. Areas of Montana that experience dry seasons can expect it to be even drier. Areas with high precipitation may see higher precipitation, which can lead to flooding.





Declining River Flows - Columbia and Missouri Basins

- **Low stream levels.**
  With low precipitation in some areas and low snow pack, river flows are declining in many places, including Montana. Low level rivers impact everything from wildlife, fish, farm irrigation and water recreation.



Rood et al. J. Hydrology 2005 Figure 5

A change in Montana's climate means that ecosystems will begin to reflect the new climate trends. Some of these predicted ecosystem changes include:

- Decreased deer and elk winter-kill
- Shortening of hibernation season and possibly no hibernation for some animals
- Increase of forest insects and crop pests
- Higher water temperatures decrease oxygen dissolution, leading to aquatic ecosystem degradation.

The University of Montana's Response to Climate Change

The University of Montana has an obligation to address climate change because we are responsible for a significant percentage of Montana's greenhouse gas emissions. As an institute of higher education we should be a model of progress for our communities, our state and our nation, and a place that provides educational opportunities and leadership addressing the most pressing issues of our time. The UM community has an opportunity to impact the choices we make with climate change – choices that will affect this generation and generations to come.

inventory overview

Because this was the first inventory done at UM, data collection entailed much digging and investigating, and it required great cooperation from various departments scattered across campus. In several instances, data were not available for certain years and/or facilities and in places approximations had to replace such gaps. Our original goal was to measure emissions as far back as 1990, to be in accordance with international and national reporting protocols, and also to include the three affiliated campuses; however, because data were not available in many circumstances, this inventory will only examine University emissions at the Missoula campus from 2000 to 2007. It should be noted that although this report contains the best available information about UM's greenhouse gas emissions, it by no means should be taken as a wholly accurate accounting system. Instead it is hoped that this first inventory will serve as a foundation to help shape future inventories that will allow The University of Montana to efficiently and accurately track its total greenhouse gas footprint.

Each section that follows will identify the various obstacles or gaps associated with collecting data for that particular sector. But in order to be as transparent as possible, a few significant gaps must be pointed out: 1) This inventory used boundaries in order to make collection feasible. Therefore, this report does not include upstream emissions—those that are associated with production and manufacturing of goods and services—student travel to and from their home towns, and activities belonging to the campus community that are outside of the campus lens (for instance, faculty members personal housing, etc.) 2) Due to the overwhelming task of data collecting and tracking information, this inventory does not include any emission information from The University of Montana's Athletics Department. However, the Athletics Department seized the opportunity to develop a strategy for data collection in order to contribute to future inventories.

methods

This inventory was compiled by the ASUM Sustainability Center through the work of one part-time employee and four interns. Many departments were involved and provided data for this inventory. In order to avoid overlap, double counting, and any confusion, the GHG inventory team communicated through an online working document, logging all communications with key contacts (see Appendix I for contact list).

The University of Montana used the Clean Air-Cool Planet Campus Climate Calculator version 5.0 to conduct this campus greenhouse gas inventory. The calculator is an MS Excel Workbook designed to assist educational institutions in measuring their greenhouse gas emissions. It includes the greenhouse gases specified in the Kyoto Protocol (as outlined in the introduction), and the spreadsheet information is based upon workbooks provided by the International Panel on Climate Change (IPCC).[21] The Campus Climate Calculator is a great tool and we were grateful to be able to use it as well as to have had support and guidance from Clean Air-Cool Planet staff.

ASUM sustainability center

inventory findings

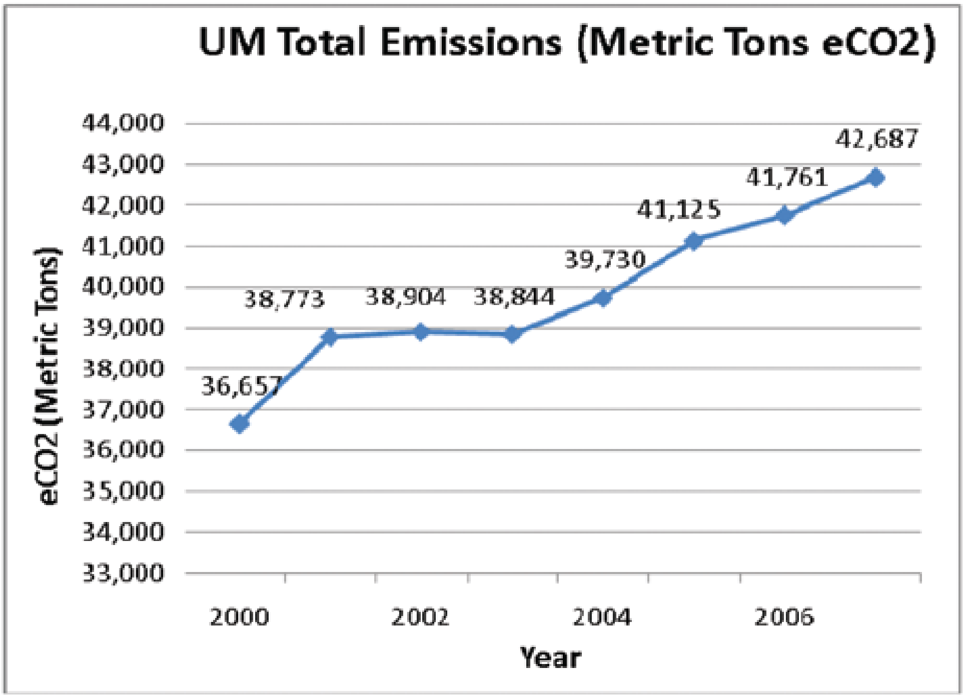


Figure 6: This graph represents UM's total amount of GHG emissions (in Carbon Dioxide Equivalents) measured in metric tons produced from 2000 -2007.

As is clear by this graph, the total amount of greenhouse gas emissions produced by The University of Montana has increased steadily since 2000. There has been a 16.44% increase in GHG emissions since 2000. Of course, there are many reasons behind this increase—increased student population, buildings on campus, technology, etc. In order to understand these increases it is important to look at emission levels according to their particular sector. Therefore, the following report will look at greenhouse gas emissions per source.

UM's Emissions by scope:

In its "User's Guide," Clean Air-Cool Planet outlines the set of accounting standards that were established by the World Business Council for Sustainable Development and the World Resources Initiative (WBCSD/WRI). These standards breakdown emission sources into three "scopes:"

Scope 1: includes all direct sources of GHG emissions from sources that are owned or controlled by your institution, including (but not limited to) production of electricity, heat, or steam; transportation or materials, products, waste, and community members; and fugitive emissions (from unintentional leaks).

Scope 2: includes GHG emissions from imports of electricity, heat or steam—generally those associated with the generation of imported sources of energy.

Scope 3: includes all other indirect sources of GHG emissions that may result from the activities of the institution but occur from sources owned or controlled by another company, such as business travel, outsourced activities and contracts, emissions from waste generated by the institution when the GHG emissions occur at a facility controlled by another company, e.g. methane emissions from land-filled waste, and the commuting habits of community members.[22]

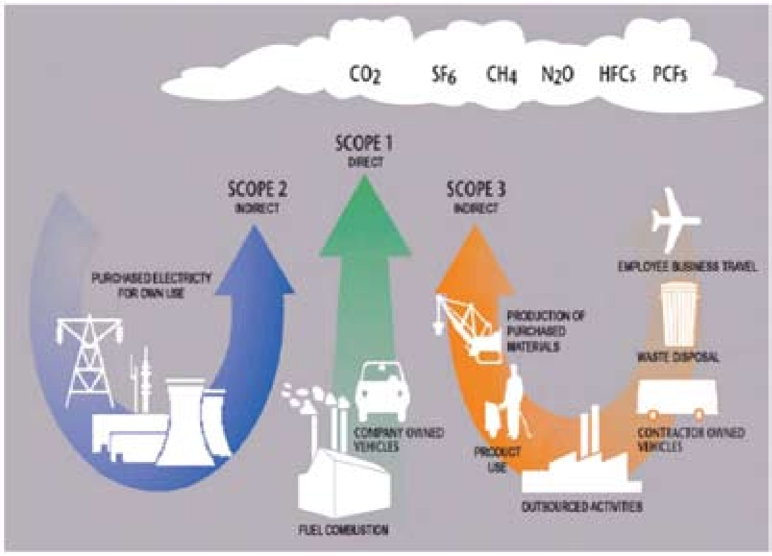


Figure 7: This picture helps illustrate the breakdown of emissions by scope. [23]

UM breakdown by scope

Scope 1	Scope 2	Scope 3
On-Campus Co-generation plant *Steam production *electricity generation	Purchased Electricity	Air Travel
University Fleet *ASUM Transportation *Facilities Services vehicles *Rental Fleet		Faculty/Staff commuter habits
Fertilizer Application		Student Commuter habits
		Solid Waste Disposal

Table 2: This table breaks down The University of Montana emissions sources based on their scope.

