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Missoula Greenhouse Gas Emissions Inventory and Analysis, 2003-2008: Toward A Blueprint For Municipal Sustainability

Robin K. Saha
University of Montana - Missoula, robin.saha@umontana.edu

Kathryn Elizabeth Makarowski
The University of Montana

Russ J. Paepeghem

Bethany Mason Taylor
The University of Montana

Michelle Lanzoni

See next page for additional authors

Authors

Robin K. Saha, Kathryn Elizabeth Makarowski, Russ J. Paepeghem, Bethany Mason Taylor, Michelle Lanzoni, Michael Lattanzio, and Owen Weber

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Robin Saha, Ph.D.
Kathryn Makarowski
Russ J. Van Paepeghem
Bethany Taylor
Michelle Lanzoni
Michael Lattanzio
Owen Weber

The University of Montana
Environmental Studies Program

City of Missoula
John Engen, Mayor

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ACKNOWLEDGEMENTS

We heartily thank Missoula Mayor John Engen for his leadership in addressing climate change locally. Without his embracing of the U.S. Conference of Mayors Climate Protection Agreement, Missoula would not be taking this important step of conducting a greenhouse gas emissions inventory of municipal operations.

We are grateful for the opportunity to assist the City by conducting real-world applied research. We appreciate the chance to learn about City operations and offer recommendations for reducing Missoula's energy use, saving on energy costs, and shrinking the City's carbon footprint.

We also appreciate working in close partnership with the City and interacting with and getting to know the City's dedicated, professional staff. We very much appreciate the time and effort that many City personnel devoted to the project in providing information, spending time helping us understand and interpret data and commenting on draft chapters. We also thank members of Mayor Engen's Administrative Leadership Team, along with numerous City personnel, for their valuable guidance and assistance.

Although the involvement of these individuals is described in applicable chapters, several individuals require special recognition for their outstanding contributions to our collective effort. First and foremost is Ginny Merriam, the City's Public Information/Communications Officer, who coordinated the project, routed our various information requests and helped tremendously with the survey we conducted of employee commuting, to name just a few of her contributions. We are grateful for her dedication to the project, good nature, patience and helpfulness. City Chief Administrative Officer Bruce Bender also helped us coordinate with various personnel and directly responded to many of our requests.

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Finally, we thank The University of Montana Sustainable Campus Committee and the Provost and Vice President for Academic Affairs Royce Engstrom, Chuck Harris of the UM Social Science Research Lab, and the Environmental Studies Program (EVST) for their support for this project. Last but not least, EVST students Matt Hodges and Laura Goldberg also contributed to this report.

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PREFACE

This document represents the City of Missoula's effort to understand its carbon footprint. Like most emissions inventories, this report can't account for every variable or reflect policy choices made in the spirit of serving the community. We leave a sizeable footprint, we know, but in exchange, we meet the daily needs of thousands of citizens whose own footprints would grow while their pocketbooks would shrink were it not for municipal government. This report is designed to inform our decisions as we move the community forward. We made many changes in the way we do business before we embarked on creating this inventory. And, already, the City's investing millions in reducing our footprint as we move forward, in part because of this report, in part because we know it's the right thing to do and in part because conservation of natural resources makes good financial sense. Our hope and our goal is to work to make this report obsolete sooner rather than later.

John Engen, City of Missoula Mayor

EXECUTIVE SUMMARY

GOALS AND OBJECTIVES

As frequent stories in the news attest, climate change is harming the natural assets that Montanans value. Scientists predict that threats to our forests, streams, wildlife, working farms, and our state's economy will grow in the future as things continue to heat up and dry out. Indeed, climate change threatens the local economy in Missoula, the fiscal well-being of City government, and our local quality of life.

As major contributors of greenhouse gas emissions that are causing climate change, cities around the world, including several cities in Montana, are facing up to their responsibility to be part of climate change solutions. In an era of ever-increasing energy costs, cities are finding many good reasons to lead by example.

Addressing climate change involves using less energy and using it more wisely and allows services that the public demands to be maintained in tough economic times. Thus, climate change action can prevent having to make undesirable and forced choices.

Missoula is not alone in recognizing that taking action as a community can improve fiscal well-being as well as benefitt the local economy and enhancing quality of life. However, to be effective, efforts require careful analysis and planning. This report seeks to assist in that regard by methodically carrying out the first of five steps for local governments to achieve emission reductions under the *U.S. Conference of Mayors Climate Protection Agreement:* conducting a greenhouse gas (GHG) emissions inventory of municipal operations.

Specific goals of this report are:

1. To present a baseline greenhouse gas emissions inventory for the City of Missoula that quantifies total energy use and associated emissions for municipal operations.
2. To identify major sources of municipal GHG emissions and relative contributions within and among the various sectors examined.

3. To analyze changes and trends in energy use, costs and emissions from Fiscal Years (FY) 2003 to 2008.
4. To identify opportunities and offer recommendations to achieve future municipal GHG emission reductions and energy cost savings.

Our study examines the following emissions sectors: (1) wastewater treatment; (2) buildings; (3) vehicle fleet; (4) employee commuting; (5) lighting; and (6) water. Emissions related to solid waste disposal are not included.

To conduct this emissions inventory and analysis, University of Montana Professor Robin Saha and students in his graduate course called Local Solutions to Climate Change examined energy use and costs for each municipal sector. Energy use data were converted to common energy units and used to calculate GHG emissions in terms of metric tons of carbon dioxide equivalents, which we refer to as *tons of* CO_2*e*.

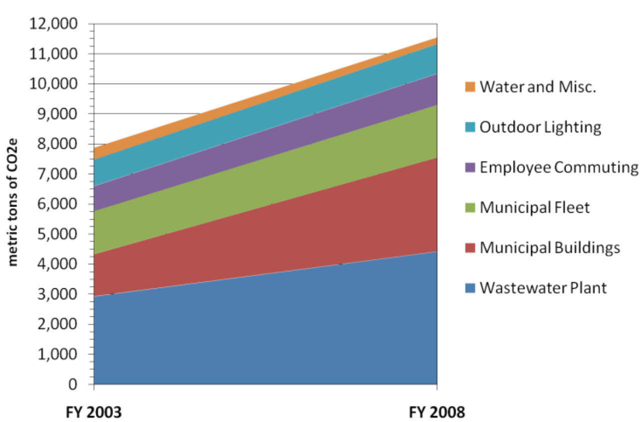
Inventoried energy use primarily included: (1) purchased energy (electricity and natural gas) for over 250 NorthWestern Energy accounts billed to the City; and (2) unleaded gasoline and diesel fuel consumption by the municipal fleet and employee commuting. Captured and released biogas from the wastewater treatment plant was another significant energy use and emission source.

NorthWestern Energy and dozens of City personnel were integral at each step of conducting this municipal emissions inventory and analysis by providing essential information, reviewing draft chapters, and contributing in many other ways. Indeed, this report is the product of a more than year-long partnership between The University of Montana Environmental Studies Program and the City of Missoula that was initiated by the request of Mayor John Engen.

KEY FINDINGS

In Fiscal Year (FY) 2008, total greenhouse gas emissions from Missoula's municipal operations totaled 11,540 tons of CO_2e, or 25.45 million pounds. This represents the equivalent weight of over 143,000 adults, or nearly three times the weight of the City of Missoula's adult population. Put another way, this is equivalent to the weight of nearly 7,500 Subaru Outback Wagons, which, lined up bumper-to-bumper, would stretch from downtown Missoula to Lolo, Montana, and back.

Figure A: Growth in City of Missoula Greenhouse Gas Emissions in Metric Tons of CO2e by Sector in FY 2003 and FY 2008



Municipal greenhouse gas emissions increased 46% from FY 2003 to FY 2008. This represents an average annual increase of 9.3%, or 731 tons of CO_2e, and is akin to each year adding the equivalent of emissions associated with the energy use of City Hall (435 Ryman St.) and City Council Chambers (140 W. Pine St.).

All major sectors examined contributed to the recent increase in emissions, including wastewater treatment, buildings, municipal fleet, employee commuting, and lighting

(Figure A). Emissions from wastewater treatment and municipal buildings increased 51% and 124%, respectively, from FY03 to FY08, and together accounted for about 55% of total emissions in both years. The growth in emissions from wastewater treatment is the result of upgrades to the system, expansion in capacity, and increase in volume of wastewater treated. The increase in emissions from buildings is primarily the result of the addition of new buildings, expansion of existing buildings, and an increase in the number of City employees. The latter is also responsible for the growth in emissions from employee commuting, which accounted for 9% of municipal GHG emissions in FY08.

The municipal fleet is also a significant contributor to the City's GHG emissions and accounted for 15% of total emissions in FY08. Fleet emissions increased 21% from FY03 to FY08 primarily due to increases in fuel use by the Police and Fire departments. Emissions from lighting increased 11% from FY03 to FY08 and accounted for 8.5% of total emissions in FY08.

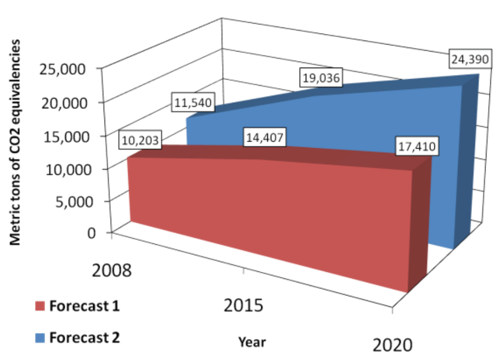
Missoula's rate of increase in GHG emissions is greater than those of other Montana cities that have conducted GHG emissions inventories and also are greater than those of The University of Montana (Table A). For example, Bozeman's municipal emissions increased 29% from 2000 to 2006, and UM's emissions increased 16% from 2000 to 2007. Helena reduced its emissions 18% from 2001 to 2007 by making energy efficiency improvements to its wastewater treatment plant.

Table A shows the emissions reduction targets of the other cities in Montana and UM, which are included in their respective climate action plans under the *Mayors Climate Protection Agreement* and the *American College and University Presidents Climate Commitment*.

Table A: Recent Changes in GHG Emissions and Reduction Targets for Montana Cities and The University of Montana

	Recent % Change	Ave. Annual % Change	Emissions Reduction Target for 2020
Bozeman	29.3%	4.9%	15% below 2000 level
Helena	-18.1%	-3.0%	15% below 2007 level
Missoula	46.4%	9.3%	Not yet applicable
Univ. of Montana	16.4%	3.3%	100% below 2007 level

Figure B: Forecasted Emissions (tons of CO_2e) for City of Missoula in 2015 and 2020 Using Recent Rates of Increase in Emissions



Missoula's recent rates of increase in total emissions were used to generate a crude forecast of future emissions under a "business as usual" scenario. First, we used an average annual rate of increase of 6% from FY03 to FY08 that excludes the addition of recent buildings (Forecast 1 in Figure B). This rate assumes there will be no new municipal buildings added in the next decade. Second, we used the average annual rate of increase of 9.3% for all municipal emissions (Forecast 2 in Figure B). These forecasts predict that, without proactive steps, emissions will increase 41-65% from FY08 levels by 2015 and 71-111% by 2020.

Inaction will carry high costs. From FY03 to FY08, Missoula's energy costs were found to increase at a much faster rate than energy use and emissions have increased. Although energy use increased 41% from FY03 to FY08, energy costs increased at a nearly six-times greater rate (233%) during this period.

Adjusting for inflation by using 2009 constant dollars, *purchased energy costs* increased nearly three-fold during this five-year period, from $341,010 to $1.28 million. This represents more than a 50% average annual rate of increase.

Fuel costs for the municipal fleet also increased rapidly: 176% during the study period, from $217,060 in FY03 to $599,490 in FY08. This represents a 35% average annual rate of increase.

Thus, the total inflation-adjusted municipal energy and fuel costs increased $1.32 million from FY03 to FY08, from $558,070 to $1,877,637 (Figure C). This represents a $263,913 average annual increase in energy costs.

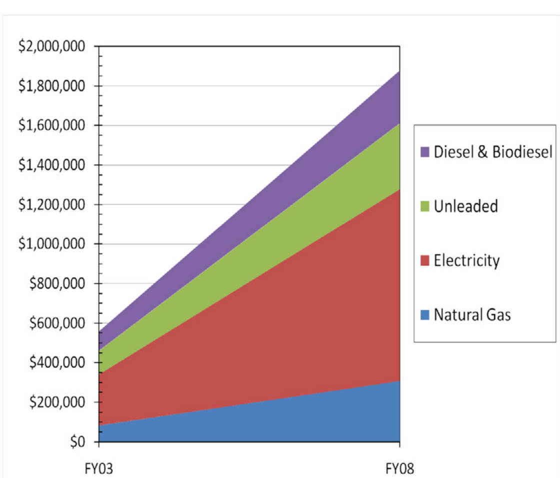
Escalating energy costs are not solely the result of utility rate and fuel cost increases. They are also affected by the increases in energy use.

CONCLUSIONS

This municipal greenhouse gas inventory shows that recent increases in the City's energy use and associated greenhouse gas emissions have been accompanied by even steeper and unsustainable increases in energy costs. From a fiscal standpoint alone, it appears that energy cost increases are not sustainable, particularly if energy use continues to increase. Even if energy use were not to increase, energy costs are still likely to increase faster than inflation and faster than growth in revenue.

Although Missoula has already begun to take steps to reduce energy use and costs, Missoula is behind other cities in Montana that are part of the *U.S. Conference of Mayors Climate Protection Agreement.* Nevertheless, elected officials, citizens, and business leaders are committed to municipal sustainability, maintaining quality of life, supporting the local economy, and protecting the environment.

Figure C: City of Missoula Purchased Energy and Fuel Costs in 2009 Dollars by Energy Type, FY03 to FY08



Moreover, Missoula has a concerned and talented pool of City employees, civic leaders, nonprofit organizations, and a state university to draw on for leadership and expertise in taking its next steps. Indeed, Missoula has the capacity and interest in making further progress on energy and climate change.
Missoula is well-positioned to become a leader among cities in Montana in addressing climate change at the local level and continuing down the path of municipal sustainability.

Using less energy and using what we use more wisely takes concerted and coordinated effort. It takes planning, and it takes involvement and cooperation of the public and private sectors. We hope that by revealing recent trends in energy use, costs, and associated GHG emissions, and by showing what is at stake and what can be done, this report gives impetus to City leaders and the broader community to confront the challenges head on.

We believe Missoula is ready to follow suit with other cities in Montana and across the country in coming together to take the next step in the *Mayors Climate Protection Agreement*: setting an emissions reduction target and developing a climate action plan for the City.

The benefits of local solutions to climate change go far beyond more efficient local government. In taking the next steps, the City of Missoula can lead by example for all Missoulians. Moving forward in ways that we have outlined in our recommendations will help protect the things the Missoula community values most: our parks and open spaces, working farms, forests and streams, wildlife habitat, public health, quality of life, and livability of our neighborhoods.

Reducing the City of Missoula's carbon footprint will also improve our buildings, waste management, and transportation systems. It will leave more in our pocketbooks and improve the local economy. It will enhance the designs of our neighborhoods, our air quality, our health and well-being as individuals, families and as a community.

EMISSIONS REDUCTION STRATEGIES AND "NEXT STEPS" FOR MISSOULA

We recommend <u>four basic strategies</u> to reduce municipal emissions and save on energy costs: (1) reducing energy use through energy conservation and efficiency; (2) generating renewable energy; (3) purchasing renewable energy; and (4) offsetting emissions.

We recommend that City officials and concerned citizens consider each of these strategies within the Cities for Climate Protection framework. Under that framework, Missoula's next steps should be:

1. To set a greenhouse gas emissions reduction target, e.g., zero net emissions by 2020; without a clear goal, progress will be hard to achieve or measure.
2. To carry out a climate action planning process – to identify, prioritize, and adopt policies to support emissions reduction goals.
3. To develop an efficient energy use monitoring and reporting system – to assure accountability and gauge progress toward emission reduction goals.
4. To delegate responsibility for implementing, managing and reporting on energy-saving measures; climate action takes dedicated personnel.

OVERARCHING RECOMMENDATIONS

Developing a climate action plan with a sound emissions reduction strategy that is appropriate for Missoula will require expertise, leadership, and citizen participation. Climate-related policies, programs, and projects that are right for Missoula will need to be cost-effective. Fortunately, a number of proven "no-net-cost" policies exist. The following recommendations were crafted with these considerations and the experiences of other cities in mind (see full report for additional information).

- **Form a Climate Action Plan Task Force to Develop a Climate Action Plan for Missoula:** Missoula is fortunate to have active citizen involvement in municipal climate change and energy initiatives. We recommend that the mayor of Missoula form a task force that brings together individuals and elements from city government, nonprofit organizations, The University of Montana, and the business community with expertise and interest in developing a comprehensive climate action plan. Helena and Bozeman found staffing, leadership and effective workgroups to be the key to success in setting feasible emissions reduction goals and devising ways to achieve them.
- **Utilize Climate Action Planning Tools to Analyze Net Costs and Saving of Specific Emission Reduction Measures**: The Climate Action Planning Program Assistant (CAPPA) tool can assist in developing customized plans for reducing GHG emissions in a cost-effective manner. We encourage its use by City divisions and departments for forecasting energy cost savings from specific emissions reduction measures. The University of Montana used similar software to conduct its climate action planning.
- **Consider a Four-Day Work Week and Work-at-Home**: Such measures can reduce energy use and costs for heating, cooling, lighting of municipal buildings, and the operation of office equipment; it can also reduce employee commuting. Although this recommendation may not be feasible for some departments while also maintaining City services, it could considerably benefit departments in offices and buildings that consume large amounts of energy.
- **Create a Revolving Energy Loan Fund for City Energy Conservation and Efficiency Projects**: Such a fund could support energy conservation and efficiency projects in municipal buildings, wastewater treatment, lighting and other City operations. The fund could pay up-front costs for various projects and would be paid back by energy savings, ensuring the sustainability of the fund to support additional projects and long-term energy costs savings.
- **Expand Renewable Energy Generation and Explore Renewable Energy Generation Partnerships**: Solar, wind, biomass, and biogas projects can reduce reliance on fossil fuels, provide energy security, create jobs, and support the local economy. Although some projects require significant capital investment and thus partnership with other public entities and the private sector, other smaller-scale renewable energy technologies can be more readily deployed. Additional solar panels on City buildings, further capture and use of biogas from the City's wastewater treatment plant, and solar water heating at aquatic recreation facilities should be an immediate priority. New buildings could utilize green building designs and groundwater heat-exchange systems for heating and cooling.
- **Advocate for Creation of a Municipal Energy Bond or Energy Improvement Districts**: Inability to finance up-front costs is widely recognized as an impediment to implementing climate action strategies such as green buildings and green fleet policies and renewable energy projects. Although authority to issue energy bonds or create energy improvement districts does not currently exist, there is great interest in Montana to enable cities to raise funds for energy improvements, much the way cities can for parks and open space. We recommend that Missoula, in conjunction with other cities in Montana, make a case and advocate accordingly.
- **Hire a Municipal Sustainability Coordinator**: Although the City already has many employees advancing municipal sustainability in myriad ways, concerned citizens have been advocating that Missoula follow other cities in Montana and The University of Montana and hire a coordinator to lead and expand such efforts. Experience has shown that real progress on climate change – being green, not just talking green – requires a dedicated person to lead efforts for municipal operations and facilitate a broader vision of municipal sustainability.

- **Make Sustainability a Part of Employee Hiring, Orientation, and Evaluation**: We recommend that skill, experience, and desire in the area of municipal sustainability be among the criteria used in advertising open positions and making hiring decisions. We also recommend that new employee orientations and trainings cover energy and water conservation. This could be accomplished by further institutionalizing the City's Green Team. In addition, we recommend incentives, rewards, and other ways of encouragement for existing City employees for leading projects that achieve emission reductions and energy savings.
- **Integrate Consideration of Greenhouse Gas Emissions into Planning and Decision Making**: We recommend that future planning processes, as well as land use, transportation, building and construction projects take into consideration impacts on the City's GHG emissions and adopt measures to minimize and mitigate impacts.
- **Establish a Renewable Energy Certificate (REC) Program:** RECS, also called green tags, are tradable energy commodities that represent proof that one megawatt-hour (MWh) of electricity was or will be generated from a renewable energy source. RECs are a market-based approach to encouraging development of renewable energy. RECs also provide a means for utilities to meet their obligations under Montana's Renewable Portfolio Standard. RECs can help cities, businesses, and institutions become carbon neutral, i.e., move toward having zero net GHG emissions. RECs also provide a means for cities to raise revenue, improve the lives of residents, add jobs, support the local economy, and help lower residential energy bills.
- **Establish a Carbon Offsets Program:** A *carbon offset* is another free market tradable commodity. It typically represents a metric ton of carbon dioxide equivalent (ton of CO_2e) prevented from entering or removed from the atmosphere. Offsets may be purchased by the City and other energy consumers to "offset" emissions, such as those associated with electricity consumption or vehicle use. Purchased offsets are used by a third party to finance projects that would not have otherwise occurred and that can achieve new GHG reductions or prevent emissions. Offsets can support renewable electricity generation, energy efficiency measures, methane capture at wastewater treatment plants, and reforestation projects. Like RECS, offsets can help in meeting emission reduction targets and can be part of a broad-based strategy that goes beyond "picking the low-hanging fruit."

SECTOR-SPECIFIC RECOMMENDATIONS

The wide range of sources of municipal emissions necessitates a broad-based approach that seeks emission reductions from each sector. Although further analysis is needed to determine which sectors offer the most cost-efficient and cost-saving opportunities, we offer a wide range of resources and approaches from which to choose. We recognize that it may be difficult for any single measure to stave off the growth in emissions or reduce overall emissions. Some highlights of our sectors-specific recommendations include:

- *For the wastewater sector*: (1) increase the quantity of biogas reclaimed for heat production to offset the amount of purchased energy for facility operations; (2) support community-wide water conservation measures to reduce the amount of sewage the plant receives that requires treatment; (3) consider energy efficiency and GHG emissions when designing future upgrades to ensure that energy-efficient equipment is chosen; and (4) consider on-site renewable energy production, for example solar or wind power production, to reduce the quantity of purchased energy needed for wastewater treatment operations.

- *For the buildings sector*: (1) adopt a comprehensive green buildings policy that requires LEED certification for new buildings, a LEED program for existing buildings and a no-net-increases in GHG emissions from buildings; (2) conduct energy audits of all municipal buildings that have not been audited and carefully consider energy performance contracting for all municipal buildings; (3) develop a new program to set building energy performance goals and monitor and assess performance; (4) consider using Energy Performance Certificates, "energy identity cards," that rate the energy efficiency of buildings, display building energy use, and provide a comparison with similar structures; (5) hire a new position to manage energy use for buildings, or train and reassign existing staff to serve in that capacity; and (6) build on the success of the City's Green Team by continuing to encourage voluntary energy conservation measures by City employees.
- *For the municipal fleet sector*: (1) consider adopting a comprehensive green fleet policy; (2) encourage efficient vehicle choice and use by City employees (needs-based vehicle selection); (3) adopt proposed anti-idling changes to Administrative Rule #11; (4) further prioritize energy efficiency considerations in vehicle replacement and maintenance; (5) consider and expand use of alternative fuel sources; and (6) continue to encourage the use of alternative transportation (such as Mountain Line buses) for City business-related trips, minimization of vehicle use, and other voluntary measures by City employees.
- *For the employee commuting sector*: (1) promote the City employee "cash for commuters" program to encourage greater use of Mountain Line transit; (2) encourage more employees to participate in commuter vanpools, carpools and ride sharing after work; (3) provide free parking for employees who carpool; (4) consider incentives for living in Missoula or closer to work; (5) partner with Missoula In Motion on an employee car-share program; and (6) research additional ways to incentivize low-carbon and carbon-free employee commuting.
- *For the outdoor lighting sector*: (1) give attention to high annual ownership, operation and maintenance charges for Lighting Districts and other outdoor lighting; (2) for streetlights, consider partnering with NorthWestern Energy to replace High Pressure Sodium Vapor (HPSV) lamps with Light-Emitting Diode (LED) luminaries which use less than half as much energy; (3) initiate outdoor lighting replacement projects for City-owned lights; (4) conduct other lighting efficiency upgrades; and (5) install small solar power cells on outdoor lighting fixtures.
- *For the water sector*: (1) invest in improvements to water distribution infrastructure; (2) support water conservation practices; (3) conduct facility-by-facility water audits; and (4) speed up schedule for metering all municipal water use.

To address climate change is to achieve a broader vision of a prosperous and sustainable future that is only limited by our imagination and courage. It is our hope that this report lays a foundation for such a vision and moves our community closer to creating a blueprint for municipal sustainability — and taking the next steps, one by one, together.

1. INTRODUCTION

BACKGROUND AND OVERVIEW

Missoula's nickname, the Garden City, embodies the ideals of living sustainably, self-sufficiently, and harmoniously with the tremendous natural assets we all enjoy. Missoula has taken many steps over the years to protect our quality of life and assure individual and collective responsibility. One such step occurred on June 17, 1996, when the Missoula City Council passed and Mayor Dan Kemmis signed Resolution #5890, which committed Missoula to join with cities from all over the world in the *Cities for Climate Protection Campaign*.

Missoula thereby resolved to take a leadership role in developing a plan to reduce greenhouse gas (GHG) emissions and increase energy efficiency of municipal operations and throughout the community. With the involvement of local officials, citizens and the business community, the City released the *Missoula Greenhouse Gas-Energy Efficiency Plan* on May 10, 2004 (City of Missoula 2004). The Plan has served as a guiding document for the public and private sectors by providing a blueprint and resources for reducing greenhouse gas emissions in Missoula. At that time, the City also formed a Greenhouse Gas & Energy Conservation Team to advise City Council.

City officials renewed the commitment to reduce greenhouse gas emissions and improve energy efficiency on May 3, 2007, when Mayor John Engen signed a resolution of support for the *U.S. Conference of Mayors Climate Protection Agreement.*[1] Missoula became one of what is now over 1,000 cities in the United States, including a handful in Montana, to have signed the *Mayors Climate Protection Agreement.*

The Cities for Climate Protection Campaign, which is supported by the International Council for Local Environmental Initiatives (ICLEI), and the U.S. Mayors Climate Protection Center provide a framework

1 See http://www.usmayors.org/climateprotection/agreement.htm.

for local governments to achieve emission reductions.[2] The framework is highly adaptable to unique local conditions and consists of the following five milestones:

1. Conduct a Greenhouse Gas Emissions Analysis (Baseline Inventory and Forecast)
2. Establish a Reduction Target
3. Develop a Climate Action Plan
4. Implement the Climate Action Plan
5. Monitor Progress and Report Results (ICLEI 2009d)

Other cities in Montana, including Helena and Bozeman, have conducted detailed data-intensive GHG emissions analyses of municipal operations, have developed comprehensive action plans, and are in the process of implementing them (Kline 2008; Bozeman Climate Protection Task Force 2008). Although the City of Missoula is behind our peer cities in various ways in rigorously reaching these milestones, Mayor Engen and the Missoula City Council have undertaken various climate change, energy conservation and sustainability initiatives that are beginning to make a difference. For example, Mayor Engen created a Mayor's Advisory Group on Climate Change and Sustainability, and with City Council adopted policies for energy conservation in municipal buildings and fuel reductions for the municipal vehicle fleet.

Wanting to continue to build on these efforts, Missoula Mayor John Engen requested the assistance of University of Montana (UM) Environmental Studies professor Robin Saha and UM students in conducting a detailed municipal greenhouse gas emissions inventory for Missoula. In addition to identifying and quantifying various direct and indirect emissions from municipal operations, this inventory examines changes in emissions from fiscal years 2003 to 2008 in order to determine sectors and sources within sectors for which emissions are increasing, decreasing and remaining stable over time.

We chose 2003 as our "base year" for this inventory and analysis because it was the earliest year for which hard copy records of purchased energy existed for most sectors. Likewise, 2008 was chosen as the "target year" because it was the most recent year for which an entire year's data could be obtained when we began this inventory.

Our emissions inventory specifically examines the following emissions sectors[3]:

1. Wastewater Treatment
2. Buildings
3. Vehicle Fleet
4. Employee Commuting
5. Lighting
6. Water

2 International Council for Local Environmental Initiatives (ICLEI), and now ICLEI-Local Governments for Sustainability, was founded in 1990 when more than 200 local governments from 43 countries convened at its inaugural conference at the United Nations in New York (ICLEI 2009a, 2009b). ICLEI is a membership association of local governments and national and regional local government associations that have made a unique commitment to sustainable development. Currently, ICLEI is made up of 1,075 local governments, including Missoula, and represents over 400 million people worldwide (ICLEI 2009c).

3 Other Montana cities that have conducted emissions inventories, as well as The University of Montana, examined emissions related to the solid waste stream (Davie 2008). These inventories found solid wastes to contribute only a very small amount of overall emissions (less than 2%). The Bozeman inventory has curiously argued that its landfill serves as a carbon sink, i.e., it stores carbon that would otherwise be released as carbon dioxide (Bozeman Climate Protection Task Force 2008). Because of the relatively small amount of emission, the limited number of people working this project and the tight timeframe, we did not examine waste-related emissions, which nevertheless should be included in future inventories.

This inventory is not intended to be a full life-cycle analysis of embodied energy of municipal goods, services and purchases, though we did conduct an analysis of purchased energy used by Mountain Water Company to deliver water to the City for municipal operations. This inventory primarily examines emissions directly resulting from purchased energy and fuel for municipal operations and for public services paid for by the City or inherently municipal in nature, such as street lighting. Thus, purchased energy for the Missoula Parking Commission and Missoula Redevelopment Agency were included in our analyses.

The primary objectives for this report are to: (1) present a baseline emissions inventory for the City of Missoula that quantifies total municipal energy use and associated GHG emissions for each municipal sector; (2) identify major sources of municipal emissions, relative contributions within and among the sectors; (3) examine changes and trends in energy use, costs and emissions from 2003 to 2008; and (4) identify opportunities and offer recommendations to achieve future municipal GHG emission reductions. These recommendations include suggestions for consistently monitoring energy use, costs and emissions over time.

It is our hope that this inventory and analysis provides valuable information for City officials to consider when setting emissions reduction targets, devising appropriate emissions reduction strategies, and conducting future emissions inventories.

Forecasting future emissions and analyses of costs of emissions reduction measures is also needed to make good decisions regarding an appropriate and achievable emissions reduction target. We provide crude projections of future emissions that are likely to occur without proactive emission reductions. Our projections provide a rough estimate based on recent rates of change in emissions. However, more refined forecasting scenarios and cost analyses of emission reduction measures were beyond the scope of this project.

The remainder of this introductory section describes climate change impacts in Montana and the compelling need of local action on climate change. We also outline the role of local government in addressing climate change and highlight some of the City of Missoula's existing climate change and energy conservation/efficiency efforts. That is followed by a description of the data gathering and analysis methods employed and the process for drafting this report. All of these stages involved close collaboration and coordination with City personnel.

CLIMATE CHANGE IMPACTS IN MONTANA – THE NEED FOR LOCAL SOLUTIONS

Global climate change is widely acknowledged as one of the most pressing issues of our time. Climate change poses serious risks to Montana's human communities, our economy, and the natural ecosystems. Relatively recent changes in the Earth's climate have been linked to human activities that have increased the concentration of certain greenhouse gases (GHGs) that trap heat in the atmosphere (IPCC 2007a). Carbon dioxide (CO_2) is the primary greenhouse gas of concern.[4] The burning of fossil fuels – coal, petroleum products, and natural gas in particular – and deforestation are major sources of atmospheric carbon dioxide emissions.

4 Other significant GHG gases include methane (CH4), nitrous oxide (N2O), halocarbons and ozone (IPCC 2007a).

In Montana, we have 60% higher per capita GHG emissions (40 metric tons/year) than the rest of the country (25 metric tons/year). Emissions in Montana are estimated to have increased 14% between 1990 and 2005 (Montana Climate Change Advisory Committee 2007, hereafter Montana CCAC 2007). Net annual GHG emissions in Montana now average approximately 12 million metric tons[5] of carbon dioxide equivalents (Montana CCAC 2007).

According to the National Climatic Data Center, the global accumulation of GHGs in the atmosphere has contributed to increases in global surface temperatures of 0.11 degrees Fahrenheit (°F) per decade over the last century. However, this rate has increased to about 0.32 °F in the last few decades (Nowakowski 2008). Atmospheric and ocean temperatures are also rising (Intergovernmental Panel on Climate Change 2007a, hereafter IPCC 2007a).

In referring to a recently published study, The University of Montana's renowned climate scientist Professor Steven Running recently stated that average temperatures in the northern Rocky Mountains are projected to increase 3.6 to 7.2 °F in the next century. Thus, we can expect to experience longer summer droughts and shorter winters. In fact, from 2003 to 2007, the state of Montana already experienced a rise in temperature of 2.1°F above average temperatures of the 20th century (Kinsella 2008).

Although it is a complex endeavor to predict future impacts of global climate change at the regional, state and municipal levels, various studies reveal adverse impacts of climate change that we are already experiencing in Montana. These impacts include the spread of pest insects, diseases and invasive species; damage to crops and trees; and increased risk of wildfires (Montana Climate Change Advisory Committee 2009; Moy 2010). Due to diminished winter snowpack, alterations in the timing and magnitude of summer run-off, and warmer air and water temperatures, climate change is expected to threaten water supplies, forest productivity, crop production, and fish and wildlife habitat (Kinsella 2008; MDEQ 2008).

For example, an average annual air temperature increase of 1.8 °F could reduce suitable habitat area of various prized trout species in the Rocky Mountains up to 16%, and 9°F increase could reduce trout habitat up to 70% (Keleher and Rahel 1996).

Indeed, climate change poses significant threats to outdoor recreation and economies close to home, particularly to Montana's tourism industry, which is the fifth largest employer in our state. According to The University of Montana's Institute for Tourism and Recreation Research, tourism expenditures in 2007 supported an estimated 45,000 jobs in Montana, an increase of 36% since 1997. Tourism travel in Montana reached nearly $10.7 million in 2007, an increase of over 20% from 1997, and non-resident travel expenditures reached $3.9 million in 2007, a 3% increase from 2006 (Grau 2008). Climate change impacts to tourism could cost jobs and reduce income for local business and tax revenue for local government.

Climate change poses significant threats to outdoor recreation and economies close to home, particularly to Montana's tourism industry, which is the fifth largest employer in our state.

5 A metric ton is 1,000 kilograms or approximately 2,205 pounds.

In fact, Montana's Department of Fish, Wildlife and Parks has already been forced to close streams to fishing due to low summer flows. Such closures can hurt revenues for the $31 million guided fishing industry. Climate change poses similar threats to the river recreation industry, which outfitted nearly 120,000 rafting and boating enthusiasts in 2005, and to the $40 million hunting outfitter industry, which faces change to the hunting season and availability and accessibility of game species as animals adapt to climate change. Montana's ski industry, which employs more than 1,100 people, is also highly vulnerable to changes in snowfall patterns, as are forest and recreation areas, which also have been closed in recent seasons due to threats from wildfires (MDEQ 2008; Hall and Higham 2005). All of these industries provide economic benefits to Missoula.

LOCAL GOVERNMENT CLIMATE CHANGE INITIATIVES

Because of the types of threats posed by climate change, state and local governments throughout the United States are taking steps to reduce their greenhouse gas emissions. In fact, local governments, in particular, have the potential to affect 30-50% of the nation's GHG emissions through policies, programs and incentives designed to reduce the "carbon footprint" of municipal operations, residents and businesses (Lindseth 2009).

Local governments are uniquely positioned to provide the leadership needed to develop long-term and effective solutions to climate change by integrating climate change mitigation into municipal planning and decision-making processes and by building public-private partnerships (ICLEI 2009d, 2009e, 2009f).

An obvious first step toward reducing GHG emissions is for local governments to inventory their emissions and develop and implement climate action plans regarding various aspects of municipal operations, including service delivery and the design and administration of schools, public lands and parks and recreation facilities. City and county governments can take a wide variety of measures to help citizens reduce greenhouse gas emissions by adopting energy efficient building codes, land use and zoning measures, transportation and infrastructure improvements, energy improvement bonds, and the like. Local government officials and employees can be energy conservation leaders and influence consumer choices in transportation, housing, food and agriculture, and other areas (ICLEI 2009a).

City and county governments can take a wide variety of measures to help citizens reduce greenhouse gas emissions.

However, any move a community makes toward sustainability relies on planning, policy and practice, a model that has proven successful in such diverse places as St. Paul, Minnesota (Zahran et al. 2008); Boulder, Colorado; Portland, Oregon (Portney 2003a); and Newcastle, UK (Bulkeley and Betsill 2003). However, local initiatives have been less successful in moving communities toward their sustainability goals in places where disconnected and piecemeal actions are implemented outside of a broader context of sustainability or where environmental priorities are seen as being in conflict with other municipal agendas (Portney 2003b).

Fortunately, the actions taken thus far by City officials and the support they have from Missoula residents indicate a vested interest and a concerted effort to reduce the City of Missoula's carbon footprint and work toward effective local solutions to climate change. Municipalities, including the City of Missoula, stand to benefit from expanding their climate protection measures. In doing so, cities become more sustainable, build the local economy, save taxpayer dollars, improve air quality and human health, connect with other leaders and resources, inspire community engagement, and build a tradition of climate leadership (ICLEI 2009a). Indeed, Missoula and its City leaders are already well on the way to creating such a legacy.

CLIMATE CHANGE AND ENERGY EFFICIENCY INITIATIVES IN MISSOULA

The City of Missoula is currently engaged in a wide range of local climate solutions and has already taken important steps too numerous to detail here. Many of these are described in relevant sections of this report. Resolution #7241 is among the most noteworthy recent policies. In passing Resolution #7241 on July 2, 2007, the City adopted "an energy efficiency and GHG reduction policy for municipal building projects, including new buildings, building additions and major remodels." The City has also embarked on an energy audit program for existing buildings along with performance contracting in order to benefit from external expertise and financing for energy efficiency retrofits and upgrades. City employees have formed a Green Team that developed a set of energy conservation behaviors that Mayor Engen has endorsed and directed City personnel to follow.

The City of Missoula is currently engaged in a wide range of local climate solutions and has already taken several important steps.

On November 3, 2008, City Council passed Resolution #7375, which set a 10% reduction goal for fuel consumption and energy use by the City of Missoula below 2007 levels by January 1, 2011. As a result, Mayor Engen directed City departments and divisions to develop plans to achieve the policy goals. Indeed, a wide-reaching vehicle fleet fuel reduction plan is already being implemented and is on track to succeed.

In addition, on February 9, 2009, the City adopted Resolution #7398, which created a renewable energy certificates program (called the Green Power Missoula program). The program allows Missoula residents and others to voluntarily offset their GHG emissions by purchasing renewable energy credits, which can help Missoula achieve GHG reductions goals in the future. Revenue from sales of these credits can be used by the City to carry out new energy conservation or GHG emission reduction projects. Some recent projects funded through other means provide good examples of possible uses of funds generated from the Green Power Missoula program. These projects include the installation of solar panels at City Hall and two fire stations and installation of energy-efficient Light Emitting Diodes (LEDs) in 11 traffic signals. The Green Power Missoula program allows citizens to invest in a sustainable future for Missoula and help the City raise much needed funds.

The City promotes non-motorized and healthy transportation options for Missoulians through its Bicycle / Pedestrian Program and its Safe Routes to School Program. It also encourages employees to join the *Way to Go* commuter club through Missoula In Motion, provides free Mountain Line Bus passes to employees, and supports alternative and public transportation in many other ways.

In collaboration with NorthWestern Energy, City leaders recently started the Green Blocks pilot program, which resulted in energy audits and energy efficiency improvements to 93 homes in seven two-block areas (Engen 2010). In conjunction with Missoula County, the City is also participating in the federal Energy

Efficiency and Conservation Block Grant (EECBG) Program, which has enabled the City to hire a municipal energy efficiency grants administrator, fund energy-efficiency projects, and develop new initiatives, some of which are recommended in this report. Using EECBG funds, the City renewed its partnership with NorthWestern Energy to launch a second Green Blocks pilot project, this time providing energy-saving retrofits to 300 homes, beginning in late summer 2010 (Engen 2010). A commercial-building pilot project is in the works. In short, Missoula is on a roll!

Although these policies and initiatives significantly help move Missoula toward a more sustainable future, Missoula has yet to establish an emissions reduction goal and adopt a coordinated set of policies to reach such a goal. The laudable steps already taken are somewhat disconnected efforts and are not part of a comprehensive sustainability approach seen in some other communities where energy conservation, land use planning, housing, air and water quality, public health and safety, transportation, municipal waste and recycling, and economic and industrial development fall under an umbrella of municipal sustainability. As the City continues to grow and develop, new opportunities will arise for City leaders and citizen alike to continue to define in policy and practice the ideals of the Garden City.

This report can serve as an important step toward establishing an emissions reduction target and adopting a comprehensive climate action plan, and doing so in the broader context for sustainability and environmental stewardship. Indeed, Missoula is well-poised and ready to make further progress as a sustainable city.

EMISSIONS INVENTORY PLANNING AND COORDINATION

This project represents a unique partnership between the City of Missoula and The University of Montana. Mayor Engen's leadership and vision was instrumental in developing this partnership, which has provided an opportunity for students and the faculty project director to lend our expertise, learn from City personnel about municipal operations, develop new working relationships with City personnel, and provide a service to the City. Several planning and coordination meetings helped make for a productive collaboration.

On February 10, 2009, an initial meeting was held at City Hall with the UM working group, which included Professor Robin Saha and most of The University of Montana student co-authors of this report, Mayor Engen, his Administrative Leadership Team, and other City personnel. At this meeting, we discussed sources of municipal GHG emissions to include, took important steps to define the scope and objectives of the inventory, identified data sources and limitations, established informal protocols for working together, and obtained an initial list of City contacts for each sector.

At this meeting, various division and department heads provided valuable information and advice for what came to be a complex Herculean endeavor. Ginny Merriam, the City's Public Information/ Communications Officer, agreed to serve as the project coordinator for the City and the point person for our various data and information requests. The project could not have been completed without her generous assistance, dedication, and patience. No other City personnel were assigned to work on the project in a dedicated manner.

On February 19, 2009, our working group met in Helena with Tim Magee, Helena's Administrative Service Director, and Liz Hirst and Carrie Hahn, both in Helena's Utility Billing Department. They shared lessons learned in compiling Helena's GHG emissions inventory. They advised us to not analyze emissions related to solid wastes, because of the amount of effort needed to inventory a very small amount of emissions that likely would be associated with solid waste disposal. We also were not able to include energy generated and use by solar panels at City Hall and Fire Station #4 because of a lack of available data, and therefore, this inventory underestimates energy use by an unknown amount. We also did not include in our analysis emissions associated with the composting of sewage sludge from the City's wastewater treatment plant by EKO Compost.

In March, our working group met with the Missoula Greenhouse Gas & Energy Conservation Team and presented the planned scope of the inventory, obtained further guidance and suggestions, and made plans to present our findings to the Team in April 2009.

DATA GATHERING AND ANALYSIS

Detailed descriptions of the methods used for data collection and analysis for each sector can be found in the respective sections of this report. We obtained many of the NorthWestern Energy electricity and natural gas account numbers and associated energy usage and cost data for this inventory from the City's hard-copy energy billing records for Fiscal Year (FY) 2003 and FY 2008, particularly for wastewater treatment, municipal buildings, and lighting sectors. We accessed these records with permission from, and under the supervision of Ginny Merriam, Mary Kay Wedgwood in the Finance Department, and Marty Rehbein, the City Clerk.

Because some of the needed records were not available in hard-copy form with the City, Ginny Merriam requested that NorthWestern Energy provide electronic records of City utility records for FY 2003 and FY 2008. Vicki Judd, Manager of Community Relations for NorthWestern Energy in Missoula, furnished us with electronic files of electricity and natural gas usage and billing data for NorthWestern Energy accounts that we identified from the hard-copy records. We used the electronic records to verify data compiled from hard copy records.

Because it became apparent that we had not identified all of the City's NorthWestern Energy accounts, we made additional requests in October and December 2009 for complete electronic records for all accounts billed to the City of Missoula, Missoula Parking Commission, and Missoula Redevelopment Agency. As a result, we identified almost 60 additional accounts that we had not previously identified. Energy use and costs for several of these accounts have been added to the analysis of appropriate sectors. The other recently-identified accounts are included in an "Other Miscellaneous" energy use section of this report.

A statistic software package (SPSS) and Microsoft Excel were used to compile and analyze the electronic data obtained from NorthWestern Energy. Table 1-1 shows the total number of NorthWestern Energy electricity and natural gas accounts by sector in FY 2003 and FY 2008.[6] In FY03 there were 243 accounts, 227 and 16 of which were for electricity and natural gas, respectively. In FY08, the City had 272 accounts with NorthWestern Energy, 248 for electricity and 24 for natural gas. It should be noted that the City also purchases energy from other providers for the wastewater treatment system and has several accounts with the Missoula Electrical Cooperative and Jefferson Energy.