	Emissions By Scope			Net
Fiscal Year	SCOPE 1 Emissions	SCOPE 2 Emissions	SCOPE 3 Emissions	Net Emissions (MT eCO_2)
2000	13,515	11,033	12,109	36,657
2001	15,340	10,959	12,475	38,773
2002	14,914	11,278	12,712	38,904
2003	14,768	11,416	12,660	38,844
2004	15,099	12,303	12,328	39,730
2005	15,993	12,385	12,747	41,125
2006	16,293	12,928	12,540	41,761
2007	16,664	13,130	12,893	42,687

Table 3: This chart shows the total breakdown of emissions, measured in MTeCO2, by scope. It also shows the annual Net Emissions produced by The University of Montana.

Emissions by Source:

This inventory followed the structure of CA-CP Campus Climate Calculator to determine the different sources to be included in the inventory. This inventory will report on emissions produced by electricity, steam production, transportation (including air travel and faculty/staff/student commuter information), solid waste, and agriculture. According to the ACUPCC's "Implementation Guide"—reporting on standards designated by the Chicago Climate Exchange and the California Climate Action Registry General Reporting Protocol—small emissions sources, comprising 5% or less of an institution's total emissions, may be considered de minimis.[24] If considered de minimis, an institution is not obligated to track and report those emissions. For our inventory we have included two sectors—agriculture and solid waste—that comprise less than 5% of emissions, but we did not include emissions associated with refrigerants, which would have been a very small percentage, because that information was not available (see "Refrigerants").

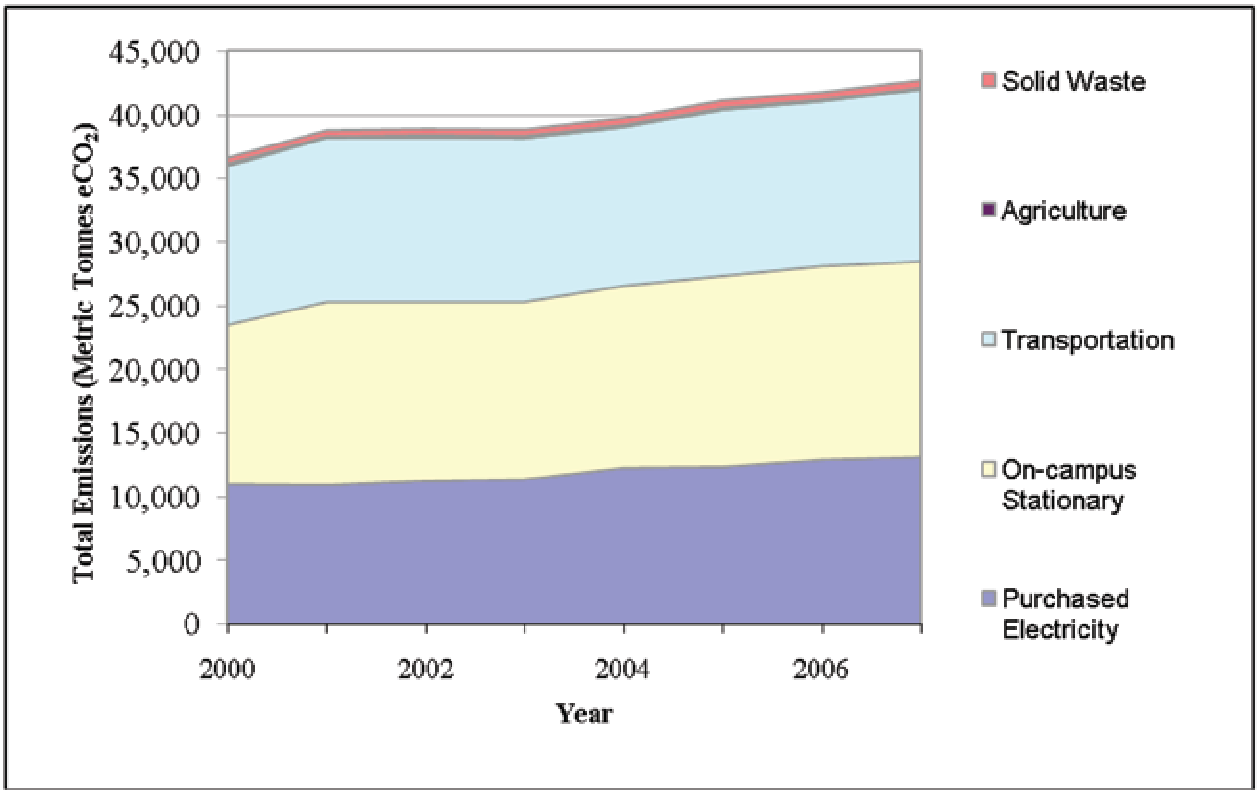


Figure 8: This graph represents the total GHG emissions per source from 2000 to 2007. In 2000 total emissions were MTeCO2 36,657 and in 2007, MTeCO2 42,687.

Breakdown by source shows that total campus emissions come from three main sectors: transportation, on-campus steam production, and purchased electricity. Agriculture (fertilizer application) only contributes .2% of total emissions, and solid waste contributes 1.3% of total campus emissions. Transportation makes up 31.6% of total emissions, purchased electricity makes up 30.8%, and on-campus production of steam contributes the most with 36.1% of total campus emissions. In order to develop a substantial reduction strategy, The University of Montana must focus its attention primarily on these three emission sources.

Source	2000 MTeCO2	2007 MTeCO2	% Change
On Campus Steam Heat	12,532	15,394	22.8%
Purchased Electricity	11,032	13,129	19.0%
Transportation	12,424	13,487	8.6%
Agriculture	205	101	-50.6%
Solid Waste	462	573	24.2%

Table 4: This table shows the percent change of emissions per source from 2000 to 2007.

energy

This section of the inventory explores emissions associated with energy use on campus. Energy is broken down into two sections: on-campus stationary sources and electricity. The data collected represents all of main campus and the College of Technology. It also includes remote facilities: Bandy Ranch, Seeley Lake, Lubrecht Forest, and Flathead Biological Station. All data pertaining to main campus and the College of Technology was provided by Facilities Services. The data from the remote facilities was provided by many individuals and records were not as complete. Some approximations and extrapolations were necessary to complete records back to 2000.

Facilities Services does not pay for or track residential housing energy usage. Instead Residence Life pays the utilities at the Lewis and Clark housing complex, and at the University Villages family housing complex the individuals pay the utility provider directly. We included Lewis and Clark data in the inventory, but did not include University Villages. This might appear as a discrepancy; however, University Villages mostly houses only families and not just students (Lewis and Clark is student-only housing, no non-students reside there). As noted earlier, we are not tracking GHG emissions of UM community members off campus. Therefore, excluding University Villages seemed appropriate for this initial inventory.

Building	Kwh Steam	Electric Kwh	Combined gas & elec Kwh	MTeCO2/yr
Library	5,519,717.6	2,573,280.0	8,092,997.6	2,705.2
Lommasson Center	3,432,266.6	2,033,313.0	5,465,579.6	1,827.0
Field House	3,095,105.1	2,356,410.6	5,451,515.7	1,822.3
University Center	2,574,941.0	2,860,640.0	5,435,581.0	1,816.9
Skaggs	3,057,414.7	1,731,107.3	4,788,522.0	1,600.6
Chemistry	2,975,421.5	1,371,880.0	4,347,301.5	1,453.2
Science Complex	1,959,080.2	2,045,400.0	4,004,480.2	1,338.6
Recreation Annex	2,145,416.3	1,067,224.0	3,212,640.3	1,073.9
Jesse	2,465,495.2	614,240.0	3,079,735.2	1,029.5
Miller	2,051,653.1	644,320.0	2,695,973.1	901.2

Table 5: This table shows the top 10 energy users on campus in 2007. This includes both electricity and steam consumption per building.[25]

Emissions from On-Campus Stationary Sources:

The University of Montana has an on-campus gas-fired, steam generating heating plant. The facility uses natural gas as its primary energy source with distillate oil #2 as a backup, and also has back-up electrical generators powered by distillate oil #2 (the generators are rarely used). As a small-scale co-generation plant, the facility not only produces steam but it also generates electricity at the same time. The plant has one turbine that produces electricity, and although it is minimal compared to the total amount of electricity used on campus (4.5% of total in 2007), it does utilize the steam production which maximizes the total energy output of the plant.