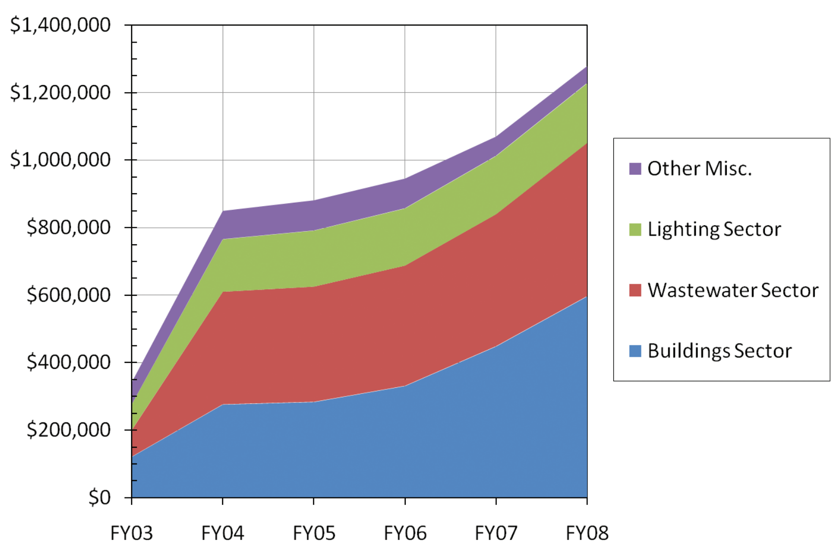
6 Each fiscal year begins on July 1 and ends on June 30 of the year identified. Thus, FY 2003 began on July 1, 2002, and ended on June 30, 2003. Fiscal years are relevant to budgeting processes used by division and department heads and proved to be an efficient means of gathering and organizing energy use and cost data for this report.

Table 1-1: Number of NorthWestern Energy Accounts by Energy Type and Sector for the City of Missoula, FY03 and FY08

Sector and Energy Type	FY03	FY08
Municipal Buildings	**31**	**48**
Electricity	18	26
Natural Gas	13	22
Wastewater Treatment	**28**	**35**
Electricity	28	34
Natural Gas	0	1
Lighting	**113**	**124**
Electricity	113	124
Natural Gas	0	0
Other Miscellaneous	**71**	**65**
Electricity	68	64
Natural Gas	3	1
Total (All Sectors)	**243**	**272**
Electricity	227	248
Natural Gas	16	24

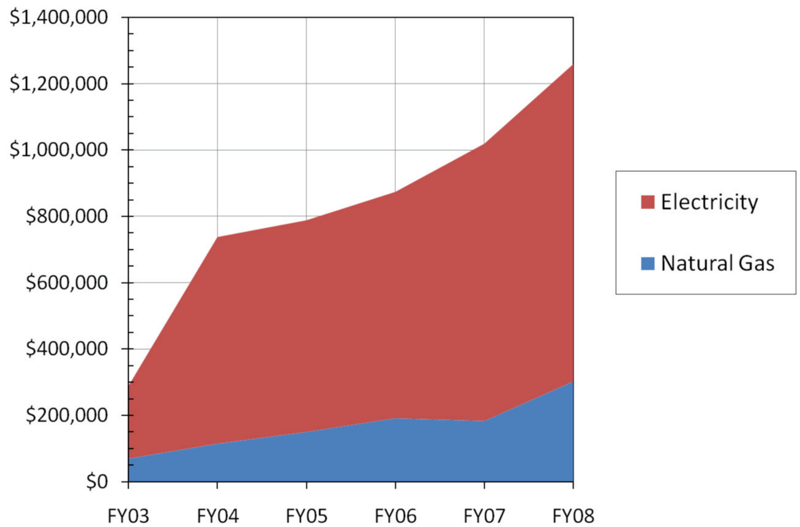
The most recent data we obtained from NorthWestern Energy also included energy use and costs for accounts billed to the City of Missoula, Missoula Parking Commission, and Missoula Redevelopment Agency for FY02 through FY09. These data allowed us to examine year-to-year changes and assess overall trends for the buildings and other sectors that rely on purchased energy, the costs of which have increased dramatically in the last several years.

Figure 1-1: City of Missoula Purchased Energy (Electricity and Natural Gas) Costs in 2009 Dollars by Sector, FY03 to FY08



For example, Figure 1-1 shows total costs of energy purchased from NorthWestern Energy in 2009 dollars and illustrates the compelling need to reduce municipal energy consumption aside from energy conservation, climate change and sustainability goals. After controlling for inflation[7], total costs of purchased energy increased at a seemingly unsustainable rate of 274% from FY03 to FY08, from $341,010 to $1,278,428. This $937,000 increase is mostly due to rate increases, since total electricity usage increased only 40% and natural gas usage increased 99% from FY03 to FY08. The rate increases appear to have been greater for electricity than natural gas. In FY03 and FY08, electricity costs accounted for 76% of the total costs of energy purchased from NorthWestern Energy (see Figure 1-2 and Appendix I-1).

Figure 1-2: City of Missoula Purchased Energy Costs in 2009 Dollars by Energy Type, FY03 and FY08



This energy cost increase represents an average annual rate of increase of 55%. The average annual rate of increase was greatest for the wastewater sector (96%), followed by the buildings sector (79%), and the lighting sector (26%). Other miscellaneous purchased energy costs decreased an average of 4.8% per year. See Appendices I-1 and I-2 for detailed tabulations of these data. More detailed sector-specific energy costs data are also presented later in this report. However, in subsequent chapters, energy cost data are generally not reported in constant dollars as they are here.

To obtain data on fuel use by the municipal vehicle fleet and various gasoline, diesel, and propane powered equipment, we relied on information from Jack Stucky, the City's Vehicle Maintenance Superintendent. Jack Stucky maintains a comprehensive database of municipal fleet fuel purchases and also provided helpful assistance for the buildings sector section of this report.

To estimate fuel use and associated GHG emission resulting from employee commuting, we conducted an employee commuting survey, for which we received 125 responses.

To determine embodied energy associated with delivery of water for municipal uses, we used information on metered and unmetered water use from John Kappes, Assistant General Manager for Mountain Water. John Kappes provided us with estimates of NorthWestern Energy electricity used by Mountain Water to

7 Values shown in Figure 1-1 and Appendices I-1 and I-2 represent constant dollars in 2009. Thus, changes shown do not include increases due to inflation. By using constant dollars here, we took into account the annual Consumer Price Index (CPI) by using a U.S. Department of Labor Statistics CPI inflation calculator. See: http://data.bls.gov/cgi-bin/cpicalc.pl .

deliver water used in City buildings and parks and recreational facilities. We found this electricity usage to be a very small percentage of the City's energy portfolio.

Additional Assistance from City Personnel and Others

Throughout the project, Ginny Merriam directed us to sources of needed information for this project. For example, Jason Diehl, Missoula's Assistant Fire Chief, and his staff compiled records of fuel consumption by Fire Department vehicles for wildland firefighting, which are not otherwise accounted by the fuel purchasing record system. We also obtained assistance from Mountain Water personnel for our analysis of embodied energy in water used by the City. Additional City employees and others who contributed to this report are identified in each section of the report.

Greenhouse Emissions Calculations

To calculate greenhouse gas emissions for City of Missoula municipal operations, we utilized ICLEI's Clean Air and Climate Protection (CACP) Software (ICLEI 2009g). The CACP software uses regional grid intensity factors and other accepted conversion factors to calculate carbon dioxide equivalencies associated with purchased electricity and natural gas use. The grid intensity factors are based on the mix of electricity-producing technologies and the design and emission characteristics of each type of facility used in various regions of the country.

The CACP software was a collaborative product of the National Association of Clean Air Agencies (NACAA) and the U.S. Environmental Protection Agency (EPA). The agencies sought to develop a software product to help local governments conduct greenhouse gas emissions inventories, quantify the benefits of reduction measures, and formulate local climate action plans.

We used the 2003 version of this software to compile the Missoula municipal emissions inventory detailed in this report. We chose this software because it is endorsed by ICLEI and readily accounts for emissions from facilities, operations, programs, and vehicles owned and/or operated directly by the local government (Torrie Smith Associates et al. 2003). Moreover, the software has been used by other Montana cities, including the City of Helena, for their inventories.

We used the Government Analysis module of the CACP software, which calculates GHG and Clean Air Act criteria air pollutant emissions from local government operations based on information entered on fuel consumption, use of purchased electricity and natural gas, and solid waste production. For electricity-related emissions, we used one of the 15 built-in regional grid intensity factors for 2003 and 2008. Specifically, we used Region 11, the Western Systems Coordinating Council/NWP grid intensity factor.

Emissions generated by the software set to these specifications are based on estimated emission from electricity generation in the Pacific Northwest region, where emissions per unit of electrical power tend to be lower than the rest of the country, because of Bonneville Power's large hydroelectric generation capacity. Although electricity purchased and delivered by NorthWestern Energy is not entirely generated in Montana, the company is likely to rely on more carbon-intensive energy supplies than the regional average due to the relatively small amount of hydroelectric power in the state compared to the region. Although grid intensity factors for NorthWestern Energy are available, we were not able to evaluate their reliability and instead used the regional grid intensity factor. As a result it is possible that our emissions inventory significantly underestimates actual emissions. Thus, our calculations represent conservative estimates.

STUDENT INVOLVEMENT

Six University of Montana students conducted initial research and analysis for this report during the spring of 2009 and took the lead on various emission sectors: Michelle Lanzoni for water; Michael Lattanzio for the municipal fleet; Kathryn (Katie) Makarowski for wastewater; Bethany Taylor for employee commuting; Russ Van Paepeghem for buildings; and Owen Weber for lighting. Katie Makarowski continued to work on revisions to and editing of all chapters of this report until its publication. This report would not have been possible without the hard work and commitment of all of the student authors.

STAFF REVIEW OF DRAFT SECTIONS

Each section of this report went through several iterations over the last year. Student authors wrote and revised initial drafts in spring 2009. All of these draft sections were subsequently checked and rechecked for accuracy and were revised by Katie Makarowski and Robin Saha during the summer and fall of 2009. Draft sections were then submitted to various City divisions and department heads for comments and suggestions and for circulation to appropriate personnel. In some instances, verification of information or additional information was requested at that time. Ginny Merriam and Bruce Bender helped involve the City personnel as needed in the review process. We responded to all feedback and suggestions received. For the buildings section, we also obtained valuable comments and suggestions from Cherie Peacock, the Sustainability Coordinator for The University of Montana. In addition, staff from Missoula In Motion provided valuable suggestions for the employee commuting section. This review process served as a quality control function and greatly improved the quality of the report.

PRESENTATION OF PRELIMINARY FINDINGS

Student authors and Professor Saha made three presentations of preliminary findings in spring of 2009, first to the Greenhouse Gas & Energy Conservation Team on April 9. Additional presentations were made to the Mayor's Advisory Group on Climate Change and Sustainability on May 12, and Mayor Engen's Administrative Leadership Team (ALT) on June 16. We used feedback and suggestions obtained from these presentations to make additional revisions.

REPORT ORGANIZATION

Our inventory and analysis of greenhouse gas emissions is presented as separate chapters corresponding to the various emission sectors that we examined. These include: wastewater; buildings; municipal fleet; employee commuting; lighting; and water. An additional chapter examines energy use, costs and emissions for miscellaneous NorthWestern Energy accounts not included in the other sectors.

Each of these chapters includes sector-specific recommendations. The chapters on the various sectors are followed by a summary of findings chapter that compares energy use, costs and emissions among the various sectors and examines Missoula overall emission trends in relation to other cities in Montana.

The final chapter of this report offers our overall recommendations to City officials to address climate change and energy use and costs. The final chapter also summarizes the sector-specific recommendations and offers concluding comments regarding next steps for Missoula in relation to the *U.S. Conference of Mayors Climate Protection Agreement.*

2. WASTEWATER

INTRODUCTION

Wastewater treatment plants are significant contributors to municipal greenhouse gas emissions in the United States. This trend may continue as demand for this service increases with population growth. In the U.S., approximately 79% of domestic wastewater is collected and treated centrally (i.e., by municipal wastewater treatment plants), with the remaining treated by septic and other on-site systems. Wastewater treatment accounts for 4% of U.S. methane emissions, or 15.8 million metric tons of carbon dioxide equivalencies (U.S. EPA 2009a).

Missoula's wastewater-related emissions result from the energy-intensive processes used for wastewater transport and treatment (i.e., electricity and natural gas use) and from the production of biogas, which is a byproduct of the treatment processes and is primarily comprised of methane (CH_4) and carbon dioxide (CO_2). Additional byproducts include biosolids, which are sent to neighboring EKO Compost (which sells a commercial compost product made from the biosolids and other organic wastes), though greenhouse gas emissions from EKO Compost were not included in this analysis. Treated wastewater, which is discharged into the Clark Fork River under a permit by the Montana Department of Environmental Quality, is the other byproduct of the wastewater treatment plant (WWTP) operation.

Scope and Objectives

The primary objectives of this section of this inventory are: (1) to provide a baseline of quantified energy use, energy cost, and related greenhouse gas emissions associated with wastewater treatment in the City of Missoula; and, 2) to identify and present several opportunities and recommendations for future wastewater emissions reduction measures and inventories. This section of our report provides relevant background information about Missoula's Wastewater Treatment system, describes the data collection and analysis used to compile this sector's inventory, and presents findings of total energy use, cost, and greenhouse gas emissions related to wastewater treatment operations. We conclude this section with our recommendations for emission reductions, which we hope will be taken into consideration in future efforts to reduce the City of Missoula's carbon footprint.

We defined the scope of emissions inventory for the wastewater treatment sector to include all emissions resulting from purchased energy used for the wastewater treatment system operations and paid for directly by the City of Missoula as well as biogas production from the treatment plant's digesters. The plant is Missoula's only municipal utility, serving most parts of the city and some areas outside of the city. Specifically, we included emissions associated with both the wastewater treatment plant facility itself, as well as 36 lift stations that pump untreated wastewater to the plant from various collection points throughout the wastewater treatment service area.[1]

According to M. Wedgwood from the Missoula City Finance Office and B. Johnson from the Wastewater Treatment Plant, the plant itself uses electricity and natural gas, whereas the wastewater lift stations use only electricity (personal communication, March 2009). NorthWestern Energy supplied electricity for the plant and 27 lift stations in FY03 and 32 lift stations in FY08; Missoula Electric Cooperative supplied electricity for four additional lift stations in FY08; Jefferson Energy Trading LLC supplied natural gas for the plant in FY08; and Commercial Energy supplied natural gas for the plant in FY03. In addition, NorthWestern Energy provided natural gas in FY08 for a heated truck barn located adjacent to the plant that stores rolling equipment (S. Sullivan, personal communication, January 2010). Electricity and natural gas use, costs, and associated greenhouse gas emissions for the truck barn were counted as part of the plant itself. Table 2-1 summarizes the energy suppliers by energy type for the Missoula wastewater system.

Table 2-1: Energy Supplier by Energy Type and Use for Missoula Wastewater Treatment, FY 2003 and FY 2008

Energy Supplier	Energy Type*	Energy Use, Fiscal Year
NorthWestern Energy	Electricity	Plant and Lift Stations, FY03 and FY08
Missoula Electric Cooperative	Electricity	Four lift stations, FY08
Jefferson Energy Trading, LLC.	Natural Gas	Plant, FY08
Commercial Energy	Natural Gas	Plant, FY03

** In FY08, NorthWestern Energy also supplied natural gas for a truck barn, which was tallied with Plant subtotal*

Missoula Wastewater Treatment History and Overview

To identify sources of greenhouse gas (GHG) emissions resulting from wastewater treatment in Missoula, and to identify opportunities for reduction in the future, it is important to describe the current wastewater treatment system and recent upgrades made to the plant facility between 2003 and 2008. Several prior upgrades and expansions to the system were also implemented. These previous and more recent upgrades are described below. Any comparisons of energy use and emissions made between the inventory's base year of FY 2003 and target year of FY 2008 need to consider that major upgrades occurred during this period.

Plant Facility History

Missoula's Wastewater Treatment Plant (WWTP) began treating wastewater in 1964, utilizing physical (primary) treatment. In 1974, secondary treatment utilizing a biological process called activated sludge was added to further improve the quality of the treated wastewater discharged into the Clark Fork River. In 1982, a new solids handling facility, a new digester and a new headworks building were constructed

1 We did not include emissions associated with composting of sludge from the wastewater treatment plant.

to further improve the treatment process (City of Missoula 2009). By 1999, Missoula's WWTP was a conventional secondary plant that served approximately 42,000 people (see Table 2-2). At this time, the City's existing wastewater facilities included a sanitary sewer collection system and an activated sludge secondary treatment system. As of 2001, the rated design capacity of the City's plant was approximately 9.0 million gallons per day (mgd), and it consistently met the effluent discharge requirements of the City's Montana Pollution Discharge Elimination System (MPDES) permit (Morrison Maierle 2001).

To handle biogas, a single digester gas compressor was installed in 1982 in a small room attached to the primary digester; as of 2009, this digester still handles all digester gas (Morrison Maierle 2008). Some of the gas is used in the boiler to heat the primary digester and the administrative/lab building; excess gas bypasses the scrubber and is flared (burned) off.

Several factors led to plans for additional upgrades to Missoula's WWTP. First, expected future population growth led to the expansion of the Missoula wastewater service area and prompted the need to expand the operational capacity of the plant. In 2001, the service population was projected to grow to more than 76,000 by the year 2015 (see Table 2-2). Second, upgrades were needed to meet new nutrient (nitrogen and phosphorus) water quality discharge standards resulting from the City's participation in the Clark Fork River Voluntary Nutrient Reduction Program (VNRP) (Morrison Maierle 2001).

Plant Facility Upgrades

Upgrades planned to begin in 2003 were intended to expand the daily treatment capacity to 12 mgd. These upgrades were designed to provide adequate wastewater treatment for a 20-year period, from 2006 to 2026 (Morrison Maierle 2001). These upgrade plans sought to characterize and evaluate the existing treatment processes, estimate future populations and wastewater quantities, determine improvements needed to meet future permit requirements and accommodate growth, and develop and evaluate alternatives for future wastewater treatment processes (Morrison Maierle 2008).

Consideration of energy efficiency went into the latest upgrade. For example, the most efficient electrical motors and drives (especially for the aeration and ultraviolet disinfection systems) that could meet design goals were installed during the 2003-2004 upgrades. However, little discussion of energy efficiency in these upgrade plans is evident in the consultant's reports, except for the digester gas handling system (Morrison Maierle 2008).

Table 2-2: Estimated and Projected Wastewater Service Area Population, Missoula, MT

Year	Estimated Wastewater Service Area Population
1999	42,000
2006	65,471
2015	76,000
2026	88,936

Sources*: Morrison Maierle 2001 and 2008.*

As shown in Table 2-2, the 2006 service area population was estimated at 65,471. An estimated annual growth rate of 1.25% was used to project a wastewater service area population of 88,936 for 2026 (Morrison Maierle 2008). The projected population in 2026 also includes about 2,300 residents who are currently not connected to the sewer system but are anticipated to receive service by 2026.

Table 2-3: Estimated and Projected Influent Flow (millions gallons/day) to Missoula's WWTP

Year	Avg. Annual Daily Flow (mgd)	Peak Monthly Average Flow (mgd)	Maximum Flow (millions of gallons)
1999	8.00	9.00	Not reported
2006	8.54	9.82	12.3 (daily)
2026	11.81	12.88	18.9 (hourly)

Sources: Morrison Maierle 2001 and 2008.

According to S. Sullivan, Missoula's Wastewater Division Superintendent, the WWTP currently receives approximately 8.5 mgd of wastewater (personal communication, March 3, 2009). Based on the five-year average from 2002-2006, average per capita flow of untreated sewage into the plant (influent) is 135 gallons per day. This amount is higher than a typical city the size of Missoula, even when including commercial/industrial flows (Morrison Maierle 2008). This relatively high per-capita flow is likely due to the wastewater contribution by Missoula's higher than average commuting population from surrounding areas, which is not included in the service area population; this also suggests that the commercial/industrial sector, which provides employment for the commuting populations, contributes a larger than average portion to the wastewater flows (Morrison Maierle 2008).

The most recent upgrades to Missoula's WWTP began in 2003. In 2004, significant hydraulic and treatment capacity were added to the Missoula WWTP when the plant was upgraded to a biological nutrient removal (BNR) system (Morrison Maierle 2008). Portions of the digester gas handling system were also upgraded to eliminate gas leakage and improve efficiency, and the biogas flare was replaced; a gas scrubber was also recently purchased to remove sulfur before the gas is burned in the boiler (Morrison Maierle 2008). According to Morrison Maierle (2008, Sec. 3-36), "the digester gas compressor is very loud and, given its age, replacement should be considered within the next five years". However, since there is currently no provision for acquisition of a second compressor, and the structure that houses the existing compressor is too small for an additional unit, replacement must likely be delayed. See Appendix WW1 for a list of other plant components added or modified as part of the recent upgrades.

As a result of these recent upgrades, the plant is currently designed for an average flow rate of 12.0 mgd and a maximum monthly flow of 13.8 mgd (Morrison Maierle 2008). According to S. Sullivan, the upgrades to advanced secondary treatment with ultraviolet disinfection significantly increased Missoula's WWTP electrical costs (personal communication, May 1, 2009).

METHODS

Data Sources and Gathering

S. Sullivan and G. Connell, Missoula's Wastewater Treatment Operations & Maintenance Supervisor, assisted in identifying the sources of GHG emissions from the City's wastewater treatment sector, including: (1) electricity used for wastewater treatment (plant) and transport (lifts); (2) natural gas used by wastewater treatment plant and associated buildings; and (3) biogas production as a byproduct of wastewater treatment.

This section *does not include* emissions associated with use of the City's vehicle fleet by WWTP personnel, which are accounted for in the Vehicle Fleet section. We also excluded emissions associated with energy use by Septic Tank Effluent Pumping (S.T.E.P.) systems, installed in the yards of some 1,200 homeowners to pump wastewater to the WWTP. These effluent transport systems are excluded because they are paid for by homeowners and not the City, although emissions from treatment of this wastewater are included in overall WWTP emissions (City of Missoula 2009).

Electricity Use and Costs

We obtained utility company account numbers for the WWTP facility and 27 lift stations from the hard-copy records of the City's Northwestern Energy bills from FY 2003. These FY03 account numbers corresponded to those in FY08, though we also similarly obtained account numbers for an additional five lift stations and an additional utility building (a "truck barn") adjacent to the plant from FY08 Northwestern Energy records. We then compiled electricity use and cost data for each of these accounts from electronic files obtained from Vicki Judd of Northwestern Energy. We also obtained account numbers and electricity usage and cost data from Missoula Electric Cooperative billing records for the four lift stations supplied by this company in FY 2008. See Appendix WW2 for detailed electricity use and cost data for FY03 and FY08.

The Missoula Electric Cooperative billing records were missing electricity use and cost data for June 2008 for *each* of the four lift stations supplied by this company; we estimated these values to be the average use and cost from the previous 11 months (July '07-May '08) for which data do exist (see Appendix WW3 for a description of these calculations).

Natural Gas Use and Costs

We obtained Commercial Energy natural gas account numbers and use (MMBTU) and cost ($) data from the City's hard-copy Commercial Energy billing records from FY 2003. Similarly, we obtained this data from Jefferson Energy billing records from FY 2008. Detailed natural gas data are available in Appendix WW2. There was one NorthWestern Energy natural gas account for the aforementioned truck barn located adjacent to the wastewater plant. As noted above, all natural gas accounts were associated with the plant facility.

Commercial Energy records were missing natural gas use and cost data for July 2002. We estimated these values as the averages of the other 11 months of FY03 (August 2002-June 2003). Jefferson Energy billing records were similarly missing data for December 2007 and June 2008. We estimated these values based on the amount paid and the reported rate (see Appendix WW3).

Biogas Production and Use

We obtained biogas and biosolid production data for October 2007 to September 2008 from G. Connell, Missoula's Wastewater Treatment Operations & Maintenance Supervisor. Since data are not available for our base and target fiscal years, we assumed biogas and biosolid production from this period to be reasonable estimates for FY 2008 (July 2007-June 2008).

Unfortunately, biogas production was unmetered in 2003, and so accurate data are not available. We were able to obtain an estimate of biosolid production in 2003 from S. Sullivan. Based on the assumption that annual biogas production is proportional to annual biosolid production, we estimated biogas production for 2003 as follows:

Total Biogas in 2003 = (Total Biogas in 2008/Total Biosolid in 2008) x Total Biosolid in 2003.

According to G. Connell, biogas production in 2003 could have produced 15% more biogas per unit weight of sludge because, at this time, Thickened Waste Activated Sludge (TWAS) was fed into the anaerobic digester whereas currently it is not (personal communication, April 2009). Upon his suggestion, we increased our estimated 2003 biogas production by 15%.

DATA ANALYSIS

Electricity and Natural Gas Emissions

To obtain the total energy use (MMBTU) and metric tons of CO_2e emissions from electricity and natural gas consumption, we entered electricity and natural gas use and cost data for FY03 and FY08 into the CACP Software. In the software, we defined the plant itself and all lift stations as two distinct groups. To facilitate use of this software, we converted natural gas use data from dekatherms to therms or from MMBTU to therms as needed (1 dekatherm = 10 therms = 1 MMBTU). These and other data described below were compiled and analyzed using Microsoft Excel.

Biogas Emissions Calculations

Because the CACP Software did not allow us to accurately calculate the carbon dioxide equivalencies from biogas production/use data, we made our own computations based on information provided by S. Sullivan and G. Connell. They indicated to use that biogas produced by Missoula's WWTP is approximately 60% methane (CH_4) and 40% carbon dioxide (CO_2), with "insignificant" proportions of other gases including water vapor and hydrogen sulfide (personal communication, March 3, 2009). Each year, approximately 2% of the total biogas produced escapes as fugitive emissions to the atmosphere. Of the remaining 98%, approximately 50% is "flared off" (and thereby converted to carbon dioxide during combustion) and approximately 50% is used to produce heat for the boiler.

Based on information available, we calculated the volume (in cubic meters, or m^3) and relative quantity of emissions (tons of CO_2e) of both CH_4 and CO_2 resulting from each of the three fates of biogas by using the combined gas law, the density for each gas at standard temperature and pressure (adjusted to elevation of Missoula), the mass balance equation for methane combustion, and the molar mass of each gas (see Appendix WW3). We did this, in part, to account for CO_2 emissions that result from CH_4 combustion during flaring and boiler heat production. Also, since fugitive CH_4 emissions are not combusted, we calculated their CO_2 equivalent emissions based on a global warming potential (GWP) value for CH_4 of 23 (IPCC 2001), as follows for any greenhouse gas: metric tons of CO_2e = (metric tons of greenhouse gas) x (GWP of that gas).

RESULTS

Electricity Use and Costs

Monthly and fiscal year totals for electricity use (kWh) and cost ($) are shown in Table 2-4. The total electricity usage for municipal wastewater treatment increased 48% from FY03 to FY08, from 3,722,321 to 5,499,286 kWh. In FY03, monthly electricity use averaged 310,193 kWh, with the lowest use of 264,461 kWh occurring in May, and highest use in June of 429,061 kWh. In FY08, monthly electricity use averaged 458,274 kWh, with lowest use of 412,242 kWh in February, and highest use of 502,826 kWh in November. Use is affected by the volume and composition of influent (untreated sewage) entering the plant as well as the type of wastewater treatment equipment used and its energy efficiency.

Table 2-4: Missoula Wastewater Treatment Electricity Use (kWh) and Cost ($)

	Electricity Use (kWh)				Electricity Cost ($)		
	FY 2003	FY 2008	% Change		FY 2003	FY 2008	% Change
July	341,485	479,358	40.4%		$5,138	$38,396	647%
August	272,831	444,903	63.1%		$4,727	$36,092	663%
September	301,688	441,219	46.3%		$5,757	$35,743	521%
October	294,581	448,591	52.3%		$5,740	$36,639	538%
November	316,260	502,826	59.0%		$5,159	$39,949	674%
December	272,310	472,267	73.4%		$4,814	$37,786	685%
January	290,079	482,735	66.4%		$5,660	$38,407	579%
February	317,648	412,242	29.8%		$5,622	$34,045	506%
March	285,330	447,108	56.7%		$5,715	$37,582	558%
April	336,587	412,876	22.7%		$5,927	$34,988	490%
May	264,461	474,800	79.5%		$5,821	$40,249	591%
June	429,061	480,361	12.0%		$6,508	$41,817	543%
Average	310,193	458,274	47.7%		$5,549	$37,641	578%
Total	3,722,321	5,499,286	47.7%		$66,587	$451,693	578%

Note*: Totals may not precisely add up due to rounding.*

Also shown in Table 2-4, the total electricity cost for municipal wastewater treatment operations in FY03 and FY08 were $66,587 and $451,693, respectively. This reflects a substantial increase of 578% in total electricity cost from FY03 to FY08 (as compared to a 48% increase in electricity use). See Appendix WW4 for electricity use and cost data for NorthWestern Energy for each fiscal year from FY03 through FY08.

Figure 2-1: Percentage of Total Electricity Use by WWT Plant and Lift Stations, FY03 and FY08

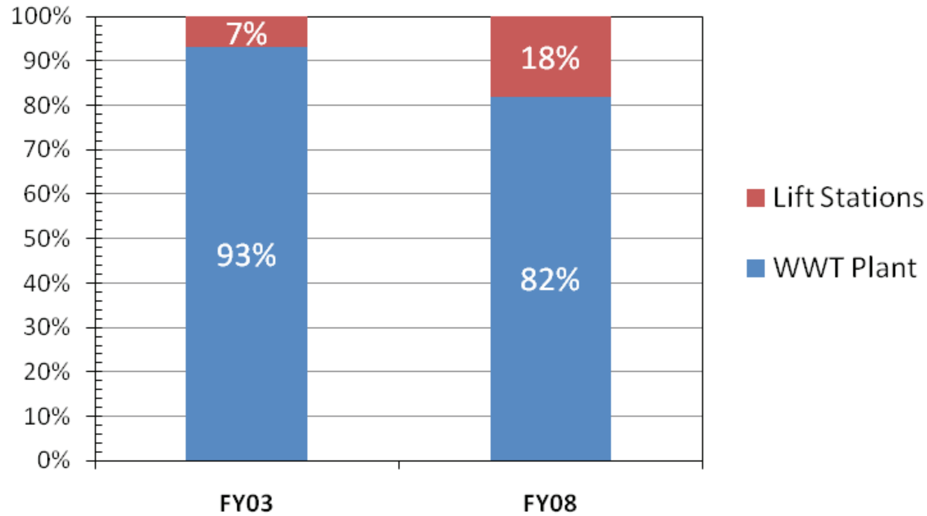


Figure 2-1 shows that the wastewater treatment plant itself uses a significantly greater percentage of total electricity than do the lift stations. In 2003, the plant used 93% and lift stations used 7% of the total electricity for wastewater system operations. This is not surprising given the array of energy-intensive equipment required at the plant for wastewater pumping, aeration, dewatering, and disinfection. However, lift station electricity use has been increasing rapidly, such that in 2008, the plant used 82%, and lift stations used 18% of total energy (see Figure 2-1). The increase in the proportion of electricity used by the lift station may be due to expansion of the service area, the addition of several lift stations, and the need to pump wastewater farther distances.

Natural Gas Use and Costs

Table 2-5 shows the monthly and total annual natural gas use (MMBTU) and costs ($) for municipal wastewater treatment in Missoula. In FY03 and FY08, total natural gas use was 4,390 and 3,606 MMBTU, respectively. This reflects an 18% decrease in total natural gas use from FY03 to FY08 (see Table 2-5). The total natural gas cost for municipal wastewater treatment operations in FY03 was $23,636 and in FY 08 was $45,108. This reflects a 91% increase in total natural gas cost from FY03 to FY08. In FY03, peak natural gas use and cost occurred during late-winter months from December to March, whereas in 2008, this peak occurred during autumn months from September to November.

Table 2-5: Missoula Wastewater Treatment Natural Gas (MMBTU) and Cost ($)

	Natural Gas Use (MMBTU)				Natural Gas Cost ($)		
	FY 2003	FY 2008	% Change		FY 2003	FY 2008	% Change
July	366	213	-41.8%		$1,970	$2,912	47.8%
August	145	310	114%		$1,352	$3,768	179%
September	144	398	176%		$1,349	$4,544	237%
October	191	864	352%		$1,483	$8,648	483%
November	281	571	103%		$1,741	$6,085	250%
December	499	275	-44.9%		$2,340	$3,590	53.4%
January	600	301	-49.8%		$2,635	$3,842	45.8%
February	636	199	-68.7%		$2,718	$2,946	8.39%
March	482	152	-68.5%		$2,291	$2,507	9.43%
April	435	132	-69.7%		$2,159	$2,341	8.43%
May	152	90	-40.8%		$1,365	$1,917	40.4%
June	459	99	-78.4%		$2,233	$2,009	-10.0%
Average	**366**	**300**	**-17.9%**		**$1,970**	**$3,759**	**90.8%**
Total	**4,390**	**3,606**	**-17.9%**		**$23,636**	**$45,108**	**90.8%**

Note: Totals may not precisely add up due to rounding.

Biogas Production, Use and Associated Emissions

The total volume of biogas produced by Missoula's WWTP increased 52% between FY03 and FY08, from 530,875m^3 to 808,872m^3 (see Table 2-6). Each year, approximately 49% of total biogas was used to produce boiler heat, approximately 49% was flared, and approximately 2% escaped as fugitive emissions.

Table 2-6 also shows the total biogas-related GHG emissions increased approximately 50% between FY03 to FY08, from 969 to 1,456 tons of CO_2e. In FY03 and FY08, biogas for the plant boiler and flared biogas each account for approximately 45% of total emissions, whereas fugitive biogas accounts for approximately 10% of total biogas-related greenhouse gas emissions. This difference between percentages of relative volume of biogas and tons of GHG emissions is due to the different global warming potential of each type of emission.

Table 2-6: Volume of Biogas (m^3) Produced and Greenhouse Gas Emissions (tons of CO_2e) from Biogas Combustion and Escaped (Fugitive) Biogas at Missoula's WWTP, FY03 and FY08

	Volume (m^3)		Emissions (tons of CO_2e)		% of Total Biogas-Related Emissions	
	FY 03	FY 08	FY 03	FY 08	FY 03	FY 08
Boiler CO2	104,052	158,539	183	279	18.9%	19.2%
Boiler CH4	156,077	237,808	250	381	25.8%	26.2%
Boiler Subtotal	260,129	396,347	433	661	44.7%	45.4%
Flared CO2	104,052	158,539	183	279	18.9%	19.2%
Flared CH4	156,077	237,808	250	381	25.8%	26.2%
Flared Subtotal	260,129	396,347	433	661	44.7%	45.4%
Boiler CO2	4,247	6,471	2.48	3.77	0.26%	0.26%
Boiler CH4	6,371	9,706	98.4	130	10.2%	8.93%
Fugitive Subtotal	10,618	16,177	100	134	10.3%	9.20%
Total	**530,875**	**808,872**	**969**	**1,456**	**100%**	**100%**

Note: Totals may not precisely add up due to rounding.

Total GHG Emissions (metric tons of CO_2e) of Missoula Wastewater Treatment Operations

As shown in Table 2-7, the total energy used for wastewater treatment in Missoula increased 36% between FY03 and FY08, from 22,711 to 30,944 MMBTU. In FY08, most of this energy (89%) was used at the WWT plant, with electricity being the largest contributor (50% of total energy use in FY08), followed by captured and burned biogas for the plant boiler (28%), and purchased natural gas (12%) for the boiler. The remainder of energy used in FY08 was electricity for the lift stations (11%).

Also shown in Table 2-7, the total GHG emissions from wastewater treatment in Missoula increased 51%, from 2,932 tons of CO_2e in FY03 to 4,422 tons of CO_2e in FY08. In FY08, electricity use for the plant accounted for 51% of total GHG emissions, captured and utilized biogas accounted for 15%, flared biogas for 15%, electricity for the lift stations for 11%, natural gas use for 4.6%, and fugitive biogas for 3.0% of total GHG emissions. Even though emissions associated with the lift stations are a relatively small proportion of total emissions from wastewater treatment in Missoula, these emissions have grown at a rapid rate, increasing 317% from FY03 to FY08.

It is important to note that, although capturing biogas to produce boiler heat is a significant and increasing contributor of GHG emissions, biogas recovery also reduces the amount of purchased natural gas and thereby results in lower net emissions than if it were flared and not used. Biogas would create an even greater amount of carbon dioxide equivalencies if released as fugitive emissions rather than being captured for boiler heat production.

Table 2-7: Total Energy Use (MMBTU) and Greenhouse Gas Emissions (tons of CO_2e) from Missoula Wastewater Treatment

	Total Energy Use (MMBTU)			Total Emissions (tons of CO_2e)		
	FY 03	FY 08	% Change	FY 03	FY08	% Change
Plant						
Electricity	11,818	15,388	30.2%	1,598	2,266	41.9%
Natural Gas	4,390	3,606	-17.8%	246	202	-17.8%
Boiler Biogas	5,620	8,574	52.6%	434	661	52.3%
Flared Biogas	---	---	---	434	661	52.3%
Fugitive Biogas	---	---	---	101	134	32.7%
Plant Subtotal	**21,828**	**27,568**	**26.3%**	**2,813**	**3,924**	**39.5%**
Lift Stations						
Electricity	883	3,376	282%	119	497	317%
Lift Stations Subtotal	**883**	**3,376**	**282%**	**119**	**497**	**317%**
Total	22,711	30,944	36.3%	2,932	4,422	50.8%

Notes: *Fugitive biogas is not combusted and thus does not produce energy (MMBTUs); flared biogas is combusted, but does not produce usable energy. See Methods for further details. Totals may not precisely add up due to rounding.*

CONCLUSIONS AND RECOMMENDATIONS

As the wastewater service area population has grown, the installation of more energy-intensive equipment at the plant as well as several additional lift stations were necessary to upgrade the wastewater treatment capacity for the City of Missoula. These developments resulted in substantial increases in energy use and related GHG emissions and even greater increases in energy costs. Increases in energy use appear to be somewhat consistent over time as shown in Appendix WW4. However, various opportunities may exist to curtail and even reverse these trends and achieve future emission reductions from the wastewater treatment sectors, which contributes over one-third (38%) of all municipal emissions quantified in this inventory. Several recommendations to reduce wastewater treatment-related emissions are described below. All will require proactive effort and initiative on the part of City leaders.

Consider Increasing the Quantity of Biogas Reclaimed for Heat Production

As previously mentioned, approximately 50% of the total biogas produced is used to produce boiler heat for the plant's operations. The biogas compressor system was installed in 1982, and an additional compressor is needed (Morrison Maierle 2008). More biogas is reclaimed for use in the winter than in the warmer spring and summer months, about 80% versus 20%, respectively. This is likely due to the fact that in colder months the wastewater influent arrives at the plant at a lower temperature than in the warmer months and thus requires more energy to raise it to the approximate required temperature of 35°C (S. Sullivan, personal communication, March 3, 2009). Since flared biogas is a significant contributor to

As the wastewater service area population has grown, the installation of more energy-intensive equipment at the plant as well as several additional lift stations … has resulted in substantial increases in energy use and related GHG emissions and even greater increases in energy costs.

municipal GHG emissions, we recommend increasing the quantity of biogas captured and used for heat production, particularly in spring and summer. As noted above, its use also offsets the need for purchased natural gas.

According to S. Sullivan (personal communication, March 3, 2009), electricity production from biogas at Missoula's WWTP is cost prohibitive at this time due to expensive infrastructure upgrades (i.e., electrical system, microturbine, Sterling engines) that would be required and would have an approximate 30-year payback period. However, as technology advancements are made or grant monies become available, this option should be revisited in the future with careful cost-benefit analysis. Perhaps if renewable energy credits could be sold for the capture and use of this resource, or energy efficiency grants obtained, the payback period may become more favorable. It is recommended that payback periods be re-evaluated as new incentives for capture become known.

Support Water Conservation Measures

If the quantity of wastewater to be treated is reduced, the energy required to treat this wastewater will also be reduced, leading to fewer wastewater-related GHG emissions. Thus, it is highly advisable for the City to develop and support community water conservation efforts. Water conservation, and hence wastewater reduction, may begin with City leadership in, for example, installing water-saving appliances in municipal buildings and parks and encouraging employees to consume water sparingly. Since the municipal wastewater treatment service spans many sectors of the community, conservation advocacy must also be extended to residential, commercial and industrial sectors. However, influent wastewater volume is not the only factor affecting emissions; because the volume of biosolids is another important factor, reduction of wastewater volume may have only limited greenhouse gas emissions reduction benefits.

Reclamation of wastewater (i.e., with greywater irrigation systems) for the purpose of reducing water consumption and influent amounts also presents a similar opportunity for the City. These systems are adaptable to local circumstances and are gaining wide support beyond the conservation community (i.e., residential property owners and the state regulators), but they currently need a county ordinance to set local performance standards to protect public health and safety.

Consider Wastewater Reclamation for Enhancement of Carbon Sinks

Wastewater, if treated properly, can be used to irrigate regional agricultural lands and tree plantation operations. Besides reducing the quantity of treated wastewater effluent discharged into the Clark Fork River, these projects support the growth of vegetative land cover, which serves as a carbon sink to help offset the greenhouse gas emissions other parts of the wastewater treatment system.

Missoula has been recently considering a project of this nature and Phase I of the feasibility study indicates that there are up to 1,500-acres of land near the WWTP that would be suitable for irrigated hybrid poplar production. If effluent were applied at the recommended irrigation rate for hybrid poplars, this acreage could treat up to 7.5 mgd of WWTP effluent that would consume a total of 195,000 lbs of nitrogen during the irrigation season lasting approximately 200 days (hybrid poplar report). Missoula's position as a wood-products industry center would facilitate marketing of the wood (saw logs) by the proposed project; other co-benefits to the City include carbon sequestration, stream bank stabilization, and wildlife habitat creation (Emergent Solutions 2008). This could also help protect surface water quality by reducing the effluent discharge to the Clark Fork River, and may be an important source of aquifer recharge.

In spring of 2008, Missoula began a pilot study of using wastewater to irrigate hybrid poplar trees. Only 1.6 acres of trees were being planted at the WWTP site approved by the Montana Department of Environmental Quality. This site will be used for the next few years and, at some point, a feasibility study and a cost-benefit analysis will be done based on the success of this 1.6-acre project. The project has brought approximately 350 trees to the plant and has the support of Mayor Engen as well as the 2007 Nobel Peace Prize winner and University of Montana professor Steve Running (Engen 2009a). This project presents an exciting opportunity for the City, and it is our recommendation that careful monitoring and analysis be carried out to ensure future expansion of the project gets full consideration along with the greenhouse gas emission reduction benefits.

Consider Energy Efficiency When Designing Future Upgrades

We recommend that a full energy audit be conducted at the WWTP facility to gain a better understanding of energy consumption and identify specific sources of greenhouse gas emissions. This would provide a more detailed analysis than was possible for this inventory, and would allow facility managers to prioritize emissions reduction efforts. Additionally, when future upgrade plans are designed or equipment/ infrastructure is replaced, we advise that the most energy efficient alternatives be given priority. This recommendation appears to be in accord with City Resolution #7241, which was passed on July 2, 2007, and requires the City to adopt "an energy efficiency and greenhouse gas reduction policy for municipal building projects, including new buildings, building additions and major remodels" (Missoula City Council 2007).

For example, facility upgrades to the aeration process at Missoula's WWTP may have the potential to significantly reduce electrical energy costs. Aeration provides dissolved oxygen (DO) to promote the growth of aerobic microorganisms and the conversion of waste material into inorganic by-products. The U.S. Environmental Protection Agency (EPA) estimates that the energy consumption associated with aeration in secondary treatment makes up from 30% to 60% of a wastewater facility's electrical energy costs. As a result, improvements made to the aeration process can have a significant impact on energy use (NorthWestern Energy 2008).

The City of Helena has had success with this kind of project. In June 2008, an energy study was developed through a collaborative effort between Helena's WWTP operators and NorthWestern Energy. The study indicated that it would be possible to save approximately 30% of the electricity used for aeration, and as a result, Helena replaced one of the existing axial turbine blowers with a positive displacement, rotary screw blower. In addition, to consistently match the dissolved oxygen demand, DO sensors were interfaced with the control system to accurately match blower speed (air flow) with the biological oxygen demand (BOD) loading rates. This project is expected to save the City of Helena 460,986 kWh annually and would have a simple payback with energy savings of 1.5 years (NorthWestern Energy 2008). Missoula also completed installation of high efficiency aeration blowers with interfaced DO sensors in

2004. The energy savings associated with this upgrade may be limited in comparison to Helena's because Missoula's biological nutrient removal system has higher dissolved oxygen requirements than Helena's conventional activated sludge plant in order to protect water quality in the Clark Fork River. Nevertheless, we recommend that potential for additional improvements to energy efficiency of the City's aeration and other equipment be evaluated.

Consider On-site Renewable Energy Production

There may be the potential for installation of solar panels, wind turbines, geothermal systems, and/or other means of production of renewable energy resources on site at the municipal-owned WWTP. The installation of photovoltaic cells at City Hall and Fire Station #4 may serve as examples during planning. On-site renewable energy production would, of course, offset the need for purchased energy and would allow the WWTP to be more self-sufficient and reduce long-term operational costs.

Develop an Efficient Energy Use Emissions Accounting System

All energy usage and cost data from each energy supply company should be entered, on a monthly basis at the minimum, into an electronic spreadsheet. This would also allow for easier analysis of trends in energy consumption and savings. Ideally, energy use could be metered and sorted by building, equipment, lift station, etc. This task may be assigned to those employees already responsible for budget/expense reporting to minimize error and maximize efficiency. Electricity and natural gas should be accounted for separately, since the global warming potential of energy sources and greenhouse gases varies. Account numbers, invoice and check numbers, and energy unit prices are also useful to include. We also recommend that universal "detailed account descriptions" be developed for each individual wastewater account billed to the City and used consistently throughout all records kept. This will help ensure inventory accuracy and avoid over- or under-calculation of emissions.

Additionally, since biogas is shown to contribute a significant portion of overall City greenhouse gas emissions, we strongly recommend that these emissions continue to be metered at the WWTP and evaluated regularly. Such accounting may be useful if renewable energy credits (RECs) can be sold someday for biogas production. Finally, it is recommended that the City investigate the financing of biogas capture through RECs or other creative means.

3. BUILDINGS

INTRODUCTION

The objectives of this section are to: (1) compare purchased electricity and natural gas costs for City buildings for FY 2003 and FY 2008; (2) analyze total energy use and greenhouse gas emissions for the base year (FY03) and target or comparison year (FY08); (3) determine if changes noted occurred consistently in the intervening years to discern any five-year trends in energy use and costs; (4) identify and compare buildings and building groups that are major contributors to municipal emissions; and (5) recommend emissions reduction strategies for municipal buildings.

The City of Missoula has already taken steps to increase the energy efficiency of City buildings, including passage of the Greenhouse Gas Reduction Policy in 2007. The City also completed energy audits on some City buildings and recently entered into an energy efficiency performance contract with Johnson Controls (Szpaller 2009a). It also has collaborated with the National Center for Appropriate Technology (NCAT) to conduct lighting upgrades at the City's central maintenance facility under a Northwestern Energy rebate program. Additional examples of energy efficiency measures implemented in recent years can be found in Appendix B1.

This section of this report provides analytic information to aid those in the City charged with furthering the energy efficiency and conservation goals for municipal buildings and reducing greenhouse gas emissions.

Using data obtained from NorthWestern Energy, we analyzed electricity (kWh) and natural gas (Dth) usage and costs for groups of municipal buildings for fiscal years 2003 and 2008. These building groups are shown in Table 3-1 and are characterized by their likeness in purpose. A total of nine building groups and 29 buildings were included in our analysis.

The *Headquarters* group denotes the administrative buildings of the City, which include City Hall (435 Ryman St.) and City Council Chambers (140 W. Pine St.) where the Missoula Redevelopment Agency (MRA) is also housed. Because the scope of this emissions inventory includes utility charges paid for directly by the City, the total energy used at City Hall and City Council Chambers was included. It is important to note that 40 county employees from the Office of Planning and Grants (OPG) who worked in City Hall in 2008 also contribute to this sector's energy use and emissions. Many of these employees work in part or whole through contract with the City of Missoula. The *Fire Stations* group includes the five individual stations, including one built between 2003 and 2008, and the McCormick Park boathouse. *Currents* includes the year-round aquatics recreation facility on Cregg Lane, and *Splash,* which operates only during the summer, includes several NorthWestern Energy accounts for the pumps, operation buildings, and bathhouse facilities for the complex. These aquatic recreation facilities are managed by the Parks Department and are represented as separate building groups because of their significant energy usage. *Parks* includes the Parks Department shop and administrative buildings on Hickory Street, in addition to associated accounts within some of the parks themselves. *Parking* includes the Central Park Structure, which also houses the Parking Commission administrative offices at 128 W. Main St., and the Bank Street Structure at 115 Bank St. The primary uses of energy by these parking structures include electricity for lighting, an elevator at 128 W. Main Street that operates only during weekday office hours, and natural gas used for heating offices. *Streets and Maintenance* includes the large facility at the City's Vehicle Maintenance Department and the parking structures beside it (Scott Street B), as well as the Streets Department administrative building (Scott Street A). *Cemetery* includes the office, shop, and chapel for the City Cemetery at 2000 Cemetery Road. *Other* includes the Missoula Museum of the Arts located at 335 N. Pattee St. (see Table 3-1).

Table 3-1: Municipal Building Groups Analyzed in Emissions Inventory

Group	NorthWestern Energy Service Address
Headquarters (HQ)	435 Ryman St
	140 W. Pine St
Fire Stations (FS)	625 E. Pine St
	247 Mount Ave
	1501 39th St
	3011 Latimer St
	6501 Lower Miller Creek
	McCormick Park-Fire Dept Boathouse
Currents Aquatic Park (*Currents*)	600 Cregg Lane
Splash Montana Waterpark (*Splash*)	3001 Bancroft # Pumps
	2100 South 10th St W # Splash
	1100 Sherwood St # Splash
Splash Montana Waterpark (*Splash*) Continued	6000 Linda Vista Blvd # Splash
	3001 Bancroft # Concsn
	1600 Ronald Ave # Splash
	3001 Bancroft # Bathhouse

Group	NorthWestern Energy Service Address
Parks Dept. (*Parks*)	McCormick Park
	100 Hickory St
	101 Hickory St #Shp/St
	Warming Shed
Parking Commission (*Parking*)	128 W. Main St # Garage
	115 Bank Street # Parking
Streets and Maintenance Dept. (*Streets*)	1305 Scott Street #A
	1305 Scott Street #B
	Scott and W Pine Sts Sandshed
City Cemetery (*Cemetery*)	2000 Cemetery Rd. # Chapel
	2000 Cemetery Rd. # Shop
	2000 Cemetery Rd. # Office
Other	335 N. Pattee St

Note: *Energy use and associated greenhouse gas emissions of administrative offices of the Missoula wastewater treatment plant were not included in this section of the report and can instead be found in the wastewater section.*

METHODS

After categorizing the nine building groups for a total of 29 structures and identifying 36 associated NorthWestern Energy accounts[2], electricity and natural gas usage and cost data were obtained from NorthWestern Energy. These data were verified against hard-copy billing records made available to us by the City Finance Department. In addition, data from FY 2004, FY 2005, FY 2006, and FY 2007 were obtained to determine if the changes observed from FY 2003 to FY 2008 represented a trend, i.e., if the changes occurred consistently over time. The data analysis methods used are described below.
A number of City and utility company contacts provided necessary data for the analyses we performed. These contacts and the information and assistance they provided are described below.

Contacts

Jack Stucky, the City's Vehicle Maintenance Superintendent, was very helpful in furnishing building data for the facilities on Scott Street, in addition to the *Headquarters* buildings (City Hall and Council Chambers). He also provided information about completed and planned building retrofits. Mary Kay Wedgewood of the City's Finance Department helped in describing the accounts associated with buildings for FY 2008 and also by providing access to the City's billing records, which were used to establish a list of account numbers for FY 2003 and FY 2008.
Vicki Judd of NorthWestern Energy facilitated our request for cost and energy use data for the energy accounts for all but one of the 29 buildings we inventoried.

2 This total does not include a NorthWestern Energy account billed to Zip Beverage for metered electricity used by the company and by the Scott Street B building of the Streets Department. We obtained electricity use and costs for the City portion of this account from Jack Stucky, the Vehicle Maintenance Superintendent.

Anne Guest, the City's Parking Commission Director; Laura Millin, Executive Director of the Missoula Art Museum; Jason Diehl, the City's Assistant Fire Chief; and Mike Painter, the City's Fire Chief, were all instrumental in checking physical buildings against account descriptions and providing specific information.

Melissa Bache, the City's Human Resources Analyst, assisted with providing full-time-equivalency data for city employees, which we intended to use to quantify greenhouse gas emissions per capita. Brentt Ramharter, the City's Finance Department Director, provided square footage data for the *Headquarters, Fire Stations, Streets and Maintenance,* and *Cemetery* building groups. No other building's square footage data were available except the *Missoula Art Museum*, the data for which were provided by Laura Millin.

Ginny Merriam, the City's Public Information/Communication's Officer, was most helpful in identifying contacts and in directly responding to and facilitating our requests for information.

A number of additional NorthWestern Energy accounts billed to the Parks Department, primarily electricity for irrigation, are tabulated in the "Other Energy Uses and Emissions Sources" chapter.

Data Analysis

We examined energy use and costs in FY 2003 and FY 2008 and change over time by building group. For each NorthWestern Energy (NWE) account number associated with each building and building group, we compiled purchased natural gas (Dth) and electricity (kWh) use data. We entered these data into the Climate Action Climate Planning (CACP) software to obtain total energy use (MMBTU) and greenhouse gas emissions (metric tons of CO_2e). This allowed us to identify the relative contribution by each building group to this sector's total energy use and emissions for both years and to calculate changes from FY03 to FY08. The raw electricity and natural gas usage and cost data for each NWE account are shown in Appendices B2 and B3.

Several building accounts were added in the interim between our base fiscal year of 2003 and target fiscal year of 2008. Of particular importance are the *Currents* and *Splash* facilities. Thus, to facilitate analysis of energy use, costs, and emissions for the two fiscal years, separate subtotals were calculated that exclude *Currents* and *Splash*, allowing for analysis using a somewhat consistent set of buildings.[3] Although an effort was made to standardize building energy use, costs and emissions by square foot and by number of employees, incomplete data and the wide variety of uses of City buildings precluded the meaningful use of these metrics, which are not reported.

We did not account for the number of "heating and cooling days" in FY03 and FY08, which, along with prolonged temperature extremes, can dramatically influence building energy use. However, we did consider statewide mean monthly temperate data from the National Oceanic and Atmospheric Administration (NOAA)[4] for each fiscal year, which we compared to monthly averages for the last 30 years. To help with the interpretation of energy use data, we used these comparisons as a rough indicator of the relative summer cooling and winter heating demands in FY03 and FY08.

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3 Subtotals without *Splash* and *Currents* nevertheless reflect the addition of City Council Chambers, the Missoula Redevelopment Agency office and Fire Station #5 between FY03 and FY08.

4 See National Climatic Data Center: http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html and description at http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html .

Finally, as a result of City staff comments on a draft of this section, we also examined energy use and costs during the interim years, i.e., for FY04, FY05, FY06 and FY07, to determine if the changes noted to have occurred from FY03 to FY08 were part of a consistent trend of increasing energy use and even greater increases in costs.

RESULTS

Electricity Use and Costs

Table 3-2 shows electricity use (kWh) and cost ($) by building group for FY03 and FY08. In FY03, total electricity consumption from all buildings was 1,831,169 kWh. *Headquarters, Parking,* and *Fire Stations* were the largest electricity consumers in FY03, accounting for 49%, 23% and 14% of total consumption, respectively. In FY08, total electricity consumption from all buildings was 3,361,649 kWh. This represents an 84% increase from FY03, much of which can be attributed to the addition of *Currents* and *Splash*. However, excluding *Currents and Splash*, electricity use still increased 23% in those five years (see subtotal on Table 3-2). *Parks* and *Parking* were the only building group that did not increase electricity use from FY03 to FY08.

Also shown in Table 3-2, electricity costs increased from $47,228 in FY03 to $288,768 in FY08, a dramatic 511% increase. Large electricity cost increases can be noted for all building groups from 2003 to 2008, particularly *Headquarters* (522%), *Fire Stations* (406%), *Other* (279%), and *Parking* (209%). Although electricity use increases generally were a part of these electricity cost increases, significant rate increases also occurred such that the total electricity costs paid for City of Missoula buildings in FY03 of $0.026/kWh increased 230% in FY08 to $0.086/kWh.

Table 3-2: Electricity Use (kWh) and Cost ($) by Building Group

Building Group	Electricity Use (kWh)			Electricity Cost ($)		
	FY03	FY08	% Change	FY03	FY08	% Change
HQ	894,320	1,156,520	29.3%	$15,724	$97,737	522%
Fire Sta.	264,482	360,332	36.2%	$6,295	$31,878	406%
Currents	0	748,160	n/a	$0	$61,361	n/a
Splash	0	365,671	n/a	$0	$33,250	n/a
Parks	103,855	71,264	-31.4%	$3,345	$6,850	105%
Parking	420,021	395,270	-5.89%	$10,220	$31,579	209%
Streets	58,049	63,597	9.56%	$4,619	$6,309	36.6%
Cemetery	37,762	43,875	16.2%	$3,007	$4,569	51.9%
Other	52,680	156,960	198%	$4,020	$15,237	279%
Subtotal*	**1,831,169**	**2,247,818**	**22.8%**	**$47,228**	**$194,158**	**311%**
Total	**1,831,169**	**3,361,649**	**83.6%**	**$47,228**	**$288,768**	**511%**

** Without Currents Aquatic Park and Splash Montana Waterpark*
(Note: Totals may not add up exactly due to rounding.)

In FY08, *Headquarters* was the largest consumer of electricity, accounting for 34% of total electricity use in all municipal buildings. This increased share was in part due to the addition of the City Council Chambers and Missoula Redevelopment Agency to this building group. City Hall, in particular, houses many employees and types of electronic equipment and appliances; it has not yet received many of the energy conservation and efficiency upgrades that the City would like to implement. In order to meet population growth and public demand for City services, the number of full-time equivalent employees in City Hall increased 25% (from 150 to 188 FTE) from 2003 to 2008; electricity use in City Hall increased 23% during that time.

The above factors have contributed to the relatively high percentage increases in electricity consumption. Because energy efficiency upgrades were made in many different years, it is difficult to say how they influenced the increases in energy use without conducting monthly and yearly analyses.[5]

When combined, *Currents* and *Splash* account for 33% of total electricity use in FY08, despite the seasonal use of *Splash*. *Parking* used 12% of total electricity in 2008, much of which is used for lighting that is important to public safety. *Parks* used only 2% of total electricity in 2008.[6]

5 Energy efficiency upgrades to buildings that took place between FY03 and FY08 are likely to have reduced the increase in energy use compared to what it would have been without them. However, upgrades that were completed before FY03 would have reduced energy consumption in FY03, thereby making the percent increase from FY03 to FY08 larger than they would have been otherwise. Some upgrades listed in Appendix B1 were either completed after FY08 or are still underway and thus have had no effect on the results presented here.

6 Note that Splash and Currents are operated by the Parks Department but were separately tabulated to enable an analysis of roughly a consistent set of buildings over time.

Natural Gas Use and Costs

Table 3-3 shows that natural gas use measured in dekatherms (Dth) and cost ($) displays a similar change to that of electricity from FY03 to FY08. During this period, total natural gas use increased 160%, from 9,886 Dth to 25,664 Dth. Total natural gas costs increased 440%, from $55,367 to $299,068. The increase in costs was due to both increased use and a higher purchase rate. Total natural gas costs paid for City of Missoula buildings in FY03 of $5.60/Dth increased 108% in FY08 to $11.65/Dth.

Table 3-3: Natural Gas Use (Dth) and Cost ($) by Building Group

Building Group	Natural Gas Use (Dth)			Natural Gas Cost ($)		
	FY03	FY08	% Change	FY03	FY08	% Change
HQ	1,905	3,007	57.9%	$10,090	$34,402	241%
Fire Sta.	2,472	2,370	-4.13%	$14,567	$28,279	94.1%
Currents	0	7,562	n/a	$0	$84,666	n/a
Splash	0	5,605	n/a	$0	$69,148	n/a
Parks	1,059	1,241	17.2%	$6,368	$14,706	131%
Parking	238	338	41.7%	$1,457	$3,967	172%
Streets	3,500	4,093	16.9%	$18,501	$46,679	152%
Cemetery	318	431	35.5%	$2,035	$5,203	156%
Other	394	1,016	158%	$2,349	$12,019	412%
Subtotal*	**9,886**	**12,496**	**26.4%**	**$55,367**	**$145,255**	**162%**
Total	**9,886**	**25,664**	**160%**	**$55,367**	**$299,068**	**440%**

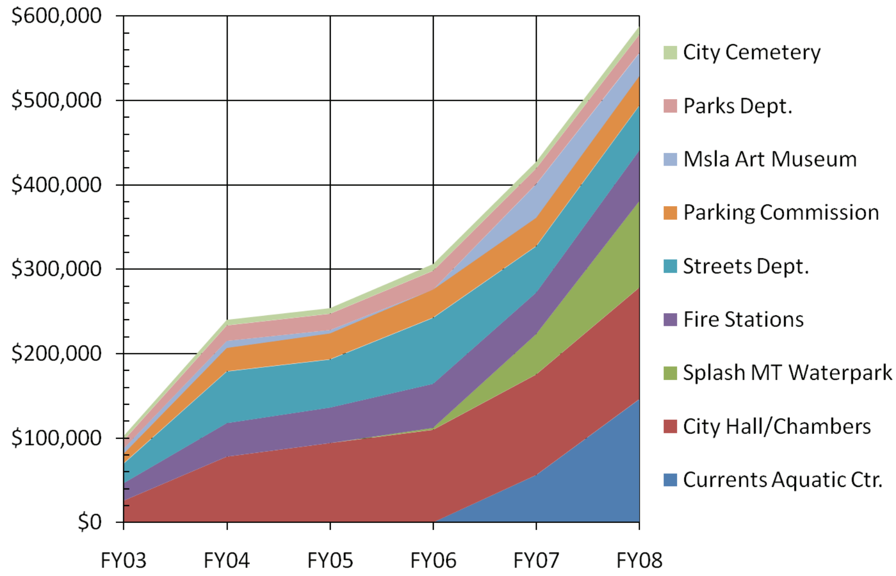
** Without Currents and Splash*
(Note: Totals may not add up exactly due to rounding.)

Natural gas use increased for all building groups except *Fire Stations*, which saw a decrease of about 4%. This decrease appears to be due to a closure of Fire Station #2 (247 Mount Ave.) for reconstruction for 11 months of FY08. Table 3-3 also shows that buildings other than *Currents and Splash* saw a 26% increase in natural gas use and a 162% increase in natural gas costs from FY03 to FY08. In FY08, *Currents and Splash* accounted for over half (51%) of the total natural gas use and costs. *Streets*, *Headquarters* and *Fire Stations* were also relatively large consumers of natural gas in FY08, at 16%, 12%, and 9.2% respectively. Of total natural gas use in FY03, *Streets* accounted for 35%, *Fire Stations* for 25%, *Headquarters* for 19%, and *Parks* for 11%.

Total NorthWestern Energy Utility Costs

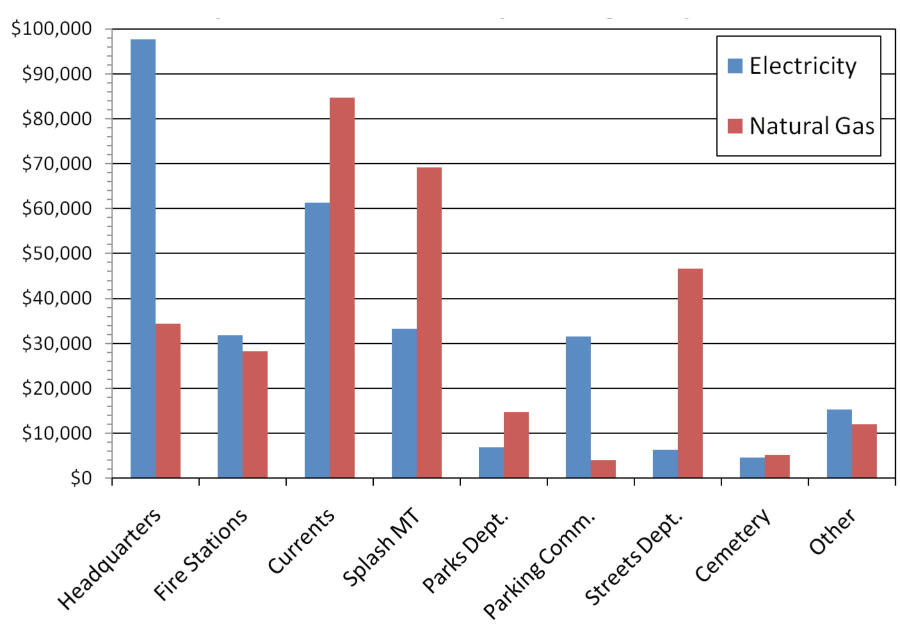
The total purchased energy costs of electricity and natural gas for municipal buildings increased 473%, from $102,595 in FY03 to $587,837 in FY08 (see Figure 3-1). In FY08 *Currents* and *Splash* accounted for $236,817 of the total energy cost. Figure 3-1 shows that the trend of continually increasing costs began well before the addition of the aquatics facilities but accelerated subsequently, although a sharp increase in costs occurred from FY03 to FY04. Recent increases in energy costs have been moderated somewhat by a decrease in costs for the Street Maintenance Division.

Figure 3-1: Total Energy (Electricity and Natural Gas) Cost for City of Missoula Buildings, FY03 and FY08



In FY03 and FY08, purchased electricity and natural gas accounted for roughly equal shares of the total energy costs for City buildings ($288,768 and $299,068, respectively, in FY08). However, for most building groups, either electricity or natural gas comprised a relatively greater portion of total energy costs. For example, as shown in Figure 3-2, purchased electricity in FY08 made up a much greater portion of total energy costs than natural gas ($97,737 and $34,402, respectively), whereas natural gas made up the lion's share of total energy costs ($46,679 for natural gas vs. $6,309 for electricity). Thus, strategies to reduce energy costs should be developed on an individual building basis and in consideration of the distribution of energy costs between electricity and natural gas.

Figure 3-2: Electricity & Natural Gas Costs by Building Group, FY 2008



Total Energy Use

Our analysis of total energy use combines energy use associated with purchased electricity (kWh) and natural gas (Dth) and reports total energy use in MMBTUs. The total energy used increased 130% from FY03 to FY08, from 16,136 MMBTU to 37,136 MMBTU. Energy use from purchased electricity and natural gas increased 100% and 160%, respectively, during this five-year period.

Total energy use without *Currents* and *Splash* increased 25%. For FY08, *Currents* and *Splash* were among the largest overall energy users and consumed 10,115 and 6,853 MMBTUs, respectively (see Table 3-4). These two facilities account for 46% of the total building sector energy use, as shown in relative proportion with other building groups in Figure 3-3. The next largest energy users in FY08 were: *Headquarters*, at 6,954 MMBTU, or 19% of the total for all city buildings; *Streets* at 4,310 MMBTU or 12%; and *Fire Stations*, at 3,600 MMBTU or 9.7%. These three building groups accounted for nearly 40% of all building energy use in FY08 (see Figure 3-3, and Appendices B2 and B3 for detailed energy use data).

All building groups showed increases in energy use from FY03 to FY08, though increases for *Parking* and *Parks* were quite small. The largest percent increase in energy use from FY03 to FY08 was experienced by the *Other* building group, at 170%. This increase is due to an addition to and remodeling of the Missoula Art Museum conducted between 2004 and 2006. Electricity use for this group nearly doubled from FY03 to FY08, while natural gas use increased 158% (see Table 3-2and Table 3-3 above).

Headquarters, *Cemetery*, and *Streets* also experienced significant increases in energy use of 40%, 30%, and 17%, respectively. Increases for Headquarters were only partially due to the addition of City Council Chambers to this building group in 2004. Energy use in City Hall, which uses about 16 times as much energy as Council Chambers does, increased 35% from FY03 to FY08, or an average of 7% per year.

Fire Stations experienced a relatively small increase in energy use of 6.7% even though Fire Station #5 was newly constructed between FY03 and FY08 (and opened in early 2007). This modest increase is partly a result of Fire Station #2 undergoing reconstruction and Fire Station #3 being remodeled in FY08. As a result, Fire Stations #2 and #3 had no energy use billed to the City of Missoula for 11 months and two months, respectively in FY08. Had these buildings been in use for longer in FY08, the energy increase from FY03 to FY08 would have been much greater. In fact, since the rebuilding of FS #2 and remodeling of FS #3, *Fire Stations* overall energy use has increased significantly, though a large solar panel installation is currently planned (Szpaller 2009b).[7]

Table 3-4: Total Energy Use (MMBTU) by Building Group, FY03 and FY08

Building Group	FY03	FY08	% Change
Headquarters	4,957	6,954	40.3%
Fire Stations	3,375	3,600	6.67%
Currents Aquatics	0	10,115	n/a
Splash MT	0	6,853	n/a
Parks Dept.	1,413	1,484	5.00%
Parking Comm.	1,672	1,687	0.89%

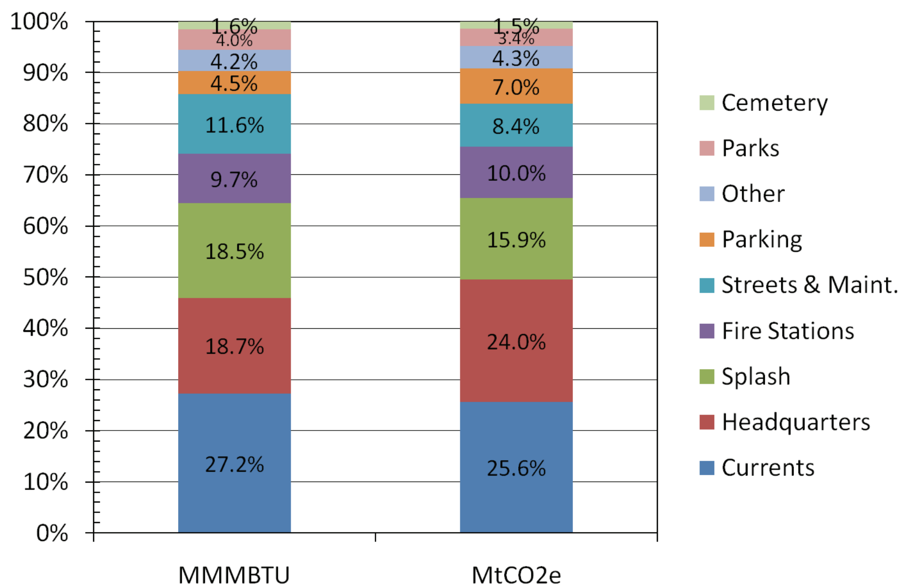
7 These changes occurred in FY09, which ended June 30, 2009.

Building Group	FY03	FY08	% Change
Streets & Maint.	3,698	4,310	16.5%
City Cemetery	447	581	29.9%
Other	574	1,552	170%
Subtotal*	**16,136**	**20,168**	**25.0%**
Total	**16,136**	**37,136**	**130%**

** Without Currents Aquatic Center and Splash Montana Waterpark*

Indeed, a more energy efficient building may not result in net energy savings if the new building is significantly larger than the one it replaces. Nevertheless, energy efficiency retrofits and upgrades to existing buildings can help to offset increases in overall energy use from building expansions and additions. One such upgrade was undertaken to FS #4 where photovoltaic cells (solar panels) were installed.[8] Electricity produced by these solar panels is not monitored or recorded. As a result, we did not quantify electricity cost savings or credits through net metering.

Figure 3-3: Relative Proportion of Energy Use (MMBTU) and CO2 Emissions (Tons of CO2e), FY 2008



The large increases in energy use for the *Headquarters*, *Streets and Maintenance*, and *Cemetery* building groups shown in Table 3-4 are likely due to a variety of factors, such as population growth and concomitant increases in the City workforce and services. However, from 2003 to 2008 the population of the City increased only 11%. Thus, increases in energy use without including *Currents* and *Splash* outpaced population growth by more than twofold.

8 Photovoltaic cells were also added to City Hall and have a display which can be read at any time but are also unmetered, and thus energy generated by them were excluded from this inventory. The specifications were not obtained for this report; neither was information about the operations and service records of the system.

Greater heating and cooling demand in FY08 than in FY03 is another possible explanation for the energy use increases. We investigated this possibility by examining mean temperatures in Missoula for FY03 and FY08. These findings are shown in Appendices B-4 and B-5 and indicate that differences in weather may account for some of the increase in energy use for buildings. A Commercial Buildings Energy Consumption Survey conducted by the U.S. Energy Information Industry in 2003 reported that heating, cooling, and ventilation account for 44% of government building annual energy use. Lighting, water heating and office equipment account for 21%, 17% and 6% of annual energy use, respectively, or 44% of energy use in total (U.S. EPA 2009b). Thus, differences in weather may account for some of the increase in energy use for buildings. However, these increases would have been much greater without various energy conservation and efficiency improvements made during this period (see below and Appendix B1).

Figure 3-4: NorthWestern Energy (NWE) Electricity Use (kWh) for City of Missoula Buildings, FY03 to FY08

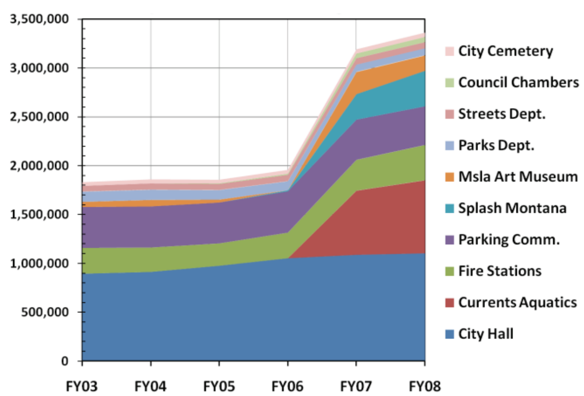
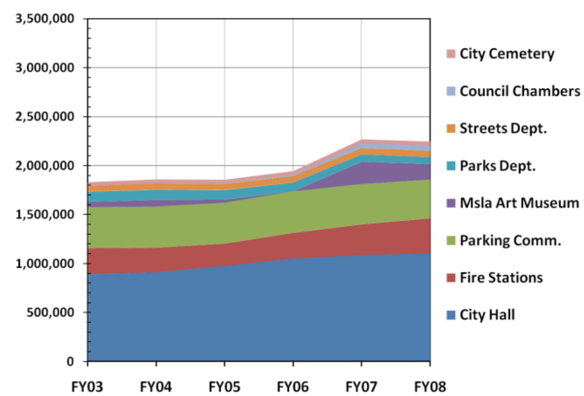


Figure 3-5: NorthWestern Energy (NWE) Electricity Use (kWh) for City of Missoula Buildings without Currents & Splash, FY03 to FY08



It is important to recognize that these increases are part of a consistent pattern of increasing energy use for municipal buildings. Figure 3-4 and Figure 3-5 show increases in purchased electricity for municipal buildings from FY03 to FY08. Figure 3-4 shows the dramatic increase in electricity use created by the Currents Aquatic Center and Splash Montana Waterpark. Figure 3-5 shows that electricity use of other building groups increased during this five-year period, due to the remodel of the Missoula Art Museum and an increase in electricity use from City Hall and Fire Stations.

Figure 3-6 and Figure 3-7 show a pattern of consistent increases in natural gas use over time, though a notable decline in natural gas use can be seen from FY07 to FY08. This decrease is the result of: (1) energy efficiency and conservation efforts by the Street Maintenance Division at the Scott Street vehicle maintenance building; and (2) a decrease in use by the Missoula Art Museum. Natural gas use by City Hall, nevertheless, continually increased.

Figure 3-6: NorthWestern Energy (NWE) Natural Gas Use (Dth) for City of Missoula Buildings, FY03 to FY08

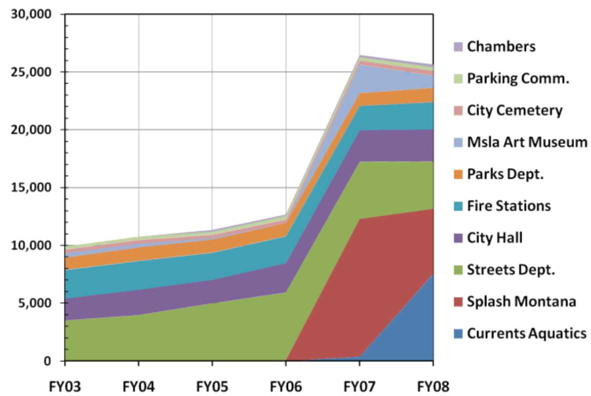
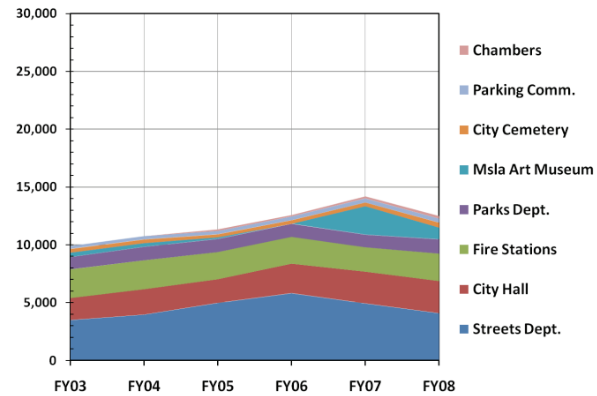


Figure 3-7: NorthWestern Energy (NWE) Natural Gas Use (Dth) for City of Missoula Buildings without Currents & Splash, FY03 to FY08



One can conclude that even though energy use in buildings may be sensitive to weather, energy use has consistently increased over time. Furthermore, this analysis shows that proactive efforts to reduce energy use in buildings can make a discernable difference. These conclusions suggest that further energy efficiency and energy conservation efforts, particularly in buildings with the greatest energy use, will allow the recent encouraging trends to continue and perhaps accelerate. This may be necessary if any future emission reduction targets are to be met, given the large portion that buildings contribute to overall greenhouse gas emissions. Behavioral changes of city employees and building energy use policies can offer additional energy savings. However, the addition of new buildings in the future could easily prevent overall energy use reduction from municipal buildings.

GREENHOUSE GAS EMISSIONS

Table 3-5 shows the total greenhouse gas emissions in metric tons of carbon dioxide equivalencies (tons of CO_2e) from each building group in FY03 and FY08. Total emissions from the building sector increased 124%, from 1,399 tons of CO_2e in FY03 to 3,128 tons of CO_2e in FY08, i.e., from 3.1 million pounds to 6.9 million pounds. Without *Currents* and *Splash*, this increase was 31% to 1,830 tons of CO_2e. Between FY03 and FY08, this sector experienced an average annual increase in emissions of nearly 25%; without *Currents* and *Splash*, this annual increase would be 6.2%.

To put these increases into perspective, one can consider that climate scientists have recommended annual reductions of at least 2% in order to reduce carbon dioxide level currently at nearly 390 parts per million (ppm) to 350 ppm. Such a reduction is recommended to prevent severe adverse impacts of global warming and keep carbon dioxide levels from exceeding the thresholds within which natural systems can continue to support human societies without severe disruptions to agriculture and settlement patterns (Hansen Sato, Kharecha et al. 200; Rockström, Steffen, Noone et al. 2009; World Wildlife Fund 2009).
In FY03, the largest contributors to buildings' emissions were *Headquarters*, at 519 tons of CO_2e or 37% of total emissions; *Fire Stations*, at 261 tons of CO_2e or 19%; *Street Maintenance*, at 223 tons of CO_2e or 16%; and *Parking*, at 207 tons of CO_2e or 15% (see Table 3-5). Greenhouse gas emissions increases followed a similar pattern to those of total energy use (MMBTUs) (see Table 3-4).

In 2008, the largest contributors to emissions were *Currents*, at 800 tons of CO_2e (1.8 million pounds of CO_2) or 26%; *Headquarters*, at 750 tons of CO_2e or 24%; *Splash*, at 498 tons of CO_2e or 16%; and *Fire Stations*, at 314 tons of CO_2e or 10% (see Table 3-5 and Figure 3-1).

Emissions from *Headquarters* increased 44% for FY03 to FY08. This is only partially due to the addition of City Council Chambers to the building group in the latter months of 2007. Emissions for City Hall (435 Ryman St.) account for nearly 20 times more than those of City Council Chambers and increased 37% in FY03 to in FY08. A similar increase of 37% was seen in City Hall's energy use (MMBTU) during this five-year period. The number of full-time equivalent City employees working at City Hall increased 25%, likely contributing to the overall increase energy use and resulting emissions from *Headquarters*.

Table 3-5: Greenhouse Gas Emissions (tons of CO2e) and % Change by Building Group, FY03 and FY08

	FY03		FY08		FY03-FY08 % Change
Building Group	Tons of CO_2e	% of Total	Tons of CO_2e	% of Total	
Headquarters	519	37.1%	750	24.0%	44.4%
Fire Stations	261	18.6%	314	10.0%	20.5%
Currents	0	0.0%	800	25.6%	n/a
Splash MT	0	0.0%	498	15.9%	n/a
Parks Dept.	107	7.67%	105	3.37%	-1.77%
Parking Comm.	207	14.8%	218	6.96%	5.06%
Street Maint.	223	15.9%	261	8.36%	17.2%
Cemetery	35	2.52%	46	1.48%	31.1%
Other	46	3.32%	136	4.34%	193%
Subtotal*	**1,399**	**100%**	**1,830**	**58.5%**	**30.8%**
Total	**1,399**	**100%**	**3,128**	**100%**	**124%**

** Without Currents and Splash*

It is important to note that electricity consumption emits more greenhouse gas equivalencies (tons of CO_2e) per unit of energy consumed than does natural gas. Thus, buildings that use relatively large amounts of electricity will have a larger carbon footprint, even if the total energy usage is the same. This helps to explain why *Headquarters*, which consumed 19% of total energy in 2008 (6,954 MMBTUs) accounted for 24% of CO_2 equivalent emissions (750 metric tons of CO_2e or 1.7 million pounds of CO_2), the second largest amount. Indeed, the energy portfolio of purchased power has a significant impact on these proportions of MMBTU to equivalent CO_2 emissions. This is one reason why the generation and purchase of renewable energy can significantly help to lower emissions.

CONCLUSIONS AND RECOMMENDATIONS

Purchased energy use for City buildings has increased rapidly from 2003 to 2008: 84% for electricity and 160% for natural gas (see Table 3-2 and Table 3-3). From FY03 to FY08, greenhouse gas emissions from City buildings increased 124% to 3,128 tons of CO2e or 6.90 million pounds of carbon dioxide. That is the equivalent weight of over 2,000 Subaru Outback wagons, which stretched bumped-to-bumper, would reach six miles from downtown Missoula to the Missoula International Airport.9 In 2008, these emissions represented 27% of total muncipal emissions accounted for in this inventroy, up from 18% of the total in FY03. Purchased energy for buildings represent 55% of purchased energy from NorthWestern Energy and other utilities.

From FY03 to FY08, greenhouse gas emissions from City buildings increased 124% to… 6.90 million pounds of carbon dioxide. That is the equivalent weight of over 2,000 Subaru Outback wagons, which stretched bumped-to-bumper, would reach six miles from downtown Missoula to the Missoula International Airport.

Costs of purchased energy for munipical buildings inceased by 473% from FY03 to FY08. In fact, total purchased energy costs in FY 2008 were nearly $600,000, about half for electricity and half for natural gas. While some of the increase in costs appears to be due to relatively low winter heatintg demand in FY03 and high summer cooling demand in FY08, energy costs exhibited a consistent upward trend each year during this period; and though ultity rate increases have also contributed to this trend, increases in energy use have as well.

The increase in energy costs (see Figure 3-1) does not appear to be sustainable if energy use continues to increase, unless ever-increasing amounts of public funds are used for energy-thirsty City buildings in Missoula. Annual average increase in emisssions of 25% creates a considerable challenge to leveling off and reducing emissions and becoming carbon neutral, i.e., having no net greenhouse gas emissions.

Although the addition of Currents and Splash accounts for a large amount of recent increases, energy use, energy costs and associated emissions have increased in several other building groups. Excluding Currents and Splash, the rate of increase in energy use (25%) and associated greenhouse gas emissions (31%) from FY03 to FY08 exceeds the population growth of Missoula (11%), but is in line with the 25% growth in the number of City employees during the same period. Recent additions of solar panels on City Hall in 2006 and Fire Station #4 may have helped reduce the amount of purchased energy consumed. In recent years, energy use and cost savings also have likely resulted from energy efficiency upgrades to City Hall and the Vehicle Maintenance Building on Scott Street (see Appendix B1). Although these savings are evident for the Vehicle Maintenance bulding, they are masked by overall energy use increases for City Hall.

9 Based on vehicle weight of 3,402 pounds and length of 15.75 feet for automatic transmission 2009 Subaru Outback Wagon 2.5. Vehicle specifications obtained from http://www.subaru.com/content/downloads/pdf/brochures/2009_outback_specs.pdf .

Additional steps currently planned or underway, such as lighting upgrades to the Scott Steet maintenance building and energy efficiency performance contracting, will result in additional energy use, costs and emission reductions in the near future. Resolution #7241, which supports building energy efficiency, recently provided policy and guidance for implementing building-related energy efficiency and conservation measures. All new construction or major remodeling now must undergo energy efficiency analyses. It is noteworthy that Resolution #7241 was not in place prior to the construction of the aquatic recreation facilities.

Some aspects to consider for any building project include site orientation, lighting, landscaping, insulation, windows, building design, solar panel locations, and heating-cooling-and-ventilation (HVAC) systems. Geothermal and groundwater heat exchange and cooling systems such as those used at the University of Montana, which have contributed substantially to University energy savings, may offer benefits as well.

Various steps already implemented, such as those under Resolution #7241 and the 2004 Greenhouse Gas/Energy Efficiency Plan, do not yet appear to have a significant effect on energy use and associated greenhouse gas emissions. A few Capital Improvement Projects (CIPs) that incorporate energy performance contracts have been funded in recent years (see Appendix B1). Nevertheless, additional energy efficiency and conservation measures are needed in order to stabilize or reduce greenhouse gas emissions associated with City buildings. This is particularly true for those buildings showing larger percent increases from FY03 to FY08. While an important and laudible step in the right direction, Resolution #7241 does not constitute a comprehensive green buildings policy. Although several pro-active efforts are underway, a comprehensive strategy for energy-efficient City buildings currently is lacking.

To be effective, additional targeted efforts also will need to be devoted to buildings with relatively large amounts of energy usage, particularly those in the *Headquarters*, *Streets and Maintenance*, and *Fire Stations* building groups. *Parks* and *Parking* are the second tier of energy users/carbon emitters. In addition, special consideration must be given for *Currents* and *Splash*, which used nearly half of all building-related energy in FY08.

We believe that the City would benefit from delegating energy use and emissions inventory duties to one person who is familiar with all City sectors and who can monitor emission in the future.

Our analyses show that any emissions reduction strategy for City buildings that hopes to achieve success will need to consider the distribtution of electrity and natural gas use. Once emission reduction targets are established, cost-effective decisions and investments can be made. Purchase of renewable energy or carbon offsets , even City-led carbon sequestration projects, may be effective and feasible strategies in the future.

While beyond the scope of this report, the use of various analytic tools for this purpose may help inform these decisions. Reliable baseline data as presented in this report can be instrumental in identifying and prioritizing buildings for which energy efficiency efforts will be the most effective and cost-efficient, for example, for projects using the City's Energy Efficiency and Conservation Block Grant.

Also, we found that inventorying energy use to provide baseline data for measuring future progess is a challenging undertaking, particularly due to the lack of a system for compiling and reporting energy use and cost data among City sectors and the wide variety of individuals responsible for maintaining energy billing records. We believe that the City would benefit from delegating energy use and emissions inventory duties to one person who is familiar with all City sectors and who can monitor emissions in the future. The development of various metrics (or standard units) and indices for monitoring and evaluating energy use and efficiency (e.g., normalizing by square foot of building space, weather, and number of City employee) may also assist with providing meaningful context for evaluating change over time.

Recently, the Missoula County Office of Planning and Grants (OPG) hired a new position for the planning and administration of its federal Energy Efficiency Conservation Block Grant and the expansion of programs to support energy efficiency and conservation for both City and County of Missoula. This emissions inventory can assist this new employee in establishing baseline energy performance for specific buildings, recommend performance goals and benchmarks, develop strategies to achieve them, and monitor progress once performance goals are set by the Mayor or City Council.

Achieving effective energy conservation and efficiency for buildings requires a systematic portfolio-wide approach for new and existing buildings and will work best within an established action plan that includes specific energy use and emission goals within a tracking and reporting system (U.S. EPA 2009b). The EPA *ENERGY STAR Guidelines for Energy Management*[10] suggest creating a multi-departmental energy management team rather than having one or two people shouldering responsibility for planning, implementation and evaluation.

Several specific recommendations for improving and monitoring energy efficiency of the Buildings sector are described below.

Continue to Assess and Monitor Building Performance and Set Goals and Benchmarks

According to Missoula's 2004 Greenhouse Gas/Energy Conservation Plan, where appropriate, City buildings should be audited and the recommendations from that audit should be implemented (Missoula GHGECT 2004). As of May 28, 2008, the following buildings have had energy inspections:

- Fire Stations # 1, 3, and 4 (625 E. Pine St., 1501 39th St., and 3011 Latimer St.)
- City Hall (435 Ryman St.)
- City Council Chambers and Missoula Redevelopment Agency (140 W. Pine St.)
- Streets and Maintenance Department Scott St. B building (1305 Scott St.)
- Cemetery Office building (2000 Cemetery Road)

Audits of remaining buildings can identify specific inefficient or wasteful uses of energy and opportunities for energy savings and emission reductions.[11] Buildings that are the largest energy users should be considered for detailed energy audits.

We recommend that the City also obtain and utilize software designed to assess baseline energy

10 See http://www.energystar.gov/index.cfm?c=guidelines.guidelines_index.

11 It is recommended that these audits be accomplished separately from private performance contracting (Stucky 2008). Having performance contracts audits verified by a third party would be another option. This may prove to be a less expensive alternative for the City than having independent contractors conduct and review the energy audits and would keep the established process of performance contracting intact.

performance of buildings, set realistic performance benchmarks, and monitor progress. Benchmarking allows facilities and energy managers to compare the energy performance of specific buildings to similar ones across the country. EnergyCAP is one such software that could serve as a useful tool for planning energy use and emission reductions strategies. The EnergyCAP software's accounting features allow financial officers, facilities managers, or the City's new energy grants staff member to predict, track, and analyze the energy usage data of all buildings. With this software, various "what if" scenarios also allow energy cost savings from retrofits (such as performance contracting) to be estimated based on projected energy costs. Because the software also enables energy use forecasting, it can be used to support more accurate energy budget projections and monitoring within the fiscal year (EnergyCAP 2009).