The plant provides heat and hot water for almost all buildings on the main campus. Over the past few years Facilities Services has undertaken a $10 million dollar "Steam Tunnel Distribution Upgrade" project. The goals of the project were to replace or upgrade steam piping and valves, install new tunnels, and improve links between buildings and piping. Although the cost benefits and energy savings are not yet determined (due to the number of buildings linked and the lines that were buried having leaks, it was hard to determine or estimate base case cost savings) Facilities Services has already noticed changes in steam load spikes on the boiler system and they speculate that the improved insulation to the system will have considerable cost and energy savings.

Fiscal Year	On-campus Stationary			
	Total	Non Co-Gen	Co-Gen Electric	Co-Gen Steam
2000	12,532	46	726	11,760
2001	14,391	64	927	13,400
2002	14,073	98	801	13,174
2003	13,950	117	823	13,011
2004	14,317	223	767	13,327
2005	15,003	184	918	13,901
2006	15,229	182	968	14,079
2007	15,394	177	980	14,237

Table 6: This table shows the total MTeCO2 of GHG emissions measured from on-campus stationary sources.

Table 6 shows the total emissions associated with on-campus stationary sources. The "Non Co-Gen" column represents emissions from propane, oil or natural gas that were reported from the remote facilities. All of the other emissions reported came directly from the heating plant on campus.

Building	MMBtu Steam	Kwh Steam	Kwh Steam MTeCO2	kwh Steam/sq. ft
Library	18,838.80	5,519,717.65	1,845.06	25.08
Lommasson Center	11,714.33	3,432,266.59	1,147.29	31.01
Field House	10,563.59	3,095,105.06	1,034.59	17.54
Skaggs	10,434.96	3,057,414.65	1,021.99	27.22
Chemistry	10,155.11	2,975,421.49	994.58	54.91
University Center	8,788.27	2,574,940.99	860.72	78.40
Jesse	8,414.73	2,465,495.16	824.13	28.03
Recreation Annex	7,322.31	2,145,416.29	717.14	26.70
Miller	7,002.29	2,051,653.15	685.80	23.48
Aber	6,736.92	1,973,901.01	659.81	22.44

Table 7: This table shows the top 10 buildings with the highest GHG emissions from natural gas usage (mostly steam heat).[26]

Building	sq. ft.	Combined gas/elec Kwh	kwh/sq. ft
University Center	32,843	5435580.985	165.50
BioResearch	10,260	1311988.403	127.87
Chemistry	54,184	4347301.49	80.23
Grizzly Pool	25,286	1921584.25	75.99
Lommasson Center	110,669	5465579.594	49.39
Music	37,180	1627045.287	43.76
Skaggs	112,328	4788521.952	42.63
Education	28,963	1172575.514	40.49
Science Complex	99,726	4004480.222	40.15
Recreation Annex	80,362	3212640.295	39.98

Table 8:This table shows the top 10 buildings on campus that have the highest electricity and steam usage per square foot (energy usage intensity).

Ground Water Cooling

UM utilizes a unique and precious resource to provide cooling to its buildings. The University sits over the Missoula aquifer, which flows at a rate of 3-4 ft per day—a much more rapid pace than most aquifers that typically travel at rates of feet per year. The Missoula aquifer is continuously recharged by the Clark Fork River, and the University is fortunate enough to be at the incoming side of the aquifer where the water temperature is a consistent 48-50 degrees. UM uses this water in a very simple manner to create a cooling system, or air conditioning. The water is pumped up from dedicated wells (supply wells) into a heat exchanger, where it exchanges its "cool" temperature with water that serves the heating, ventilating, and air conditioning (HVAC) equipment in the building. The well water is then allowed to drain back into the ground via another well, called an "injection well". The well water picks up a maximum of 10 degrees F as it passes through a building during peak cooling times (summer months). UM has many measures in place to ensure that contamination of the well water does not happen, including regular testing of the injection water for verification.

Fifteen buildings on campus are centrally cooled with this type of system, and only 1 traditional chiller plant remains. Virtually all new buildings and cooling projects utilize ground water cooling. The energy savings using ground water cooling are substantial. It is estimated that these systems use 15% the amount of energy a traditional chiller plant would use. Over the past 10-15 years, while campus has continued to grow in size (with new buildings, and also in overall energy consumption) the "peak demand" of electricity on campus has stayed almost the same.

This is a good measure of how effective converting to ground water cooling has been in moderating the electrical energy consumption on campus. Not only does ground water cooling save energy, but it uses no refrigerants, and is dramatically simpler to maintain and keep running, which is good for the long term operating costs (not just energy but also repair and replacement costs for the University).

The Curry Health Service serves as a great example in illustrating the benefits of ground water cooling. Recently the Curry Health Service replaced an old steam absorption chiller with ground water cooling. During the summer cooling months, total energy consumption for the entire building dropped by about half. The energy and cost savings have been quite significant.

NOTES and RECOMMENDATIONS

- This section of the inventory does not include information from the University Villages (UV) family housing complex. Gas and electricity usage at those facilities are paid per unit by the individuals. Future inventories should investigate a method to include energy usage from UV. One possible method might be to work with Northwestern Energy on compiling UV utility bills.
- The co-gen system already runs at maximum capacity. It is a backpressure system and is dependent on the amount of steam that campus is calling for. Therefore, it can only produce electricity if campus is calling for steam (through it), and it is only running at maximum generation 1-2 months a year. Since it is a heating application, the load varies with the season. In sum, it would not be feasible at this time to try to improve/upgrade the electricity output of our current facility (basically an entirely new facility would be needed). However, UM should investigate options for alternative sources of energy to potentially power the facility.
- Create a reporting system to ease record keeping burdens from remote facilities.

ENERGY CONSERVATION MEASURES:

- Continue with steam tunnel improvements geared at maximizing efficiency of heat transfer from facility to building
- Begin campus-wide HVAC upgrades and provide building temperature controls
- Improve insulation and roofing in all campus buildings
- Audit existing steam valves for efficiency and proper function

Emissions from Purchased Electricity:

The CA-CP Campus Climate Calculator allows the user an option to select the region of their energy supplier. The calculator also provides the user the option to input the fuel mix that they know is specific to their energy purchases. The University of Montana purchases all electricity from Northwestern Energy. Northwestern Energy does not own any generation facilities and instead contracts with other companies to provide an electrical mix. Because of this, Northwestern Energy has made many internal changes over the years, and providing an electrical portfolio for our campus was not possible. Therefore, we used the default option offered in the calculator, which bases our electricity information on regional data generated by the Environmental Protection Agency (EPA).[27] The University of Montana's region is WECC Pacific Northwest. This region's electricity portfolio consists of coal and oil, but it also has a significant amount of hydroelectric power. This is likely a key factor as to why our emissions from this sector appear to be relatively low. Therefore, UM's emissions from purchased electricity need to be viewed with the understanding that they are based upon an adjustment factor due to our region's energy portfolio. In sum, UM's total electricity usage is high and we must work towards reducing our campus electricity consumption.

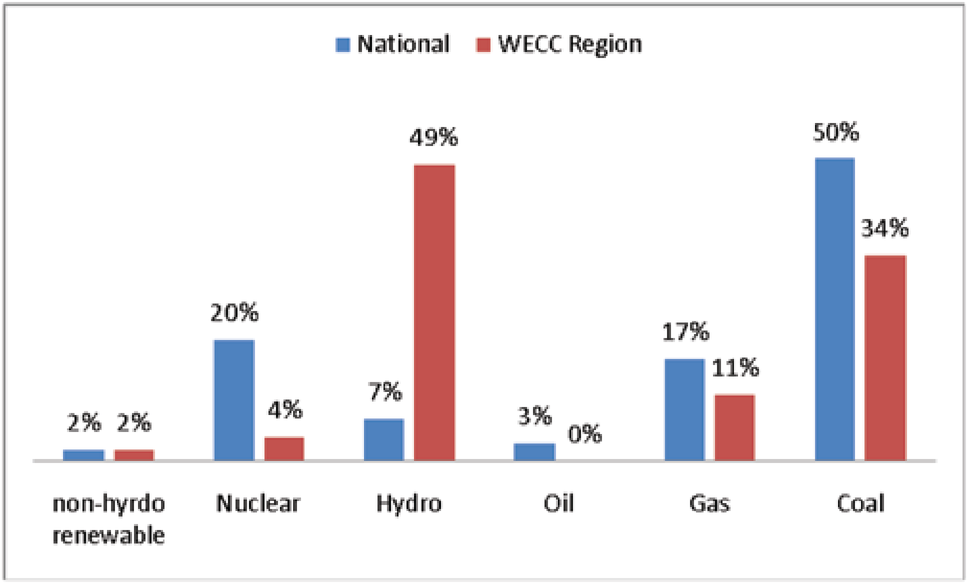


Figure 9: This shows the breakdown of energy sources in the WECC Pacific Northwest region vs. national averages.[28]

U.S. Combined Margin Grid Intensity Factors	
Subregions (eGrid subregion names in parentheses)	**Grid Intensity Factors (metric tons CO_2/MWh)**
NWPN (WECC Pacific Northwest)	0.600

Table 9: This table illustrates the regional emission factor of MTeCO2 per MWh

UM's GHG emissions from purchased electricity have steadily increased since 2000. Some of this increase is due to building expansions, increased population size, and many technological advances.