The International Council for Local Environmental Initiatives (ICLEI) recently launched the Climate Action Planning Program Assistant (CAPPA) tool to assist local governments in developing customized plans for reducing climate and local air pollution. The CAPPA software will provide a comprehensive, customizable, and expandable library of emissions reduction strategies relevant for local government, as well as decision support capability to assist in identifying strategies for emissions reduction plans. The software provides information and quantitative tools for over 100 distinct emissions reduction strategies (ICLEI 2009h). Fortunately, U.S. Department of Energy stimulus funds may provide a valuable source of funds for meeting building performance benchmarks and broad emission reduction goals.

The U.S. EPA ENERGY STAR Portfolio is another energy management tool for measuring and tracking energy use of buildings. The tool also can normalize energy use for weather and square footage to assess energy efficiency of buildings and energy savings from efficiency upgrades.[12]

Finally, the City may consider the using Energy Performance Certificates. These "energy identity cards," required by policy in England and Wales since 2007, rate buildings on their energy efficiency in the areas of cooling, heating, ventilation, lighting, and hot water. The certificates visually display a structure's energy use and provide a letter grade comparison with similar structures. The certificates help building occupants and the public keep up-to-date on the efficiency of municipal buildings and can serve as a useful tool to educate Missoula citizens about the steps the City is taking toward energy efficiency as well as encourage behavior change among city personnel (Directgov 2009).

Continue to Encourage Voluntary Energy Conservation Measures

In November of 2008, a City Green Team was formed to look at ways the City can be more sustainable and reduce energy use while achieving cost savings or expending little or no additional funds. This energetic volunteer group of city employees developed 25 specific measures most, if not all, of which employees can do voluntarily. These measures were adopted by the City through a mayorial directive in February 2009. Several of these measures will directly reduce the purchased energy and greenhouse gas emissions related to the buildings sector, including turning off office equipment (i.e., computers monitors, copiers) and lights when not in use and purchasing EPA ENERGY STAR certified appliances, office machines and vending machines (Engen 2009b). These and similar behavioral changes should be further encouraged and incentivized.

12 See http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager.

Adopt Energy Conservation Policies for Office Equipment and Lighting

A policy requiring new office equipment, applicances and lighting to be ENERGY STAR certified and limiting or prohibiting personal space heaters and other appliances could achieve even greater energy and emission reductions in City buildings than voluntary measures. That is not to say that voluntary efforts of employees are not also to be encouraged. They are important because use of lighting, office equipment and personal appliances account for about one-third of the typical office building's energy use (U.S. EPA 2009b).

Strengthen Energy Efficiency Standards for New Buildings

Although Resolution #7241 is an important step toward reducing energy consumption and associated greenhouse gas emissions, the escalating costs and urgency of the problem of climate change may provide sufficient rationale for city officials to consider strengthening the energy conservation policy of new buildings, such as requiring LEED cerification (Leadership in Energy and Environmental Design) by the U.S. Green Building Council. Moreover, we recommend that decisions about new buildings give consideration to net greenhouse gas emissions within a framework of a City-wide emissions reduction goals. The purchase of carbon offsets or renewable energy credits could assure that new buildings do not increase overall emissions as recently occurred with *Currents* and *Splash*.

Consider Tax Increment Financing

Tax increment financing, which directs redevelopment funds in urban renewal projects, has the potential to revitalize city buildings based on the growth and resulting increased tax structures that follow growth. The Missoula Redevelopment Agency currently oversees this program for the City of Missoula. Cook County (Chicago, IL) is one leader in TIF that utilizes funds to pay for public works projects which incorporate sustainability (Neighborhood Capital Budget Group 2009). If TIF allocation proves to be a realistic possibility, the City may consider using these funds as capital to retrofit municipal buildings with energy conservation technologies.

Encourage Collaborative Efforts with the University of Montana and Others

In 2007, University of Montana President George Dennison signed the *American College and University Presidents Climate Commitment*, which obligated the University to take several steps in pursuit of climate neutrality. In 2008, the University conducted a greenhouse gas emissions inventory. In 2009, The Sustainable Campus Committee and the UM Office of Sustainability (directed by a full-time sustainability coordinator) have been charged with guiding development and implementation of a climate action plan for future emission reductions. Indeed, the University has taken several steps to reduce its greenhouse gas emissions and make sustainability part of the curriculum and other educational experiences. All new University buildings are now required to be certified by the U.S. Green Building Council to at least the LEED Silver standard (Greening UM 2009).

These examples and those involved with the University's recent Climate Action Plan may serve as useful sources of information and collaborative assistance for the City as it considers further steps it can take. Additionally, the University of Montana's Office of Sustainability, the Environmental Studies Program, and the College of Technology could facilitate student projects in conjunction with the learning objectives of courses in energy conservation, sustainable design, or related fields. Likewise, student interns could assist with research and project implementation, for example, students in the Climate Studies Minor Program. Establishing partnerships with the University can be an effective, meaningful way for the City to receive additional assistance with achieving greenhouse gas reduction targets. Similar partnership could be established or existing ones expanded with non-profit energy organizations such as the National Center for Appropriate Technology (NCAT). AmeriCorps and Montana Campus Corps volunteers could also be used to bolster implementation of energy-related City projects through public education and community involvement.

Additional guidance and resources at the state government level may be available for the City as additional building-related energy efficiency measures are developed. For example, in 2007, Montana Governor Brian Schweitzer announced his 20x10 Initiative, which aims to achieve a 20 percent reduction in energy use by state buildings by the end of 2010. The Montana Department of Environmental Quality (DEQ) is providing technical assistance for this effort. The U.S. EPA also provides a wide variety of clean energy resources, tools, and best practices for local governments.[13]

Conduct Further Energy-Efficiency Research and Analysis

Although this report provides a detailed analysis of Missoula's municipal energy consumption, costs and associated greenhouse gas emissions, further research and analysis would help the City understand and share with the public the benefits of past, present, and future energy conservation and efficiency efforts. The quantification of these savings was beyond the scope of our analysis but will be important to document to make wise decisions and justify future energy-efficiency investments.

For example, a quantitative analysis of the energy use and cost savings that have resulted from the installation of solar panels on several City buildings can be used to evaluate the merits of additional installations. Similar analyses of other energy efficiency upgrades and retrofits may also help the City to determine savings already achieved and ways to efficiently allocate funds for additional energy-efficiency measures. These are good examples of research projects that may be suitable for University of Montana student involvement.

This report primarily provides a comparison of two years (base year FY03 and target year of FY08) and some preliminary examination of trends over time, i.e., energy use, costs, and emissions during intervening years. Further analysis of these trends could reveal additional insights and opportunities for energy and cost savings.

13 See: http://www.epa.gov/cleanenergy/energy-programs/state-and-local/local.html and http://www.energystar.gov/index.cfm?c=government.bus_government_local.

4. MUNICIPAL FLEET

INTRODUCTION

Conducting a detailed inventory of the City's greenhouse gas emissions requires an analysis of the City's fleet of motorized vehicles and equipment that use fossil fuels. The objectives of this section are to: (1) quantify vehicle fleet fuel consumption and costs for fiscal years 2003 and 2008; (2) provide a baseline inventory of fleet-related energy use and greenhouse gas emissions; (3) compare fuel consumption and costs in FY03 and FY08; (4) identify the current major fuel consumers and emissions contributors by department; and (5) recommend strategies for fleet emissions reduction.

Missoula has already recognized that reducing fuel consumption of the municipal fleet makes good economic sense and is consistent with the City's ongoing efforts to reduce its greenhouse gas emissions. With these considerations in mind and with the support of Mayor Engen, City Council passed Resolution #7375 on November 3, 2008. The policy established a goal of reducing municipal fleet fuel consumption and energy use 10% below 2007 levels by January 1, 2011; Resolution #7375 also directed the Mayor to develop a plan to achieve this goal and policy.[14]

14 See ftp://ftp.ci.missoula.mt.us/Documents/Resolutions/7375.pdf .

The Public Works Department was assigned this task, and Vehicle Maintenance Superintendent Jack Stucky, with input from various divisions and department heads, drafted a Fuel Energy Reduction Plan that was adopted by the City in September 2009.[15] The Plan provided details of fuel use by department, factors contributing to increased fuel use in recent years, and ways of reducing fuel consumption in the future. This plan acknowledges that since fuel prices are beyond the City's control, fuel quantity must be the primary means of reducing the City's fuel costs. Although the price of diesel fuel decreased in 2009, it increased 267%, from $0.94 per gallon in 1998 to $3.45 per gallon in 2008. Gasoline prices have also increased in the last decade.

City Council passed Resolution #7375 on November 3, 2008, with the support of Mayor Engen … establishing a goal of reducing municipal fleet fuel consumption and energy use 10% below 2007 levels by January 1, 2011.

The challenge facing the City will be to reduce fuel consumption by 10% without reducing services accordingly. It is also important to note that, in the past decade, Missoula street miles (total miles of streets within the City boundaries) have increased 57%, from 212 miles in 1998 to 332 miles in 2007, and growth has also taken place in open space areas and park lands that require maintenance and upkeep (Stucky 2009). As a result, departments and divisions such as Police, Parks & Recreation, and Streets must serve a larger area. Moreover, these demands on the Missoula fleet are occurring in the context of ever-rising fuel expenses.

The fleet is responsible for 21% of the City's total greenhouse gas emissions. Thus, the municipal fleet is a sector of City operations that offers good opportunities and potential for energy savings and greenhouse emission reductions. These goals can be accomplished by improving the efficiency of vehicles in the fleet, altering employee driving habits and equipment use, and changing the fuel used to power City vehicles and equipment.

Table 4-1: Number of Vehicles and Equipments in Missoula Fleet by Reporting Unit in FY08

Reporting Unit	Rank Order	No. of Vehicles and Equipments	% of Total
Building Inspection Div.	12	7	1.37%
Cemetery	6	24	4.69%
City Attorney	14	1	0.20%
Engineering Div.	10	12	2.34%
Finance Dept.	15	1	0.20%
Fire Department*	5	29	5.66%
Information Services	16	1	0.20%
Mayor	13	2	0.39%
MCAT	17	1	0.20%
MRA	18	1	0.20%

15 See: http://www.ci.missoula.mt.us/DocumentView.aspx?DID=2294 .

Reporting Unit	Rank Order	No. of Vehicles and Equipments	% of Total
Parking Commission	11	8	1.56%
Parks & Recreation	1	161	31.4%
Pending Sale	8	22	4.30%
Police Department	3	64	12.5%
Street Division	2	101	19.7%
Traffic Services Division	7	24	4.69%
Vehicle Maintenance Div.	9	17	3.32%
Wastewater Division	4	36	7.03%
Total	n/a	512	100%

Source: Missoula Fleet Growth and Replacement List, 4/7/2008. Includes Fire Administration and emergency vehicles.
**Includes Fire Administration and emergency vehicles.*

Description of Fleet

The municipal fleet consists of all vehicles and equipment (e.g., street cleaners, compressors, generators, mowers, backhoes) owned by the City. In total there are over 500, of which over 329 (approximately 62%) are vehicles. The remaining are various vehicular and non-vehicular "equipments" (see Table 4-1). The number of vehicles and equipments fluctuates throughout the year, and from year-to-year, due to the constant acquisition, purchase and sale of them by the City.

The fleet is divided into 18 separate divisions, departments and other reporting units, such as the Police Department, Fire Department, Streets Division, Traffic Services Division, Wastewater Division, and Parks & Recreation Department. Table 4-1 shows Missoula's fleet for 18 reporting units and the number of equipments that each operates. Parks and Recreation, Streets, and Police have the largest fleets, with 161, 101 and 64 vehicles or equipments, respectively. These three units account for nearly 64% of the total number of vehicles and equipments. Wastewater, Fire, Cemetery, and Traffic Services account for an additional 22% of the total.

Fleet Fuel Consumption

The fleet primarily runs on two kinds of fuel. Unleaded gasoline fuels vehicles used for transporting people, such as law enforcement, traffic and parking control vehicles. Diesel fuel is the fleet's "workhorse" and fuels vehicles used for snow removal, sewer maintenance, street construction and maintenance, parks, etc. It has been suggested that it may be more feasible to make significant reductions in unleaded gasoline consumption without reducing City services than reducing diesel fuel consumption; this goal can be accomplished with more efficient vehicles, alternative fuels, and changing employee fleet use. Reducing vehicle miles driven, which have increased rapidly over the last decade, is another approach to reducing fuel use.

Vehicles that use gasoline are typically fueled under a contract with Hi-Noon gas stations. Purchases are made using a fuel card. This allows gasoline usage and costs to be recorded for each vehicle. Vehicles and equipment that use diesel also may be fueled at Noon's gas stations, though some, such as street pavers, are typically fueled from portable tanks on the back of pick-up trucks. These tanks are also filled through the Hi-Noon contract. For FY08, biodiesel was also purchased from Cenex gas stations, which no longer carry this fuel. Various departments also run equipment on propane fuel, more so in 2003 than 2008. However, because the amounts of propane used were very small, they were excluded from this analysis.

In this section of the emissions inventory, we report unleaded, diesel and biofuels consumption and associated greenhouse gas emissions by department and by fuel type. This allows us to identify which departments are the largest fuel consumers and which fuel types are the prominent sources of greenhouse gas emissions. We also examine fuel costs for the municipal fleet. This information can help identify divisions and departments that may be in the best position to reduce fleet-related emissions and reduce or stabilize fuel costs.

METHODS

We obtained most of the fuel consumption and fuel costs for this sector of our inventory from Jack Stucky, who also supplied us vehicle fleet growth and replacement reports. We were very fortunate that he has kept meticulous records and has a database that can be queried for a wide variety of data. We obtained additional fuel use and cost data for the Fire Department fire engines from Cheryl Schatz, Missoula's Fire Department Administrative Services Manager/Project Coordinator. Data for these vehicles were not included in Jack Stucky's database, because the Fire Department is responsible for its emergency vehicles.

We used the above data to calculate the total amount of fuel consumed (unleaded gasoline, diesel, and biodiesel), in gallons, for the entire fleet in fiscal years (FY) 2003 and 2008. We also calculated total fuel use (gallons) by reporting unit and by fuel type and assessed each with respect to their relative proportions of total fuel use.

Finally, we used the Climate Action Climate Planning (CACP) Software to quantify the fleet-related energy use (in MMBTU) and greenhouse gas emissions in carbon dioxide equivalencies (metric tons of CO_2e) by department and fuel type. This allows comparisons to be made with other emission sectors such as buildings, wastewater and employee commuting.

The CACP software offers several options for fuel type and for vehicle type. The software can thereby account for the different energy content and emissions resulting from the combustion of each fuel type. We entered data for each division/department as unleaded gasoline, diesel, or biodiesel, and for the latter fuel type, using the B-20 biodiesel option.

Because the available fuel use data were not grouped according to the categories of vehicles within the software, we entered a majority of the fleet's fuel use into the CACP software under the "light truck/SUV/pickup" category. We entered data this way after we determined that entering fuel data into different vehicle type categories allowed by the software had an insignificant effect on our greenhouse gas emissions totals (i.e., yielded differences of less than 1%).

Because of the large number of vehicles in the fleet (over 300), it would have been very time-consuming to classify each vehicle according to the CACP software vehicle types and tabulate fuel consumption by type. Moreover, doing so would have made an insignificant difference in the results. We made exceptions to the above procedure when we were certain of the vehicle type, in two cases: police vehicles were entered as full-size autos, and the Mayor's vehicle was entered as a compact car (which is recommended by ICLIE for hybrid vehicles). We entered all fleet fuel use data as U.S. gallons.

RESULTS

Fleet Fuel Consumption and Costs by Department

Table 4-2 shows the total gallons of fuel consumed by reporting unit and fuel costs for the entire City fleet in FY03 and FY08. Table 4-2 combines unleaded, diesel and biodiesel fuel consumption for each department, thereby providing an indication of overall fuel consumption. Total gallons of fuel consumed increased 22%, from 148,786 gallons in FY03 to 181,017 gallons in FY08. This represents a 4-5% increase per year, which makes a 10% reduction from 2007 levels by 2011 as required by Resolution #7375 appear achievable.[16]

In FY08, Streets Division, Police Department, and Parks & Recreation Department used the most fuel. These three units accounted for 32%, 27% and 15%, respectively, of the municipal fleet's total fuel consumption (74% collectively). The Fire Department and Wastewater Division are the next largest fuel consumers, and together account for 16% of total fuel consumption. These five units therefore have the greatest potential to reduce the municipal fleet fuel consumption.

Several reporting units had large increases in fuel use in recent years, including Buildings Inspection (322%), Vehicle Maintenance (185%), Wastewater (82%), and Police (81%). The Fire Department, one of the City's larger fuel consumers, had moderate growth in fuel consumption (17%) from FY03 to FY08.

One might assume that fuel use increases could be attributed to growth and concomitant increases in City street miles, park areas, etc. However, several departments for which one might expect to see large increases had small increases between FY03 and FY08, including Streets (4.2%), and Parks & Recreation (8.4%). Traffic Services actually decreased its fuel consumption by 17%.

16 Omitting fuel used by the Fire Department for wildand fire responses, fuel consumption increased by 6,700 gallons from FY08 to FY09, though the FY09 fuel consumption represents a 2.5% decrease from FY07 (Jack Stucky, personal communication July 30, 2009).

Table 4-2: Municipal Fleet Fuel Consumption and Fuel Costs by Reporting Unit in FY03 and FY08

Reporting Unit	Quantity (Gallons)				Cost ($)		
	2003	2008	% Change		2003	2008	% Change
Cemetery Dept.	2,964	3,231	9.01%		$3,828	$10,685	179%
Engineering Div.	3,324	4,153	24.9%		$4,293	$13,161	207%
Fire Department	13,727	15,988	16.5%		$16,177	$48,864	202%
Parks & Recreation	25,754	27,919	8.41%		$33,417	$91,406	174%
Police Department	26,631	48,157	80.8%		$34,738	$151,489	336%
Street Division	54,801	57,079	4.16%		$64,066	$193,566	202%
Traffic Services Div.	3,783	3,158	-16.5%		$4,774	$10,435	119%
Wastewater Div.	7,015	12,767	82.0%		$8,859	$43,929	396%
All Others	10,787	8,565	-20.6%		$13,915	$26,784	92.5%
Total	**148,786**	**181,017**	**21.7%**		**$184,067**	**$590,319**	**221%**

Notes: Values may not precisely add up due to rounding. Quantity of fuel consumed includes unleaded gasoline, diesel (and biodiesel in 2008). "All Others" include: Building Inspection; City Attorney; Finance Dept.; Information Services; Mayor; MCAT; MRA, Parking Commission; and Vehicle Maintenance Division.

From FY03 to FY08, fuel costs for the municipal fleet more than tripled from $184,067 to $590,319. This represents a rate of increase more than 10 times greater than the fuel consumption rate of increase (see Table 4-2).

Figure 4-1: Municipal Fleet Fuel Costs by Department, FY08

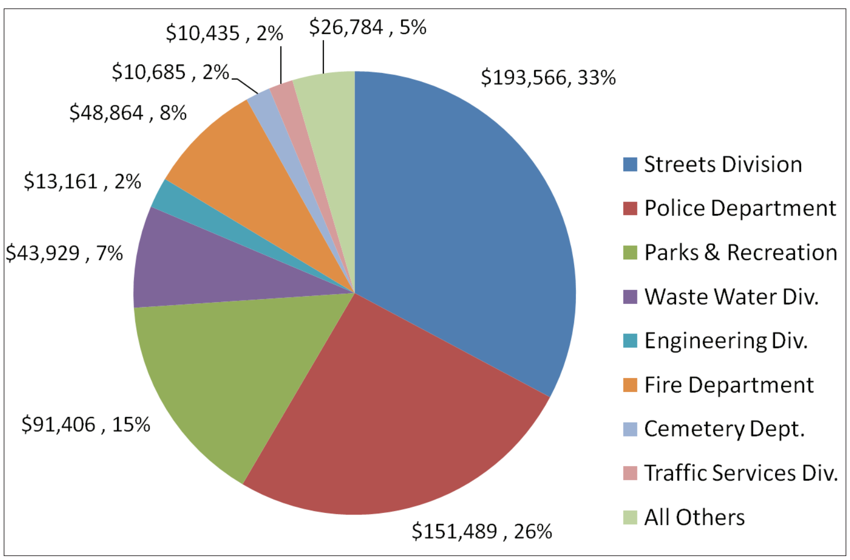


Figure 4-1 shows departments with the largest fuel costs in FY08 and percentage of total fuel costs. The Streets Division, Police Department, and Parks & Recreation Department accounted for 74% of the Missoula municipal fleet fuel costs in FY08, with combined fuel costs of $436,461.

Fleet Fuel Consumption by Fuel Type

Table 4-3 shows the total fuel consumption in gallons for the City fleet by fuel type in FY03 and FY08. In FY03, unleaded gasoline comprised 52% of the total gallons of fuel consumed and grew to 57% of total fuel use in FY08. While unleaded gasoline consumption increase 34% from FY03 to FY08, diesel consumption increased only 6%. In FY08, unleaded comprised 56% of these costs, diesel accounted for 44%, and biodiesel for accounted for less than 1% of total fuel costs.

These percentages are virtually unchanged from FY03 (see Appendix F1). Thus, it appears that fuel use and greenhouse gas emission reduction strategies regarding the fleet would need to target both unleaded and diesel fuel use, though staving off further increases in unleaded gasoline could prove challenging while maintaining the level of service City officials and citizens require.

Table 4-3: Municipal Fleet Fuel Use (gallons) by Fuel Type in FY03 and FY08

	FY 2003		FY 2008		FY03-FY08 % Change
Fuel Type	Fuel Use	% of Total	Fuel Use	% of Total	
Unleaded	77,672	52.2%	103,877	57.4%	33.7%
Diesel	71,114	47.8%	75,612	41.8%	6.3%
Biodiesel	---	---	1,527	0.8%	n/a
Total	**148,786**	**100%**	**181,016**	**100%**	**21.7%**

Note: Values may not precisely add up or match other tables due to rounding.

Fleet Energy Use and Greenhouse Gas Emissions by Department

Table 4-4 shows the total energy use (in millions of BTUs, or MMBTU) associated with fuel consumption by the municipal fleet in FY03 and FY08 for divisions and departments that are the primary fuel consumers (Fire, Park & Recreation, Police, Streets and Wastewater) and all others combined (see Appendix F2 for a detailed tabulation of reporting units omitted from Table 4-4). Energy use values account for the slightly different energy content of diesel and unleaded gasoline per gallon. In addition, energy content in 2003 and 2008 may have also slightly differed due to the use of different formulations.

The total energy used by the fleet sector increased 22%, from 18,457 MMBTU in FY03 to 22,459 MMBTU in FY08. As seen in Table 4-4, all departments with large amounts of fuel consumption experienced growth in energy use between FY03 and FY08, particularly the Police Department and Wastewater Division. Too much should not be read into some of the smaller changes shown in Table 4-4 since fuel use to some extent depends on demand for City services, which can naturally fluctuate from year to year. Nevertheless, it is well known that overall fuel use has been steadily increasing over time, a trend that will need to be reversed if the municipal fleet fuel costs are to be contained and fuel reduction goals met.

Table 4-4: Municipal Fleet Energy Use (MMBTU) and Greenhouse Gas Emissions (tons of CO2e) by Department or Division in FY03 and FY08

Department / Division	Energy Use (MMBTU)				Emissions (tons of CO_2e)		
	FY03	FY08	% Change		FY03	FY08	% Change
Fire Dept.	1,695	1,971	16%		134	155	15%
Parks Dept.	3,209	3,480	8.4%		250	271	8.2%
Police Dept.	3,345	6,047	81%		259	467	80%
Streets Div.	6,709	6,991	4.2%		531	550	3.6%
Wastewater Div.	866	1,577	82%		68	124	82%
All Others	2,633	2,393	-9.1%		204	185	-9.3%
Total	**18,457**	**22,459**	**21.7%**		**1,447**	**1,752**	**21.1%**

Table 4-4 also shows the total greenhouse gas emissions (GHG) in carbon dioxide equivalencies (metric tons of CO_2e) associated with fuel consumption by Missoula's municipal fleet in FY03 and FY08. Total emissions increased 21%, from 1,447 tons of CO_2e in FY03 to 1,752 tons of CO_2e in FY08, an average increase of about 4% per year. Changes in greenhouse gas emissions from FY03 to FY08 for the various divisions and departments closely track changes in energy use.

For FY08, the Streets Division was the largest contributor of total GHG emissions of Missoula's municipal fleet (31%), followed by the Police Department (27%), and Parks & Recreation (15%). Thus, fuel use reductions by these departments can offer the great potential for reducing GHG emissions of the municipal fleet in the future.

Fleet Energy Use and Greenhouse Gas Emissions by Reporting Method and Fuel Type

Table 4-5 shows total energy use and greenhouse gas emissions by fuel type in FY03 and FY08. From FY03 to FY08, the increases in energy use and emissions from unleaded gasoline consumption (33-34%) was much higher than the increases from diesel (6.3%). Of course, energy use and emissions are directly related to the amount of fuel consumed, and unleaded consumption increased at a much faster rate than diesel consumption (see Table 4-3). In FY08, unleaded gasoline accounted for over half (58%) of the total energy use and emissions, unleaded gasoline accounted for 41-42%, and biodiesel accounted for less than 1% of total energy use and emissions.

Table 4-5: Municipal Fleet Energy Use (MMBTU) and Greenhouse Gas Emissions (tons of CO2e) by Fuel Type in FY03 and FY08

Fuel Type	Total Energy Use (MMBTU)				Total Emissions (tons of CO_2e)		
	FY03	FY08	% Change		FY03	FY08	% Change
Unleaded	9,756	13,047	33.7%		756	1,008	33.3%
Diesel	8,677	9,226	6.3%		688	732	6.3%
Biodiesel	---	184	n/a		---	12	n/a
Total	**18,433**	**22,457**	**21.8%**		**1,445**	**1,752**	**21.3%**

Note: Total energy use and emissions in Table 4-4 and Table 4-5 differ slightly due to rounding and differences in the CACP software output resulting from entering data as departmental usage totals (gallons) versus fuel type.

CONCLUSIONS AND RECOMMENDATIONS

From FY03 to FY08, fuel consumption by Missoula's municipal fleet has increased 22% or 4% per year, while fuel cost have more than tripled. In these five years, fuel costs increased a total $406,252, an average of over $81,000 per year (see Table 4-2). Although these findings reflect the very high fuel prices of 2008, fuel prices remain high and no doubt will increase in the future. As a result of increased consumption, greenhouse gas emissions from the municipal fleet have also increased, 21% from FY03 to FY08. Several departments and divisions account for the lion's share of fuel consumed and these increases in consumption. These departments and divisions offer the greatest opportunity to reduce fuel consumption, fuel costs and associated GHG emissions in the future.

As previously mentioned, several initiatives have been undertaken or are being planned to reduce fleet-related fuel consumption and costs and thereby reduce greenhouse gas emissions. The recently enacted Resolution #7375 sets a specific reduction target for fuel use, which could directly translate into a decrease in greenhouse gas emissions. The City of Missoula's Fuel Use Reduction Plan developed and adopted in 2009 offers concrete step to achieving the goal of a 10% reduction in fuel use from 2007 levels by 2011.

In addition, the Public Works Director and the Mayor's Office are also in the process of updating the City of Missoula Vehicle Usage Policy by amending Administrative Rule #11. The rule includes anti-idling guidelines for City personnel. Many of the City Green Team's 25 priority recommendations (Engen 2009b) are aimed at reducing fuel consumption as well. For several years, some divisions and departments have encouraged the use of alternative transportation (such as Mountain Line bus) for City business-related trips, minimization of vehicle use and other voluntary measures. In addition, fuel efficiency has been a consideration in vehicle replacement in recent years.

It is unclear whether the above measures have begun to reverse the trend of increased fleet usage. Although fleet fuel consumption went down 11,200 gallons (6.2%) from FY07 to FY08, it went up 6,700 gallons (4.0%) from FY08 to FY09.[17] It would take further analysis to know what explains these ups-and-downs. It may be that FY07 was a particularly busy year and FY08 was slower than average for the

17 These figures do not include fuel used for wildland fire response by the Fire Department.

Streets Division, Police Department, Parks & Recreation Department, and Fire Department. Fuel consumption by these units is affected by demand for services and project schedules, which in turn, are affected by seasonal weather conditions.

This baseline inventory helps to identify those units within the fleet sector for which fuel use reduction measures could be prioritized to achieve the greatest emissions and cost savings. Overall success will depend on the major fuel consuming divisions and departments (Streets, Police, Parks & Recreation, and Fire in particular) improving their efficiency by successfully implementing their fuel reduction plans. However, further emission reductions in the fleet sector may not be feasible without progress by City divisions and departments in the next tier in terms of fuel consumption: Wastewater, Engineering, Cemetery, and Traffic Services. Together, these eight units are responsible for 95% of the fuel consumed in FY08.

The expansion of City street miles and services will likely continue to pose a challenge to those responsible for ensuring the City's 2011 fuel reduction goals are met. To reduce fuel use and save on fuel costs while maintaining the same level of service, several existing measures can be expanded upon, and new measures developed to achieve even further reductions in fuel consumption. Such efforts will be needed if the City sets greenhouse gas emissions reduction targets for 2015 and beyond.

Overall success will depend on the major fuel consuming divisions and departments... improving their efficiency by successfully implementing their fuel reduction plans.

Many of the recommendations that follow mirror the proposed actions prepared by Jack Stucky and various division and department heads who contributed to the City's Fuel Reduction Plan, as well as steps identified by the City Green Team. Some of our recommendations require little money but pose a challenge to implement because they require City employees to alter their behavior when choosing and operating vehicles. Others, involving fleet replacement and upgrades to more fuel efficient and alternative fuel vehicles, for example, may require substantial funds which, realistically, tend to be limited in the short-term but may lead to substantial long-term savings.

Encourage Efficient City Employee Vehicle Choice and Use (Needs-Based Vehicle Selection)

Policies that require or encourage City employees to modify their choices and uses of City fleet vehicles can effectively reduce fleet fuel consumption. Departments can continue to encourage City employees to make use of alternative transportation (i.e., walk, bike, and bus) for work-related trips, for example by using their City passes on the Mountain Line transit system. This is one example that could help to achieve desired reductions.

The expansion of City street miles and services will likely continue to pose a challenge to those responsible for ensuring the City's 2011 fuel reduction goals are met.

Employees should be encouraged or required to use the most energy-efficient vehicle that is available and adequate to perform the intended tasks. This could apply to "take-home" and "on-call" vehicles. Once the appropriate vehicle is chosen, employees operating them should: stay below the speed of 65 mph on the highway (though the Fuel Reduction Plan sets a 75 mph limit); not idle unnecessarily; choose the most efficient routes to job sites and; bring all necessary equipment; follow standards set for personal use of City vehicles and remove excess weight from vehicles. Several of these recommendations may be official policy if they are incorporated in the City Vehicle Usage Policy under Administrative Rule #11.

Also, satellite work stations may also shorten travel distance to and from job sites, and City Departments and Divisions can be encouraged to review their operations from a fuel efficiency perspective and explore areas of their operation that could make use of these satellite work stations.

Longer workdays, such as four 10-hour days, and 4-day work weeks, for example, in the Streets Division and Parks & Recreation Department could consolidate and reduce the number of trips to worksites. Such changes could be made on a year-round or seasonal basis as appropriate.

Finally, current and new employees could receive training or information on ways of driving to improve mileage and reduce the carbon footprint of driving, such as the tips offered in the Eco-Drivers™ Manual.[18]

Energy Efficiency Considerations in Vehicle Replacement and Maintenance

The need for each vehicle in the fleet could be assessed from a fuel-efficiency perspective and those deemed unnecessary could be sold. Similarly, those that remain could be evaluated according to fuel economy and, as funds allow, either be upgraded or replaced with a more fuel-efficient vehicle whenever possible. For example, while not appropriate for all purposes (i.e., police pursuit and other emergency vehicles), standard gasoline hybrid and plug-in hybrid electric vehicles have good potential for many municipal uses, and costs for these vehicles are expected to decline as their technology and availability improves in the coming years. Currently, the City owns seven gasoline hybrid vehicles. The City's Fuel Reduction Plan has already made it City policy to purchase the most energy-efficient vehicle that is the "right size" for its intended task.

> *The City's Fuel Reduction Plan has already made it city policy to purchase the most energy-efficient vehicle that is the "right size" for its intended task.*

Additionally, any older diesel vehicles in the diesel fleet would be upgraded with SCR (Selective Catalytic Reduction of NO_X). Five diesel trucks with carbon filtration systems have recently replaced five of the City's older diesel-fueled trucks and, in FY10, four other diesel trucks will be replaced with more efficient vehicles (Stucky 2009). Emission reductions targets could also be set according to fuel type.

Consider and Expand Use of Alternative Fuel Sources

As technological advancements are made, alternative fuels should become more available and economical. Depending on their potential for use in various vehicles and equipments and their emissions reduction characteristics, these alternatives should be considered to achieve fuel and emission reductions.

18 See: http://www.fs.fed.us/sustainableoperations/documents/TheEcoDriversManual.pdf .

Compressed natural gas (CNG) has a high ratio of energy to carbon dioxide emissions compared to other fossil fuels and does not produce other air pollutants that gasoline and diesel do. Unfortunately, it is not commercially available in Missoula. Hydrogen is another fuel that burns cleanly and is not yet readily available, but it could offer promise in the future.

Biofuels, such as biodiesel and vegetable oil, can yield real carbon dioxide emissions reductions and be used for various equipments, though some may require modifications. However, some types of biofuels, such as corn-based ethanol, and products such as E-85 that contain large amounts of ethanol, offer little or no carbon dioxide emission benefits, because of the fossil fuels and land-use changes associated with their production. Although biodiesel is not currently commercially available in Missoula and carried relatively high costs when it was sold here, it could provide carbon dioxide emission reductions, particularly if produced in Montana.

Staff Certifications and Trainings and Fleet Operations Management Tools

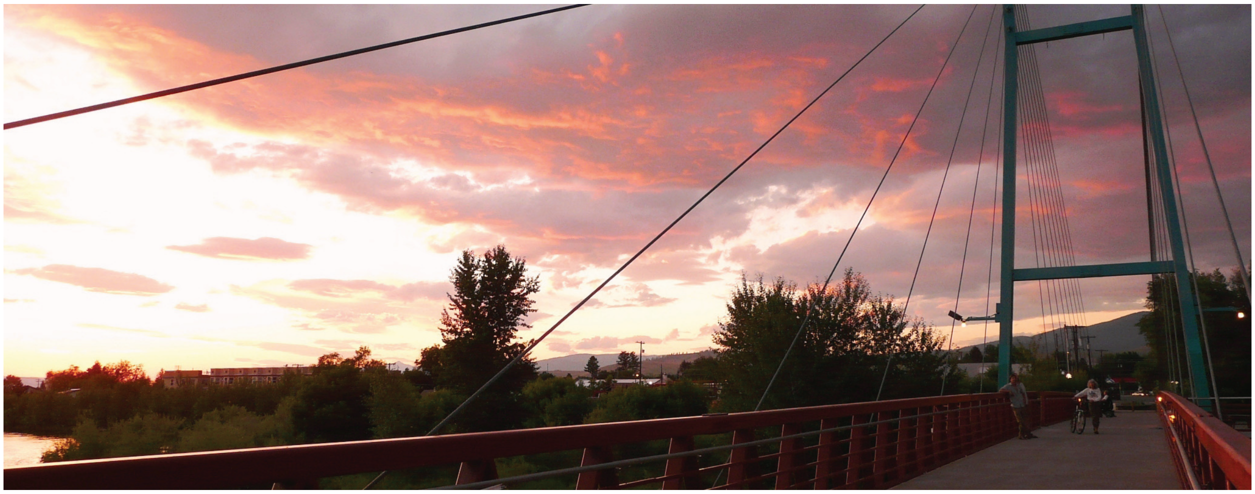
Missoula's Vehicle Maintenance staff has benefited from certifications and trainings needed to remain current with changes in energy technology. All of the mechanics have at least four Automotive Service Excellent (ASE) certifications and several master level certifications. Superintendent Jack Stucky has a current Certified Public Fleet Professional (CPFP) certification (Stucky 2009). Fleet operation management tools, though perhaps better suited to larger cities, may also help with vehicle scheduling and use efficiency. For example, ZipCar has such a program called FastFleet.[19]

GHG Emissions Monitoring and Reporting

Individual departments and City elected officials are no doubt sensitive to these costs during the budgeting process and monitor them closely throughout the fiscal year. Indeed, the existing system for recording fuel consumption and fuel costs is also well-suited to monitoring greenhouse emissions, which is essential for tracking progress on future municipal greenhouse gas reduction goals for the fleet sector, which is in perhaps the best position of all City sectors to meet the next milestones under the *U.S. Conference of Mayors Climate Protection Agreement*.

19 See http://www.fastfleet.net/.

5. EMPLOYEE COMMUTING



INTRODUCTION

To analyze City of Missoula employee commuting habits, we examined: (1) commuting patterns in 2008 and extrapolated those back to Fiscal Year 2003; (2) carbon dioxide equivalency emissions associated with employee commuting in FY03 and FY08; and (3) ways to enhance existing City programs and policies that encourage alternatives to single-driver commuting. We also make several recommendations for new programs and policies to reduce greenhouse gas emissions from commuting.

In 2004, the Missoula Greenhouse Gas & Energy Conservation Team (GHGECT) laid out several recommendations and programs that could be implemented to reduce vehicle emissions, particularly regarding vehicular emissions resulting from City employees' commuting (Missoula GHGECT 2004). Several of these programs, such as the Safe Routes to Schools and the completion of the East/West Commuter Bikeway, have been successfully implemented in recent years.

Several other recommendations from 2004, such as urban development and land use planning that encourage the burgeoning Missoula population to live closer to City services, have been more difficult to implement and evaluate. City Council has nevertheless expressed support of well-planned growth and urban density as recently advanced by the City's Office of Planning and Grants (OPG) with the Urban Fringe Development Area (UFDA) planning efforts (OPG 2009). The UFDA planning process is intended to identify where growth is mostly to occur within the Urban Service Area boundary, which corresponds with the City of Missoula Wastewater Sewer Service Area, with particular attention to the Urban Fringe, the area between the City limits and Urban Service Area boundary (OPG 2009). Planning for the UFDA involves developing strategies for addressing growth in accordance with adopted policy within growth areas.

According to the 2004 Missoula GHGECT report, "the transportation sector is projected to account for approximately 18% of the Missoula area [carbon dioxide equivalences] (CO_2e) emissions by 2010, an increase from about 12% in 1990" (Missoula GHGECT 2004). This increase is due, in large part, to the combination of population growth and sprawl leading many people to drive greater distances from their homes to central services and jobs.

To examine the commuting habits of City employees, we distributed a survey to all employees. We sought to obtain a representative sample and information about commuting behaviors, and single-occupancy driving in particular. The City is in an excellent position to craft new programs and improve existing ones (such as Missoula in Motion's Way to Go Club and existing City bus pass program) to reshape commuting behaviors of City employees as well as support similar programs for all Missoula commuters. Ultimately, commuting-related emission reduction solutions to encourage biking, walking, bus use, and carpooling will benefit more than City employees and can extend to commuters in the entire city of Missoula and surrounding communities.

In the recommendations section, we included several of the comments and recommendations that survey respondents themselves made about what might be done to decrease employee commuting-related emissions and make alternate forms of commuting more attractive for City employees. Areas for additional research are also identified.

2002 Employee Survey

An employee commuting survey was conducted by Missoula In Motion and the City of Missoula Bike-Pedestrian program in April 2002 (FY02). In total, 141 of 360 (39%) City employees responded to the 2002 survey, and it was determined that 49% lived within the Missoula Urban Transportation District (MUTD) and 51% lived outside the MUTD or work in the Police or Fire Departments. Of the 71 respondents living within the MUTD, 61% reported typically driving alone to work, 13% bicycled, and 10% carpooled. Of these 71 employees, 55 (85%) reported never riding the bus to work, although all were familiar with the free bus pass program, called City EZ Pass. The program started in 1999.[20] Of the 70 respondents living outside the MUTD or working in the Police or Fire Departments, 57% typically drove alone to work, 37% used car- or vanpools, and a vast majority (97%) *never* rode the bus, though over 30% reported using their City bus pass for non-commuting work-related trips and for other non-commuting trips. Because the April 2002 survey results were not available in time for us to use them as a baseline for our comparison with FY 2008, we extrapolated our survey results back to FY 2003 (see below). The wording of the questions also made direct comparison with our survey difficult. The April 2002 survey, as do most commuting surveys, asked for respondents' typical or usual mode of commuting. Our survey asked about and took into account seasonal differences in individuals' commuting modes.

In total, 141 of 360 (39%) City employees responded to the 2002 survey, and it was determined that 49% lived within the Missoula Urban Transportation District (MUTD) and 51% lived outside the MUTD

20 According to Missoula in Motion, for September 2007 to September 2008 the contract cost $4,500 for the City EZ Pass program. The City paid $3,600, Missoula In Motion paid $225, and MUTD contributed $675. The City Public Works Department's-Bicycle/ Pedestrian Office helps coordinates the program.

Other Commuting Surveys

Other recent commuting surveys have been conducted for the Missoula area, including surveys in 2006 by the U.S. Census Bureau of Missoula County workers, and in 2008 by the University of Montana Bureau of Business and Economic Research of Missoula Valley workers. A thorough review of these studies is beyond the scope of this report. These surveys are summarized and compared in the *2008 Missoula Long-Range Transportation Plan Survey Draft Final Report* (Baldridge 2008). We make some brief comparisons of our survey results of City of Missoula employees to these more general surveys of Missoula workers.

METHODS

In April 2009, we administered a written survey to City employees to understand current commuting habits. A copy of the survey is included in Appendix E1. We designed the survey, and Ginny Merriam, Missoula's Communications/Public Information Officer, and the City of Missoula Human Resources and Finance Departments were instrumental in printing, distributing and collecting the surveys. Of the 499 full time equivalent (FTE) employees in Fiscal Year 2008, (a number we received from M. Bache, Missoula's Human Resource Analyst), 125 employees responded, for a response rate of approximately 25%.

We had hoped for a better response rate and had offered an incentive prize (which we awarded to an employee drawn from the pool of respondents who completed the survey). Because we were not able to survey non-responders, we assumed that the 125 responses were representative of overall City employee commuting habits. Therefore, we extrapolated from the sample population to estimate overall commuting miles by commuting mode and associated greenhouse gas emissions for all City employees (see below). We assumed that non-respondents commuted similar numbers of days each week, similar distances, and used similar commute modes and vehicles in the same proportions as reported by survey respondents. If survey respondents have commuting habits with different carbon footprints than non-respondents, our findings will under- or over-estimate commuting miles driven and associated greenhouse gas emissions. It was necessary to extrapolate the results and findings of the sample to total City employee population such that a complete emissions estimate could be obtained and comparison made to other City sectors. The results can provide useful baseline data for future inventories and monitoring.

The survey asked how many days a week employees commuted to work each season (i.e., summer, winter and spring/fall) in the last year, how far they commuted, how many times per week each season they drove, biked or walked, rode the bus, and carpooled, and what type of vehicle they used to commute, if applicable. Another section of the survey asked for open-ended comments and suggestions about employee commuting (see survey in Appendix E1).

We compiled the survey response data and subsequently entered the annual distances driven by vehicle and fuel type into the CACP software to determine metric tons of carbon dioxide equivalents (tons of CO_2e) for all respondents. Hybrid vehicles, which three respondents reported driving, were entered as regular, gasoline-fueled compact/subcompact cars. This procedure was recommended by A. Frankel, an ICLEI Program Associate (personal communication, May 6, 2009). To estimate total greenhouse gas emissions related to City of Missoula employees as a whole, we divided the total tons of CO_2e for all respondents by 125 to calculate per-employee emissions, and then multiplied that number by the number of FTE employees in 2008 (499). Emissions from carpooling and bus commuting were also estimated by entering into the CACP software the total vehicle miles driven commuting by carpool and bus. Thus, by entering our estimates of total miles driven by vehicle and fuel type, we obtained an estimate of total carbon dioxide equivalencies (tons of CO_2e) from the City employee commute sector.[21]

One important objective of this emissions inventory is to determine how the City of Missoula's emissions have changed over time. However, the lack of available and detailed data regarding City employee commuting habits in our 2003 base year required us to extrapolate backwards in time based on the assumption that City employee commuting habits remained relatively consistent between 2003 and 2008. As such, we again took our calculated value of emissions per employee from 2008 and multiplied it by the number of FTE employees that the City reported having in 2003 (357). However, it is important to note that this assumption may not be accurate for all modes of transportation. For example, City employee bus ridership has increased 23% from FY03 to FY08, from 2,915 rides to 3,595 rides in FY08 (Stokman 2009a).

To those conducting future energy use and emissions inventories, for example to monitor emissions and evaluate achievement of reduction targets under the *U.S. Conference of Mayors Climate Protection Agreement*, we recommend using the 2008 emission totals for employee commuting as a base year, since our estimations for 2003 are not as reliable as the 2008 emission data.

We used our survey data to assess employee commuting patterns, such as distances traveled to the workplace by the various commuting modes of biking, walking, bus riding, and ride-sharing. For our calculations, we used 240 as the average number of days a full-time employee works and commutes annually (48 weeks). This number represents the total of 365 days a year, minus weekends (260), minus 20 days for vacation, sick days, and holidays. We used this number of annual commuting days to calculate, for example, the annual number of commutes and commuting distances by commute mode from the employee-reported weekly and seasonal commuting behaviors.

We also calculated the mean and median distances that employees commute, as well as the relative degree with which various modes of transportation are used. Because these data represent patterns in commuting behavior, rather than actual measures of emissions, we depict these patterns in tabular form below for only the 125 survey respondents. However, for total commuting-related energy use and associated greenhouse gas emissions we computed average values per employee that completed the survey and multiplied those values by the total number of full-time equivalent employees.

RESULTS

We present our findings in three main sections: (1) overall commuting patterns; (2) energy use and emissions for survey respondents; and (3) estimated energy use and emissions for all City employees. The overall commuting patterns section examines distribution of commuting mode by total commute trips and the number and percentage of survey respondents who use various types of transportation to commute to work. Although single-occupancy commuting is the most prevalent, we found that many respondents utilize a variety of modes of transportation and change their primary mode of transportation

21 The ICLEI CACP software also provided pounds of nitrogen oxides (NOx), sulfur oxides (SOx), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM10) emitted by vehicle type, and while this information is useful in determining "criteria" air pollutants associated with vehicle use—and how overall air quality might be improved by reducing fuel combustion—it is not immediately relevant to this step in the inventory process. These data may be requested from the authors.

during different seasons of the year—walking and biking were much more common during the summer than winter, for example. The overall commuting patterns section also discusses reported commuting distances of City employees. It is noteworthy many respondents live beyond City limits and existing bus routes, which likely makes walking and biking year-round a less viable option. However, it is reasonable to believe that biking is possible for *some* City employees living within approximately five miles of their place of employment. Recognizing employee commuting patterns and commuting needs is useful in identifying opportunities for crafting better commuting and public transportation policies and services in the future.

The energy use and commuting emissions sections details our findings on commuting-related energy use and greenhouse gas emissions based on respondents' commuting habits. To make the results from this sector compatible with results from other sectors included in this report, the units we used are millions of British Thermal Units (MMBTUs) for total energy use, and carbon dioxide equivalencies (tons of CO_2e) for total greenhouse gas emissions. These sections also include analyses of total miles driven. Further explanation of the energy use emissions estimates and miles driven by commute mode for all City employees is provided below, along with illustrative charts.

Overall Commuting Patterns

Table 5-1 shows the total number and percentage of annual commuting days by commute mode for all 125 survey respondents, including those who are multi-modal commuters. Table 5-1 shows that 71% of all City employee round-trip commutes (i.e., 19,139 of 26,880 commute days) are made driving alone; carpooling and vanpooling account for 11.4%, biking and walking for 11.0%, and transit bus for 6.2% of total commute days.[22]

Table 5-1: Total Number and Percentage of Annual Commuting Days by Commute Mode for All 125 Survey Respondents, and for Those Who Drive Always or Sometimes (114) or Never (11) in 2008

Commute Mode	All Commuters			Drive Always or Sometimes			Never Drive	
	Days	% of Ttl.		Days	% of Ttl.		Days	% of Ttl.
Driving Alone	19,139	71.0%		19,139	77.8%		0	0.00%
Carpooling*	3,051	11.4%		2,535	10.4%		516	21.4%
Biking/Walking	2,947	11.0%		1,747	8.10%		1,200	45.5%
Busing	1,743	6.20%		867	3.60%		876	33.2%
Total	26,880	100%		24,288	100%		2,592	100%

** Includes vanpooling*

22 An April 2002 City employee commuting survey reported that 59% usually drove alone to work, 23% carpooled or vanpooled, 13% biked of walked, and 5% took the bus (derived from Stokman 2009b, combining results for employees living inside and out the MUTD). The April 2002 survey and ours are not directly comparable; thus, it cannot be inferred that single-occupancy commuting increased and alternative forms of commuting decreased in the last seven years. In fact, City EZ Pass ridership nearly doubled from 2002 to 2008 (Stokman 2009a).

Table 5-2: Reported Commuting Modes of Respondents

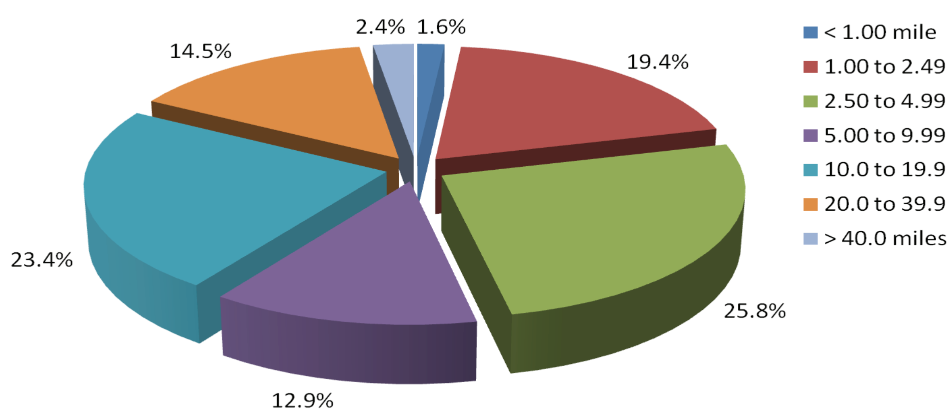
Commute Mode	Number of Respondents	% of Respondents*
Drive Alone	114	91.2%
Carpool or Vanpool	32	25.6%
Bike or Walk	32	25.6%
Bus	16	12.8%

**Percentages do not total 100% because of multi-modal commuting*

Of the 125 respondents, 114 or 91% reported driving alone always or sometimes; 60 or 48% always drive alone, i.e., they never use other modes of commuting (see Table 5-2). Table 5-1 shows that only 11 respondents, or 8.8%, *never* drive to work alone. In 2008, for those who never drive alone to work, 46% of commutes were made biking or walking, 33% of commutes were by bus, and 21% were by carpool or vanpool (see Table 5-1). As shown in Table 5-2, a total of 32 (26%) of respondents reported carpooling at least sometimes, 32 (26%) reported biking or walking at least sometimes, and 16 or (13%) reported taking the bus at least sometimes.

One particularly interesting pattern that emerged from the survey responses is the distances people commute. In some cases, the City requires emergency response employees (i.e., police and fire) to live within a "response time" distance, although there is not currently an all-inclusive policy requiring City employees to live within certain boundaries. However, through various policies and programs discussed below, City officials can encourage shorter commute distances and alternatives to commuting by single-occupancy vehicle. The average (mean) and median one-way commuting distance of all respondents was 10.5 and 5.0 miles, respectively. Thus, at least half of City employees surveyed are likely to live outside of the City of Missoula (more than five miles from their workplace).

Figure 5-1: Distribution of One-Way Commuting Distance in Miles



As shown in Figure 5-1, only 1.6% of respondents live within one mile of work, 19% live between 1.00 and 2.49 miles of work, 26% live between 2.50 and 4.99 miles, and 13% live between 5.00 and 9.99 miles of work. The remaining 40% of respondents live more than 10 miles from work (see Appendix E2 for detailed tabulation of commuting distances). Among the 19.4% of City employees living within 1.00 and 2.49 miles of work, only 11% reported biking or walking to work, suggesting an opportunity for an 8% improvement in the use of carbon neutral modes of transportation for shorter commute distances.

While 71% of employees predominantly commute in single-ccupancy vehicles, it appears that employees commuting the greatest distances do so in relatively fuel-efficient vehicles. For example, as shown in Table 5-3, the three employees who commute by Prius Hybrids travel an average of 25 miles one way to work, and the 22 employees who drive non-hybrid compact or subcompact cars travel an average of 15 miles one way to work. These 22 employees annually commute a total of 97,727 miles, which accounts for 24% of total miles driven. In contrast, only four respondents reported driving large SUVs or trucks, and they commuted an average of 5 miles one way to work, accounting for 7,712 or 2% of total single-occupancy vehicle miles driven.

Table 5-3: Average Distances of Employee Commutes by Single-Occupancy Vehicle and Annual Commuting Miles Driven, by Vehicle Type

Vehicle Type	Number of Respondents	Average One-way Commuting Distance (miles)	Annual Commuting Miles Driven	% of Total Annual Miles Driven
Compact/Subcompact Cars	22	15.4	97,727	24.1%
Mid-sized Cars	21	11.4	79,703	19.7%
Full-sized Cars	18	9.3	60,067	14.8%
Large SUVs & Trucks	4	5.1	7,712	1.9%
Med./Lg. SUVs & Trucks	20	7.8	43,841	10.8%
Med./Sm. SUVs & Trucks	13	9.1	35,269	8.7%
Small SUVs & Trucks	13	11.0	49,203	12.2%
Prius Hybrid	3	24.8	31,440	7.8%
Total	**114**	**11.0**	**404,963**	**100.0%**

Nevertheless, these findings combined with the 11.4% of roundtrip commutes that are made by carpool and the 11.0% of commutes by biking or walking (see Table 5-1) are evidence that City employees are already, independently, looking for alternative and fuel-efficient ways to commute. These behaviors should be taken into account when devising the employee commuting section of Missoula's Climate Action Plan, as they are existing positive patterns to be reinforced.

Commuting Energy Use and Emissions for Survey Respondents

Table 5-4 shows the total energy consumption (MMBTU) and greenhouse gas emissions (tons of CO_2e) by commuting vehicle and fuel type for the 125 survey respondents (not all City employees). Emissions were based on the total reported number of commuting miles driven by each type of vehicle and the fuel type in 2008. Separate subtotals were calculated for single-occupancy vehicles (full-sized, mid-sized and compact/subcompact cars; and light trucks/SUVs/pickups) and multiple-occupancy vehicles (carpools and buses). The numbers of miles driven that we entered into the CACP software includes annual miles driven for single-occupancy cars and for carpools, as well as annual commuting miles on the Mountain Line bus service. The mileages for all vehicle and fuel types represent vehicle use by 122 of the total 125 respondents (some of whom may occasionally bike or walk as well); the three other employees walk or bike exclusively, and no emissions were tabulated for them.

Table 5-4: Annual Commuting Miles Driven and Associated Energy Consumption and Greenhouse Gas Emissions by Vehicle and Fuel Type, for 122 Survey Respondents, in 2008

Vehicle Type	Fuel Type	Number of Commuters or Vehicles*	Distance (Miles)	Energy Use (MMBTU)†	Emissions (tonsCO_2e)†
Full-size Car	Gasoline	18	60,067	394	30
Mid-size Car	Gasoline	21	79,703	487	38
Compact/Subcompact Car	Gasoline	25	129,167	620	48
Light Truck/SUV/Pickup	Gasoline	50	136,026	1,228	95
Single Occupancy Subtotal		**114**	**404,963**	**2,729**	**212**
Carpool/Vanpool±	Gasoline	32	40,760	368	28
Transit Bus	Diesel	16	11,988	267	21
Multiple Occupancy Subtotal		**48**	**52,748**	**635**	**49**
TOTAL		**162**	**457,711**	**3,364**	**261**

** Numbers do not add to 122 due to multiple commute modes used by commuters. All values represent the number of vehicles except for the carpool/vanpool row, which represents the number of carpoolers/vanpoolers (32).*

† CACP software accounts for non-whole numbers, but does not show them in totals.

± Vehicle miles entered into CACP software as light truck/SUV/pickup. Actual person-miles carpooled or vanpooled equaled 118,205. Respondents reported an average carpool/vanpool size of 2.9 persons, which was used to calculate total carpool/vanpool vehicle-miles (40,760).

Table 5-4 shows that a total of 3,364 MMBTU were used by the survey respondents in 2008. Single-occupancy vehicles account for 2,729 MMBTU, or 81% of the total energy use, and multiple-occupancy vehicles account for 635 MMBTU, or 19% of the total. For FY08, the corresponding emissions total in carbon dioxide equivalencies is 261 tons of CO_2e, with single-occupancy vehicles responsible for 212 tons of CO_2e, or 81% of total emissions. Of emissions from single-occupancy vehicles, light trucks/SUVs/pickups account for 95 tons of CO_2e or 45% of emissions. Compact/subcompacts cars account for 48 tons of CO_2e or 23%, mid-size cars for 38 tons of CO_2e or 18%, and full-size cars for 30 tons of CO_2e or 14% of total emissions from single-occupancy vehicles.

Multiple-occupancy vehicles accounted for an additional 49 tons of CO_2e, or 19%, of total emissions (see Table 5-4). Of emissions from multiple-occupancy vehicles, carpooling accounted for 28 tons of CO_2e or 57%, and transit buses for 21 tons of CO_2e or 43%.

Table 5-4 also shows total annual commuting miles by vehicle (and fuel) type for single-occupancy and multiple occupancy vehicles in 2008. For survey respondents, the aggregate annual commuting miles driven for single occupancy vehicles was 404,936 miles, which represents 88.5% of total vehicle miles driven (457,711). Multiple-occupancy vehicles (carpools, vanpools and buses) accounted for 52,748 vehicle miles driven, or 11.5% of total (see Table 5-4).

However, *vehicle miles* shown in Table 5-4 do not represent all *commuting miles* for survey respondents, which totaled 549,336. Biking and walking accounted for 14,180 *commuting* miles or 2.6% of total *commuting miles* (see Appendix E3).

When combined with energy use and emissions analyses for the other City sectors, the above data can help the City to determine how best to prioritize energy use and emission reductions measures based on relative contributions per sector.

Commuting Energy Use, Emission Estimates and Miles Driven by Commute Mode for All Employees

As explained above, we first calculated commuting-related energy use and emissions for the 125 survey respondents to determine emissions per respondent and then extrapolated to get an estimate of total commuting-related emissions for City employees as a whole. In 2008, per-employee energy used for commuting is 27 MMBTUs and commuting-related emissions are 2.1 tons of CO_2e (see Table 5-5). Using these per employee estimates, we found the total energy use by the employee commuting sector to be 10,694 MMBTU in 2003 and 13,418 MMBTU in 2008, a 25.5% increase (see Table 5-5).

Table 5-5: Estimated Energy Use (MMBTU) and Emissions (tons of CO2e) for All City Employees in FY03 and FY08

	Energy Use (MMBTU)	Emissions (tons of CO_2e)
FY03 Estimate for All Employees †	10,694	827
FY08 Estimate for All Employees*	13,418	1,037
FY03-FY08 % Change for All Employees†	25.5%	25.5%

*Based on 498.57 FTE in 2008 and 397.37 FTE in 2003

† Estimates for 2003 were proportionately based on FTE per year, so percent change is the same both years

Likewise, we found total emissions from the employee commute sector of 827 tons of CO_2e in 2003 and 1,037 tons of CO_2e in 2008, also a 25.5% increase. As the City has increased its FTE employees 25.5%, it can be reasonably assumed that emissions related to employee commuting habits have grown commensurately.

Table 5-6 shows estimates of total commute miles for all City employees. These values are also based on calculations of annual commuting distances per employee multiplied by the respective number of full-time employees in FY03 and FY08. "Carbon commuting," defined as commuting involving the use of fossil fuels, and "carbon-free commuting," defined as human-powered commuting, are separately tabulated.

In FY08, carbon commuting accounted for 97% of the estimated annual commuting miles for all City employees (2,134,502 of 2,191,060 miles), with driving alone accounting for 1.6 million miles or 74% of total commuting miles. Carpooling accounted for a total of 471,467 or 21.5% of total commuting miles in FY08, though transit buses accounted for only 47,815 or 2.2% of commuting miles.

Table 5-6: Estimated Annual Commuting Miles by Commute Mode for All City Employees, FY03 and FY08

	FY03	FY08	% of Total*
"Carbon Commuting"			
Driving Alone	1,026,052	1,615,220	73.7%
Carpooling/Vanpooling	299,495	471,467	21.5%
Busing	30,374	47,815	2.18%
Carbon Commuting Subtotal	1,355,921	2,134,502	97.4%
"Carbon-free Commuting"			
Biking/Walking	35,928	56,557	2.58%
Carbon-free Commuting Subtotal	35,928	56,557	2.58%
Total	**1,391,849**	**2,191,060**	**100.0%**

** Values identical for FY03 and FY08, due to estimates being based on FTE*

In FY08, carbon-free commuting accounted for 56,557 miles or 2.6% of City employee commuting miles. If emission reductions goals are set by the City, encouraging carpooling and carbon-free commuting is likely to have promising results. Encouraging more bus-riding, for example, through greater participation in the existing program that provides free bus passes to City employees, should also lead to commuting-related emission reductions.

In later sections of this report the above emissions data are combined with the emissions of the other sectors to identify where Missoula will be most able to make significant reductions in its overall energy usage and emissions. These comparisons reveal how employee commuting fits into the full scope of Missoula's municipal emissions.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, we found the vast majority of respondents commute via single-occupancy vehicles: 71% of employees commute always or sometimes by single-occupancy vehicles and 91% of commuting trips are made by single-occupancy vehicles. Commuting by single-occupancy vehicles contributed the most (81%) to the overall energy use and greenhouse gas emissions for the employee commute sector. Thus, steps to reduce driving alone will likely lead to the greatest reduction in overall energy use and emissions.

We also found that respondents live farther from work, and therefore, commute greater distances than we had expected, on average about 11 miles one-way, with 53% living more than 5 miles from work. As Missoula continues to grow, the possibility that this growth will result in larger City employee commuting distances should be taken into account in planning and land use decisions.

The commuting habits of City employees appear to be similar to Missoula's overall commuting community (see Baldridge 2008, p. 20).[23] Thus, efforts to reduce urban sprawl and concentrate future residential development close to employment, services and attractions could reduce commuting distances and single-occupancy vehicle commuting, and thereby emissions, for the Missoula community as a whole. Reduced commuting distances would also help the City contribute to meeting federal Clean Air Act fine particulate air quality standards.

We found the vast majority of respondents commute via single-occupancy vehicles: 71% of employees commute always or sometimes by single-occupancy vehicles and 91% of commuting trips are made by single-occupancy vehicles.

If the City would like to reduce greenhouse gas emissions, future land use, transportation planning, and urban area development policies should explicitly consider emissions associated with transportation and commuting, and they should encourage expansion within pre-existing areas that are already developed. To gain public support, the City of Missoula and sustainable transportation advocacy groups should consider providing education and outreach regarding the impacts of residential location choices on greenhouse gas emission goals and continue to promote alternative transportation and carbon-free commuting.

There is public support, though it is divided. Half of City residents responding to a 2008 transportation survey indicated that added and improved pedestrian and bicycling facilities would do more to enhance transportation than expanding roads (Baldridge 2008, p. 18). The larger survey sample of Missoula Valley residents rated improved pedestrian facilities as a very high transportation priority and improved bicycling facilities a high priority; these were ranked 5th and 10th, respectively, in priority out of 22 transportation planning criteria. Reducing energy use and climate change impacts was not explicitly included among the criteria, though respondents ranked minimizing impacts on the natural environment 2nd in priority. In addition, respondents ranked reducing vehicle emissions in general 9th in priority (Baldridge 2008, p. 13).

… future land use, transportation planning, and urban area development policies should explicitly consider emissions associated with transportation and commuting …

As discussed earlier in this report, Missoula recently hired a new position to oversee energy efficiency and conservation measures. We recommend that this person and others in City government continue implementing steps to achieve measurable success in reducing emissions from the employee commute sector. The valuable partnership with Missoula In Motion, the City Green Team, and other efforts will surely enhance the efficacy of these initiatives. It is our hope that this new office can also continue to monitor commuting-related energy use and emissions into the future.

23 Recent commuting surveys of workers in the Missoula area found 76-77% of employees usually commute by single-occupancy vehicle. As noted above, our survey is not directly comparable because of differences in the questions asked. Nevertheless, City of Missoula employees appear to drive alone slightly less than the typical Missoula area commuter.

City employee comments from our commuting survey provide some specific recommendations for altering employee commuting habits to reduce greenhouse gas emissions. We found that concerns regarding child care, bus routes, and work schedules are all major reasons that respondents decide to drive alone to and from work. A complete list of respondents' recommendations and comments are included in Appendix E4.

Many employees noted that their schedules necessitate driving due to child-care needs. Shift flexibility or a City-provided program or public-private partnerships for child-care close to work would be one way to address this barrier. Missoula In Motion has also developed and funded an incentive to avoid barriers to choosing sustainable modes of commuting as a result of emergencies (e.g., one involving child care). The Guaranteed Ride Home (GRH) program makes all City employees, both Way to Go! Club members and City EZ Pass holders, eligible to receive up to four free guaranteed rides home per year in the case of emergency.[24]

To reduce future emissions, programs that encourage City employees to use sustainable modes of transportation should continue to be supported and promoted. The main transfer station for all Mountain Line bus routes is conveniently located at the core of downtown Missoula, between City Hall and the County Courthouse on West Pine Street. We recommend that the benefits of the City EZ Pass be clearly communicated and promoted to new and existing City employees during orientations and annual meetings.

One particularly exciting incentive program has been proposed recently, aiming to increase awareness and participation in the Mountain Line City bus pass program. The program, called "City Employee Cash for Commuters," would reward City employee who regularly drive alone to work by giving them $2 per day to ride the bus to and from work.

We also found that carpooling (and vanpooling) is more prevalent than we had expected, with 25% of City employees participating at least occasionally. The average carpool size of three persons found in our survey means that commuting-related emissions may be reduced by as much as one-third for carpool trips over single-occupancy car trips. This is a positive finding that could continue to be expanded upon and encouraged as the City moves forward to achieve the ICLEI milestones.

One City employee survey respondent stated that, "City employees need parking provided to them." Clearly, for purposes of reducing emissions, making it more attractive to use alternatives to single-occupancy commuting is going to produce better results than providing free parking to City employees, which would seem to encourage driving. Perhaps a more effective and viable option would be offering free parking for carpool vehicles, especially in locations that are close to office buildings or weather-protected. This would provide the incentive for employees to fill the empty seats in their vehicles.

24 Additional information about the Guaranteed Ride Home (GRH) program is available on the Missoula In Motion website at http://www.missoulainmotion.com.

City employees already have access to vanpool and carpool coordination services on behalf of the Missoula/Ravalli Transportation Management Association (MRTMA), which oversees ride matching and vanpools for the area.[25] MRTMA also facilitates use of Park-and-Ride sites where employees can park for free at locations served by Mountain Line bus system.[26] Furthermore, posting a simple ride offered/needed sign-up sheet in a prominent place (i.e., employee break room) can be effective.

There were also several comments about creating more flexible work schedules to allow for greater use of the bus system and other alternatives to driving. One person suggested "look[ing] at four 10-hr shifts and telecommuting for employees" to reduce the total miles driven. Another said, "give 10-minute incentives morning and evening to ride the bus, bike, or walk to and from work" to account for increased travel time. A simple flex policy is an approach that could shift work arrival and departure times to and from work from "on-the-hour" times to times that match the Mountain Line bus timetable more closely (i.e., :45 or :15 minute intervals).[27] These are all excellent suggestions, and while they may not be applicable to all City departments, they should be examined in greater detail for those departments and offices where they might be viable ways to reduce emissions.

Several other programs have the potential to further reduce barriers to sustainable modes of commuting. Car share programs using one or more of the City's fleet vehicle(s) could, if permitted, reduce driving for errands and meetings. The City, along with Missoula In Motion and Missoula County, are researching the feasibility of implementing a formal car share service, such as ZipCar. We recommend that formal plans be developed accordingly. Furthermore, a non-motorized solution could include purchasing and incorporating a fleet of bicycles that are equipped for safe and efficient commuting to errands and meetings.

A main challenge with reduced commuting-related energy consumption and related greenhouse gas emissions is that it often requires significant behavioral changes, which can be hard to implement. Commuting is at the interface of employees' personal and professional lives. Further investigation into employee commuting behavior motivations is needed, particularly regarding perceived barriers and benefits of carbon-free commuting. Likewise, further work is needed on programs and incentives that could make it more attractive for employees to utilize less carbon-intensive ways of commuting.

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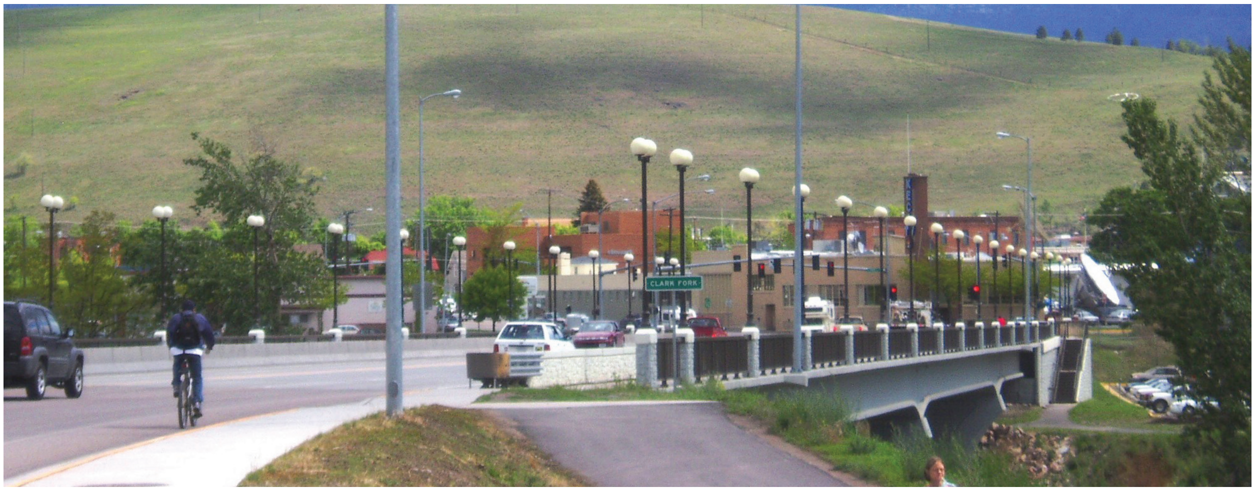
25 More information about the MRTMA ride matching service can be accessed online at http://alternetrides.com/Home_Rides.asp and http://mrtma.org/rideshare_application.htm.

26 A full list of Park-and-Ride sites is available at http://www.mrtma.org.

27 Additional information regarding flexible employee commuting programs can be found at http://www.commuterchallenge.org/flexwork.html.

6. LIGHTING



INTRODUCTION

Lighting is an important public service. It makes intersections safer for pedestrians, bicyclists, and cars by helping to prevent traffic accidents. Lighting also improves the safety of sidewalks, streets, parking lots and other public areas. This section provides an analysis of energy use, energy cost, and greenhouse gas emissions associated with Missoula's street and traffic intersection lighting systems in FY03 and FY08. Other outdoor lighting such as lighting associated with parking structures, parking lots, and parks is similarly analyzed. In addition, we recommend emissions reduction strategies to supplement the City's previous and current reductions measures in this sector.

The City of Missoula has begun to improve the energy efficiency of its street and traffic lighting system. Comparisons of lighting-related energy usage, costs, and emissions between FY03 and FY08 help to identify opportunities for achieving further reductions in energy use, energy cost, and greenhouse gas emissions related to lighting for both the City of Missoula and Missoula homeowners and businesses whose property assessments pay for streetlight districts.

This section considers Missoula's five main categories of public lighting for which NorthWestern Energy directly bills the City: (1) Street Light Districts; (2) Multiple Intersections billing group; (3) Miscellaneous Intersections billing group; (4) Other Lighting; and (5) Traffic Signals. Each of these categories is described below, though categories #2 and #3 are grouped together as "Intersection Lighting" to facilitate the presentation, and Traffic Signals are reported as a separate tabulation since they are a subset of categories #2 and #4.

Lights contribute 8.5% of total greenhouse gas emissions for the City of Missoula municipal operations. Thus, the lighting sector provides an opportunity to meet future emission reduction targets.

Street Light Districts

In Missoula, streetlights, the poles, lamps and controls, are grouped into 36 districts known as Street Lighting Districts. These districts vary in size and in the number and type of lighting equipment contained within them. The lamps have High Pressure Sodium (HPS) luminaries that range from 70 watts to 400 watts. In Missoula's 36 streetlight districts, there are a total of 1,923 streetlights, which are all owned by NorthWestern Energy. In the State of Montana, the company owns 78,000 lights, and approximately 40,000 of these are located in streetlight districts.

The City of Missoula receives a monthly streetlights bill from NorthWestern Energy for each district. These are consolidated in a single bill or billing group. On July 28, 1986, the Missoula City Council voted to have the City General Fund pay 10% of the annual costs for each streetlight district and have homeowners assume 90% of the annual costs. This cost is assessed twice a year on homeowners' and commercial property owners' property taxes (City of Missoula, 2006).

Streetlight districts can be established under Montana Code Annotated (MCA) Title7, Chapter 12, Part 43. A streetlight district is formed when the City of Missoula enters into a contract with NorthWestern Energy, in which the City agrees to pay the company for the "furnishing, operating and maintaining of streetlight facilities, and for delivering electric energy" to the lighting facilities. The contracts were carried over during the transition from Montana Power to NorthWestern Energy. The majority of contracts are at least 30 years old and self-renew generally every three years.

State law allows for nine separate charges to be included in streetlight district billing statements.

The City of Missoula is charged for the electricity portion of streetlight district costs at a rate approved by the Montana Public Service Commission (PSC). The rates may be changed at the request of NorthWestern Energy, subject to approval by the PSC. These rates are the same in each city throughout Montana that utilizes NorthWestern Energy's services. State law allows for nine separate charges to be included in streetlight district billing statements (see Appendix L1 for a description). Of these nine charges, only three are directly related to electricity supply and transmission. The other charges include ownership, operation and maintenance charges, for example. As such, the City and property tax payers alike face a variety of charges as a result of essentially leasing rather than owning streetlights.

A 2003 analysis of these charges in Great Falls found that the City pays $2.60 to $21.86 per month per light pole (Kinzler and Lawton 2003). There are also distribution pole charges. Great Falls indicates that it has paid for many poles four times over, due to the longer than planned replacement schedule. A similar situation is likely to be the case in Missoula.

Multiple Intersections and Miscellaneous Intersections

Multiple Intersections and Miscellaneous Intersections refer to the billing group name on NorthWestern Energy (NWE) bills for groups of separate NWE accounts that are not part of a streetlight district. There are 33 and 18 separate accounts, respectively, listed under Multiple Intersection and Miscellaneous Intersection billing groups.[28] Nearly all of the accounts are for lighting but not exclusively for intersection lights. Both billing groups and accounts associated with them are billed to the Missoula Public Works Department.

The individual account descriptions or names for lights listed on both billing groups indicate the lights consist of flashers, blinkers, and streetlights that are found at crossings and intersections, often where there are also traffic signals (see Appendix L2 for the NorthWestern Energy account names). Generally though, both billing groups appear to contain the same types of lights. This makes it difficult to determine how or why it was decided which type of light to include in each account. In fact, City personnel we contacted were not able to explain the groupings, other than by remarking that "it just evolved that way."[29]

Because we were not aware of any functional or operational difference between the two billing groups, the lights included in both are hereafter combined in this report into a category referred to as "Intersection Lights" though it should be recognized that not all of the lighting in this category is for intersections. Another reason that we combined Multiple Intersections and Miscellaneous Intersections into a single group is that both billing group include individual accounts for lights that are not City-owned and thus, also have associated ownership, operation and maintenance charges from NorthWestern Energy.[30]

Other Lighting

An examination of the City's NorthWestern Energy accounts revealed an additional 32 accounts in FY03 and an additional 37 accounts in FY08 with account names and descriptions similar to those included among the Multiple Intersections and Miscellaneous Intersections billing groups, i.e., they appear to be lighting accounts. Thus, we have included energy use, costs and emissions associated with these accounts in this section and included among a separate line item in the tabulations below labeled "Other Lights." Most of these other lights are billed to the Parks Department (15 accounts in FY08) and the Missoula Parking Commission (11 accounts in FY08). See Appendix L2 for a list of these accounts.

These other lights appear to be City-owned, and thus do not have the additional charges as do Street Light Districts and the Multiple Intersections and Miscellaneous Intersections billing groups. There may be other NorthWestern accounts for lighting that are included in the Other Energy Uses and Emissions section of this report. Although we attempted to accurately identify lighting accounts, it is possible that some are misidentified and that some of the other 64 unspecified accounts not covered in this section that we did not classify as lighting accounts indeed may be wholly or partially lighting-related.[31] A field

28 In FY03 there were only 12 accounts for the Miscellaneous Intersections group. Six accounts have been added since then.

29 In fact, in FY03 and FY08, an account for the City's Upland Trail radio tower was included in this Miscellaneous Intersections billing group and as such was included as part of the group for this analysis.

30 Miscellaneous Intersection billing group did not have ownership, operations and maintenance charges in FY03.

31 The NorthWestern Energy account names and service addresses were not always adequately descriptive enough to know with certainty what the type of energy use was associated with each account, and City personnel we contacted did not have complete knowledge of accounts. A good portion of lighting not included in this section is likely to be associated with accounts billed to the Parks Department. In addition, outdoor lighting affixed to an existing building is most likely billed through the building electricity account, and thus, such lighting is not necessarily included in the tabulations below.

inventory of lighting would need to be conducted to identify all lighting accounts with certainty. It should be noted that these 37 Other Lighting accounts and the Multiple Intersection and Miscellaneous Intersection accounts are paid for monthly from the City's General Fund.

Traffic Signals

The City of Missoula currently owns 11 sets of traffic signals billed under 10 NorthWestern Energy accounts (see Appendix L2). Five of these accounts were in existence in FY03, and five were added since then. Most, but not all, of the accounts for traffic signals are included in the Multi-intersection billing group. Because the traffic signals accounts are not a subcategory of any of one of the other lighting categories, we present energy use, costs and emissions for them as a separate tabulation.

Accounts for nearly all City-owned traffic signals also include electricity charges for streetlights at the same intersections. The only accounts that include charges solely for the traffic signals (including pedestrian signals as well) are the signals at the Higgins Avenue and Spruce Street intersection and the Higgins Avenue and Pine Street intersection (Rick Larson, personal communication, March 2009).

In FY05 and FY06, as part of a capital improvement project, the City's existing 11 traffic signals were converted from incandescent bulbs to more energy efficient Light-Emitting Diode (LED) lights. The green signals, green arrows, red signals, and pedestrian indicators were all replaced. This change represents an important initiative taken by the City to reduce lighting-related energy use and emissions, and the benefits should not be understated. The City deemed the yellow signals as a lower priority and has not yet replaced them with LED lights because they are on for a shorter duration than the other signals.[32]

METHODS

For each of the lighting categories described above, we compiled NorthWestern Energy account numbers from the City's hard-copy billing records for FY03 and FY08. As noted above, each bill for the Street Light Districts, Multiple Intersections and Miscellaneous Intersections are broken down into individual accounts.

32 Also, according to Rick Larson, Missoula's Traffic Services & Communications Shop Supervisor, the City also maintains (but does not pay electricity costs for) 53 State-owned traffic signals within the city limits. Of these, the six newest have LED lights for all traffic lights except the yellow lights. The 47 remaining signals have LED lights for the red light only (Larson, personal communication, April 2009).

Table 6-1 shows the number of NorthWestern Energy accounts for each type of billing group.

Table 6-1: Number of NorthWestern Energy Accounts by Lighting Account Type in FY03 and FY08

Lighting Account Types	FY03	FY08
Street Light Districts	36	36
Intersection Lights	45	51
"Multi-intersection"	33	33
"Misc-intersection"	12	18
Other Lighting	32	37
Traffic Signals	5	10
Total	**113**	**124**

Notes: Street Light Districts and the Intersection Lights billing groups include NWE ownership, operations & maintenance charges. For billing purposes traffic signals are a subset of the Miscellaneous Intersection and Other Lighting billing groups. Thus, the totals do not add up.

We obtained in electronic form the electricity usage (kWh) and electricity cost ($) data from FY03 and FY08 for each of these accounts from NorthWestern Energy, and we spot-checked these figures against the hard-copy billing records. In the process we discovered that ownership, operation and maintenance charges data for streetlight districts were not included in the electricity costs data we obtained from NorthWestern Energy.

To determine ownership, operations and maintenance costs, we examined several months of hard-copy records for FY03 and FY08. We determined the percentage of those charges of the total costs and used the average of those percentages to estimate the charges for other months for each year based on known electricity costs. For example, if hard-copy records for several months indicated that ownership, operation and maintenance costs accounted for an average half of the billed costs, we doubled the electricity costs to estimate total costs.

This reduced the time needed to find and transcribe 12 months of hard-copy billing records for each account within these billing groups. We are confident that this method yielded accurate results because streetlight district and intersection light charges are very consistent from month to month.

We used a similar procedure to determine ownership, operation and maintenance costs for Multiple Intersections and Miscellaneous Intersections (reported below as "Intersection Lights" or "Intersection Lighting"). Although we were able to determine ownership, operation and maintenance costs for Multiple Intersection accounts for both FY03 and FY08 from hard copy records, for Miscellaneous Intersections we were only able to do so for FY08. The FY03 hard copy records do not indicate such charges were billed that year. Thus, it appears that those non-electricity charges were added since FY03 to the Miscellaneous Intersection accounts (which increased from 12 to 18 during that time), as shown in Appendix L2.

Electricity use data were entered into the CACP software to convert from kilowatt-hours (kWh) to millions of BTUs (MMBTUs) and metric tons of carbon dioxide equivalencies (tons of $C0_2e$) associated with the generation of electricity used for municipal lighting in Missoula.

Contacts

Several City employees were instrumental in providing us with the information necessary to compile this section of our report. Jolene Ellerton, Missoula's Public Works Permit Specialist, provided helpful information, particularly regarding streetlight districts and traffic signals. Rick Larson was very helpful in clarifying for us the structure and operation of the City of Missoula's traffic light system. Mary Kay Wedgwood, in the City Finance Department, was also instrumental in facilitating data collection from the City's hard copy NorthWestern Energy billing records. Bruce Bender, the Chief Administrative Officer, also provided information about traffic signal energy efficiency retrofits. Finally, the WGM Group, Inc. provided useful resources regarding the use of LED lights.

FINDINGS

Electricity Usage (kWh)

Table 6-2 shows the total electricity usage (kWh) in FY03 and FY08 for the four lighting categories analyzed in this inventory. As shown in Table 6-2, total electricity usage for the lighting sector decreased 1% overall, from 1,926,692 kWh in FY03 to 1,947,891 kWh in FY08. Electricity usage for streetlight district was fairly consistent over the five-year period from FY03 to FY08. Electricity usage by intersection lights increased by 6.5, and use by other lights stayed about the same during the period.

Table 6-2: Electricity Use (kWh) by Missoula Streetlight Categories in FY03 and FY08

Lighting Category	FY03	% Total		FY08	% Total		% Change
Street Light Districts	1,346,304	69.9%		1,343,413	69.0%		-0.2%
Intersections Lights	395,945	20.6%		421,541	21.6 %		6.5%
Other Lights	184,443	9.6%		182,937	9.4%		-0.8%
Total	**1,926,692**	**100%**		**1,947,891**	**100%**		**-1.1%**

The modest increase in electricity use by Intersection Lights may be explained by the addition of individual lights within existing accounts, and the addition of six new accounts to the Miscellaneous Intersections billing group, though this increase would have been greater if LEDs had not been installed in traffic signals, most of which are included among Intersection Lights.

Of the three lighting categories included in Table 6-2, streetlight districts were proportionally the largest consumers of electricity in both FY03 and FY08. In FY08, streetlight districts used 1,343,413 kWh (69%) of the total electricity used by the City's lighting sector, Intersection Lights used 421,541 kWh (22%), and Other Lights used 182,937 kWh (9%) (see Table 6-2). Relative percentages of electricity use in FY03 were nearly the same.

Thus, streetlight districts and intersection lighting offer the greatest opportunity for energy savings through conservation, energy efficiency and renewable energy. This may be difficult though, due to the fact that the City does not own these lights and the poles they are on.

Lighting Costs ($)

Table 6-3 shows the total costs in FY03 and FY08 for the three categories of lights examined. Total municipal lighting costs were $306,946 in FY03, and $453,758 in FY08, which represents a 48% increase. This increase occurred despite electricity use for municipal lighting remaining flat during the period (see Table 6-2). From FY03 to FY08, streetlight district costs increased 33%, intersection light costs increased 108%, and "other lighting" costs increased 93%.

In FY03 and FY08, streetlight districts accounted for the largest share of Missoula's municipal lighting costs. In FY08, streetlight districts, intersection lighting, and other lighting accounted for 72%, 24%, and 3.9% of the total lighting costs, respectively. Thus, streetlight districts and intersection lighting offer the greatest opportunity for cost savings, though the increase in costs for the other light category should also be a concern.

Table 6-3: Electricity Costs and Ownership, Operation and Maintenance Costs ($) by Lighting Category in FY03 and FY08

Lighting Category and Cost Type	Electricity Costs ($)				
	FY03	% by Type	FY08	% by Type	% Change
Street Light Districts	**$244,531**		**$325,349**		**33.1%**
Electricity	$39,526	16.2%	$117,227	36.0%	197%
Own., Oper., & Maint.	$205,005	83.8%	$208,122	64.0%	1.5%
Intersection Lighting	**$53,173**		**$110,543**		**108%**
Electricity	$15,873	29.0%	$39,231	35.5%	147%
Own., Oper., & Maint.	$37,300	71.0%	$71,313	64.5%	91.2%
Other Lighting	**$9,242**		**$17,866**		**93.3%**
Electricity	$9,242	100%	$17,866	100%	93.3%
Own., Oper., & Maint.	---	---	---	---	---
Total – All Lighting	**$306,946**		**$453,758**		**47.8%**
Electricity	$64,641	21,1%	$174,324	38.4%	172%
Own., Oper., & Maint.	$242,305	78.9%	$279,434	61.6%	15.1%
General Fund	**$86,868**	**28.4%**	**$160,944**	**35.0%**	**85.3%**
Property Assessment	**$220,078**	**71.6%**	**$292,814**	**65.0%**	**33.1%**

Table 6-3 also shows the relative proportion of total NorthWestern Energy costs for electricity as compared to the estimated costs for ownership, operation, and maintenance. In FY03, 84% of the total cost of streetlight districts went toward ownership, operation, and maintenance, and 16% of the total cost of streetlight districts was for actual electricity. In FY08, electricity accounted for about one-third of the total costs for streetlight districts and intersection lighting, and ownership, operation and maintenance accounted for about two-thirds of total costs.

Despite the fact that the relative costs of ownership, operation, and maintenance costs from NorthWestern Energy decreased for each lighting category from FY03 to FY08, these costs nevertheless constitute a significant portion of Missoula's lighting costs, nearly $280,000 in FY08.

If one omits the portion of the lighting costs that are assessed to property owners for streetlight district, lighting costs to the City's General Fund increased from $86,868 in FY03 to $160,944 in FY08. In FY08, the General Fund paid for 35% of total municipal lighting costs, while homeowners were assessed for the remaining 65%. However, from FY03 to FY08, General Fund lighting costs increased 85%, while property owner assessed costs (for streetlight districts) increased 33%, from $220,078 to $292,814. Thus, General Fund costs for lighting have increased at a faster rate than residential and business property owner streetlight district assessments.

Electricity costs for lighting nearly tripled in five years, going from $39,526 in FY03 to $117,227 in FY08.

Figure 6-1 provides a visual comparison between electricity costs and the ownership, operation and maintenance costs for streetlight districts in FY03 and FY08. Electricity costs for lighting nearly tripled in five years, going from $39,526 in FY03 to $117,227 in FY08. This increase can almost entirely be attributed to electricity rate increases. Although the ownership, operation, and maintenance costs increased only 1.5%, these costs account for a much larger portion (84% in FY03 and 64% in FY08) of total streetlight district costs (see Table 6-3).

Figure 6-1: Electricity Costs vs. Ownership, Operation & Maintenance Costs for Missoula Street Light Districts, FY03 and FY08

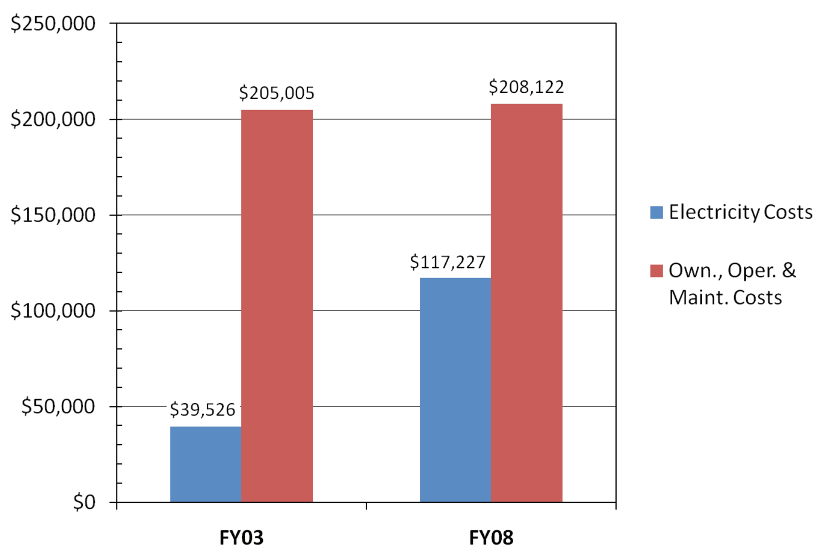
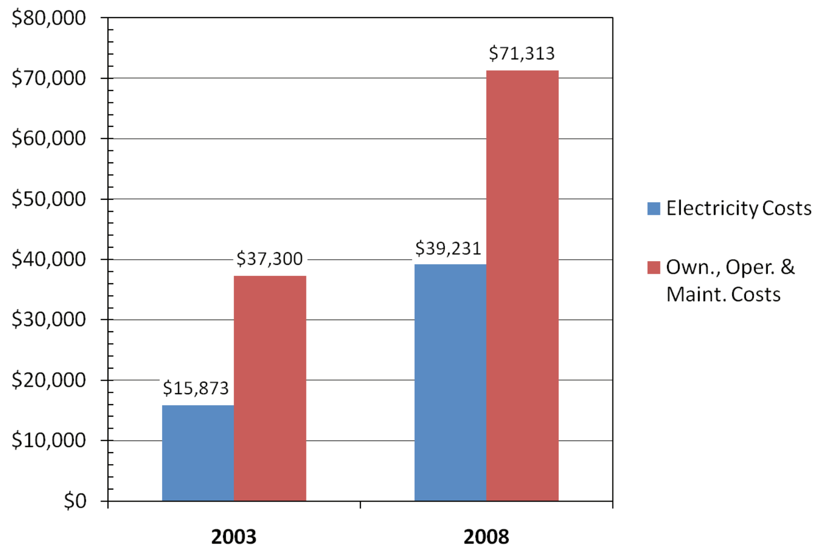


Figure 6-2: Electricity Costs vs. Ownership, Operation & Maintenance Costs for Other Missoula Intersection Lighting, FY03 and FY08



As shown in Figure 6-2, the electricity costs for intersection lights increased from $15,873 in FY03 to $39,231 in FY08 (147%). The estimated ownership, operation, and maintenance costs for intersection lights increased from $37,300 in FY03 to $71,313 in FY08 (91%). In FY08, nearly two-thirds (65%) of the total costs of intersection lights resulted from charges other than those for direct electricity supply, distribution and transmission (see Table 6-3).