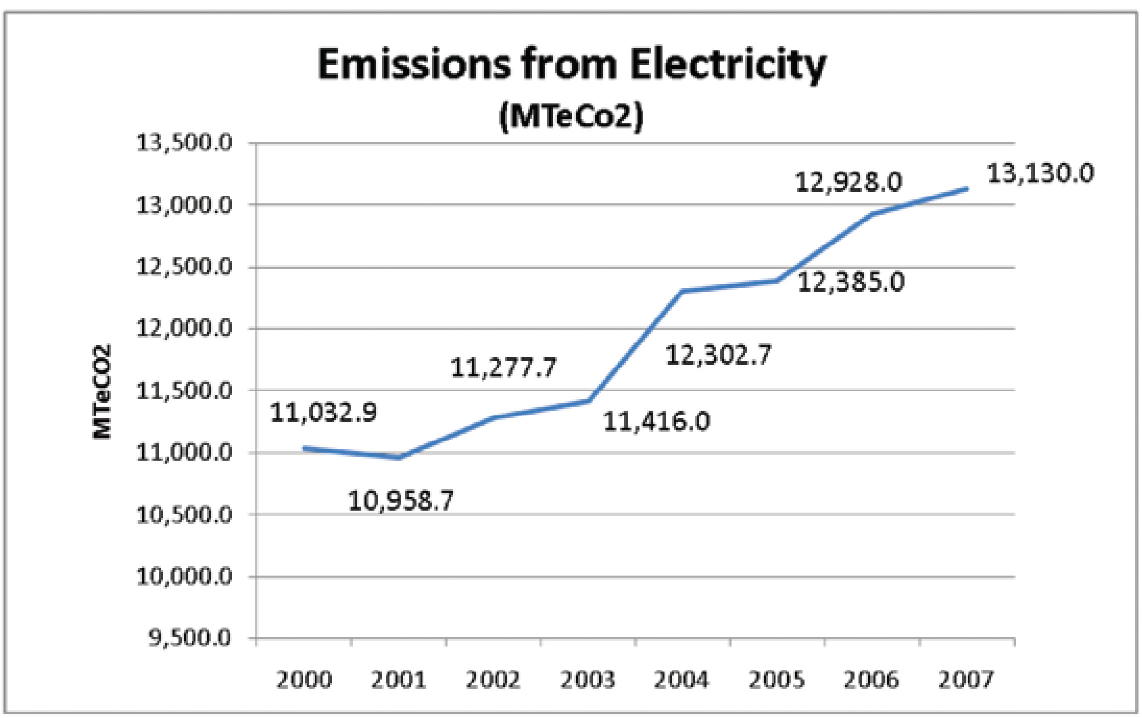


Figure 10: UM GHG emissions from purchased electricity, 2000-2007.

Building	Electric Kwh	MTeCO2	kwh/sq. ft.
University Center	2,860,640	956.22	87.10
Library	2,573,280	860.16	11.69
Field House	2,356,411	787.67	13.36
Science Complex	2,045,400	683.71	20.51
Lommasson Center	2,033,313	679.67	18.37
Skaggs	1,731,107	578.65	15.41
Gallagher	1,553,359	519.24	11.90
PARTV	1,547,000	517.11	21.75
Chemistry	1,371,880	458.57	25.32
Liberal Arts	1,232,256	411.90	12.24

Table 10: This table shows the top 10 buildings with the highest GHG emissions from electricity consumption.

NOTES and RECOMMENDATIONS

- Table 10 points out the largest electricity users on campus. This information provides a good starting point in seeking out buildings to begin energy audits. The accuracy of meters on each building are not known, and upgrades would be recommended.
- UM should investigate alternatives to purchasing electricity from the grid: invest in wind energy, solar, biofuels, etc.
- Professional building audits should be completed and recommendations implemented
- Energy upgrades, such as indoor/outdoor lighting retrofits, should become a priority
- Individual appliances such as refrigerators, heaters, and coffee makers should be inventoried and scaled back
- Appoint energy monitors for every building on campus
- UM should explore the possibilities of purchasing Renewable Energy Credits
- There should be estimates made on phantom power drains and a campus educational campaign should target such waste
- Educational campaign to campus community to utilize day lighting, scale back on electricity consumption, and help make connections between use and impacts
- Create incentives (financial and/or awards) to reduce use

transportation

Transportation is a major source of GHG emissions at UM. When measuring emissions for this inventory, transportation was broken up into three categories: the University fleet, commuter habits, and air travel.

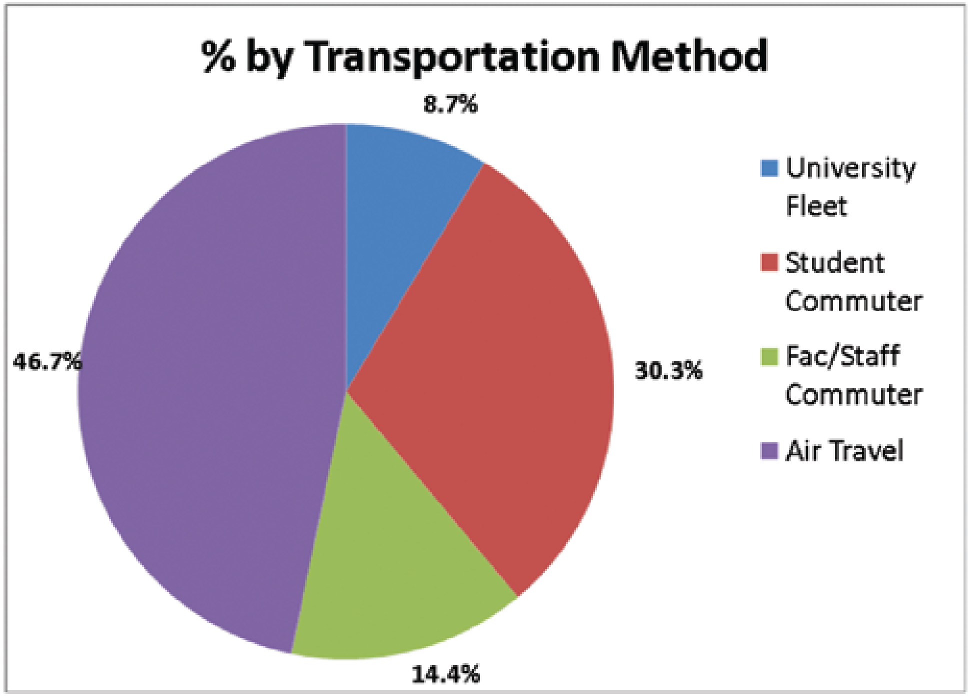


Figure 11: This chart shows the percentage breakdown of the GHG emissions associated with the UM's various methods of transportation in 2007.

University Fleet

The University fleet measures all GHG emissions associated with University owned and operated vehicles as well as any recorded University-related ground travel (which almost always is done in University-owned vehicles). It was difficult to determine the emissions for this sector because many departments on campus own and operate their own vehicles; however, Facilities Services and the Business Office were able to provide the best data available based on purchasing codes through the computer accounting database. Facilities Services has gas pumps on site and campus vehicle users are encouraged to fill up at that location. F.S. tracks the annual fuel consumption at that site.

Furthermore, F.S. operates a rental service and the campus community is expected to use these rental vehicles whenever possible. All fuel in the rented vehicles must be purchased with a specific credit card.

The University also has a campus-wide bus transportation system, ASUM Transportation. ASUM Transportation was founded in 1999 and is a student-run operation. In 2000 ASUM Transportation began using biodiesel in their buses and today every bus runs year round on a B20 blend. ASUM Transportation data was provided by Business Services and confirmed by ASUM Transportation.
All data pertaining to the University Fleet was provided in dollar amounts.[29] Therefore, we had to convert the dollars into gallons based on annual and regional price per gallon data provided by the Energy Information Administration.[30]

ASUM Transportation

ASUM Transportation's (ASUMT) mission is to increase transportation options and awareness on campus. Since it began operation in 2000, ASUMT has increased bus ridership by a factor of 60, and has been instrumental in promoting alternative forms of transportation. ASUMT has a free Cruiser Co-op Program that provides bikes for students to check out for day-to-day usage, it installs more campus bike racks every year, and it even participates in special events like the Walk-N-Roll week aimed to award the campus community for not driving their cars to the University. ASUMT has used a 20% biodiesel blend (B20) in all of its buses since 2000.