Traffic Signal Electricity Use and Costs

As noted above, traffic signals are a subset of other lighting categories and therefore are tabulated separately. Table 6-4 shows that traffic signal electricity use and costs in FY03 and FY08, with separate lines for the five signals that existed prior to FY03 and the five that were added later. LEDs were installed in all 10 signals in FY05 and FY06. By showing electricity use for the pre-FY03 signals, one can see that a 58% reduction in electricity use was achieved and a 36% reduction in electricity costs from FY03 to FY08. The costs signal in FY08 was just over $800 compared to $1,270 in FY03. Traffic signal energy costs still account for only 5% of the General Fund costs for lighting in Missoula.

Table 6-4: Electricity Costs ($) and Use (kWh) for Traffic Signals in FY03 and FY08

	Electricity Costs ($)				Electricity Use (kWh)		
Traffic Signals	FY03	FY08	% Change		FY03	FY08	% Change
5 Pre-FY03 Signals	$6,361	$4,046	-36.4%		90,441	38,217	-57.7%
5 Post-FY03 Signals	---	$4,073	n/a		---	36,921	n/a
Total	**$6,361**	**$8,119**	**27.6%**		**90,441**	**75,138**	**-16.9%**

City officials have offered the LED replacement as a prime example of the City's energy conservation efforts (Szpaller 2009c). The findings here suggest that additional installations of LEDs would be an effective approach to reducing energy costs of lighting.

Greenhouse Gas Emissions (metric tons of CO_2e)

Table 6-5 shows the quantity of greenhouse gas emissions in metric tons of carbon dioxide equivalencies (tons of CO_2e) from the four lighting categories in FY03 and FY08. As shown in Table 6-5, streetlight districts were responsible for the largest amount of greenhouse gases emissions in both FY03 and FY08. Of total municipal lighting-related emissions in FY08, streetlight districts accounted for 675 tons of CO_2e (69%), intersection lights accounted for 212 tons of CO_2e (22%), and other lights for 97 tons of CO_2e (10%). Traffic signals accounted for 38 tons of CO_2e (3.8%) in FY08. From FY03 to FY08, greenhouse gas emissions from streetlight districts, intersection lights, and other lights increased 8.7%, 16%, and 13%, respectively (see Table 6-5). Emissions associated with traffic signals decreased 9.5%. Emissions closely track electricity usage. However, the gird intensity factor in was slightly higher in FY08 than in FY03, which means that using the same amount of electricity in both years would result in more emissions in FY08.

Table 6-5: Greenhouse Gas Emissions (tons of CO2e) for Missoula Municipal Lights

	Emissions (tons of CO_2e)						
Lighting Category	FY03	% Total		FY08	% Total		% Change
Street Light Districts	621	69.9%		675	68.6%		8.71%
Intersection Lights	183	20.6%		212	21.5%		16.0%
Other Lights	85	9.57%		97	9.81%		13.4%
Traffic Signals	42	4.69%		38	3.84%		-9.49%
Total*	**889**	**100%**		**983**	**100%**		**10.7%**

**Total does not include traffic signals, which is a subset of other categories.*

CONCLUSIONS AND RECOMMENDATIONS

This section of our report helps the City of Missoula identify the categories of municipal lighting that are contributing the most to greenhouse gas emissions. This information along with a more comprehensive inventory of city-owned lighting can be used a first step in prioritizing efforts to achieve reductions in electricity use, overall costs and emissions with the lighting sector. Additional analysis will need to be done of costs and payback periods of specific energy saving measures. Grants and other source of funds could also be investigated for improving the efficiency of the City's outdoor lighting infrastructure.

As previously described, the City has already taken some significant steps to improve the efficiency of its lighting system. Despite these efforts, the greenhouse gas emissions resulting from this sector have increased 8.3% from FY03 to FY08. In the future, Missoula's lighting system, along our roadways, in our parks, in our parking lots and elsewhere, will continue to be a valuable public service. As Missoula experiences population growth, it is likely that lighting will also need to be expanded to ensure the safety of our community. However, the installation of additional lighting equipment does not necessarily mean that energy consumption and resulting emissions must also increase.

Opportunities to reduce electricity consumption, costs, and associated greenhouse gas emissions from Missoula's lighting sector can involve making physical changes to the lighting equipment itself, further evaluating the lighting use and needs, and curtailing unneeded uses. Missoula residents and business owners could be involved in creative problems-solving to identify additional opportunities, and the City could engage in negotiations over costs or equipment ownership transfers with NorthWestern Energy and the Public Service Commission.

Although not specifically discussed below, small-scale renewable energy, particularly solar cells and wind turbines, as well as purchased renewable energy could offer significant energy and costs savings and emission reductions. Because these measures apply to other sectors, such as buildings and the wastewater treatment plant, they are considered as part of overall recommendations of this report.

Outdoor Lighting Equipment Upgrades

Reducing energy consumption associated with lighting can be readily achieved if energy-efficient lighting equipment is used. We recommend that the City consider developing a program to replace most if not all remaining lighting with Light Emitting Diode (LED) luminaries. Such a change, even if gradually implemented, would be a major modification to the lighting system.

Opportunities to reduce electricity consumption, costs, and associated greenhouse gas emissions from Missoula's lighting sector can involve making physical changes to the lighting equipment itself, further evaluating the lighting use and needs, and curtailing unneeded uses.

Missoula has already replaced nearly all of its 10 traffic signal lights with LED lights. We recommend that the City greatly expand this effort into other lighting categories, particularly when existing equipment is replaced or repaired, and when new lighting equipment is installed. For example, the City could install LED lights to replace existing yellow traffic signal lights, and the most energy-efficient lights should also be chosen to replace City-owned intersection lights and other light categories. Costs for these lights appear to be billed primarily to the Parks Department and the Missoula Parking Commission (see Appendix L2).

Replacement of streetlights and intersection lights, which are not owned by the City, will pose a greater challenge. Nevertheless, the above analysis strongly suggests that greater efficiencies in these two lighting categories will be needed if significant energy saving and emission reductions in the lighting sector are to be achieved in the future.

Replacement of the High Pressure Sodium Vapor (HPSV) lamps currently used in streetlight district lights and various intersection lights in Missoula could be difficult to finance, and it would be administratively and legally daunting. Nevertheless, the payback could be shorter than at present if electricity prices continue to rise and costs of LED lamps continue to decrease. Moreover, lighting change-out projects could become increasingly fundable if federal and state grants and NorthWestern Energy support such "low-hanging fruit" projects and the already vigorous demand of carbon offsets and green tag programs continue to increase and provide funds. In addition, a concerned public may demand, or conservation champions within City government may show the leadership that will be needed to face the challenges head on.

The U.S. Department of Energy reports, "Overall the performance of LED Luminaries is advancing in efficiency at a rate of approximately 35% annually with costs decreasing 20% annually" (Cook and Summer, 2008, p.1). Unlike HPSVs, LED lamps do not contain mercury, and thus do not pose a hazard during handling and disposal. Furthermore, LEDs also are consistent with the ideals of a sustainable city and Missoula's self-image.

Streetlight retrofits have been successfully implemented in many cities. For example, the city of Anchorage recently replaced one-quarter of its streetlights (16,000 in total) with the LED Way Luminary. This brand of luminaries has been shown to consume 50% less energy than high-pressure sodium lamps. This project will save the city $360,000 per year in energy costs as well as reduce labor needed and maintenance costs (Beta LED, 2008, p.1-2). Greensburg, Kansas, a small town of 800 people, is the first U.S. town to have all LED streetlights. Mayor Bob Dixon had said using "330 LED streetlights has cut our energy by 40%" (Doty, 2008, p.9). Ann Arbor, MI, Greensburg, KS, Kenosha, WI, Racine WI, and Raleigh, NC have carried out similar efforts. Indeed cites the size of Missoula have found a way to make the investments to achieve energy cost saving and do their parts to address climate change.

In one study done for the Pacific Gas & Electric Company, HPSV luminaries in Oakland, California, were replaced with LED luminaries. Energy use was monitored, and significant savings were achieved (Cook and Sommer, 2008). The study also looked at the annual cost of LED and HPSV luminaries and compared *spot replacement*, done when an individual lamp fails, and *group replacement*, done when working lamps are replaced every six years. The study notes reduced maintenance costs are associated with LEDs due to their longevity and reliability and lower overall costs. Of course, this applies to situations in which the maintenance and replacement costs are borne by the same entity that pays for the electricity. This is the case for about half to the 124 NorthWestern Energy accounts we identified that are devoted to lighting.

Reduced maintenance costs are associated with LEDs due to their longevity and reliability and lower overall costs.

Thus, it is recommended that the City of Missoula continue to examine how other cities have initiated LED projects and how Missoula could "Go LED." We encourage the City to undertake an LED pilot project as soon as possible involving a single streetlight district, perhaps the one encompassing the University of Montana, or one initiated by another district's residents or businesses. A lighting retrofit of a single park, parking lot or parking structure could be another way to lower Missoula's carbon footprint; NorthWestern Energy could make an excellent partner for such a project.

Attention to Costs and Contracts

Municipal outdoor lighting costs in Missoula increased nearly 50% from FY03 to FY08 and are approaching $500,000 annually. The General Fund portion increased 85% during this time. Missoula's strained coffers would benefit from devoting more attention to the City's contracts and costs associated with streetlight districts and the various multiple and miscellaneous intersection accounts and the additional other lighting accounts we identified (see Appendix L2). Streetlight district contracts can be renegotiated every three years: Montana Code Annotated Section 7-12-4351 states that the council in any city or town in Montana can modify an existing special improvement light district in a variety of ways.

Ownership, operations, and maintenance charges were 64% of the total cost for streetlight districts in FY08. We suggest that the city conduct a careful examination of the services Missoula receives from NorthWestern Energy for paying over $200,000 in annual ownership, operation and maintenance charges for streetlight districts, and for annually paying over $70,000 of these charges for multiple and miscellaneous intersection lights.

Ownership, operations, and maintenance charges were 64% of the total cost for streetlight districts in FY08.

Missoula's property owners and taxpayers are directly responsible for paying the vast majority of the costs associated with streetlight districts and supporting annual General Fund costs of $161,000 for municipal lighting. Missoula residents have a direct interest in the City trying to holding the line on these rapidly increasing "pass-through" costs.

Thus, we also recommend that Mayor Engen, Missoula City Council, and other City officials, along with Neighborhood Councils and other civic bodies, become more informed and invite the public and business community to participate in discussions about not just how to hold the line on lighting costs increases but how to reverse them.

Consider the opportunity costs of not moving toward more an efficient lighting system. What cherished things may get squeezed out of the future budgets or are being already if we do not take the opportunity to improve the energy efficiency of outdoor lighting?

As a starting point, the City would benefit from closely examining each of the charges on NorthWestern Energy accounts associated with the streetlight and intersection lighting bills. For example, the City pays NorthWestern Energy an ownership charge for each streetlight pole. We question why this cost is continually charged rather than being a one-time or time-limited cost, particularly if the service life of poles is extended years and even decades beyond the period during which charges would reasonably be expected to pay for a replacement pole. Thus, each pole could be paid for over time at an established rate such that the City eventually gains ownership over the pole from NorthWestern Energy.

What cherished things may get squeezed out of the future budgets … if we do not take the opportunity to improve the energy efficiency of outdoor lighting?

Similarly, we believe that City should question why maintenance costs are charged at a flat rate within each streetlight district. The City, perhaps with others in Montana, could try to renegotiate terms of payment such that maintenance costs are only charged by NorthWestern Energy when maintenance services are actually carried out. The City and owners of assessed properties could benefit greatly from an arrangement whereby transfer of responsibility for ownership, operations, and maintenance to the City for certain districts or lighting groups while the utility maintains direct costs for electricity supply and transmission.

Energy and Emissions Monitoring and Reporting

We also recommend that the City implement a monitoring and reporting system to allow for accurate analysis over time of costs, electricity use, and associated greenhouse gas emissions from each lighting-related NorthWestern Energy account. To develop ongoing monitoring, the City might benefit from consolidating or recombining some of its lighting system accounts. Combining some accounts could allow for easier inventory and trend analysis. The 36 streetlight district accounts are already combined, and as noted above, multiple intersections accounts and miscellaneous intersection accounts are also separately combined. These might be logically combined or other more logical groupings of accounts established. Such an effort might include some or all of the 37 "other lighting" accounts and any other lighting-related accounts not already identified in this report (see Other Energy Uses and Emissions section). The current organization of NorthWestern Energy billing accounts appears to be designed to facilitate payment, which certainly is important. However, the current organization is not conducive to developing a climate action plan or energy conservation plan, implementing emission reduction measures and monitoring results, which is the next step of the U.S. Conference of Mayors Climate Protection Agreement.

7. WATER

INTRODUCTION

Municipal water consumption requires pumping and transporting, and sometimes treating water, all of which require energy. In this chapter, we report our estimates of embodied energy in the water consumed by the City of Missoula for municipal operations. We also report greenhouse gas emissions associated with the embodied energy of municipal water consumption in 2003 and 2008. We conclude this chapter with recommendations for water-related emission reductions.

Although the emissions resulting from municipal water consumption contribute a small percentage of total municipal emissions, including embodied energy of water in this inventory helps us achieve our goal of performing a comprehensive inventory of municipal emissions. We believe it is important for the City to demonstrate leadership in water conservation because it can help reduce emissions, not just for City operations but for the community as whole, particularly in areas where water is pumped uphill. In addition, climate change itself may place strains on water supplies, and thus water conservation may be important for adapting to climate change and protecting water supplies and the value Missoulians place on water in the future.

Emissions inventories of other Montana cities (Helena and Bozeman) combine water and wastewater into a single sector, primarily because both are municipal services in those cities. Although the City of Missoula manages wastewater treatment service in the Missoula area, it does not operate drinking water treatment and delivery service. Thus, estimates of emissions for Missoula's municipal water consumption require the use of different sources of data and sets of assumptions.

The primary uses of water by the City of Missoula are for operation and maintenance of the City's parks and recreational facilities, municipal buildings, the City cemetery and the Missoula wastewater treatment plant. Water use in about half of the City's parks is unmetered, though the remaining parks and all other City uses are metered (John Kappes, Mountain Water Assistant General Manager, e-mail, March 9, 2010). The Parks, Fire, and Public Works (which includes the Street Maintenance Division) departments are some of the City's primary water users.

MISSOULA'S WATER SUPPLY

The Missoula Valley is fortunate that the Missoula Valley aquifer provides ample withdrawal capacity to supply the City of Missoula with a reliable and very clean supply of water for municipal operations and services. The Missoula Valley Aquifer is a shallow alluvial aquifer that is the sole source of water for Missoula residents in over 40,000 households (Missoula Valley Water Quality District 2009).

Water is supplied to the City of Missoula by the Mountain Water Company, an investor-owned utility regulated by the Public Service Commission. To provide water service for Missoula, Mountain Water has 37 wells, 45 boosters, 24 storage facilities, and a storage capacity of approximately 9.3 million gallons. Mountain Water does not have a water treatment facility but instead uses chlorination to treat the water supply.[33] NorthWestern Energy provides all electricity used for Mountain Water Company operations. The City of Missoula is Mountain Water Company's largest flat-rate customer. In the past, street cleaning and sewer flushing was unmetered. Beginning this year (2010), the street cleaning and sewer flushing are being charged for actual water consumption. In addition, the City recently agreed to meter all of its flat-rate accounts within three years of February 2009 (John Kappes, e-mail, March 9, 2010).

METHODS

Upon request of the Missoula Mayor's Office, we obtained electronic records of the City's water consumption from Mountain Water Company. John Kappes, the Assistant General Manager for Mountain Water, was especially helpful and acted as our primary contact. He, Mike Ogle, and other personnel at Mountain Water provided water consumption data for the 2004 and 2008 calendar years for 444 Mountain Water accounts that are billed directly to the City of Missoula. We assigned each of these accounts to various City divisions and departments for this analysis.

Calendar Year 2004 was the most current year for which we could obtain municipal water consumption data. To provide consistency with the other sections of this report, we estimated water consumption and embodied energy of water for 2003 by extrapolating backwards using the average annual rates of change in water consumption and water-related electricity use from 2004 to 2008 (13.4% and 14.85% respectively).

Although embodied energy in water and associated greenhouse gas emissions are reported by calendar year and all other sectors are reported by fiscal year in this report, we do not believe this is likely to detract from the reliability of our analysis, given the fact that six months of the 2003 and 2008 calendar years are in common with Fiscal Years 2003 and 2008.

Using data from Mountain Water Company, we calculated electricity used to supply water consumed by the City of Missoula for municipal operations as follows:

> Electricity Use (kWh) = City water consumption (gallons))/ Mountain Water annual rate of production (gallon/kWh).

33 For more information, visit the Mountain Water Company website at http://mtnwater.com/history.htm.

The rate of production is a measure of the gallons of water pumped from the aquifer and delivered into the water distribution system per kilowatt hour. The rate of production was 771.24 gallons/kWh in 2004 and 742.62 gallons/kWh in 2008. We used Mountain Water's "lowland" production rate, which does not include energy needed for booster pumps to transport water to the Rattlesnake area and the South Hills. We used the lowland production rate because municipal water use occurs in the parts of Mountain Water's Missoula service area that do not require booster pumps. Because much of the water used for irrigation by the Parks Department is unmetered, our estimates of municipal water consumption and resulting greenhouse gas emissions assumed an average rate of irrigation and the irrigated area.
As with other sectors, we used the CACP Software to calculate total embodied energy of water in millions of British Thermal Units (MMBTU) and greenhouse gas emissions in metric tons of carbon dioxide equivalencies (tons of CO_2e) for FY03 and FY08.

RESULTS

Municipal Water Consumption

As seen in Table 7-1, the estimated total gallons of water consumed by the City of Missoula increased 75.5% from 2003 to 2008, from 20.9 million gallons to 36.7 million gallons. Water consumption by most departments/divisions increased during this time, especially the Street Maintenance Division (277%) and Parks Department (120%). Two departments experienced a decrease in water consumption from 2003 to 2008: Fire (-22.1%) and Public Works (-76.8%).

Weather and project schedules can significantly affect water consumption, particularly for the Parks Department and Street division. Thus, differences from one given year to another cannot be inferred to be indicative of a trend. Nevertheless, the two aquatic recreational facilities that were added between 2003 and 2008 are likely to have contributed to the increase in water consumption by the Parks Department during this time.

Table 7-1: Estimated Gallons of Water Consumed by City Department/Division in 2003 and 2008

	2003			2008			
Dept./Div.	**Gallons**	**% of Total**		**Gallons**	**% of Total**		**% Change**
Cemetery	141,410	0.7%		250,580	0.7%		77.2%
Fire Dept.	1,932,227	9.2%		1,504,976	4.1%		-22.1%
Parks Dept.	14,897,159	71.2%		32,792,320	89.3%		120%
Public Works	3,042,793	14.5%		704,616	1.9%		-76.8%
Street Division	183,800	0.9%		693,396	1.9%		277%
Wastewater	728,678	3.5%		772,684	2.1%		6.0%
Total	**20,926,066**	**100.0%**		**36,718,572**	**100.0%**		**75.5%**

Note: Values may not sum due to rounding off.

Table 7-1 also shows the relative proportion of the total gallons of water consumed by each City department/division in 2003 and 2008. The Parks Department consumed the greatest amount of water in FY08, at 32.8 million gallons (89%), followed by the Fire Department at 1.5 million gallons (4.1%), and the Wastewater Division at 772,684 gallons (2.1%). The Public Works Department, Street Division and Cemetery each used less than 2% of water consumed by municipal operations.

Electricity Use

Table 7-2 shows the total electricity in kilowatt-hours (kWh) used to supply each City department and division with water, as well as rates of change from 2003 to 2008. Total electricity use increased 85% during this time, from 26,677 kWh to 49,445 kWh. In 2008, the Parks Department was responsible for the largest amount of water-related electricity at 44,158 kWh (89%), followed by the Fire Department at 2,027 kWh (4%), Wastewater Division at 1,040 kWh (2%), and Public Works at 949 kWh (2%).

Table 7-2: Estimated Electricity Consumed in Kilowatt-hours (kWh) by City Department/Division for Water Consumption in 2003 and 2008

	Kilowatt-hours (kWh)				
Dept./Div.	2003	% Total	2008	% Total	% Change
Fire Dept.	2,487	9.3%	2,027	4.1%	-18.5%
Parks Dept.	18,909	71%	44,158	89%	134%
Public Works	3,937	14.8%	949	1.9%	-75.9%
Streets Dept.	229	0.9%	934	1.9%	307%
Wastewater	935	4.1%	1,040	2.1%	11.2%
Total	26,677	100%	49,445	100%	85.3%

Note: Totals may not precisely add up due to rounding.

Embodied Energy and Emissions

Table 7-3 shows total embodied energy in millions of British Thermal Units (MMBTU) and total greenhouse gas emissions in metric tons of carbon dioxide equivalencies (tons of CO_2e) associated with municipal water use in 2003 and 2008. The total energy embodied to pump and transport water for City operations increased 86%, from 91 MMBTU in 2003 to 169 MMBTU in 2008. The total greenhouse gas emissions associated with City water use increased 102% from 2003 to 2008, from 12.3 tons of CO_2e to 24.8 tons of CO_2e (see Table 7-3).

Table 7-3: Estimated Embodied Energy (MMBTU) and Greenhouse Gas Emissions (tons of CO2e) from Water Consumption by City Department/Division in 2003 and 2008

	Embodied Energy (MMBTU)			Emissions (tons of CO_2e)		
Dept./Div.	**2003**	**2008**	**% Change**	**2003**	**2008**	**% Change**
Cemetery	0.6	1.2	87.5%	0.1	0.2	103.6%
Fire Dept.	8.4	6.9	-17.6%	1.1	1.0	-11.2%
Parks Dept.	65	151	133.0%	8.7	22	154.4%
Public Works	13	3.2	-75.5%	1.8	0.5	-73.7%
Streets Dept.	0.8	3.2	299.3%	0.1	0.5	344%
Wastewater	3.2	3.6	12.2%	0.4	0.5	21.2%
Total	**91**	**169**	**85.7%**	**12.3**	**24.8**	**101.9%**

Note: Totals may not precisely add up due to rounding.

CONCLUSIONS AND RECOMMENDATIONS

Although municipal water use accounted for only a very small percentage of the City's overall energy usage and greenhouse gas emissions in 2008, 0.15% and 0.22% respectively, there was a significant increase in the associated energy use and in greenhouse gas emissions. This sector nevertheless provides opportunities for emission reductions through water conservation. Existing measures in Missoula and in other cities in Montana offer potentially promising approaches for the City of Missoula to consider. Although these alone may not have significant impacts on municipal emissions, the City's leadership can inspire residents, businesses and institutions to follow suit in areas of the city where water use has a larger carbon footprint. Several recommendations for the City to lead by example in reducing water-related emissions are presented below.

Invest in Improvements to Water Distribution Infrastructure

In 2009, the Montana Public Service Commission (PSC) estimated that approximately 40% (approximately $500,000) of the water pumped by Mountain Water Company leaks into the ground rather than reaching Mountain Water customers at the point of use (Szpaller 2009d). As Mountain Water's largest flat-rate customer, the City could advocate for repairs of the company's water distribution infrastructure. In addition, the City should identify and repair any leaks in municipally-owned water lines.

The City's leadership can inspire residents, businesses and institutions to follow suit in areas of the city where water use has a larger carbon footprint

Support Water Conservation Practices

Mountain Water already promotes water conservation through its every-other-day watering and time-of-day restrictions, which help reduce water waste and reduce evaporation that occurs during the hottest part of the day. Thus, Missoula is well-poised to continue its leadership in adapting water conservation measures. In particular, we believe the City could benefit from considering several recommendations in the

City of Helena's Climate Change Task Force Action Plan (2009) to regulate water use in Missoula, including requirements or promotion of voluntary measures for: (1) water-conserving fixtures (i.e., low-flow toilets and sinks) on new construction and retrofits; (2) water efficiency features such as dual metering systems for indoor and outdoor use; (3) low-water-use landscaping on City property and in commercial developments.

For example, we recommend that when designing and maintaining municipal landscaping projects the City should use xeriscaping techniques and plant more native plants that are better suited to Montana's climate and require less irrigation. Mountain Water's Water-Wise Garden serves as a fantastic demonstration of ways by which water resources can be used wisely while also appealing to the public's aesthetic preferences.[34]

As mentioned in the Wastewater chapter, the use of wastewater reclamation and gray-water irrigation systems also may afford an opportunity for the City to reduce the water consumption for City parks and other purposes. Because a county ordinance would likely be needed to assure compliance with health codes, the City could advocate for such an ordinance.

Conduct Water Audits

As previously mentioned, the Parks Department is by far the largest municipal consumer of water. We recognize that the City's parks and open spaces are invaluable assets to the Missoula community and by no means mean suggest that their care and maintenance should be compromised. However, we recommend that City officials consider conducting an audit to examine the quantity of water consumed by the Parks Department for its aquatic recreational facilities and for irrigation. A careful examination of maintenance requirements and public expectations may present opportunities to reduce water consumption. In fact, we recommend that the City audit all of its water use and examine the possibility of reusing water and using water more efficiently for various operation and maintenance functions of the Parks and Public Works departments in particular.

Meter All Municipal Water Use and Develop a Monitoring System

Ongoing accurate monitoring of municipal water consumption is necessary for tracking water-related emission reductions in the future. Thus, we recommend that the City meter all municipal water use by each department/division, and if possible, do so ahead of the schedule agreed to in 2009 with the Public Service Commission and Mountain Water. Priority should be given to metering water used for City park sprinkler and irrigation systems, many of which are unmetered at this time.

Furthermore, we recommend the development of a water use monitoring system to accurately track water consumption and associated embodied energy and emissions by department.

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34 The U.S. Environmental Protection Agency (EPA) also provides guidance on water-efficient landscaping on its website at http://www.epa.gov/owow_keep/NPS/toolbox/other/epa_waterefficiency.pdf

8. OTHER ENERGY USES AND EMISSIONS

INTRODUCTION

In FY 2003 and FY 2008 respectively, there were 71 and 65 NorthWestern Energy accounts billed to the City that were not included in the sectors inventoried and analyzed in previous chapters. In this chapter, we include an analysis of those "other" accounts. This effort helps to achieve our goal of conducting as comprehensive an emissions inventory as is feasible.

The objectives of this chapter are to (1) analyze total energy costs, use, and associated greenhouse gas emissions for these additional accounts for the base year (FY03) and the comparison year (FY08); (2) identify departments that account for relatively large proportions of energy use, costs, and emissions associated with these accounts; (3) determine if changes from FY03 to FY08 occurred consistently in the intervening years to discern possible trends; and (4) recommend emission reductions strategies for these accounts.

METHODS AND ANALYSIS

Data for this chapter were obtained from NorthWestern Energy (NWE) in December 2009. As noted in Chapter 1, it only came to our attention during a late stage of drafting this report that our initial examination of hard copy records of the City's NorthWestern Energy bills had failed to identify all NWE accounts billed to the City of Missoula. When we realized this, a complete set of electronic data were requested from NorthWestern Energy so that all accounts not otherwise inventoried could be.

For this supplemental request, we asked for data for all accounts billed to the City of Missoula, the Missoula Redevelopment Agency and the Missoula Art Museum for FY02 to FY09. This allowed us to identify remaining NWE electricity and natural gas accounts not tabulated for the Wastewater, Buildings, and Lighting sectors. The vast majority of these "other" NWE accounts were for electricity (68 of 71 in FY03 and 64 of 65 in FY08). There were only three natural gas accounts in FY03 and one such account in FY08 included in this "other" sector.

Table 8-1 shows the number of NWE electricity and natural gas accounts by City department that are examined in this chapter. In FY03, 52 of these accounts were billed to the Parks Department, and much smaller numbers of accounts were billed to the Cemetery, Public Works, Streets and Vehicle Maintenance departments and to the Parking Commission. In FY08, the Parks Department held 58 of the 65 accounts (91%).[35] A large number of the Parks Department accounts appear to be associated with irrigation of City parks (see Appendices O-1 and O-2).

Table 8-1: Number of Other NorthWestern Energy Accounts Not Included in Other Emissions Sectors, by City Department

	FY 2003			FY 2008	
Department	**Electricity**	**Natural Gas**		**Electricity**	**Natural Gas**
Cemetery Dept.	2	0		2	0
Parking Commission	5	0		2	0
Parks Dept.	50	2		58	1
Public Works Dept.	7	0		1	0
Street Maintenance	3	1		0	0
Vehicle Maint. Dept.	1	0		1	0
Total (All Sectors)	**68**	**3**		**64**	**1**

Data for these accounts were compiled, analyzed and presented in a similar manner as data for the other sectors (for details, see Chapter 1). The total energy costs, usage and greenhouse gas emissions for various City departments were examined in FY03 and FY08, along with the percentage change from FY03 to FY08.

Although it could be argued that energy use and costs for some of these accounts would have been more appropriately included in the analysis of the buildings or sectors, we did not have sufficient information about the accounts early enough to do so. Those conducting future emissions inventories would benefit from having better information for identifying and categorizing NorthWestern Energy accounts such that energy use and change over time can be reliably monitored and analyzed at the department level.

35 For nearly all of these NorthWestern Energy accounts, associated departments were determined by the billing address. For a few accounts, the service address or other descriptors associated with the accounts were used to infer the billing department. See Appendices O-1 and O-2 for a complete listing of accounts.

RESULTS

Electricity Use and Costs

Table 8-2 shows electricity use and associated costs in FY03 and FY08 for the miscellaneous NWE accounts not examined in other emission sectors.[36] From FY03 to FY08, total electricity use for these accounts decreased 12%, from 435,368 kWh to 384,791 kWh, while electricity costs increased 21%, from $40,241 to $48,853. These changes did not occur consistently from year to year. In some years electricity use increased slightly from the previous year (e.g., from FY03 to FY04 and from FY05 to FY06), perhaps due to higher demand for irrigation. See Appendix O-3 for annual electricity use and costs from FY03 through FY08.

The Parks Department had by far the largest proportion of electricity use and costs in FY03 and FY08 (about three-quarters of the total). The Cemetery Department had the next largest amount of electricity use and costs for these miscellaneous accounts.

Electricity use and costs of accounts billed to the Parking Commission and Public Works Department decreased substantially from FY03 to FY08. These decreases appear to be due to accounts being closed, though some closed accounts may have been replaced by newer accounts that were tabulated as part of other sectors in FY08, such as buildings. Further investigation would be needed to make such a determination.

Table 8-2: Electricity Use (kWh) and Costs ($) for
Other NorthWestern Energy Accounts, FY03 and FY08

	Electricity Use (kWh)				Electricity Cost ($)		
Dept.	**FY03**	**FY08**	**% Change**		**FY03**	**FY08**	**% Change**
Cemetery Dept.	57,097	64,800	13.5%		$5,954	$7,789	30.8%
Parking Comm.	16,620	1,052	-93.7%		$654	$259	-60.5%
Parks Dept.	302,692	297,014	-1.9%		$30,493	$38,520	26.3%
Public Works Dept.	13,938	2,930	-79.0%		$980	$313	-68.1%
Street Maintenance	33,573	---	-100%		$1,254	---	-100%
Vehicle Maint. Dept.	11,448	19,175	67.5%		$904	$1,973	118%
Total	**435,368**	**384,971**	**-11.6%**		**$40,241**	**$48,853**	**21.4%**

Note: Values may not add up exactly due to rounding.

Although the Cemetery Department had the same two NorthWestern Energy accounts, and Vehicle Maintenance Department had the same single account in FY03 and FY08 (see Table 8-2), electricity use and costs for these accounts increased significantly during this period. For example, electricity use for the two Cemetery Department accounts increased 13% and costs increased 31%, from $5,954 in FY03 to $7,789 in FY08.

36 It should be noted that data obtained from NorthWestern Energy indicate no electricity use for about a dozen electricity accounts for which electricity costs totaled $825 in FY03 and $1,124 in FY08 (see Appendix O-1). This may be due to these accounts being unmetered. Because electricity use was not imputed for these accounts, Table 8-2 may not include all electricity use associated with the miscellaneous NWE accounts.

Natural Gas Use and Costs

As noted above, there were only a few natural gas accounts not included in the inventory for other sectors. See Appendices O-2 for a list of these accounts. Table 8-3 shows that total natural gas use for these accounts decreased from 3,191 dekatherms (Dth) in FY03 to virtually negligible amounts in FY08 (4.5 Dth). During the same period, total natural gas costs decreased from nearly $15,000 to only $131. This reduction appears to be largely due to the closure of Parks Department accounts associated with Spartan Park and McCormick Park pools (see Appendix O-2).

Table 8-3: Natural Gas Use (Dth) and Costs for
Other NorthWestern Energy Accounts, FY03 and FY08

	Natural Gas Use (Dth)				Natural Gas Cost ($)		
Department	FY03	FY08	% Change		FY03	FY08	% Change
Parks Dept.	3,188	4.5	-99.9%		$14,986	$131	-99.1%
Streets Dept.	3	0	-100%		$123	$0	-100%
Total	**3,191**	**4.5**	**-99.9%**		**$15,109**	**$131**	**-99.1%**

Energy Use and Greenhouse Gas Emissions

Table 8-4 shows total energy use in millions of British Thermal Units (MMBTU) and total greenhouse gas emissions in metric tons of carbon dioxide equivalencies (tons of CO_2e) in FY03 and FY08. Total energy use decreased 72% during this time, and total emissions decreased 49%, from 380 tons of CO_2e in FY03 to 194 tons of CO_2e in FY08. These substantial decreases are nearly entirely due to the decrease in natural gas use noted above.

Table 8-4: Total Energy Use (MMBTU) and Greenhouse Gas Emissions (tons of CO2e)
for Other NorthWestern Energy Account, by Energy Type

	Total Energy Use (MMBTU)				Total Emissions (tons of CO_2e)		
Energy Type	FY 03	FY 08	% Change		FY 03	FY08	% Change
Electricity	1,485	1,314	-11.6%		201	193	-3.7%
Natural Gas	3,191	4.50	-99.9%		179	0.25	-99.9%
Total	**4,676**	**1,318**	**-71.8%**		**380**	**194**	**-49.0%**

Note: Values may not add up exactly due to rounding.

This is the only sector for which energy use and emissions were substantially lower for the comparison year (FY08) than the baseline year (FY03). Although these decreases may appear encouraging, the reductions are primarily due to the closure of natural gas accounts associated with closed public swimming pools, which have been replaced by new aquatic recreation facilities that consume much larger amounts of energy (see Chapter 3: Buildings).

CONCLUSIONS AND RECOMMENDATIONS

Although the City of Missoula currently has over 70 NorthWestern Energy accounts that are not accounted for in other sectors examined in this inventory, the energy use and associated greenhouse emission for these accounts represent a relatively small proportion of the corresponding totals from municipal operations.

Greenhouse gas emissions associated with the accounts examined in this chapter constituted 6.8% and 2.2% of total emissions from purchased energy, respectively, in FY03 and FY08. These accounts comprised 4.8% and 1.7% of total municipal emissions from all sources in FY03 and FY08. Thus, during this time, these accounts comprised a decreasing share of Missoula's overall municipal energy use and emissions.

Nevertheless, it is possible that energy use for these accounts or other miscellaneous accounts added to the City's energy portfolio could begin to increase again.[37] Moreover, growth in energy use and emissions by the Cemetery Department and the Vehicle Maintenance Department noted in this chapter may warrant further examination. If these recent increases in energy use continue in the future, they may be a concern, particularly if City officials and department heads embrace a municipal greenhouse gas reduction target for municipal operations.

Although electricity use by the Parks Department regarding the miscellaneous NorthWestern accounts examined in this chapter remained stable from FY03 to FY08, the Parks Department now accounts for 77% of the electricity usage among these accounts. As noted above, much of this energy use appears to be related to irrigation. Energy costs noted in this chapter do not include the cost of water itself that is purchased from Mountain Water. Thus, a water conservation program for City Parks may have a number of additional benefits that extend beyond energy use and greenhouse gas emission reductions.

With these findings and considerations in mind, we offer the following recommendations, several of which will sound like a familiar refrain of previous chapters:

- *Monitor energy use, costs, and emissions* associated with the various miscellaneous NorthWestern Energy accounts identified in this chapter (see Appendices O-1 and O-2 for a complete listing). In monitoring energy use, include estimates of electricity use for the dozen or so NorthWestern Energy electricity accounts that show electricity charges but no use.
- *Develop a water conservation program for the Parks Department* that can also reduce energy use and GHG emissions; provide incentives such that energy savings can be used to support additional energy conservation measures (also see Chapter 7: Water).
- *Investigate increases in energy use* at the departmental level, as appropriate.
- *Set an emissions reduction target* for the City of Missoula.
- *Develop a municipal climate action plan* for achieving reduction targets and a timeline for doing so.
- *Require each City division and department to contribute to the climate action plan* by developing its own reduction target and implementation strategy.

37 In fact, electricity use for these accounts did increase 7% from FY08 to FY09 (data available by request).

- *Identify and secure needed resources and support*, through grants and other revenue sources, perhaps also in partnership with ICLEI, the University of Montana, NorthWestern Energy, Missoula's business and non-profit communities, and interested and concerned Missoula residents.

A sound emission reduction strategy for Missoula should include, where feasible, a reduction in the rate of increase in energy use by all City divisions and departments followed by a leveling off of such growth and subsequent reductions.

9. SUMMARY OF FINDINGS

OVERALL EMISSIONS AND CROSS-SECTOR ANALYSIS

In Fiscal Year (FY) 2008, total greenhouse gas emissions from Missoula's municipal operations totaled 11,540 metric tons of carbon dioxide equivalencies (tons of CO_2e), or 25.45 million pounds. This represents the equivalent weight of over 143,000 adults, or nearly three times the weight of the City of Missoula's adult population.[38] Put another way, the weight of municipal greenhouse gas emissions in FY08 is the equivalent of nearly 7,500 Subaru Outback Wagons, which lined up bumper-to-bumper, would stretch from downtown Missoula to the town of Lolo and back![39]

Municipal greenhouse gas emissions increased 46% from FY03 to FY08. This represents an average annual increase of 9.3%, or 731 tons of CO_2e, which is akin to each year adding the equivalent of emissions associated with energy use of City Hall and Council Chambers. As mentioned in Chapter 1, this is likely to be a conservative estimate, because we calculated emissions associated with electricity consumption using an electricity-to-emission conversion based on the entire electrical generating system in the Northwest region of the country, which includes more carbon-neutral hydropower than our utility, NorthWestern Energy, purchases and delivers.

The weight of municipal greenhouse gas emissions in FY08 is the equivalent of nearly 7,500 Subaru Outback Wagons, which lined up bumper-to-bumper, would stretch from downtown Missoula to Lolo, Montana, and back!

38 Based on adult population of 57,457, determined from 2006 Census estimates (See http://quickfacts.census.gov/qfd/states/30/3050200.html) and average adult weight in the United States in 2002 of 177.5 pounds from http://en.wikipedia.org/wiki/Human_weight.

39 See Chapter 3 (Buildings) for technical documentation used for these calculations.

As shown in Table 9-1, all major sectors examined have contributed to the recent increase in emissions, including wastewater treatment, buildings, municipal fleet, employee commuting, and lighting.[40] Wastewater treatment and municipal buildings increased 51% and 124%, respectively, from FY03 to FY08 and together accounted for about 55% of total emissions in both years.

The growth in emissions from wastewater treatment, from 2,932 tons of CO_2e in FY03 to 4,422 tons of CO_2e in FY08, is the result of upgrades to the system, expansion of its capacity, and increase in volume of wastewater treated. The increase in emissions from buildings (from 1,399 to 3,128 tons of CO_2e) is primarily the result of the addition of new buildings, expansion of existing buildings, and an increase in the number of City employees. The latter also accounts for the 25% increase in emissions from employee commuting, from 889 tons of CO_2e in FY03 to 983 tons of CO_2e in FY08.

Table 9-1: City of Missoula Municipal Greenhouse Gas Emissions (tons of CO2e) by Sector, FY03 and FY08

	Emissions (tons of CO_2e)						
Sector	**FY03**	**% Total**		**FY08**	**% Total**		**% Change**
Municipal Buildings	1,399	17.7%		3,128	27.1%		123.6%
Municipal Fleet	1,445	18.3%		1,752	15.2%		21.3%
Employee Commuting	827	10.5%		1,037	8.99%		25.4%
Lighting	889	11.3%		983	8.52%		10.7%
Misc. NWE Accounts	380	4.82%		194	1.68%		-49.0%
Water	12.3	0.16%		24.8	0.22%		101.9%
Total	7,883	100.0%		11,540	100.0%		46.4%

Note: Values may not sum due to rounding off.

The municipal fleet is also a significant contributor to the City's greenhouse gas emissions, accounting for 15% of total emissions in FY08. Fleet emissions increased 21% from FY03 to FY08, from 1,445 to 1,752 tons of CO_2e, primarily due to increases in fuel use by the Police and Fire departments. Emissions from lighting increased 11% from FY03 to FY08 and accounted for 8.5% of total emissions in FY08.

The various miscellaneous NorthWestern Energy accounts that are primarily billed to the Parks Department were the only category for which emissions decreased. However, because these accounts represent a relatively small proportion of total municipal emissions (1.7% in FY08), the decrease had little effect on overall emissions. Similarly, emissions associated with water used by the City also contributed little to overall emissions (0.22% in FY08), even though they doubled from FY03 to FY08.

Table 9-1 shows that the sectors with the largest amounts of emissions are also among the sectors with

40 Note that emissions from solid waste disposal (associated with Allied Waste trucking solid waste generated from City facilities to the landfill and gas emissions from the landfill) were not within the scope of our inventory. Although the omission of solid waste-related greenhouse gas emissions results in underestimating overall emissions, we are confident this under-estimation is very small, if the inventories for Helena and the University of Montana serve as a good guide. Solid waste-related emissions for Helena and UM accounted for only about one percent of total emissions. Curiously, Bozeman counted the solid waste as a carbon credit – a negative emission essentially. We also did not include emissions from composting sewage sludge.

the largest increases in emissions in the five-year period from FY03 to FY08. This observation and the fact that no single sector is a predominant contributor to municipal emissions suggest that strategies to slow or curtail the growth in emissions will need to attend to multiple sectors.

To put the City of Missoula's rate of increase into perspective, one can consider that emissions in the State of Montana are estimated to have increased 14% between 1990 and 2005, approximately 1% per year (Montana CCAC 2007). Missoula's annual rate of increase in emissions, approaching 10%, is also a concern, particularly considering that *U.S. Conference of Mayor's Climate Protection Agreement* calls for 12% reductions in greenhouse gas emissions from 1990 levels by 2012. Even if it would be possible to accurately determine 1990 emissions levels, this goal is infeasible even though the City has already undertaken a number of steps to reduce energy use, such as setting an energy and fuel use reduction target of 10% from 2007 levels by 2011.

Table 9-2 shows projected emissions for the City of Missoula in 2015 and 2020 if the rate of increase in emissions from FY03 to FY08 (9.3% per year) continues. Under "business as usual," emissions are projected to increase 65% by 2015 and more than double by 2020. Even if a projected rate of increase is used that excludes recently constructed buildings (6.0% per year), which added significantly to overall emissions (see Chapter 3: Buildings), emissions are projected to increase 41% and 71%, respectively, by 2015 and 2020 (see Table 9-2). Forecasting future emissions was not a goal of this report, and more accurate forecasting might consider the most recent annual emission increases and take into account FY08 to FY09 changes.[41] Table 9-2, nevertheless, is an indication that emissions are likely to increase significantly, even if not as quickly as shown.

Missoula's annual rate of increase in emissions, approaching 10%, is also a concern, particularly considering that U.S. Mayors' Climate Protection Agreement calls for 12% reductions in greenhouse gas emissions from 1990 levels by 2012.

Table 9-2: Projected Emissions (ton of CO2e) in 2015 and 2020 Based on FY03-FY08 Rate of Change for All Emissions and Rate of Change Excluding New Buildings

	Using FY03-FY08 Rate of Change for All Emissions		Using FY03-FY08 Rate of Change Excluding Recent New Buildings*	
YEAR	2015	2020	2015	2020
Projected Emissions (tons of CO2e)	19,036	24,390	14,407	17,460
% Change from 2008	65.0%	111.3%	41.2%	70.6%

** Excludes Currents Aquatics Center, Splash Montana Waterpark, and City Council Chambers*

41 Purchased energy increased each year from FY03 to FY08 (see Appendix C-2).

COMPARISON WITH PEER CITIES IN MONTANA AND THE UNIVERSITY OF MONTANA

Other cities in Montana that have signed on to the U.S. Conference of Mayors' Climate Protection Agreement and the University of Montana, which is part of the American College & University Presidents' Climate Commitment,[42] have also conducted emission inventories. Table 9-3 shows the results of the UM, Bozeman, Helena and Missoula emission inventories. Per capita comparisons would be misleading because each entity provides and maintains different types of services and infrastructure. However, it is noteworthy that Missoula has the largest rate of increase in emissions. Helena's reduction is largely due to energy efficient upgrades to the city's wastewater treatment plant.

Table 9-3: Greenhouse Gas Emission Trends and Emission Reduction Targets (tons of CO2e) for Bozeman, Helena, Missoula and the University of Montana

	Base Year / Comp. Year	Base Year Emissions	Comp. Year Emis-sions	% Change	Ave. Annual % Change	Emissions Reduc-tion Target
Bozeman	2000 / 2006	6,083	7,866	29.3%	4.9%	15% below 2000 level by 2020
Helena	2001 /2007	12,691	10,397	-18.1%	-3.0%	15% below 2007 level by 2020
Missoula	2003 / 2008	7,883	11,540	46.4%	9.3%	N/A
Univ. of Montana	2000 / 2007	36,657	42,687	16.4%	3.3%	100% below 2007 level by 2020

Sources: Bozeman Climate Protection Task Force 2008; Helena Climate Change Task Force 2009; Davie 2007; and Peacock and Bloom 2010.

LOCAL GOVERNMENT FRAMEWORK FOR CLIMATE PROTECTION

Emissions inventories provide a valuable baseline information for forecasting and monitoring future emissions and gauging progress toward emission reduction targets. Recognizing that proactive measures are needed to prevent rapid increases, The University of Montana, City of Bozeman, and City of Helena have taken this next step in addressing climate change: conducting climate action plans that include identifying strategies, programs and projects that can reduce greenhouse gas emissions. Table 9-3 also shows the emission reduction targets that are part of UM's, Bozeman's and Helena's climate action plans.

As noted in the introduction to this report, the *U.S. Conference of Mayors' Climate Protection Agreement* provides a framework for local government to address climate change. The framework is highly adaptable to unique local conditions and consists of the following five milestones:

1. Conduct a Greenhouse Gas Emissions Analysis (Baseline Inventory and Forecast)
2. Establish a Reduction Target
3. Develop a Climate Action Plan
4. Implement the Climate Action Plan
5. Monitor Progress and Report Results (ICLEI 2009d)

42 See http://www.presidentsclimatecommitment.org/.

Thus, Missoula's next steps under the *U.S. Conference of Mayors' Climate Protection Agreement* are to set a greenhouse gas emissions reduction target and develop a climate action plan to reach the target. In a time of strained budgets and economic recession, City officials, Missoula businesses, and residents alike will no doubt be concerned about the costs of achieving emission reductions. We believe it is equally as important to ask: "What are the costs of not reducing emissions?"

ENERGY COST INCREASES

Escalating energy costs and tight budgets are reasons UM and Missoula's peer cities are vigorously addressing climate change by reducing energy use. The City of Missoula also faces rapidly increasing energy costs, which are putting a strain on the City's budget. This fact has caught the attention of City officials who have implemented a number of energy saving measures (see Chapter 1: Introduction for a summary of these efforts).

Table 9-4 shows that purchased energy (electricity and natural gas) and fuel (unleaded gasoline, diesel and biodiesel) costs have increased dramatically from the base year (FY03) to the comparison year (FY08) of this report.[43] Adjusting for inflation by using 2009 constant dollars,[44] *purchased energy costs* increased nearly three-fold during this five-year period, increasing from $341,010 to $1.28 million. This represents more than a 50% average annual rate of increase. *Fuel costs* for the municipal fleet have also increased rapidly: 176% during the study period, from $217,060 in FY03 to $599,490 in FY08. This represents a 35% average annual rate of increase. The total of inflation-adjusted municipal energy and fuel costs inventoried in this report increased $1.32 million from FY03 to FY08, from $558,070 to $1,877,637.

The total of inflation-adjusted municipal energy and fuel costs inventoried in this report increased $1.32 million from FY03 to FY08, from $558,070 to $1,877,637.

Table 9-4: Purchased Energy and Fuel Costs for City of Missoula in 2009 Dollars, FY03 and FY08

	FY 2003		FY 2008		FY03-FY08 % Change	Average Annual % Change
	Costs (2009$)	% of Total	Costs (2009$)	% of Total		
Purchased Energy						
Electricity	$257,900	46.2%	$970,640	51.7%	276%	55.3%
Natural Gas	$83,109	14.9%	$307,508	16.4%	270%	54.0%
Subtotal	$341,010	61.1%	$1,278,148	68.1%	275%	55.0%
Fuel						
Unleaded	$119,600	21.4%	$333,024	17.7%	178%	35.7%

43 Propane costs were not included.

44 U.S. Department of Labor Statistics inflation calculator was used to report costs in 2009 constant dollars (see http://data.bls.gov/cgi-bin/cpicalc.pl). It is based on the national cost-of-living index.

	FY 2003		FY 2008		FY03-FY08 % Change	Average Annual % Change
	Costs (2009$)	% of Total	Costs (2009$)	% of Total		
Diesel	$97,460	17.5%	$261,457	13.9%	168%	33.7%
Biodiesel	$0	0.0%	$5,009	0.3%	n/a	n/a
Subtotal	$217,060	38.9%	$599,490	31.9%	176%	35.2%
Lighting Districts Subtotal*	**$41,951**	**7.5%**	**$107,144**	**5.7%**	**155%**	**31.1%**
General Fund Subtotal†	**$516,119**	**92.5%**	**$1,770,494**	**94.3%**	**243%**	**48.6%**
Total	**$558,070**	**100.0%**	**$1,877,637**	**100.0%**	**236%**	**47.3%**

Note: Values may not sum due to rounding.

** Includes electricity costs paid by Street Light Districts, not including 10% paid from General Fund*

† Includes energy costs paid from City of Missoula General Fund, including 10% of Street Light District electricity costs

Because the total shown in Table 9-4 includes electricity costs of Street Lighting Districts paid by the City that are recovered through property tax assessments (see Chapter 6: Lighting), the total does not reflect energy and fuel costs solely paid from the City's General Fund.[45] Thus, Table 9-4 includes a separate subtotal that excludes the assessed portion of Street Lighting Districts. Adjusting for inflation, unrecovered energy and fuel costs paid by the City General Fund for municipal operations increased 243% or $1.25 million from FY03 to FY08, from $516,119 to $1.77 million. This represents a 49% average annual increase or a $250,875 per year increase in energy costs.

It should be noted that purchased energy increases were the largest from FY03 to FY04, partially as a result of energy deregulation (see Appendix E1). Similarly, fuel cost increases were greatest between FY07 to FY08, also due in part to a steep increase in fuel costs.

It also should be noted that increases in energy costs are not solely the result of utility rate and fuel cost increases; increases in the cost of energy are also affected by increases in energy use. Municipal energy use in Missoula increased 41% from FY03 to FY08, or 8.3% per year (see Appendix E2 for the energy use by sector).

45 Energy costs from the City's wastewater treatment plant are also recovered from sewage service ratepayers. Some energy costs for operating the City's aquatic recreational facilities are also recovered through the collection of entrance fees."

CONCLUSION

Missoula's municipal greenhouse gas emissions have increased rapidly in recent years, at a far greater rate than other cities in Montana that have conducted emissions inventories. Missoula's average annual increase in emissions of 9.3% is due to an increase in energy use, the costs of which have increased at a much faster rate.

From a fiscal standpoint alone, it appears that energy cost increases are not sustainable, particularly if energy use continues to increase. Even if energy use were not to increase, energy costs are still likely to increase faster than inflation. These findings suggest that climate protection and energy costs savings can be mutually beneficial civic goals.

Indeed, Missoula has the capacity and interest in making further progress on energy and climate change, and it is well-positioned to become a leader among cities in Montana in addressing climate change at the local level.

Missoula has already begun to take steps to reduce energy use and costs (see Chapter 1: Introduction). However, Missoula is behind other cities in Montana that are part of the *U.S. Conference of Mayors' Climate Protection Agreement.* Missoula has not set an emission reduction goal or developed a climate action plan. Nevertheless, elected officials, citizens, and business leaders are committed to municipal sustainability, maintaining quality of life, supporting the local economy, and protecting the environment. Moreover, Missoula has a concerned and talented pool of City employees, civic leaders, non-profit organizations, and a state university to draw on for leadership and expertise in taking its next steps within the climate protection framework.

Indeed, Missoula has the capacity and interest in making further progress on energy and climate change, and it is well-positioned to become a leader among cities in Montana in addressing climate change at the local level. The next chapter provides recommendations for City officials for reducing greenhouse gas emission and continuing to move Missoula down the path of municipal sustainability.

10. CONCLUSIONS AND RECOMMENDATIONS

Most people have seen the renowned graph of carbon dioxide (CO_2) in the atmosphere as measured atop Mauna Loa Observatory in Hawaii over the last half century: the graph that inches up from left to right, signifying an increase in CO_2 levels. The graph shows a similar trend to that of Missoula's municipal greenhouse gas (GHG) emissions that this baseline emissions inventory has revealed.

However, the difference is that Missoula's curve is much steeper, and it also outpaces national growth in emissions.[46] The City of Missoula's rate of increase in emissions is greater than that of the State of Montana as a whole (Montana CCAPC 2007). Our local rate also outpaces other cities' in Montana such as Helena and Bozeman. Missoula's 46% increase in emissions from 2003 to 2008 also outpaces the growth in the City's population (11%) and is associated with more than a tripling of the City's energy costs during this time.[47]

How Missoula responds to this substantial growth in GHG emissions matters. Collectively, cities are significant emitters of greenhouse gases. As major contributors to global warming, cities are also becoming active participants and leaders in forging climate change solutions (Lindseth 2009). Missoula had joined over 1,000 cities as part of the *U.S. Conference of Mayors' Climate Protection Agreement*, thereby committing to performing baseline inventories and charting a course for reducing emissions in the future. The framework for action that these cities have signed onto recognizes that tackling a global problem requires collective action at the local scale.

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46 Observed carbon dioxide levels at Mauna Loa Observatory increased 2.6% from 2003 to 2008, from 376 ppm to 385 ppm (See ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_mlo.txt). A recent U.S. EPA report, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2007, states: "Overall, total U.S. emissions have risen by 17 percent from 1990 to 2007" (U.S. EPA 2009a). The report indicates that overall emission in the U.S. have increased about 2% annually between 2000 and 2007.

47 In 2008, emissions from municipal operations were over eight million pounds greater than they were in 2003. In "Subaru Outback equivalencies," Missoula added the equivalent weight in carbon dioxide of nearly 2,400 of the beloved vehicles into the atmosphere (see Table 9-1). During the same period, energy and fuel costs to the General Fund increased from just over half a million dollars to $1,877,000, an average increase of over $250,000 per year (see Table 9-4). Although utility rates and fuel price increases contribute to the increase in costs, so too does the City's energy consumption which has increased over 8% per year from FY03 to FY08.

Local government is well-suited to being a part of the solution because it is often able to act more quickly than state and national levels can. Local governments, by setting an example, can motivate residents and local businesses to do their part. However, cities are more than a role model; they can affect land use and development, transportation, building practices, and other areas that contribute to our carbon footprint. City services and public infrastructure such as drinking water, sewage treatment, waste management, parks and open space management, and lighting provide opportunities for reducing emissions while also saving on energy costs.

Missoula's 46% increase in emissions from 2003 to 2008 also outpaces the growth in the City's population (11%) and is associated with more than a tripling of the City's energy costs during this time.

Local solutions to climate change provide a means to achieve mutually beneficial civic goals of environmental protection and economic well-being. Missoula residents and City officials value the quality of life and the vibrancy of the economy in Missoula. As Missoulians, we pride ourselves on the natural amenities we all enjoy. Yet, climate change poses significant threats to both the economy and the quality of life by adversely impacting our parks and open spaces, air quality, rivers and streams, fish and wildlife, outdoor recreation and natural resource-dependent industries.

Recognizing these threats, the City is already implementing measures to reduce energy costs and improve the energy performance of municipal operations. Rapid increases in energy costs give added urgency to this effort.

What follows next in this chapter are overall recommendations for grappling with the uptick in Missoula's emissions. That is followed by a summary and compilation of recommendations from previous chapters that are specific to the various emissions sectors we inventoried.

Local solutions to climate change provide a means to achieve mutually beneficial civic goals of environmental protection and economic well-being.

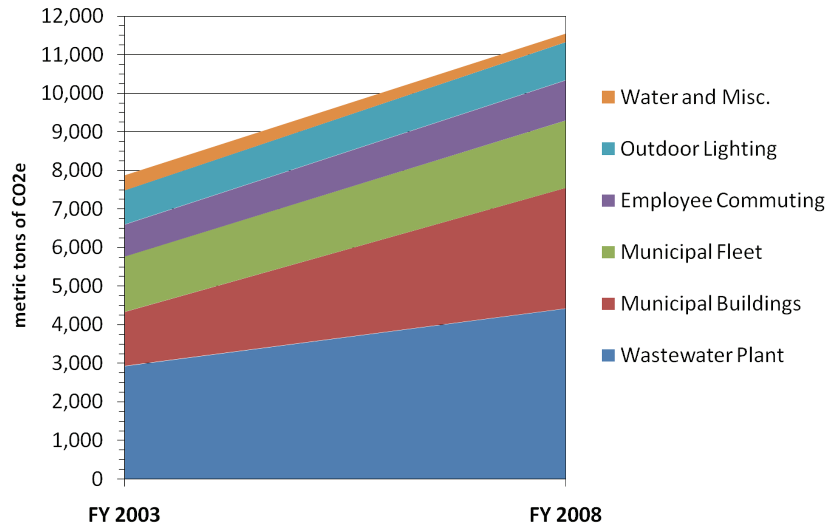
The 46% increase in greenhouse gas emissions from FY03 to FY08 and the wide range of sources of municipal emissions necessitates a broad-based approach that seeks emission reductions from each sector (see Figure 10-1). Although further analysis is needed to determine which sectors offer the most cost-efficient and cost-saving opportunities, our purpose here is to provide resources and a wide range of approaches from which to choose. In doing so, we recognize that it may be difficult for any single measure to stave off the growth in emissions or achieve a reduction of net emissions.

Current projections show that Missoula is not likely to match or exceed the emission reductions set by Governor Schweitzer in his 20x10 Initiative to reduce energy use by state government agencies 20% by 2010.[48] Despite this, Missoula has the capacity to achieve reductions on par with what other cities in

48 See http://governor.mt.gov/20x10/default.asp.

Montana are attempting, and thereby continue to move toward municipal sustainability. In doing so, Missoula can reel in Missoula's emission growth curve while achieving cost savings, reducing air pollution, improving quality of life, and helping protect our rivers and streams and open spaces.

Figure 10-1: Growth in City of Missoula Greenhouse Gas Emissions in Metric Tons of CO2e by Sector in FY 2003 and FY 2008



OVERALL RECOMMENDATIONS

As noted in previous chapters, the next step for Missoula under the *U.S. Conference of Mayors' Climate Protection Agreement* is to set a specific emissions reduction target and develop an action plan to achieve those reductions. We recommend four basic strategies to reduce municipal emissions and save on energy costs: (1) reducing energy use through energy conservation and efficiency; (2) generating renewable energy; (3) purchasing renewable energy; and (4) offsetting emissions. We recommend that City officials and concerned citizens consider each of these strategies within the Cities for Climate Protection framework (see Chapters 1 and 9).

Setting a municipal emissions reduction goal also necessitates an effective energy use monitoring system and the delegation of responsibility for implementing, managing and reporting on energy saving measures.

In addition to documenting the steep upward trend in municipal emissions, this emissions inventory provides valuable baseline information for gauging the efficacy of emissions reduction measures over time. However, setting a municipal emissions reduction goal also necessitates an effective energy use monitoring system and the delegation of responsibility for implementing, managing and reporting on energy-saving measures. Moreover, developing a sound climate action plan that moves toward a reductions strategy that is appropriate for Missoula will require expertise and citizen participation. The following recommendations were crafted with these considerations in mind.

Set an Emissions Reduction Target and Develop a Climate Action Plan

As noted above, setting an emissions reduction target and a climate action plan together comprise the next step in the *U.S. Conference of Mayors' Climate Protection Agreement*. City officials will be responsible for determining an emissions reduction target and can decide whether to use peer cities in Montana as a guide. As shown in Chapter 9, Bozeman's climate action plan calls for a 15% emissions reduction from 2000 levels by 2020. Helena's target is less ambitious: a 15% reduction from 2007 levels by 2020 (see Table 9.2). Nevertheless, for Missoula, achieving similar reductions could be challenging, because Missoula has had a much higher annual rate of increase in emissions in recent years compared to Bozeman, whereas Helena has already begun to reduce emissions.

As Missoula considers climate action, it must recognize that leveling off the growth curve in emissions will take more than incremental expansion of existing energy conservation and efficiency efforts.

Because Missoula's emissions are on an upward trajectory, before reducing emissions the City of Missoula would first need to slow the rate of increase and then stabilize emissions. Thus, we also recommend that along with setting an emission reduction target that the City set an interim target date for stabilizing emissions.

The University of Montana is striving for a 100% emissions reduction, or "carbon neutrality," by 2020. Such as aggressive target can only be achieved by investing in renewable energy generation and purchasing carbon offsets to supplement other energy conservation and efficiency measures. Planning much further beyond that time horizon is not recommended because of the uncertainties in forecasting energy prices, interest rates, technology development, and the like.

As Missoula considers climate action, it must recognize that leveling off the growth curve in emissions will take more than incremental expansion of existing energy conservation and efficiency efforts. A comprehensive and proactive approach will be needed.

Form a Climate Action Plan Task Force

We recommend that Mayor Engen and the Missoula City Council jointly form a climate action task force that involves key staff to develop a climate action plan for municipal operations. To develop their climate action plans, Bozeman and Helena formed task forces and working groups that brought together key individuals to research and evaluate various energy saving measures for technical feasibility and cost-effectiveness. Bozeman had a full-time sustainability coordinator coordinate the effort.

Because energy conservation and efficiency is so specialized, it may be helpful to have separate working groups to work on sector-specific plans that can be included in the overall plan. This would also allow for greater participation. There are a number of individuals in Missoula who are already committed to helping Missoula reduce its carbon footprint. Some already provide public service as members of the Mayor's Advisory Group on Climate Change and Sustainability and the Missoula Greenhouse Gas & Energy Conservation Team. In addition, individuals from the University of Montana and Missoula's nonprofit and local business communities who have specialized knowledge and expertise should be enlisted.

Utilize Climate Action Planning Software

The International Council for Local Environmental Initiatives (ICLEI) has a Climate Action Planning Program Assistant (CAPPA) tool to assist local governments in developing customized plans for reducing greenhouse gas emissions and local air pollution. The CAPPA software provides information and quantitative tools for over 100 distinct emissions reduction strategies (ICLEI 2009). We encourage its use for forecasting energy cost savings from specific emissions reduction measures. This will help to assure City officials that emission reductions can be achieved in a cost-effective manner. Utilizing the software may require staff training and reassignment to perform such duties. The University of Montana used similar software to conduct its climate action planning (Peacock and Bloom 2010).

Develop Energy and Emissions Monitoring and Reporting System

We recommend that the City implement a monitoring and reporting system for energy use, energy costs, and associated greenhouse gas (GHG) emissions from all NorthWestern Energy accounts, other utilities, and fuel use of the municipal fleet. This is essential to gauging progress toward emissions stabilization and reduction goals. Although a system is in place for monitoring fuel consumption, the City lacks adequate accounting systems for tracking purchased energy. In fact, we found inventorying energy use to be a challenging undertaking, particularly due to the lack of a system for compiling and reporting data among City sectors and the wide variety of individuals responsible for maintaining energy billing records.

Although the current organization of NorthWestern Energy billing accounts appears to be designed to facilitate payment, it is not conducive to developing a climate action plan, implementing emission reduction measures, and monitoring results. Energy use and cost information needs to be more readily available to department/division heads, the chief administrative officer, the Mayor, City Council, and the public.

To develop an accurate and complete monitoring system, the City would need to compile purchased energy usage and cost data from each utility company into a single electronic database much like the one used to monitor and report fuel usage and costs for the municipal fleet. These data would then need to be combined with fuel consumption data.

Meeting energy reduction goals would be facilitated if each division/department's energy use and costs could be readily accessed and monitored throughout the year. Thus, the City might benefit from consolidating or recombining some of its building, lighting and parks irrigation accounts into billing groups by division/department.

Furthermore, in order to regularly report emissions, data on electricity and natural gas use data, fuel consumption, and biogas releases (from the wastewater treatment plant) would need to be complied separately because each energy and fuel source is associated with different amounts and types of greenhouse gases, which in turn have different global warming potential. Given the escalating costs of energy, we believe that fiscal responsibility necessitates adopting such a system.

Finally, solar energy generated by solar cells at City Hall and two fire stations should be monitored and counted toward the City's energy use. We were not able to do so, because the systems are not metered, and we were not able obtain performance and reliability information to estimate power generation. As noted above, renewable energy such as solar energy needs to be a part of any comprehensive emissions reduction strategy. By monitoring energy generation, building occupants, managers, elected officials and the public can gain more understanding and appreciation of the role that solar power plays and its potential to meet energy demand with zero emissions.

Expand No-Net-Cost Energy Policies

Various cities implementing climate action plans have adopted no-cost energy policies, which can allow cities to control of rising energy costs. However, they are not belt tightening or austerity programs. Rather, they involve making energy-conscious decisions in purchases and use of equipment. Green fleet policies are one example whereby fleet size is reduced, smaller and more fuel efficient vehicles are purchased, and unneeded uses are eliminated. Missoula already has such a policy to reduce fuel consumption 10% by 2011. Procurement policies that encourage or require that office and computing equipment be EPA ENERGY STAR-certified are another example, whereby purchasing equipment of equal or lower costs can reduce energy use and yield shorter payback times from energy savings.

Consider a Four-day Work Week and Work-at-Home

A four-day work week can reduce the energy use for heating, cooling, lighting of municipal buildings and the operation of office equipment; it can also reduce employee commuting. Thus, a four-day work week can reduce municipal energy costs and GHG emissions. In addition, work-at-home policies can also reduce the City's energy costs. Some departments may already be utilizing such work schedules for employees, whereas it may not be feasible for some departments while maintaining City services. Achieving savings would require entire buildings or offices to be closed and thermostat control of individual offices. This could require an expensive retrofit in buildings that do not have such controls. Thus, a number of considerations would need to be made involving City services, employee preferences, office and building heating, ventilation and cooling systems. We believe this recommendation is nevertheless worthwhile to consider, particularly in buildings that consume large amounts of electricity and in future buildings (see Chapter 3: Buildings and Sector-specific Recommendations below).

Create a Revolving Energy Loan Fund for City Energy Conservation and Efficiency Projects

A revolving energy loan fund supported by the City's federal Energy Efficiency and Conservation Block Grant could provide a much-needed funding source for implementing energy conservation and efficiency upgrades to municipal buildings, wastewater treatment plant, lighting and other City operations. Once established, the fund could pay upfront costs for various projects and be reimbursed by budgeted energy savings. Students at the University of Montana recently implemented such a program funded by a voluntary student fee (Groover 2010).

Although it would also help Missoula residents and businesses if they could borrow from a municipal revolving energy loan fund, we recommend that such a fund be initially used primarily for high-profile City projects. We believe demonstrating leadership will increase Missoulians' interest in and support for larger energy conservation and efficiency projects after the EECBG grant is expended.

Fostering support for larger projects such a renewable energy partnerships and energy bonds will require the City to continue to be a champion on behalf of Missoula residents and businesses. Our concern is for the long-term sustainability of energy conservation and efficiency within City government, i.e., using the current projects, such as the Green Blocks Project carried out in partnership with NorthWestern Energy, to develop a long-term program.[49]

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49 See http://www.ci.missoula.mt.us/index.aspx?nid=517.

Explore Renewable Energy Partnerships

In Missoula, about 65% of the purchased electricity comes from coal-fired power plants (MDEQ 2010), and this electricity use is responsible for 52% of municipal emissions (see Table 9-3). As noted above, energy conservation and efficiency is extremely important. However, it can only reduce emissions so far and for so long, after which growth in population and accompanying City services will reverse the gains. Renewable energy is essential to long-term sustainability, since its use contributes either no or substantially lower emissions than energy produced from fossil fuels.

There are a number of renewable energy technologies that have varying levels of feasibility depending on their scale and location. Examples include solar, wind, biomass, and biofuels. Solar and biogas are the only forms of renewable energy that are currently used by the City though in minimal amounts (biodiesel fuel was previously used in some City vehicles, but is no longer commercially-available in Missoula).

Renewable energy is essential to long-term sustainability, since its use contributes either no or substantially lower emissions than energy produced from fossil fuels.

We recommend further capture and use of biogas from the City's wastewater treatment plant (see Chapter 2 and Sector-specific Recommendations below). Because the City's use of solar energy is still quite limited, it could be further expanded by adding additional photovoltaic panels to produce more electricity for municipal buildings. This would be a relatively easy and affordable way to expand renewable energy use. The City has yet to install a solar water heating system, which also could be part of an emissions reduction strategy.

Missoula is not a good location for wind power generation with current technology. However, wind energy could be purchased from an existing source or if a project were developed where wind can be harnessed in a cost-effective manner. Projects in the works, such as one in the Judith Highlands (not to be confused with the existing Judith Gap project), offer tremendous potential. Biomass generation carries similar constraints and opportunities. However, wind and biomass projects could become more attractive if federal incentives are provided and the costs of developing coal continue to increase. The Missoula Area Economic Development Corporation and the University of Montana could be partners for such projects. Funding recommendations are offered below.

Groundwater heat exchange is another renewable energy technology that could be considered for new and existing City buildings. On the University of Montana campus at least 15 buildings are centrally cooled with this type of system. The energy savings of ground water cooling are substantial. According to UM's greenhouse gas inventory (Davie 2008: 21-22):

> It is estimated that these systems use 15% the amount of energy a traditional chiller plant would use … 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 … [T]he 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 City of Missoula could follow the University of Montana's example by developing groundwater heat exchange systems for City Hall and Council Chambers, perhaps in collaboration with Missoula County and nearby local businesses to take advantage of economy of scale.

Consider Creation of a Municipal Energy Bond or Renewable Energy Loan Fund

In 1988, the City of Ann Arbor (Michigan) approved a $1.4 million Energy Bond, and in 1995 approved a Performance Contracting Bond to encourage further use of energy-saving technology in municipal operations. Additionally, Ann Arbor established a $100,000 per annum Energy Fund to assist in building retrofits and other energy efficiency programs. Under this system, facilities implementing energy-saving projects retain 20% of the cost savings, providing an incentive to develop individual energy efficiency projects.

The other 80% returns to the Energy Fund to meet the expiring Energy Bond payments (Epstein et al. 2003). Ann Arbor is a mid-sized university town much like Missoula. The City of Missoula could consider establishing a similar fund to pay the capital costs for energy efficiency retrofits to City buildings. Missoulians have shown great support for the Open Space bonds. Could it be time for an Energy Bond for Missoula?

Hire a Sustainability Coordinator

In a chapter in the book *Creating a Climate for Change*, Abby Young (2007, p. 289) notes that a major requirement of making municipal actions to address climate change happen is to "dedicate staff time to coordinating the climate protection program, develop new policies and programs, implement them in practice, and assess the effectiveness of the local government's approach."

In a March 2009 memo to Mayor Engen, a group of concerned citizens, City employees, and members of the Mayor's Advisory Group on Climate Change and Sustainability provided a rationale for hiring a sustainability coordinator. The memo outlined possible duties of and benefit to the City of such a position, supported by case examples from nine other cities. The memo also highlighted the risks associated with not hiring a sustainability coordinator. In essence, the memo warned that not hiring a sustainability coordinator would impair the ability of the City to "participate meaningfully in the Mayor's Climate Protection Agreement … [and] report on our progress in reducing carbon emissions and protecting [the] environment."[50]

Recently, the Missoula County Office of Planning and Grants (OPG) hired a new position for the planning and administration of its federal Energy Efficiency and Conservation Block Grant and the expansion of programs to support energy efficiency and conservation for both the City and County of Missoula. A number of projects are being developed by this new employee. This emissions inventory provides a useful baseline of energy use and emissions data that can assist this employee in whatever next steps Mayor Engen and the Missoula City Council endorse.

50 On file with first author.

A sustainability coordinator position may very well be needed to accomplish the next milestones of the *U.S. Conference of Mayors' Climate Protection Agreement*. Consider that the EPA *ENERGY STAR Guidelines for Energy Management*[51] suggest creating a multi-departmental energy management team rather than having one or two people shouldering responsibility for planning, implementation and evaluation.

A sustainability coordinator position may very well be needed to accomplish the next milestones of the Mayors' Climate Protection Agreement.

The need for continual monitoring of energy use and emissions, coordinated public outreach, and effective emission reductions measures will be a challenge for the City for many years to come. It is our hope that this new office can carry out such activities for at least the next two years and that such functions can be sustained in the future. Still, we believe that the creation of a permanent position is the only way to assure climate action by the City of Missoula is sustainable in the long run.

Make Sustainability a Part of Employee Orientation, Training, and Personnel Policies

We are not of the illusion that municipal sustainability can be solely the purview of one person or office. Indeed, the City already has many employees in many departments advancing municipal sustainability. Nevertheless, we recommend including skills, experience, and desire in the area of municipal sustainability among the criteria used in advertising open positions and in making hiring decisions as appropriate to the position. We also recommend incentives and rewards be provided to City employees for spearheading projects that achieve emission reductions and energy savings. In addition, we recommend that new employee orientations and trainings cover energy and water conservation, for example, by further institutionalizing the City's Green Team or assigning such tasks to the municipal Sustainability Coordinator position.

Integrate Consideration of Greenhouse Gas Emissions into Planning and Decision Making

Because future City growth is likely to require expansion of City wastewater treatment, street, police, fire, and other services, such growth, particularly if it moves outward, could also significantly increase municipal greenhouse gas emissions. If the City sets a GHG reduction target, future land use planning, street projects, and other decisions related to the provision of carbon-intensive City services should take into consideration and try to mitigate impacts to the City's carbon footprint.

Outward growth also results in increased commuting and travel distances for City employees. Policies that concentrate future residential development close to employment, services and attractions could reduce commuting distances and single-occupancy vehicle commuting, and thereby emissions, not just for City employees but for the Missoula community as a whole.

Although the City's ability to minimize increases in emissions from growth may be limited, offsetting emissions could indirectly help reduce net emissions of growth, for example, by increasing funding for less carbon-intensive transportation services related to light rail, transit, and bicycle and pedestrian use. In the future, funding mechanism to offset emissions should be explored.

51 See http://www.energystar.gov/index.cfm?c=guidelines.guidelines_index.

Establish Renewable Energy Certificate and/or Carbon Offset Program

Renewable energy certificates or renewable energy credits (RECs), also called green tags, are tradable, non-tangible energy commodities that represent proof that 1 megawatt-hour (MWh) of electricity was or will be generated from a renewable energy source. RECs are sold separately from electricity itself. The purchaser of a REC need not switch electricity provider or directly utilize the renewably-generated electricity that the REC represents.

If the carbon-intensity, i.e., carbon dioxide equivalent emissions per kilowatt-hour (CO_2e per kWh), are known for the non-renewably-generated electricity that may not be utilized as a result of increasing renewable power generation from the purchase of the REC, then the corresponding reduction in emissions can be "credited" to the REC purchaser.

RECs are a market-based approach to encouraging development of renewable energy. RECs also provide a means for utilities to meet their obligations under Montana's Renewable Portfolio Standard law,[52] which allows for the trading of RECs by certified traders. RECs can help cities, businesses, and institutions become carbon neutral, i.e., move toward having zero net greenhouse gas emissions.

RECs also provide a means for cities to raise revenue. For example, Portland developed an innovative program with various public, private, and non-profit partners to finance rental housing weatherization through the sale of RECs. The program has:

> … improved the lives of residents, added jobs and dollars to the local economy, and helped lower energy bills for many middle- and low-income families, resulting in significantly increased discretionary incomes. It has upgraded Portland's building stock and reduced tenant turnover. It has helped local weatherization firms add jobs and has redirected funds back into the local economy that previously went to purchase fossil fuels (Mayors Climate Protection Center 2007, p. 55).

Missoula is already exploring the sale of RECs to support energy conservation and efficiency projects. In partnership with REC marketers, cities in Iowa, Massachusetts, Nevada, and Vermont have sold RECs to finance biogas capture from wastewater plant (Crowe et al. 2009).

Other cities have sold RECs to finance biogas capture from municipal landfills. For example, the City of Benton, Texas, captured natural gas from its landfill to run a biodiesel plant that provided the City with an alternative fuel for its fleet and diesel-powered equipment, thereby allowing it get into compliance with air quality standards (Mayors Climate Protection Center 2007).

> *RECS and carbon offsets require rigorous means of verification … and can be part of a broad-based strategy that goes beyond "picking the low-hanging fruit."*

A *carbon offset* is another free market tradable commodity. It typically represents a metric ton of carbon dioxide equivalent GHG emissions (tons of CO_2e) prevented from entering or removed from the atmosphere. Offsets may be purchased by electricity consumers to "offset" their own emissions,

52 MCA 69-3-2001 "Montana Renewable Power Production and Rural Economic Development Act".

such as those associated with electricity consumption or vehicle use. Purchased offsets are used by a third-party to finance projects that would not have otherwise occurred and that can achieve GHG reductions or prevent emissions, such as renewable electricity generation, energy efficiency measures, methane capture at wastewater treatment plants, and reforestation projects.

RECS and carbon offsets require rigorous means of verification and tracking. Nevertheless, they can help in meeting emission reduction targets and can be part of a broad-based strategy that goes beyond "picking the low-hanging fruit."

RECs in particular can serve as a means of financing emission reduction projects such as energy recovery and renewable energy generation. We encourage City leaders to take advantage of the tremendous potential of RECs and carbon offsets to support emission reductions.

SECTOR-SPECIFIC RECOMMENDATIONS

In this section we list key recommendations for each sector examined in this report: wastewater; buildings; municipal fleet; employee commuting; lighting; and water. More detailed descriptions of these recommendations are provided in the correspondingly-titled chapters of this report.

Wastewater Treatment (4,442 tons of CO_2e in FY08, up 51% from FY03)

Energy use and related GHG emissions by Missoula's wastewater treatment plant have grown steadily in recent years as the service area and population has grown, necessitating the installation of more energy-intensive equipment and additional lift stations. This has resulted in even greater increases in energy costs for wastewater treatment. Even with capture and use of some biogas, the plant contributes over one-third (38%) of all municipal emissions quantified in this inventory. Several recommendations to reduce wastewater treatment-related emissions are listed below. All will require proactive effort and initiative on the part of City leaders. Please see Chapter 2 for detailed description of these recommendations.

- Consider increasing the quantity of biogas reclaimed for heat production to offset the quantity of purchased energy needed to maintain required influent temperatures.
- Support water conservation measures to reduce the total quantity (gallons) of influent wastewater that the plant receives for treatment.
- Consider wastewater reclamation for enhancement of carbon sinks by redirecting treated effluent to grow biomass, i.e., hybrid poplars rather than discharging this treated wastewater into the Clark Fork River.
- Consider energy efficiency when designing future upgrades to ensure that the energy-efficient fixtures and equipment are chosen.
- Consider on-site renewable energy production, for example, solar or wind power production, to reduce the quantity of purchased energy needed for wastewater treatment operations.

Buildings (4,128 tons of CO_2e in FY08, up 126% from FY03)

If City leaders adopt an emission reduction goal, attention to energy use in buildings will be essential to implementation. Although modest steps have been taken to improve the energy efficiency of municipal buildings, for example, by adopting Resolution #7340, performance contracting, and other measures under the 2004 Greenhouse Gas/Energy Efficiency Plan, these do not yet appear to have a significant effect on energy use and associated GHG emissions.

Missoula lacks a vigorous comprehensive green building policy. Thus, we recommend adoption of a green building policy that requires LEED (Leadership in Energy and Environmental Design) certification by the U.S. Green Building Council for new buildings. We also recommend a program to adopt LEED certification for existing buildings (LEED-EB).

We also recommend a no-net-increase policy for greenhouse gas emissions from buildings, whereby the City is required to purchase of carbon offsets or renewable energy credits to assure that new municipal buildings do not increase overall emissions as occurred with the recently-built aquatic recreational facilities.

To be effective, additional targeted efforts also will need to be devoted to exisiting buildings with relatively large amounts of energy usage, particularly those in the *Headquarters*, *Streets and Maintenance*, and *Fire Stations* building groups. In addition, special attention must be given to *Currents* and *Splash*, which used nearly half of all building-related energy in FY08.

In addition, we recommend the following (see Chapter 3 for more details):

- Conduct energy audits of all municipal buildings that have not been audited and consider performance contracting for all municipal buildings.
- Develop a new program and plans to assess and monitor building energy use by setting goals, benchmarks, and monitoring performance, for example, using the EnergyCAP software or the U.S. EPA ENERGY STAR Portfolio.
- Consider using Energy Performance Certificates, "energy identity cards," that rate buildings on their energy efficiency, visually display a structure's energy use, and provide a letter grade comparison with similar structures (Directgov 2009).
- Hire a new position to manage energy use for buildings, or train and reassign existing staff to serve in that capacity (see Make Sustainability a Part of Employee Orientation, Training, and Personnel Policies above).
- Build on the success of the City's Green Team by continuing to encourage voluntary energy conservation measures by City employees; consider further institutionalizing the Green Team through mandatory inter-departmental participation; and make such coordination part of the job description of a future sustainability coordinator.
- Adopt energy efficiency policies or standards for office equipment and lighting that requires new office equipment, applicances and lighting to be ENERGY STAR-certified.
- Inventory personal space heaters and other office appliances (e.g., mini-frigs and microwaves, water coolers, etc.) and consolidate or prohibit their use.
- Reduce the number of vending machines in City buildings.
- Strengthen energy efficiency standards for new buildings.
- Encourage collaborative efforts with the University of Montana and others.
- Conduct further energy-efficiency research and analysis.

Municipal Fleet (1,752 tons of CO_2e in FY08, up 21% from FY03)

As mentioned previously, several initiatives have been undertaken or are being planned to reduce fleet-related fuel consumption and costs, and thereby reduce greenhouse gas emissions. The recently-enacted Resolution #7375 sets a specific reduction target for fuel use, which could directly translate into a decrease in greenhouse gas emissions. The City of Missoula's Fuel Use Reduction Plan developed and adopted in 2009 offers concrete steps to achieve the goal of a 10% reduction in fuel use from 2007 levels by 2011.

In addition, the Public Works Director and the Mayor's Office are also in the process of updating the City of Missoula Vehicle Usage Policy by amending Administrative Rule #11. The rule includes anti-idling guidelines for City personnel. Many of the City Green Team's 25 priority recommendations (Engen 2009) are aimed at reducing fuel consumption as well, and in recent years, fuel efficiency has been a consideration in vehicle replacement.

It is too soon to tell if these measures will reverse the trend of increased fleet fuel usage. This baseline inventory helps to identify those departments and divisions within the fleet sector for which fuel use reduction measures could be prioritized to achieve the greatest emissions and cost savings. Overall success will depend on the major fuel consuming divisions and department (Streets, Police, Parks & Recreation, and Fire in particular) improving their efficiency by successfully implementing their fuel reduction plans. The next tier in terms of fuel consumption includes the Wastewater Division, Engineering Division, City Cemetery, and Traffic Services Department. Together, these eight units are responsible for 95% of the fuel consumed in FY08.

The expansion of City street miles and services will likely continue to pose a challenge to those responsible for ensuring the City's 2011 fuel reduction goals are met. To reduce fuel use and save on fuel costs while maintaining the same level of service, several aforementioned existing measures can be expanded upon, and new measures developed.

Many of our recommendations closely mirror those in the City's Fuel Reduction Plan, as well as steps identified by the City's Green Team. Some of our recommendations require little money but pose a challenge to implement because they require City employees to alter their behavior when choosing and operating vehicles. Others, involving fleet replacement and upgrades to more fuel efficient and alternative fuel vehicles, for example, may require substantial funds which, realistically, tend to be limited in the short-term but may lead to substantial long-term savings (see above for suggestions for financing municipal emission reductions).

Our recommendations for the municipal fleet are as follows (see Chapter 4 for more details):

- Consider adopting a comprehensive green fleet policy.
- Encourage efficient City employee vehicle choice and use (needs-based vehicle selection) by adopting proposed changes to Administrative Rule #11.
- Prioritize energy efficiency considerations in vehicle replacement and maintenance.
- Consider and expand use of alternative fuel sources.
- Continue to encourage the use of alternative transportation (such as Mountain Line buses) for city business-related trips, minimization of vehicle use, and other voluntary measures by City employees.
- Continue or expand staff certifications and trainings and fleet operations management tools.

Employee Commuting (1,037 tons of CO_2e in FY08, up 25% from FY03)

In our survey of City employees, we found the vast majority of respondents commute via single-occupancy vehicles: 71% of employees commute always or sometimes by single-occupancy vehicles and 91% of commuting trips are made by single-occupancy vehicles. Thus, steps to reduce driving alone will likely lead to the greatest reduction in overall commuting-related energy use and emissions.

We also found that respondents live farther from work, and therefore, commute greater distances than we had expected, on average about 11 miles one-way with 53% living more than 5 miles from work.

To gain public support, the City of Missoula and sustainable transportation advocacy groups should consider providing outreach and information regarding how residential location choices can impact greenhouse gas emission goals and continue to promote alternative transportation and "carbon-free" commuting, i.e. walking and biking.

A 2008 transportation survey of Missoula Valley residents asked respondents to rate various transportation planning priorities. Although reducing energy use and climate change impacts was not explicitly included among the criteria, Missoula residents ranked minimizing impacts on the natural environment second in priority out of 22 transportation planning criteria. Respondents also rated improved pedestrian facilities as a very high transportation priority and improved bicycling facilities as a high priority; these were ranked 5^{th} and 10^{th}, respectively. In addition, respondents ranked reducing vehicle emissions in general 9^{th} in priority (Baldridge 2008). Thus, the public would like to see more alternative transportation options that can have positive environmental and health benefits.

City employee comments from our commuting survey provide some specific recommendations for altering employee commuting habits to reduce greenhouse gas emissions. We found that concerns regarding child care, bus routes, and work schedules are all major reasons that respondents decide to drive alone to and from work. A complete list of respondents' recommendations and comments are included in Appendix E4.

Our employee commutuing recommendations are as follows (see Chapter 5 for more details):

- Fund and implement the City employee "cash for commuters" program to encourage greater use of Mountain Line Transit.
- Encourage more employees to participate in vanpools and carpools to and from work and ride sharing after work.
- Provide free parking for employees who carpool.
- Consider incentives for living in Missoula or closer to work.
- Empower division and department heads and supervisors to allow four-day work weeks as appropriate (see above).
- Partner with Missoula In Motion or other entities on an employee car-share program.
- Further research ways to incentivize low-carbon and carbon-free employee commuting.

Lighting (983 tons of CO_2e in FY08, up 11% from FY03)

Opportunities to reduce electricity consumption, costs, and associated GHG emissions from Missoula's lighting sector can involve making energy efficiency upgrades, replacing or eliminating lighting equipment, further evaluating the lighting use and needs, and curtailing unneeded uses. In addition, we recommend the following (also see Chapter 6):

- Give attention to high annual ownership, operation and maintenance charges for Streetlight Districts and other outdoor lighting.
- Inform and invite the public and business community to participate in discussions about reducing lighting costs for Streetlight Districts paid by property assessments and the General Fund.
- Consider renegotiating contracts with NorthWestern Energy regarding light maintenance services.
- Consider transfer of responsibility for lighting equipment ownership, operations, and maintenance to the City for certain districts or lighting groups.
- Consider partnering with NorthWestern Energy to install energy-saving Light-Emitting Diode (LED) luminaries for streetlights.
- Initiate outdoor lighting replacement projects for City-owned lights, for example, by replacing High Pressure Sodium Vapor (HPSV) lamps with LED luminaries, which can cut energy use in half.
- Conduct other lighting efficiency upgrades.
- Install small solar power cells on outdoor lighting fixtures.

Other Miscellaneous Energy Use (194 tons of CO_2e in FY08, down 49% from FY03)

Much of the miscellaneous energy use not accounted for in other sectors appears to be related to irrigation of City parks and landscaped areas along streets. Thus, a water conservation program for City parks can help reduce energy use and greenhouse gas emission reductions. With these findings and considerations in mind, we offer the following recommendations:

- Investigate increases in energy use at the departmental level, as appropriate.
- Monitor energy use, costs, and emissions associated with the various miscellaneous NorthWestern Energy accounts identified in Chapter 8.
- Develop a water conservation program for the Parks Department that can also reduce energy use and GHG emissions.
- Provide incentives to the Parks Department such that energy savings can be used to support additional energy conservation measures.