Commuter Habits

Commuting habits are categorized as Scope 3 emissions. It is difficult to accurately measure emissions from commuting habits, but we have relied on the CA-CP CCC "Commuter Habit" Input sheet to help estimate these emissions as best as possible. We used data from two different surveys to generate averages about campus commuting habits, average commuting distances, and number of trips made to campus. These averages were then entered into the calculator to determine an overall GHG footprint from commuter habits.

Missoula is a unique town in that its layout offers many alternatives to driving. Much of the campus community lives within biking or walking distance from the University and this has had significant impacts on the total GHG emissions measured associated with commuting habits.

Faculty and Staff

Faculty and staff commuting habits comprise 14.4% of total transportation GHG emissions. A survey conducted in 2006 by ASUM Transportation assessed the commuting habits of University of Montana employees. The results found that 35% of faculty and staff drive alone to campus, 16% carpool, 17% ride the bus, and 32% bike or walk. Two percent of faculty and staff reported using the UM Vanpool service. In order to include this in the inventory calculator we grouped it under the "carpool" category.

Student

Student commuting habits comprise 30.3% of total transportation GHG emissions equaling roughly 4,100 GHG emissions in 2007 alone. Student commuter information only measures students commuting habits to and from the University campus in and around Missoula, but does not include emissions associated with their travel to and from their home towns to Missoula. The Bureau of Business Research conducted a survey in spring 2008 that helped determine student commuting habits. The results showed that 35% of students drive alone to campus, 9% carpool, and the remaining either ride the bus, bike, or walk.

NOTES and RECOMMENDATIONS:

- Continue to promote and encourage alternative forms of transportation
- Look into the possibility of increasing the size of the bus fleet, allowing more people to ride with a convenient schedule
- Investigate the possibility of increasing the biodiesel blend throughout the year. Also, ASUM Transportation and Facilities Services should investigate the option of using Dining Services fryer grease again
- Explore using vehicles powered by alternative sources: electric, hybrids, natural gas, etc.
- Improve pedestrian and bike access to campus (ie: solar lighting, well marked and safe crossing facilities)
- Add more covered bike parking facilities on campus to help promote year-round biking
- Implement a physical ride board on campus for easier access for local ride-sharing.
- Include transportation options in future campus building, construction and design

Air Travel

Air travel represents (not including the Athletics Department) 46.7% of all UM's transportation GHG emissions. Towards the end of 2005, The University of Montana adopted a new policy that required all air travel purchases be acquired by using a University credit card, ProCard. This was a fortunate policy for our GHG inventory because it allowed for Business Services to use a computer code to pull up all University-related air travel from October 2005 through December 2007. In order to have three completed years of data we extrapolated through the beginning of 2005 based upon averages from 2006/2007 data. Travel dollars were totaled per year. The ACUPCC "Implementation Guide" suggests that in order to convert the dollars to miles travel, universities can use the factor of $0.25 per passenger air mile.[31]

2005 Calculated Total Dollars	$2,043,447.38
Total $ / $.25/mile	8,173,789.54 miles
2006 Total Dollars	$1,949,921.94
Total $ / $.25/mile	7,799,687.76 miles
2007 Calculated Total Dollars	$2,001,911.55
Total $/ $.25/mile	8,007,646.19 miles

Table 11: This table shows the conversion from air travel dollars to miles.

In order to have a more comprehensive inventory, we extrapolated air travel data back to 2000, using the average of all three years which gave a total of 7,993,708 miles.

2000	6,213
2001	6,210
2002	6,210
2003	6,210
2004	6,210
2005	6,350
2006	6,059
2007	6,300

Table 12: GHG Emissions from Air Travel: MTeCO2

NOTES and RECOMMENDATIONS:

- Improve tracking system of air travel through ProCard purchases. Require that all reimbursement for air travel—particularly for student travel—get tracked and reported and included in future inventories.
- Improve tracking system to include air travel information from the Athletics Department.
- Promote alternatives to air travel such as video and web conferencing.
- Investigate the possibility of purchasing carbon offsets for all university-related travel.*

*The American College and University Presidents Climate Commitment's "Implementation Guide" provides a list of seven "Tangible Actions" that each signatory must review. Each institution must commit to at least two actions within the first year of signing the commitment. Action C requires an institution to "establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by [the] institution."[32] This recommendation should be seriously considered by the University. Typically purchasing carbon offsets should not be the route that UM takes in softening its carbon footprint. However, because there are few alternatives to fossil fuel based air travel, carbon offsets may sometimes be the only possible way—besides cut-backs on travel—to confront the challenges of greenhouse gas emissions associated with this particular sector. Carbon offsets come at a price, and UM would have to determine the appropriate method to make this financially possible.

TRANSPORTATION RECOMMENDATION

Business Services and Facilities Services were instrumental in gathering the data necessary to complete the "Transportation" section of this inventory. The numbers included in this report represent the most comprehensive data available; however, after working with Business Services we identified gaps and determined that there are many places where data collection could be improved. For instance, car and air mileage—faculty, staff and student reimbursement for business travel—is not included because it is currently not coded in the University accounting system. This, however, can be tracked because reimbursements are always explained in expense reports. Other areas of weakness include tracking rental car information. Departments across campus must be reminded to use correct account coding (such as gasoline for diesel or propane, etc.), and avoid breaking departmental policy. Business Services is optimistic that such inventory gaps can be filled through their accounting system. Two avenues were discussed. The first, and the more preferable option, would be to hire a part-time employee in Business Services to provide an "in-house" tracking service. This employee would review all expense reports and would monitor all inventory related accounts. The second option would be a computer system conversion. This would require the addition of codes in the accounting system that would help track this information. Unfortunately, this second option would require many extra steps for employees all across campus. It is highly recommended that changes to the University's accounting system become a priority.

refrigerants

As noted earlier, we did not track the emissions from refrigerants in this inventory. Although Chlorofluorocarbons (CFCs) were phased out a number of years ago, the university continues to use other Freon gases in refrigeration and cooling systems. These gases are called hydrofluorocarbons (HFCs). The University of Montana uses substantially fewer Freon gases than many other universities of its size. Most of our cooling systems use groundwater, not Freon gases. Only a few cooling systems and appliances such as refrigerators and freezers use Freons, and the university is continuing to phase out its use of Freon gases whenever possible. The university captures the Freon gases from appliances and cooling systems when they become obsolete. Freons at UM have been captured since 1994 in accordance with the EPA. There are no records regarding Freon use available pre-1994. After the gases are captured, they are sent away for recycling. Only when cooling systems or appliances leak are gases emitted into the atmosphere. According to Facility Services this is extremely rare. Therefore, we do not have HFC data to include in the carbon calculator. Furthermore, because these emissions would comprise less than 5% of total emissions they can be considered de minimis.

solid waste

Although UM's GHG emissions associated with Solid Waste only amount to 1.3% of the University's total, it still represents a significant impact. We did not include any emissions associated with "upstream" production. In other words, we only measured emissions that are the direct result of waste leaving campus. We did not account for emissions associated with production or transportation. If we were to take these emissions into account, the total GHG percentage would be much higher. Therefore, it must be noted that reducing our consumption—consumption at all levels—is the best way to reduce our total GHG emissions.

The University of Montana contracts solid waste disposal through Allied Waste Services of North America, LLC. Waste is taken to the Missoula County Landfill, which flares the methane gas resulting from the waste.[33] Allied Waste keeps no record of the amount of waste they collect from the university, so solid waste data was estimated primarily by using the solid waste contracts which are renewed every three years by the university.

Contracts were available for 1999 (applicable 1999-2001), 2002 (applicable 2002-2005), and 2005 (applicable 2005-2007). For the years 1990-1999, the 1999 contract was used. Therefore, the data for these years is less reliable. Each solid waste contract details how often trash is removed from each UM building every week. The contracts cover all buildings on the main UM campus, university-owned apartments, the College of Technology, Lubrecht Forest, the research facility at Fort Missoula, and the Salmon Lake facility.

In order to determine the total weight of solid waste produced each year, we had to figure out the amount of cubic yards of waste generated on campus each year and the approximate weight of each cubic yard. Therefore, last November Allied Waste weighed all the trash it collected from the University on one Wednesday. Based on the contracts and the totals provided by Allied Waste for that Wednesday, we decided to use a .055 tons/yard conversion factor to help determine our total weight. As long as that Wednesday in mid-November was representative of most Wednesdays when trash is collected, our approximations should be fairly accurate.

We used the CA-CP calculator to determine the amount of GHG emissions associated with tons of solid waste.

Building:	Years counted:	yards emptied per week:	Average fullness of dumpster	tons/yard conversion factor	Weight per week (tons):	Weeks per year:	Weight per year (tons):
Adams Center	18	30.00	0.75	0.055	1.24	47.60	58.91
Law Bldg (north side)	18	9.00	0.75	0.055	0.37	47.60	17.67
Journalism (east side)	18	18.00	0.75	0.055	0.74	47.60	35.34
Science Complex (south side)	18	18.00	0.75	0.055	0.74	47.60	35.34
Social Science (west side)	18	9.00	0.75	0.055	0.37	47.60	17.67
Fine Arts	18	4.50	0.75	0.055	0.19	47.60	8.84

Table 13 (2007): This table illustrates the process used to determine the weight of solid waste UM sends to the landfill every year. It represents only a fraction of the buildings on campus that were measured. The "Yards emptied per week" was determined by the size of the dumpster emptied and how often it was emptied based on contracts with Allied Waste. The total amount of waste measured in 2007 was 2236.28 tons.

NOTES and RECOMMENDATIONS:

- Reduce amount of waste being sent to the landfill. This can be done by increasing recycling efforts, purchasing products with less packaging, increase composting efforts, and educating the campus community about waste reduction.
- Create a better tracking system to measure the amount of waste going to the landfill. This might also help us cut down on the amount of pick-up trips necessary which would also cut down on total GHG emissions.
- Investigate the possibility of working with Allied Waste to capture the methane gas produced through waste decomposition to be used to produce electricity.

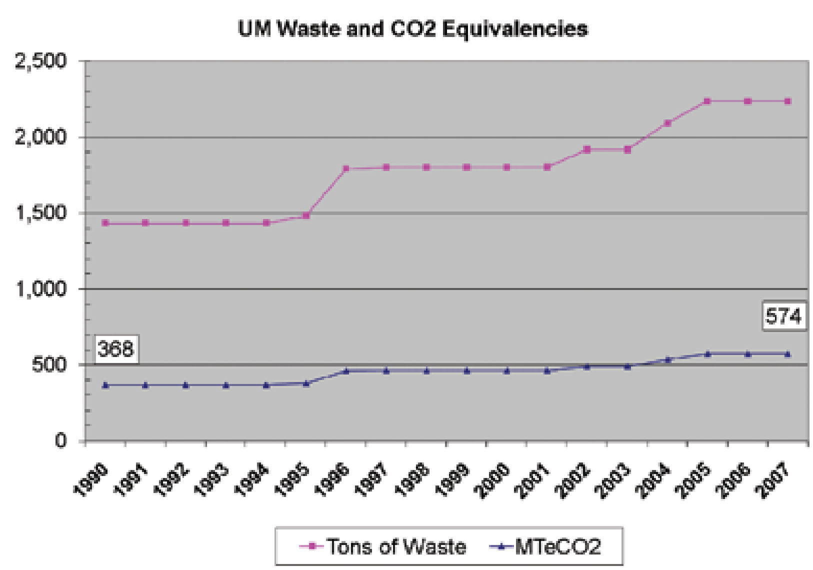


Figure 12: This graph shows the increased amounts of solid waste produced on campus since 1990. It also illustrates the correlation between increased waste and increased levels of GHG emissions.

recycling at um

UM Recycle receives about 80% of its funds from a student recycling fee ($4 per student per semester). The program is overseen by the UM Recycling Oversight Committee, which is made up of students, faculty, staff, and administrators. The Recycling program is currently undergoing a transition and has hired a full-time recycling coordinator.

UM estimates that it currently diverts 18% of its waste from the landfill through its recycling efforts, but it has set a goal of diverting 25% (which exceeds state targets of 22%). UM offers 100 % recycled paper at its printing & copy facilities, sells surplus materials to the public, provides several recycling locations on campus, and recycles all materials accepted by local recycling companies. As of 2007 all surplus electronics are sent to a reputable recycler and e-waste is diverted from the landfill.

Environmental Studies graduate student and recycling intern, Paul Kerman, analyzed UM recycling data from 1991 through June 2006. The analysis was conducted in order to measure the amount of waste diverted from landfill, energy and materials saved, and pollution reduced (using an EPA recycling benefits calculator). His findings include: Over 3000 tons were diverted from the landfill during this period. About 12 tons of waterborne pollutants were not produced. Paper recycling saved 24,000 trees. Energy savings was 82 billion BTUs, enough to power over 780 homes for a year. Documentation of these and other savings will contribute to UM's efforts to reduce its carbon emissions and shrink its ecological footprint.

This year The University of Montana purchased two balers with the goal of reducing transport costs and getting a higher return on plastic and aluminum. By providing a baled product, the purchasers will pick up the materials (saving UM transport costs), and will pay more per pound.

Despite many great efforts, UM still needs to make many great strides to improve its recycling efforts on campus. During Earth Week 2008, a group of students participated in a campus-wide dumpster dive initiative. The purpose of the dumpster dive was to examine the type of materials being thrown into garbage bins on campus. The findings were startling. Within two hours of digging through campus dumpsters—only a small fraction of campus dumpsters were rummaged—students pulled out 2 truckloads of recyclable materials that had been thrown into the garbage.

To learn more about UM Recycling efforts visit:
http://www.facs.umt.edu/Recycle/
Or, the "Greening UM" webpage:
http://www.umt.edu/greeningum/campusorgs.htm

RECOMMENDATIONS

- UM needs a campus-wide recycling campaign that focuses on educational outreach including how to recycle, what to recycle, and the cost/energy savings associated with recycling.
- The campus needs more recycling bins. There should be a recycling container next to every garbage bin on campus.
- UM is hiring a full-time recycling coordinator. This person should monitor recycling percentages on campus and share this information with the campus community on a frequent basis.
- Every dorm room should have its own recycling container.

COMPOSTING

The University does not currently compost any food at this time; however, Dining Services has been working with local PEAS farm—a partnership project between the non-profit Garden City Harvest and the UM Environmental Studies program—to begin a composting project. Dining Services is donating two Earth Tubs™ to PEAS farm so that the farm can compost all UMDS food waste. This project is expected to be up and running by Fall 2008. The farm currently collects food waste from the Rattlesnake elementary school and feeds it to pigs.

agriculture

Emissions from Fertilizer Application ("Agriculture")

The "Agriculture" section of the CA-CP Campus Climate Calculator (CCC) measures emissions related to animal waste and emissions associated with fertilizer application. During our inventory research we did not come across any University-owned animals. Therefore, we did not enter any data into that section. However, we were able to uncover data related to fertilizer application on campus. This information, although only a very small portion of the campus' total emissions, was included in the overall inventory.

finding the average percentage and finding a gross total, we instead calculated the weight of the nitrogen component of each fertilizer individually and then took the sum total of that component of each. Therefore we put 100% as the value in the percentage Nitrogen composition column and summed the weights of this component. Fertilizer was counted in pounds, sometimes extrapolated over larger surfaces due to values being given in lbs/acre. We were only able to obtain information going back a few years, but we extrapolated to 2000 to be consistent with the entire inventory.

We were only able to obtain fertilizer information from the University main campus, Bandy Ranch (3,500 acre ranch owned and operated by the University), and the University Golf course and Dornblaser fields. Although we would have preferred data from all campus facilities—University Villages, Salmon Lake, etc.—the facilities we did receive data from are the largest fertilizer users.

The input fields in CA-CP's CCC for fertilizer include Synthetic vs. Organic fertilizers (all of the University's inputs were synthetic), % composition of nitrogen, and total poundage. This became a complication because each of the University facilities fertilizers contain a different ratio of N (Nitrogen) to P (Phosphorus) to K (Potassium). To simplify the addition then, instead of

Fiscal Year	Includes all agricultur			
	Fertilizer Application			
	Synthetic	% Nitrogen	Organic	% Nitrogen
	Pounds	%	Pounds	%
1999				
2000	51,271	100%		
2001	21,124	100%		
2002	39,751	100%		
2003	38,798	100%		
2004	37,195	100%		
2005	32,169	100%		
2006	26,827	100%		
2007	25,335	100%		
2008				
2009				
2010				
2011				

SHEET 1

MTeCO2

Fiscal Year	Agriculture
1996	-
1997	-
1998	-
1999	-
2000	206
2001	85
2002	159
2003	156
2004	149
2005	129
2006	108
2007	102

SHEET 2

Table 14: These two spreadsheets were taken from the CA-CP Campus Climate Calculator. Sheet 1 represents the total pounds of Nitrogen applied to University grounds from 2000-2007. Sheet 2 shows the calculated data in the CA-CP CCC results section that provides MTeCO2.

emissions per student

As seen throughout this inventory, GHG emissions at UM have consistently increased since the year 2000. This increase is also seen in the amount of GHG emissions associated with each student per year since 2000. Student population (full-time students) has increased by over 900 people during this 7 year period. During this time there has been a 6.7% increase in emissions per student at The University of Montana.

Although emissions per student may appear low if compared to other schools, it must be clear that these numbers reflect an inventory that, at this point, has not been able to quantify all of UM's GHG emissions. This results in an overly optimistic value of emissions per student average. As UM continues to monitor its carbon footprint we can hope that the data will become more complete.

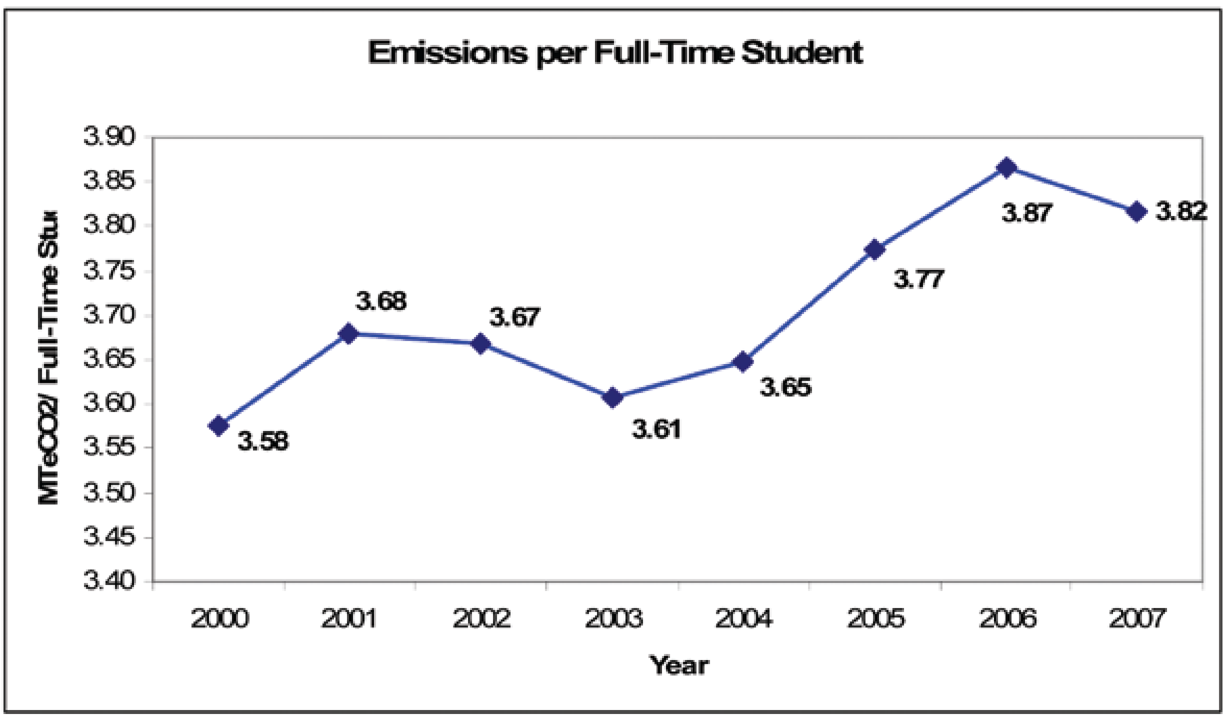


Figure 13: This graph shows UM's total emissions divided by the number of full-time students (Metric Tonnes eCO2 / Student full-time).

End Notes

[1]American College & University Presidents Climate Commitment. "Implementation Guide: Information and Resources for Participating Institutions. V1.0. Sept. 2007. (6).
[2] Intergovernmental Panel on Climate Change (2007a). Climate Change 2007 - The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge: Cambridge University Press. ISBN 978 0521 88009-1.
[3]The National Academies. "Understanding and Responding to Climate Change: Highlights of National Academies Reports." 2008. http://dels.nas.edu/dels/rpt_briefs/climate_change_2008_final.pdf
[4]Cohen, Betsy. "State Wants Low Campus Energy Bill." The Missoulian. 2008.
[5]Cohen, Betsy. "UM joins global warming coalition." The Missoulian. 2008.
[6]IPCC, 2007
[7]Henson, Robert. 2008. The Rough guide to climate change. London: Rough Guides, Penguin Books.
[8]Henson, 2008.
[9]www.climateaudit.org.
[10]Henson, 2008.
[11]Henson, 2008
[12]IPCC, 2007
[13]Henson, 2008
[14]Henson, 2008
[15]There are many documents that demonstrate the overwhelming scientific consensus on climate change. The "Joint science academies' statement: Global response to climate change," stands as a great example of such a consensus: http://nationalacademies.org/onpi/06072005.pdf.
[16]Northern Rocky Mountain Science Center (NOROCK) from U.S. Geological Survey (USGS)
http://www.nrmsc.usgs.gov/research/glaciers.htm
[17]National Weather Service
http://www.drought.mt.gov/committee/PowerPoints/2007/august/NWS.pdf.
[18]Credit for March Snowbowl snowlevel for 2005 and 2055 goes to Saxon Holbrook at Numerical Terradynamic Simulation Group (NTSG) College of Forestry, The University of Montana.
http://www.ntsg.umt.edu/
[19] Barnett, et al. "Human-Induced Changes in the Hydrology of the Western United States."
Science Express. 31 January 2008. Science 22 February 2008. Vol. 319. no. 5866, pp. 1080 - 1083
DOI: 10.1126/science.1152538
[20]A.L.Westerling et al. "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity."
Science Express on 6 July 2006. Science 18 August 2006: Vol. 313. no. 5789, pp. 940 – 943 DOI: 10.1126/science.1128834
and Steven W. Running "CLIMATE CHANGE: Is Global Warming Causing More, Larger Wildfires?"
Science Express on 6 July 2006
Science 18 August 2006: Vol. 313. no. 5789, pp. 927 - 928
DOI: 10.1126/science.1130370
[21]Intergovernmental Panel on Climate Change (http://www.ipcc.ch/)
[22]Scope language is directly taken from Clean Air-Cool Planet's "Campus Carbon Calculator User's Guide." 2006. Pg. 7.
[23]This picture is courtesy of Clean Air-Cool Planet
[24]ACUPCC "Implementation Guide" (12).
[25]For these tables all building data only includes buildings that had information about both steam usage and electricity consumption. This is important to note because there are buildings on campus that use large amounts of energy, but are not tracked in these tables (they are included in the overall GHG inventory). For example, Facilities Services was able to provide information regarding electricity consumption at the Washington-Grizzly stadium but could not provide information regarding its steam usage. Therefore, the Wash-Griz stadium was not included in these tables; however, it is a large electricity user and it—along with all buildings on campus—should be included in future inventories and should be accurately metered.
[26]In order to be consistent with other building data MMbtu's from natural gas usage per building was converted into kwh and then converted into MTeCO2.
[27]US Environmental Protection Agency Office of Atmospheric Programs, eGRID Emissions & Generation Resource Integrated Database. Prepared by E.H. Pechan & Associates, Inc., Version 2.01, May 2003.
[28]Figure 9 provides the energy portfolio derived from the EPA's 2004 eGRID Database. The CA-CP CCC uses figures from EPA's 2000 version. Therefore, the conversion factors used in the calculator are based off of 2000 figures and not 2004. Figure 9 is to be seen as a representative chart of the breakdown of energy sources in this region; however, it does not directly reflect the conversion factors used to calculate the GHG emissions (although it is close). The CA-CP CCC reference guide writes: "CO2 Emission factors are from year 2000. This was done because data was only available back to 1998 at the subregion scale. Using constant electric emission factors will not capture changing emission due to changes in fuel source. However, it will result in more transparent final emission estimates for the university because all changes in emissions will be due to changes at the university." http://oaspub.epa.gov/powpro/ept_pack.charts
[29]Facilities Services did provide information from their pumps in gallons; however, to remain consistent we converted dollars provided instead of gallons (the totals were not exact but similar). A 6% adjustment was made on F.S. purchased gasoline because they purchase their gas in bulk and receive a price reduction of roughly 6%.
[30]Energy Information Administration. "Petroleum Navigator." http://tonto.eia.doe.gov/dnav/pet/hist/ddr005m.htm
[31]ACUPCC Implementation Guide. Pg. 15
[32]ACUPCC Implementation Guide. Pg. 15
[33]Allied Waste has expressed hopes to do electric-generation with the methane gas opposed to the flaring.

Appendix I:

Contacts:

There were many people involved in the data sharing/collection process of this inventory. Below is a list of all people who participated in this project. This contact list is designed to help facilitate data collection processes in the future. Some contacts listed did not actually provide data, but their assistance was beneficial to the outcome of this inventory.

Institutional Data:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Operating Budget				
Ginna Reesman	Senior Budget Analyst	UM Planning, Budget & Analys	243-4781	reesmanGM@mso.umt.edu
Mona Weer	Financial Mgr/Res & Spo	Research Administration	243-2354	mona.weer@umontana.edu
Tony Tomsu	Program Mgr/OPBA	Budget Office	243-5801	tony.tomsu@umontana.edu
Peggy Schalk	Associate Director of Fiscal Operations	Facilities Services	243-5565	schalkpj@mso.umt.edu
Campus Pop.				
Bonnie Holzworth	Computer Sys Analyst I/Regstr	Registrars Office	243-2997	holzworthBM@mso.umt.edu
Tony Tomsu	Program Mgr/OPBA	Budget Office	243-5801	tony.tomsu@umontana.edu
Campus Size				
Peggy Schalk	Associate Director of Fiscal Operations	Facilities Services	243-5565	schalkpj@mso.umt.edu
Brad Evanger	Project Manager	Office of Planning & Construction	243-4180	brad.evanger@mso.umt.edu

INSTITUTIONAL DATA: The above contacts provided information regarding the operating budget, research budget and the energy budget. They also provided data about campus size, community population and number of working days/class days per year.

ELECTRICITY:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Electricity				
Laura Howe	Maint Svcs Mgr I/Fac Svcs	Facilities Services	243-2127	laura.howe@umontana.edu
Mike Panisko	Project Leader/Fac Svcs	Facilities Services and Admin	243-6057	mike.panisko@umontana.edu
Rick Edwards	Campus Correspondent	Northwestern Energy	497-3621	rick.edwards@northwestern.com
Rita Tucker	Admin Assoc Mgr/Res Life UM	Residence Life	243-2611	rita.tucker@umontana.edu
David Weis	Bandy Ranch Manager	Bandy Ranch	793-5581	david.weis@umontana.edu
Jennifer McCall	CFC Account Manager	College of Forestry Conservation	243-4537	jennifer.mccall@cfc.umt.edu
Jane Fisher	Dir/MT Island Ldg	UM MT Island Lodge-Salmon Lake	773-2643	jane.fisher@umontana.edu
Judy Maseman	Accounting Assoc III/Bio-Sta	Flathead Lake Biological Center	982-3301	judy.maseman@umontana.edu

ELECTRICITY: The above contacts provided information regarding the operating budget, research budget and the energy budget. They also provided data about campus size, community population and number of working days/class days per year.

ENERGY:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Energy - Gas Usage				
Laura Howe	Maint Svcs Mgr I/Fac Svcs	Facilities Services	243-2127	laura.howe@umontana.edu
Rita Tucker	Admin Assoc Mgr/Res Life	UM Residence Life	243-2611	rita.tucker@umontana.edu
David Weis	Bandy Ranch Manager	Bandy Ranch	793-5581	david.weis@umontana.edu
Jennifer McCall	CFC Account Manager	College of Forestry Conservation	243-4537	jennifer.mccall@cfc.umt.edu
Jane Fisher	Dir/MT Island Ldg	UM MT Island Lodge-Salmon Lake	773-2643	jane.fisher@umontana.edu
Judy Maseman	Accounting Assoc III/Bio-Sta	Flathead Lake Biological Center	982-3301	judy.maseman@umontana.edu

ENERGY: The above contacts provided data about gas usage on campus at remote campus facilities.

TRANSPORTATION:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Transportation				
Peggy Schalk	Associate Director of Fiscal Operations	Facilities Services	243-5565	schalkpj@mso.umt.edu
Kathy Benson	Program Coord II/Envir Hlth	Environmental Health	243-2700	kathy.benson@umontana.edu
Bob Peterson	Maint Svcs Mgr I/Fac Svcs	UM Fac Svcs - Vehicle Repair	243-6580	
Kay Lamphiear	Purchasing Mgr/Bus Svcs	UM Business Services	243-4935	kay.Lamphiear@umontana.edu
Sandy Shook	Admin Assoc I/COT Inst Supp	Instruction Support-COT	243-7640	sandra.shook@umontana.edu
Jennifer McCall	CFC Account Manager	College of Forestry Conservation	243-4537	jennifer.mccall@cfc.umt.edu
Nancy Wilson	Program Mgr/ASUM	ASUM Transportation	243-4599	
Air				
Kay Lamphiear	Purchasing Mgr/Bus Svcs	UM Business Services	243-4935	kay.Lamphiear@umontana.edu
Athletics				
Edward Wingard	Associate Athletic Director - Business Operations	Athletic Department	243-6926	ed.wingard@umontana.edu
James O'Day	Dir/Athl	Athletic Department		
Kay Lamphiear	Purchasing Mgr/Bus Svcs	UM Business Services	243-4935	kay.Lamphiear@umontana.edu

TRANSPORTATION: The contacts above provided all data relating to transportation on campus. Although the Athletic Department did not contribute data to this inventory, the contacts are listed for future reference.

SURVEYS:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Surveys				
Nancy Wilson	Program Mgr/ASUM	ASUM Transportation	243-4599	
John Baldridge	Data/Research Analyst/BBER	UM Bureau of Bus Res	243-5113	john.baldridge@umontana.edu
Jim Sylvester	Data/Research Analyst/BBER	Bureau of Business and Econ Researc	243-5113	james.sylvester@umontana.edu

SURVEYS: The Contacts above either were involved in conducting the commuter habit surveys or they provided the survey results and analysis.

SOLID WASTE:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Solid Waste				
Max Bauer	Vice President	Allied Waste	543-3157	
*This contact provided information regarding Landfill/solid waste contract information, ton/yard conversion factors				
Dining Services			243-6325	
Gerald "Frenchy" Michaud	Maint Svcs Mgr II/Fac Svcs	Facilities Services	243-2420	gerald.michaud@umontana.edu
Brad Evanger	Computer/Tech Support/Fac Svcs	Facilities Services	243-4180	bradley.evanger@umontana.edu
Tom Welch		Dining Services	243-4501	
Recycling				
Gerald "Frenchy" Michaud	Maint Svcs Mgr II/Fac Svcs	Facilities Services	243-2420	gerald.michaud@umontana.edu
Vicki Watson	EVST/ Recycling Committee	EVST Professor	243-5153	vicki.watson@umontana.edu

SOLID WASTE: The names above helped provide information about solid waste and recycling on campus.

REFRIGERANTS:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Refrigerants				
Greg Plants	Maint Svcs Mgr I/Fac Svcs	Facilities Services	243-6091	gregjay.plantz@umontana.edu
Dan Corti	Dan Corti	Office of Environmental Health Quality	243-2881	danny.corti@umontana.edu
Facility Services Warehouse		Facilities Services	243-5680	
Laura Howe	Maint Svcs Mgr I/Fac Svcs	Facilities Services	243-2127	laura.howe@umontana.edu

REFRIGERANTS: Although emissions from refrigerants were not included in this inventory, we still had to be in contact with campus members to gather information regarding refrigerants on campus.

AGRICULTURE:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Agriculture				
Rich Chaffee	Maint Svcs Mgr I/Fac Svc	Facilities Services/Grounds	243-2183	Richard.Chaffee@umontana.edu
David Weis	Bandy Ranch Manager	Bandy Ranch	793-5581	david.weis@umontana.edu
Tom Burt	Groundskeeper Mgr/Golf Crs Ma	Campus Rec Admin/So. Campus	543-1927	tom.burt@mso.emt.edu
Richard Irving		University Villages		
Josh Slotnick	Environmental Studies/PEAS farm	Adj Instructor	523-3663	joshua.slotnick@umontana.edu
Lisa Gerloff		Lubrecht Forest	243-5346	lisa.gerloff@umontana.edu

AGRICULTURE: The contacts above provided information about fertilizer application on the main UM campus and also at remote locations.

OTHER KEY CONTACTS:

NAME	TITLE	DEPARTMENT	PHONE #	EMAIL
Other Key Contacts				
Emily Peters	Sustainability Coordinator	Facilities Services	243-6001	emily.peters@mso.umt.edu
Dustin Leftridge	ASUM President 2007/08	ASUM		
Phil Condon	EVST Associate Professor, SCC Member	Environmental Studies, SCC	243-2904	phil.condon@mso.umt.edu
Faith Ann Heinsch	Research Scientist/For/NTSG	College of Forestry and Conservation	243-6218	faith.heinsch@umontana.edu
Hugh Jesse	Director	Facilities Services	243-2788	hugh.jesse@umontana.edu
Robin Saha	EVST Assistant Professor	EVST	243-6285	robin.saha@umontana.edu

KEY CONTACTS: These contacts were all involved in the inventory process and are excellent resources for future inventories.

Printed on 100%
Recycled Paper

ghg

greenhouse gas

inventory

The University of Montana