Water (25 tons of CO_2e in FY08, up 102% from FY03)

Although embodied energy in water and associated emissions are a very small percentage of overall emissions, if the City leads by example, it can have a multiplier effect by encouraging water conservation among residential and commercial water users, particularly in areas of the city where water is pumped, which in turn could reduce influent and energy demands at the City's wastewater treatment plant. Thus, in addition to the water monitoring and conservation recommendations above, we recommend:

- Investing in improvements to water distribution infrastructure.
- Supporting water conservation practices.
- Conducting facility-by-facility water audits.
- Speeding up schedule for metering all municipal water use.

MOVING FORWARD – NEXT STEPS

This municipal greenhouse gas inventory shows that recent increases in the City's energy use and associated greenhouse gas emissions have been accompanied by even steeper and seemingly unsustainable increases in energy costs. Rising energy prices force many Missoulians to make trade-offs in their housing and vehicle choices and food budgets. Difficult choices will face a similarly-squeezed City government in the provision of services in the future, if they have not already.

As we have seen with gasoline prices in recent years, and may also see with utility prices in coming years, instability of energy markets creates uncertainty and threatens to eat up more and more disposable income, dig into profits, and leave less and less to spend and invest in the local economy. These are risks that can be lessened considerably by being wiser energy consumers, by becoming energy producers, and by recovering more waste energy.

Although controlling the price of energy is beyond the jurisdiction of the City, controlling energy costs of municipal operations is not. Reducing unnecessary energy use and being smarter energy consumers is already squarely on the City's agenda and makes the prospects of further progress good.

The benefits of local solutions to climate change go far beyond more efficient local government … Climate action planning will leave more in our pocketbooks and improve the local economy. It will enhance the designs of our neighborhoods, our air quality, our health and well-being as individuals, families, and as a community.

The *U.S. Conference of Mayors' Climate Protection Agreement* provides a road map for reducing municipal energy costs while also helping to protect the things the Missoulians value: our parks and open spaces, forests and streams, working farms, wildlife habitat, public health, quality of life, and livability of our neighborhoods.

Using less energy and using what we use more wisely takes concerted and coordinated effort. It takes planning, and it takes involvement and cooperation of the public and private sectors.

We hope that by revealing recent trends in energy use, costs and associated greenhouse gas emissions, and by showing what is at stake and what can be done, that this report gives impetus to City leaders and the broader community to confront the challenges head on.

We believe Missoula is ready to follow suit with other cities in Montana and across the country in coming together to take the next step in the *Mayors' Climate Protection Agreement*: setting an emission reduction target and developing a climate action plan for the City.

Though it is appropriate to ask, "What are the costs of doing so?" it is equally as important to consider the costs of not doing so. Energy is integral to the way we move around and the way we stay comfortable inside, safe and secure outside, and healthy wherever we are. Energy is critical to building, maintaining, and operating our infrastructure and city services. How we use energy, where we obtain it from, and how much it costs all impact our local economy, our environment, and our quality of life in profound ways. The benefits of local solutions to climate change go far beyond more efficient local government. In taking the next steps of the *U.S. Conference of Mayors' Climate Protection Agreement*, the City of Missoula can lead by example for all Missoulians. Moving forward in ways that we have outlined will improve our buildings, waste management, and transportation systems. Climate action planning will leave more in our pocketbooks and improve the local economy. It will enhance the designs of our neighborhoods, our air quality, our health and well-being as individuals, families, and as a community.

Addressing the City of Missoula's carbon footprint can help achieve a broader vision of a prosperous and sustainable future that is only limited by our imagination and courage. It is our hope that this report lays a foundation for such a vision and moves our community closer to creating a blueprint for municipal sustainability.

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12. APPENDICES

Appendix I-1 – City of Missoula Costs (in 2009 Dollars) for Energy Purchased from NorthWestern Energy by Sector and Energy Type, FY03 and FY08

Sector and Energy Type	FY03	FY03 % of Total	FY08	FY08 % of Total	2003-08 % Change
Buildings					
Electricity	$55,694	16.3%	$293,255	22.9%	427%
Natural Gas	$65,292	19.1%	$303,715	23.8%	365%
Buildings Subtotal	$120,986	35.5%	$596,970	46.7%	393%
Wastewater					
Electricity	$78,524	23.0%	$450,741	35.3%	474%
Natural Gas	$0	0.00%	$3,660	0.29%	n/a
Wastewater Subtotal	$78,524	23.0%	$454,401	35.6%	479%
Lighting					
Electricity	$76,228	22.4%	$177,032	13.9%	132%
Natural Gas	$0	0.00%	$0	0.00%	n/a
Lighting Subtotal	$76,228	22.4%	$177,032	13.9%	132.2%
Other Misc.					
Electricity	$47,454	13.9%	$49,612	3.88%	4.5%
Natural Gas	$17,817	5.22%	$133	0.01%	-99.3%
Other Misc. Subtotal	$65,271	19.1%	$49,745	3.89%	-23.8%
All Sectors					
Electricity	$257,900	75.6%	$970,640	75.9%	276%
Natural Gas	$83,109	24.4%	$307,508	24.1%	270%
Grand Total	**$341,010**	**100%**	**$1,278,148**	**100.0%**	**275%**

Note: Totals may not precisely add up due to rounding of values.

Appendix I-2 – City of Missoula Costs (in 2009 Dollars) for Energy Purchased from NorthWestern Energy by Sector, FY03 to FY08

Sector	FY03	FY04	FY05	FY06	FY07	FY08
Buildings	$120,986	$276,401	$283,723	$331,113	$448,564	$596,970
Wastewater	$78,524	$333,536	$341,409	$356,337	$391,272	$454,401
Lighting	$76,228	$155,674	$166,148	$169,643	$172,869	$177,032
Other Misc.	$65,271	$83,566	$89,329	$87,786	$56,632	$49,745
Grand Total	**$341,010**	**$849,177**	**$880,609**	**$944,880**	**$1,069,338**	**$1,278,148**

Note: Totals may not precisely add up due to rounding of values.

Appendix WW1 –Recent Upgrades to Missoula's Wastewater Treatment Plant

Between 2003 and 2006, the following major plant components were added or modified:

- Grit removal and screening processing;
- Conversion and addition of secondary treatment bioreactors and associated piping, to achieve nutrient removal at an average day design capacity of 12 mgd;
- Addition of 3 clarifiers to handle flow from the new bioreactors;
- Incorporation of modifications to achieve biological nutrient removal;
- Addition of a new primary sludge fermentation facility;
- Aeration system improvements;
- Addition of U.V. light disinfection;
- Polymer handling and feed systems;
- Miscellaneous plant modifications, including modifications in the headworks and primary effluent lift station expansion;
- Headworks and solids handling improvements;
- Replacement of the existing three-belt filter presses with a high volume centrifuge dewatering system (Morrison Maierle 2008).

Appendix WW2 - Missoula Wastewater Treatment Energy Supply Account Numbers and Raw Data by Company for FY 2003 and FY 2008*

Energy Provider/ Acct. #	Account Name	FY03 kWh	FY03 Electric Costs ($)	FY03 Dth	FY03 Gas Cost ($)	FY08 kWh	FY08 Electric Costs ($)	FY08 Dth	FY08 Gas Cost ($)
NorthWestern Energy									
WWT Plant									
100435	1100 Clark Fork Lane	3,463,552	$49,092			4,501,632	$363,051		
1546647 *	1175 Clark Fork Dr #TrkBarn					8,199	$892	292	$3,604
Lift Stations									
100389	Higgins Ave Bridge - Lift Station	37,693	$799			41,969	$3,956		
100457	S Reserve St Lift Station	30,880	$588			121,120	$10,319		
716946	E Broadway St 1220 Blk - Lift Station	13,993	$1,113			20,892	$2,142		
717070	Dickens St - Lift Station Pump	11,818	$963			11,832	$1,250		
717412	Lift Station 2-E of Momont	7,660	$645			20,920	$2,136		
717413	Lift Station 1-Momont Rd	7,790	$655			17,193	$1,778		
717596	Grant Crk Lift Sta-300 Blk Expressway W of UPS	17,560	$1,295			34,440	$3,126		
718866	6401 Linda Vista Blvd #Pmphse	14,915	$1,183			29,225	$2,963		
719382	Madison St Bridge UM Lift Station	38,695	$2,943			30,659	$2,902		
719923	3224 Helena Dr #Lift	1,620	$202			1,247	$211		
720300	Linda Vista Blvd and Helena Dr East	859	$146			874	$174		
720301	Linda Vista Blvd and Helena Dr 2 West	4,209	$392			4,634	$543		
720302	Linda Vista Blvd and Eldora Ln	8,046	$674			6,753	$752		
720303	Lamoureaux and Lower Miller Cr Rd	15,814	$1,248			8,408	$915		
720304	Linda Vista Blvd and Raymond Ct	1,389	$185			802	$166		
720305	Linda Vista Blvd and Lower Miller Crk Rd	2,145	$240			1,255	$213		

Energy Pro-vider/ Acct. #	Account Name	FY03 kWh	FY03 Electric Costs ($)	FY03 Dth	FY03 Gas Cost ($)	FY08 kWh	FY08 Electric Costs ($)	FY08 Dth	FY08 Gas Cost ($)
720306	Linda Vista Blvd and Paul Ln	3,577	$346			2,350	$320		
721047	1 Dorothy Ct	411	$111			471	$134		
721158	Highwood and Country Club Ln	1,594	$161			1,624	$214		
721608	End of Industry Rd, Sewer Lift Pump	864	$146			428	$130		
721609	Leo and Powell Sewer Lift Pump	851	$145			1,068	$193		
721610	Leo and Kennedy St Sewer Lift Pump	1,700	$208			1,449	$230		
880837	Fort Missoula Sewer LiftStation	12,965	$1,124			8,352	$1,025		
908558	DJ Dr #Sewer	683	$133			1,006	$187		
912958	Lower Miller Ck Maloney Ranch; Lift Station	8,192	$686			10,219	$1,092		
973116	Hiberta St #Lift Pump	9,156	$758			15,126	$1,576		
1111258	935 Montana Ave #Lift St	3,690	$406			10,242	$1,238		
1189870 *	1100 Clark Fork Dr					459,680	$37,480		
1642700 *	Mastad Dr Sewer Lift Station					4,240	$651		
1645239 *	Canyon River Lift Station					5,082	$554		
1652050 *	1200 Otis St # Pmphse					5,670	$627		
1665581 *	6950 US Highway 10 W (Futurity Lift Station)					3,920	$706		
Missoula Electric Coop									
342896	Kona Ranch, Mullan Rd, Council Way, Kelley Is. Lifts					106,305	$7,848		
Jefferson Energy									
3216	WWT Plant							3,314	$41,504

Energy Pro-vider/ Acct. #	Account Name	FY03 kWh	FY03 Electric Costs ($)	FY03 Dth	FY03 Gas Cost ($)	FY08 kWh	FY08 Electric Costs ($)	FY08 Dth	FY08 Gas Cost ($)
Commercial Energy									
3216	WWT Plant			4,390	$23,636				
Subtotals and Grand Total									
Lift Stations Subtotal		258,769	$17,495			989,455	$87,751		
Wastewater Treatment Plant Subtotal		3,463,552	$49,092	4,390	$23,636	4,509,831	$363,943	3,606	$45,108
Grand Total		3,722,321	$66,587	4,390	$23,636	5,499,286	$451,694	3,606	$45,108

*Notes: *Asterisk denotes lift station account that existed in FY08 only, not in FY03. Any other missing values in this table equal zero. Northwestern Energy supplied electricity to the WWT Plant and 27 lift stations in FY03; Northwestern Energy supplied electricity to the WWT Plant and 32 lift stations in FY08; Missoula Electric Coop supplied electricity to four lift stations in FY08 (Council Way, Kelley Island, Mullan Rd. and Kona Ranch); Commercial Energy supplied natural gas to the WWT Plant in FY03; and, Jefferson Energy supplied natural gas to the WWT Plant in FY08. Totals may not precisely match tables due to rounding.*

Appendix WW3 – Wastewater Treatment Sector Electricity,

Natural Gas and Biogas Calculations

Electricity

The following method was used to estimate missing month of Missoula Electrical Cooperative data:

1. Sort data by lift station;
2. Calculate unit cost ($/KWh) per month (= dollar amount paid/energy used);
3. Calculate average unit cost of previous 11 months; enter this value as unit cost for "missing 12th month";
4. Calculate average energy use (KWh) of previous 11 months; enter this value as energy use for "missing 12th month";
5. Calculate energy cost for "missing 12th month" (= calculated average unit cost * calculated average energy use);
6. Calculate 12 month totals;
7. Calculate total for all four stations using "real" and "calculated" data.

Natural Gas

The following method was used to estimate missing month of Jefferson Energy data:

1. Calculate difference between "amount paid with fees" - "amount paid fuel only";
2. Calculate average of difference between amounts paid based on 10 months of "real data"; enter this value as "difference" for DEC 07 and JUNE 08 FUEL;
3. Calculate "amount paid fuel only" for DEC 07 and JUNE 08 based on "real data" for "amount paid with fees" and calculated "difference";
4. Calculate natural gas use based on previously calculated "amount paid fuel only" and given gas price ($8.4580/MMBTU).

Biogas

The following steps were taken to calculate the mass of biogas-related emissions for both fiscal years 2003 and 2008:

1. Calculate volumes (m^3) for both years by "fate" of biogas:
   - fugitive biogas = 2% of total biogas emissions
   - flared biogas = 49% of total biogas emissions
   - boiler biogas = 49% of total biogas emissions.

2. Based on the assumption that 60% of biogas is methane and 40% of biogas is carbon dioxide, calculate volumes (m^3) for each type of gas for each "fate" listed above.

3. For flared and boiler biogas, calculate separately for each fate and year (2008 flared biogas, 2008 boiler biogas, 2003 flared biogas, 2003 boiler biogas), dealing with methane and carbon dioxide components of biogas separately and using the following constants and unit conversion factors:

"Given" Constants/Equations			
Standard Temperature	P_{std}	298	K
Standard Pressure	P_{std}	101.325	kPa
Missoula Pressure	P_{3300}	90.28	kPa
Density, CO2 gas at STP	Á$_{CH4}$	1.98	kg/m^3
Density, CH4 gas at STP	Á$_{CO2}$	0.656	kg/m^3
Molar Mass CH4	m_{CH4}	16.042	g/mol
Molar Mass CO2	m_{CO2}	44.0095	g/mol
Combined gas law	$(P_{std}V_{std})/T_{std}=(P_{3300}V_{3300})/T_{3300}$		
Density	Á=mass*volume		
1kg =	2.20	Lb	
1lb =	0.0004535	metric tons	
1g =	0.000001	metric tons	

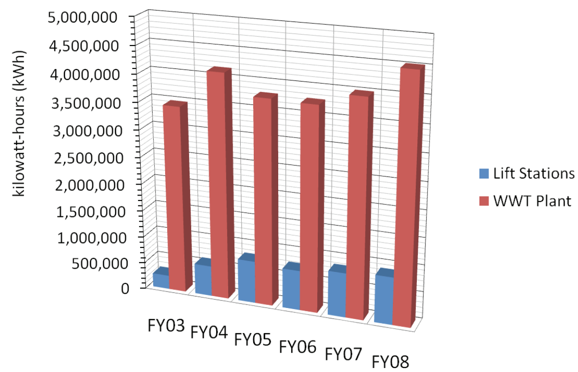
- Adjust volume of methane CH_4 from atmospheric pressure in Missoula (at 3300ft) to Standard Pressure using the combined gas law (as shown above), holding standard temperature constant to calculate Volume of flared or boiler CH_4 at STP;
- Calculate mass of CH_4 (mol) based on Volume and density of CH_4 at STP;
- Assuming complete combustion ($CH_4 + 2O_2 = CH_4 + 2H_2O$), so 1 mol CH_4 yields 1 mol CO_2, calculate the mass of CO_2 from CH_4;
- Adjust volume of CO_2 from Pressure in Missoula (3300ft) to Standard Pressure, using combined gas law, holding standard temperature constant to find the volume of CO_2 flared (at STP);
- Calculate mass of CO_2 (mol) based on Volume and density of CO_2 at STP; and,
- Calculate Total mass (mol) of CO_2 emitted by adding mass from methane and mass of carbon dioxide, then convert moles to metric tons of carbon dioxide equivalents (tons of CO_2e).

4. For fugitive biogas, calculate

   - Calculate Mass of fugitive CO_2 emissions by multiplying volume by density of CO_2 at STP;
   - Calculate Mass of fugitive CH_4 emissions using the combined gas law and density of methane at STP, then convert to metric tons of CO_2e;
   - Convert mass of fugitive CH_4 emissions into CO_2e by multiplying by 23 (Based on methane global warming potential of 23 (IPCC 2001));
   - Calculate Total CO_2e (metric tons) emissions from fugitive biogas by adding mass from CH_4 and CO_2.

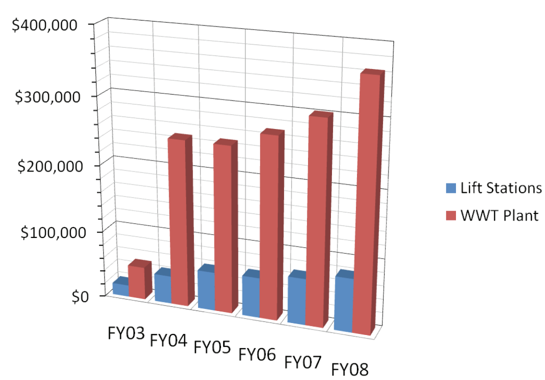
Appendix WW4 – NorthWestern Energy (NWE) Electricity Use (kWh) and Costs ($) for Missoula Wastewater Treatment, FY03 to FY08

Figure 12-1: NorthWestern Energy Electricity Use (kWh) for Missoula Wastewater Treatment (WWT), FY03 to FY08



	FY03	FY04	FY05	FY06	FY07	FY08
Lift Stations	258,769	569,692	788,258	740,794	827,371	883,150
WWT Plant	3,463,552	4,145,280	3,779,712	3,761,856	3,983,918	4,509,831

Figure 12-2: NorthWestern Energy Electricity Costs ($) for Missoula Wastewater Treatment (WWT), FY03 to FY08



	FY03	FY04	FY05	FY06	FY07	FY08
Lift Stations	$17,495	$41,948	$57,956	$59,996	$69,183	$79,902
WWT Plant	$49,092	$247,879	$247,657	$269,533	$301,023	$363,943

Lift Stations and WWT Plant	FY03	FY04	FY05	FY06	FY07	FY08
Total NWE Electricity Use (kWh)	3,722,321	4,714,972	4,567,970	4,502,650	4,811,289	5,392,981
Total NWE Electricity Costs ($)	$66,587	$289,827	$305,613	$329,529	$370,205	$443,845

Appendix B1 – Additional Examples of Energy-Efficiency Measures by the City of Missoula as of 2009

Several additional energy reduction measures not described in the body of this report have been funded by the City in recent years. The following is a list of many of those accomplishments:

1. An additional 3-5 inches of insulation was added to the roof of City Hall (2007). Maintenance added a surplus oil burner (2006-07).
2. Infrared heating replaced four forced air units in the Maintenance shop (2006-07).
3. The boiler in City Hall was replaced with an energy efficient model (2000).
4. The chiller unit on the roof of City Hall was update and replaced (2006).
5. Plans to replace thirty-five 1,000 watt lights and forty-nine 800 watt lights in Maintenance shop with more energy efficient bulbs to reduce lighting energy demand by 21,015 watts have been about half-way implemented and will be completed as funds are made available (2008-2009).
6. Several lights throughout the City were replaced based on light meter measurements.
7. Motion sensors that control lighting and "turn out the light" signs were installed in some City buildings.
8. More efficient Light-Emitting Diode (LED) "exit" and "entry" signs were installed to complete a 2001 retrofit.

Appendix B2 – Electricity Use (kWh) and Cost ($) Data by NorthWestern Energy (NWE) Account for Missoula Buildings and Building Groups, FY03 and FY08

NWE Acct. # by Building Group	Account Name	Physical Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
Headquarters						
0100407-6	Headquarters	435 Ryman St	894,320	15,724	1,103,760	91,859
1299523-9	Chambers	140 W. Pine St	-	-	52,760	5,878
Fire Stations						
0100403-5	FS 1	625 E. Pine St	141,880	2,533	141,320	12,426
0722499-1	FS 2	247 Mount Ave	18,526	1,447	7,700	739
0100453-0*	FS 3	1501 39th St	38,520	848	35,920	3,267
0100447-2	FS 4	3011 Latimer St	65,440	1,376	82,120	7,223
1565886-7	FS 5	6501 Lower Miller Cr Rd	-	-	93,260	8,134
0722478-5	Boathouse	McCormick Park-Fire Dept Boathouse	116	91	12	89
Currents						
1526898-0	Currents	600 Cregg Ln	-	-	748,160	61,361
Splash						
1493973-0	Splash	3001 Bancroft # Pumps	-	-	276,640	24,419
1486120-7	Splash	2100 S. 10th St W # Splash	-	-	10,259	1,098
1486122-3	Splash	1100 Sherwood St # Splash	-	-	9,970	1,065
1486126-4	Splash	6000 Linda Vista Blvd #Splash	-	-	10,299	1,098
1493965-6	Splash	3001 Bancroft #Concsn	-	-	45,920	4,243
1486128-0	Splash	1600 Ronald Ave # Splash	-	-	12,583	1,327
Parks						
0722600-4	McCormick	McCormick Park	533	17	492	43
0100426-6	Operations	100 Hickory St	87,630	2,012	69,160	6,560
0723567-4	Shop	101 Hickory St #Shp/St	3,591	348	1,612	247
0494712-3	McCormick	Warming Shed	12,101	969	-	-
Parking						
0100406-8	Parking Commission	128 W. Main St # Garage	316,960	4,059	282,320	22,461
0996360-4	Banks St. Parking	115 Bank Street # Parking	103,061	6,161	112,950	9,118

NWE Acct. # by Building Group	Account Name	Physical Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
Street Maintenance						
Billed through Zip Beverage	Vehicle Maintenance	1305 Scott Street #B	25,648	2,216	30,250	3,001
1042072-7	Streets Dept.	1305 Scott Street #A	19,800	1,712	31,400	3,118
0717137-4	Streets Dept.	Scott and W Pine Sts. Sand-shed	12,601	691	1,947	190
Cemetery						
0717572-2	Chapel	2000 Cemetery Rd. # Chapel	274	103	933	181
0717584-7	Shop	2000 Cemetery Rd. # Shop	22,001	1,704	18,963	1,950
0717585-4	Office	2000 Cemetery Rd. # Office	15,487	1,200	23,979	2,438
Other						
0532536-0	Missoula Museum of the Arts	335 N. Pattee St	52,680	4,020		
1502124-9	Missoula Museum of the Arts	335 N. Pattee St			156,960	15,237

** Note: The account number listed for Fire Station #3 is no longer active. This account was established during the remodeling of the station. The current electricity account number for Fire Station #3 is 1743305-3.*

Appendix B3 – Natural Gas Use (Dth) and Cost ($) Data by NorthWestern Energy (NWE) Account for Missoula Buildings and Building Groups, FY03 and FY08

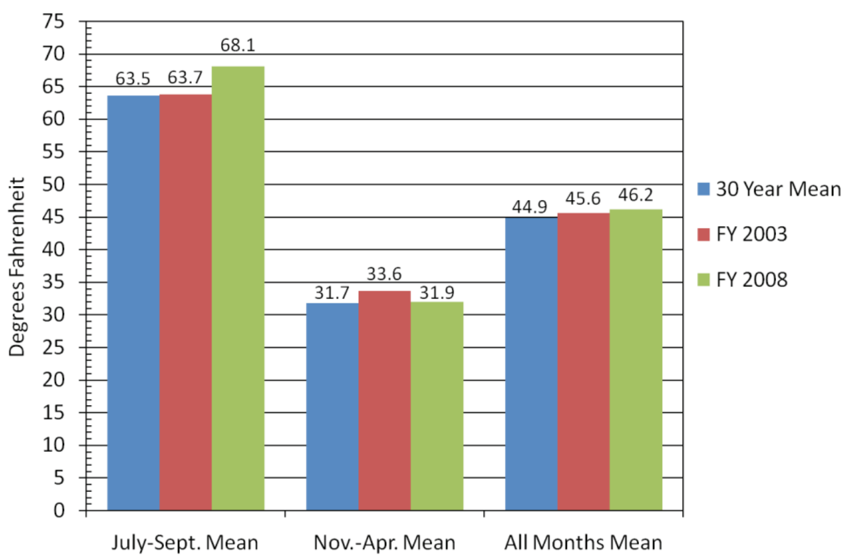
NWE Acct # by Building Group	Account Name	Physical Address	2003 Gas Use (Dth)	2003 Gas Costs ($)	2008 Gas Use (Dth)	2008 Gas Costs ($)
Headquarters						
0722518-8	Headquarters	435 Ryman St	1,905	10,090	2,778	31,462
1299523-10	Chambers	140 W. Pine St	-	-	229	2,939
Fire Stations						
0723006-3	FS 1	625 E. Pine St	794	4,630	655	7,891
0722499-2	FS 2	247 Mount Ave	465	2,740	22	361
0722553-5	FS 3	1501 39th St	380	2,297	410	4,728
0722956-0	FS 4	3011 Latimer St	834	4,900	667	7,988
1565886-8	FS 5	6501 Lower Miller Creek	-	-	616	7,312
Currents						
1526898-0	Currents	600 Cregg Ln	-	-	7,562	84,666
Splash						
1493973-0	Splash	3001 Bancroft # Pumps	-	-	5,325	64,887
1486120-7	Splash	2100 S. 10th St W # Splash	-	-	62	908
1486122-3	Splash	1100 Sherwood St # Splash	-	-	31	561
1486126-4	Splash	6000 Linda Vista Blvd # Splash	-	-	32	571
1486128-0	Splash	1600 Ronald Ave # Splash	-	-	81	1,172
1493974-8	Splash	3001 Bancroft # Bathse	-	-	74	1,050
Parks						
0722479-3	Operations	100 Hickory St			1,136	13,361
0723567-5	Shop	101 Hickory St #Shp/St	234	1,369	105	1,344
0494712-3	McCormick	Warming Shed	24	311	-	-
Parking						
0722842-2	Parking Commission	128 W. Main St # Garage	238	1,457	338	3,967
Street Maintenance						
0887577-5	Veh Maintenance	1305 Scott Street Gas #B	3,322	17,441	3,918	44,538
1042072-7	Streets Dept.	1305 Scott Street #A	178	1,061	175	2,140
Cemetery						
0717584-7	Shop	2000 Cemetery Rd. # Shop	146	932	299	3,498

NWE Acct # by Building Group	Account Name	Physical Address	2003 Gas Use (Dth)	2003 Gas Costs ($)	2008 Gas Use (Dth)	2008 Gas Costs ($)
0717585-4	Office	2000 Cemetery Rd. # Office	172	1,103	132	1,705
Other						
0532536-0	Missoula Museum of the Arts	335 N. Pattee St	394	2,349		
1502124-9	Missoula Museum of the Arts	335 N. Pattee St			1,016	12,019

Appendix B4 – Analysis of Mean Monthly Temperatures in FY03 and FY08 Compared to 30-Year Mean Temperatures for Missoula (FY78 to FY08)

Figure 12-3 below shows mean (average) monthly temperatures in Missoula in FY03 and FY08 as compared to 30-year monthly averages.[1] The mean temperature in summer months (July-September 2002) in FY03 (63.7°F) was very close to the 30-year average (63.5°F); however, the mean monthly temperature during the winter months from November 2002 to April 2003 (33.6°F) was 5.6% warmer than the 30-year monthly winter average (31.9°F). See Appendix B5 for a detailed tabulation. These data indicate relatively low winter heating demand and average summer cooling demand for City buildings in FY03.

Figure 12-3: Mean Monthly Temperatures in Missoula in FY03 and FY08 Compared to 30-Year Mean (FY 1978 to FY 2008)



Although there was a severe winter cold snap in FY08, FY08 appears to have had average winter heating demand, with monthly mean temperatures just 0.63% (0.2°F) above average. However, it had much higher than average summer cooling demand, with temperatures 6.7% above the 30-year average of 63.5°F: mean monthly temperatures in summer 2007 were 68.1°F. In fact, the summer of 2007 had record high temperatures with 11 days in July above 100 degrees in Missoula (Devlin 2007).

These differences in weather between FY03 and FY08 can explain some of the increase in energy use observed. As noted above, the addition of new buildings and expansion and remodeling of existing buildings coupled with an increase in city employees also contributed to a consistent increase in energy use even in the intervening years (FY04, FY05, FY06 and FY07).

1 Monthly mean temperatures were derived from average daily temperatures from the Missoula International Airport obtained from the National Climatic Data Center.

Appendix B5 – Mean Monthly Temperatures in FY03 and FY08 Compared to 30-Year Mean Temperatures for Missoula (FY78 to FY08)

Month	30-Yr Mean				% Difference from 30-Year Mean	
		FY03	FY08		FY03	FY08
July	68.0	70.9	78.5		4.06%	13.4%
August	66.5	63.1	68.5		-5.31%	2.99%
September	56.1	57.2	57.3		1.92%	1.96%
October	44.1	40.1	45.3		-9.76%	2.63%
November	31.9	32.1	32.3		0.89%	1.48%
December	24.0	29.0	28.0		17.1%	14.1%
January	24.2	28.8	22.0		16.1%	-9.69%
February	28.5	29.2	33.1		2.43%	14.11%
March	37.1	37.8	35.8		1.87%	-3.55%
April	44.9	44.9	40.4		0.02%	-11.1%
May	53.0	51.6	53.2		-2.80%	0.37%
June	60.3	62.3	59.8		3.25%	-0.89%
July-Sept. Mean	**63.5**	**63.7**	**68.1**		**0.32%**	**6.70%**
Nov.-Apr. Mean	**31.7**	**33.6**	**31.9**		**5.61%**	**0.63%**
All Months Mean	**44.9**	**45.6**	**46.2**		**1.57%**	**2.84%**

Source: National Oceanic and Atmospheric Association (NOAA), National Climatic Data Center (NCDC)

Appendix F1 – Municipal Fleet Fuel Costs ($) by Fuel Type, FY03 and FY08

	FY 2003			FY 2008			FY03-FY08 % Change
Fuel Type	Costs	% of Total		Costs	% of Total		
Unleaded	$101,420	55.1%		$327,929	55.6%		223%
Diesel	$82,645	44.9%		$257,457	43.6%		212%
Biodiesel	$0	0.0%		$4,932	0.8%		n/a
Total	**$184,065**	**100%**		**$590,318**	**100%**		**221%**

Note: Values may not precisely add up or match Table 6-3 due to rounding.

Appendix F2 – Municipal Fleet Energy Use (MMBTU) and Greenhouse Gas Emissions (tons of CO2e) for by Department or Division, FY03 and FY08

	Energy Use (MMBTU)					Emissions (tons of CO_2e)			
Department	FY03	FY08	% Change	% Total FY08		FY03	FY08	% Change	% Total FY08
Building Insp.	88	372	323%	1.7%		7	29	320%	1.6%
Cemetery	369	398	7.9%	1.8%		29	31	8.7%	1.8%
City Attorney	6	9	50.0%	0.0%		0.5	0.7	n/a	0.0%
Engineering	417	522	25.2%	2.3%		32	40	25.0%	2.3%
Finance Dept.	0	8	n/a	0.0%		0	0.6	n/a	0.0%
Fire	1,695	1,971	16.3%	8.8%		134	155	15.4%	8.8%
Info. Services	75	12	-84.0%	0.1%		6	0.9	-84.7%	0.1%
Mayor	49	47	-4.1%	0.2%		4	4	-4.1%	0.2%
MCAT	0	7	n/a	0.0%		0	1	n/a	0.1%
MRA	0	8	n/a	0.0%		0	0.6	n/a	0.0%
Parking Comm.	198	252	27.3%	1.1%		15	19	26.7%	1.1%
Parks & Rec.	3,209	3,480	8.4%	15.5%		250	271	8.2%	15.5%
Pending Sale	892	173	-80.6%	0.8%		69	13	-81.2%	0.7%
Police Dept.	3,345	6,047	80.8%	26.9%		259	467	80.3%	26.7%
Streets Div.	6,709	6,991	4.2%	31.1%		531	550	3.6%	31.4%
Traffic Serv.	472	395	-16.3%	1.8%		37	31	-16.7%	1.7%
Vehicle Maint.	67	190	184%	0.8%		5.2	15	184%	0.8%
Wastewater	866	1,577	82.1%	7.0%		68	124	81.8%	7.1%
Total	**18,457**	**22,459**	**21.7%**	**100%**		**1,447**	**1,752**	**21.1%**	**100%**

Note: Values may not precisely add up and totals may differ from Table 5-4 and Table 5-5 due to rounding.

Appendix E1 – Missoula Employee Commuting Survey

Mayor Engen has requested the assistance of the University of Montana in conducting an emissions inventory for the City of Missoula. The results of this survey will become part of a larger report for the City with recommendations for implementing the U.S. Mayor's Climate Change Commitment, ensuring further reductions in emissions, saving on energy costs to the taxpayer and freeing up funds. Your responses will be anonymous and confidential, and your participation is greatly appreciated.

Please return your survey to the Mayor's Office by April 7, 2009. Please fill out the included form, to be entered into a drawing for a $50 gift certificate to the UM Bookstore. Thanks again for your time!

1. How many days a week do you commute to work (please circle best answer)?

   (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

2. About how many times a week do you drive your vehicle to work each season? Please circle best answer for winter, summer and spring & fall.

Winter	Summer	Spring and Fall
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

3. What type of vehicle do you typically use when you drive to work? If you drive more than one vehicle or got a new vehicle recently, please pick the one that you have driven more often in the last year. Classifications of common vehicles are provided in the box to the right. →

   (a) Auto—subcompact/Compact
   (b) Auto—mid size
   (c) Auto—full size
   (d) Light truck/SUV/pick-up—Large
   (e) Light truck/SUV/pick-up—Medium/Large
   (f) Light truck/SUV/pick-up—Medium/Small
   (g) Light truck/SUV/pick-up—Small
   (h) Motorcycle
   (i) Other (please describe, make, model, year and fuel type.)

   ____

   ____

VEHICLE TYPES BY COMMON MODELS:

Auto – Subcompact/Compact examples:
Civic, Corolla, Focus, Neon, Cavalier, Impreza, Legacy, and Jetta.

Auto – Mid-Size examples:
Accord, Camry, Passat, Monte Carlo, Sable, and Sebring.

Auto – Full-Size examples:
Impala, Intrepid, Taurus, Crown Victoria, Bonneville, Outback, and Town Car.

Light Truck/SUV/Pickup – Large examples:
Suburban, Expedition/Lincoln Navigator, Ford E250/350/450, and cube-van style ambulances.

Light Truck/SUV/Pickup – Medium Large examples:
Durango, GMC 1500/2500 Safari Cargo Van (8 cylinder),
Ford F150 Pickup Truck, and Ford E150 Econoline van.

Light Truck/SUV/Pickup – Medium Small examples:
virtually all Minivans, Explorer, Sonoma Pickup Truck, and Astro Cargo Van (6 cylinder).

Light Truck/SUV/Pickup – Small examples:
Toyota RAV4, Tracker, S10 Pickup (4 cylinder), and Forrester, PT Cruiser.

4. What sort of fuel do you typically use in your vehicle?

   (a) Standard (leaded/unleaded/Premium, etc.)
   (b) Biodiesel
   (c) Diesel

5. How many miles do you commute from your home to your workplace? ______________________
(please fill in approx. one way miles to work)

6. How many times a week do you take the bus to work?

Winter	Summer	Spring and Fall
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

7. How many times a week do you ride a bike or walk to work?

Winter	Summer	Spring and Fall
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

8. How many times a week do you carpool?

Winter	Summer	Spring and Fall
(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7	(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

9. When you do carpool, how many people do you commute to work with?

(a) 1 (b) 2 (c) 3 (d) 4 (e) 5 (f) 6 (g) 7

10. Comments: ____

- -

Drawing for $50 Gift Certificate from The UM Bookstore Please fill out this portion to enter drawing. Entries will be entered only if attached to the survey. All survey responses will be held confidential and separate from this entry form. Completed surveys and drawing entries must be received by April 7, 2009.

Name: ____

Phone: ___________________________ Email: _______________________________

Appendix E2 - Number and Percentage of Respondents by Commuting Distance to Work

Commute Distance (miles)				Number of Respondents	% Total
One-way		Round-Trip			
< 1		0 to 1.99		2	1.60%
1 to 2.49		2 to 4.99		24	19.4%
2.5 to 4.9		5 to 9.99		32	25.8%
5 to 9.9		10 to 19.9		16	12.9%
10 to 19.9		20 to 39.9		29	23.4%
20 to 39.9		41 to 79.9		18	14.5%
> 40		> 80		3	2.40%

Appendix E3 – Total Miles Commuted by Commute Mode for 125 Survey Respondents

Commute Mode	Total Miles Commuted	% Total
Driving Alone	404,963	73.7%
Busing	11,988	2.2%
Biking/Walking	14,180	2.6%
Carpooling person miles*	118,205	21.5%
Total	**549,336**	**100.0%**

** Equal to 40,760 vehicle miles based on reported average of 2.9 persons per carpool*

Appendix E4 – Employee Commute Survey Respondents' Comments and Suggestions

Comments and suggestions are divided into sections based on what came up most often. The most prevalent comments were that people with children have a difficult time utilizing car and van pools, and that the bus routes and schedules are not convenient for many people. Of the 125 respondents 42% gave comments and suggestions.

Noted Challenges and Offered Solutions

- "Distance & location of home related to work as well as unpredictable over time hours prohibit pooling."
- "Would like the City to look at 4-10 shifts and telecommuting for employees."
- "These sorts of surveys ought to include options for differing modes of transportation to and from work. I never walk to work, but I often walk home."
- "I would probably use a van pool--Turah area 3x a week or so?"
- "I would ride the bus more if my work hours could be modified."
- "A lot of my driving is dependent on contractors &/or weather.
- "I walk/ride my bike if at all possible."
- "City employees need parking provided to them."
- "Would be wonderful if we had parking and didn't have to worry about parking tickets or finding a place to park."
- "I would like to carpool but do not know about a system by which I could sign up."
- "Hours are part-time and variable, unable to carpool."
- "Give 10 minute incentives a.m. and p.m. to ride/bike/or walk to and from work."
- "Drive city-owned vehicle to/from/during work."
- "Usually stop places to and from work, disabled--too far to walk/bike for a 10 hour shift."
- "Would start biking earlier in year if Hillview was cleaned sooner"

Bus Comments

- "Mountain Line Bus System is poor and never used for that reason."
- "No bus available."
- "Motorcycle 2 months--I live outside the bus routes."
- "Public transportation outside the city limits is very limited."
- "Have a 15 month old that goes to daycare--hard to ride bus and/or carpool."
- "I need to get around the City during the day. I would take the bus if they had more routes."
- "Would use Mountain Line if more scheduled pickups happened more frequently or time was different."
- "I would ride the bus, but it doesn't come out to my house."

- "I wish the bus would go to Clinton--I would ride a lot!"
- "I have two elderly, ill dogs so I have to come home for lunch otherwise I would take the bus--"
- "I ride City Bus to and from work each work day."
- Re: Bus "Does not have a route to get me to work."
- "Ride bus mainly--drive possibly one or two a weeks if necessary.
- "Always ride the bus."

Childcare Comments

- "It's pretty hard to carpool/bus when you have kids. I would suggest promoting 4 day work weeks."
- "Can't carpool due to daycare here in Missoula."
- "I have a child to get to daycare; I carpool to the rink with another skater 1-2 times per week Sep-Apr."
- "It's hard to bike to work with gun from the Bitterroot Valley & the car seat won't fit!"

Other Comments

- "I ride bicycle!"
- "I have never taken the bus, I don't carpool and I've never walked or rode my bike to work."
- "Van Pool"
- "I do not take bus, do not ride a bike or walk, and do not carpool."
- "I ride in the Van Pool. 13 people are signed up--averages 8."
- "I ride my bike to work in summer."
- "I ride the Van Pool--we have 12 people"
- "I've been walking to work year round for 2 years now."
- "I plan to bike part of the way during the summer. New to area!"
- "I walk to and from everyday"
- "The above are averages at best--I often walk in spring and fall and carpool w/3."
- "Thanks for doing this survey."

Appendix L1: Street Light District Allowable Charges

Street Light District bills may include various charges. The Budget Officer and City Manager of Great Falls, Montana, wrote a report titled, City of Great Falls Street Lighting Districts Ownership Analysis, which was use to identify the following list allowable charges for streetlight districts:

1. The Supply charge is for electricity use for each streetlight unit. All streetlights within each district are unmetered and so an industry standard rate is applied for each streetlight, presumably based on the light's wattage and estimated usage.
2. The Transmission charge is for the service NorthWestern Energy provides in delivering "electricity from the supplier through the electric transmission system to the local distribution wires" near to point of service (Kinzler and Lawton, 2003, p. 6).
3. The USBC, Universal Systems Benefits Charge, represents recovery costs from public programs (i.e., energy assistance and weatherization programs aimed at helping low-income families improve the energy efficiency of their homes and pay their energy bills).
4. The Distribution charge is the local service delivery charge for receiving energy from an electric supplier.
5. The Res.CTC-QF charge is to help Northwestern Energy recover out-of-market costs "associated with the Qualifying Facilities Power Contracts, pursuant to electric restructuring" (Kinzler and Lawton, 2003, p. 6).
6. The Ownership charge is for the City of Missoula's use of lighting units (poles and luminaries) which NorthWestern Energy owns; it is "based on the average installed cost of the lighting units per project system wide" (Kinzler and Lawton, 2003, p. 6). "Ownership charges are calculated based on total investment in all streetlights throughout Montana, less depreciation. This is why the City's ownership charges for light increases even though the lights are aging" (Kinzler and Lawton, 2003, p. 7).
7. The Operations charge is for actual operation of the streetlights, including the labor and materials "associated with relamping, cleaning luminaries, replacing broken and damaged refractors, and minor testing of circuitry."
8. The Maintenance charge is for the maintenance of the streetlights. "Maintenance means exclusively the labor and materials associated with maintaining the poles, conductors, luminaries, controls, and protective system" (Kinzler and Lawton 2003, p. 6).
9. The Billing charge is the cost of "having NorthWestern Energy handle the billing" for lights and poles that the utility company does not own (Kinzler and Lawton, 2003, p. 7).

Appendix L2: Electricity Use (kWh) and Costs ($) for NorthWestern Energy Accounts for City of Missoula Street Light Districts, Multiple Intersections, Miscellaneous Intersections, Traffic Signals and Other Lighting, FY03 and FY08

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
STREET LIGHT DISTRICTS						
724757	Daly Ave SID 8 6 INST COSQ	Finance Dept.	44,544	$1,308	44,544	$3,887
724758	SID 23 BANK ST 400 W HPSST SQOHDED	Finance Dept.	3,888	$114	3,888	$339
724759	SID 26 100 W HP ST SG OH	Finance Dept.	30,504	$896	30,504	$2,662
724760	SID 30- TW 400 W HP ST OH /400 W HPSTOHDED	Finance Dept.	33,060	$971	33,060	$2,885
724761	SID 31 100W HPS ST PTUG	Finance Dept.	5,904	$173	5,904	$515
724762	SID 32-100 W HPOHSQDST/100 WHPDED	Finance Dept.	5,904	$173	5,904	$515
724763	SID 33 100 W Hp ST SGOHDED	Finance Dept.	28,044	$823	25,584	$2,233
724764	SID 34 - 100W HPSDSQOHDIST / 100 W SSQOHDED	Finance Dept.	246,492	$7,237	246,113	$21,476
724765	SID 36 100W HPS ST PTUG	Finance Dept.	7,380	$217	7,380	$644
724766	SID 37 100 W HPS ST PTUG	Finance Dept.	9,348	$274	9,348	$816
724767	SID 38- Pine & SPRUCE 200W HPSST SQOHDED	Finance Dept.	43,200	$1,268	43,200	$3,770
724768	SID 39- 100W HPS ST UG PT	Finance Dept.	10,332	$303	10,332	$902
724769	SID 40-200W HPWDOHDIST/200W HPSTSQOHDED	Finance Dept.	10,080	$295	11,520	$1,005
724770	SID 41-400W HPS ST SG OH	Finance Dept.	15,552	$457	15,552	$1,357
724771	SID 42 400W HPS ST SG OH	Finance Dept.	13,608	$400	13,608	$1,188
724772	SID 43-100W HPS ST UG PT	Finance Dept.	16,236	$477	16,236	$1,417
724773	SID 44 100W HPS ST UG PT	Finance Dept.	12,096	$355	12,096	$1,056
724774	SID 45-CEDAR ST 250 W HPSWD OHSQDED	Finance Dept.	5,940	$174	5,940	$518
724775	SID 46- 400 W HPS ST SQ OH	Finance Dept.	182,970	$5,372	181,112	$15,801
724776	SID 47-400 W HPS ST OH SQ	Finance Dept.	15,552	$457	15,552	$1,357
724777	SID 48-T400WHP&400WHP/400WHPSSTUGSQ	Finance Dept.	36,948	$1,085	36,948	$3,224

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
724778	SID 49-GRANT CR CENTER 400 W HPSSTUGSQ	Finance Dept.	69,984	$2,055	69,984	$6,107
724779	SID 36-HALLMARK &DIXON 100WHPSSTPTUG	Finance Dept.	492	$15	492	$43
724780	RESERVE ST IND PARK 50-400 W HPSSTUGDED	Finance Dept.	27,216	$799	27,216	$2,375
724781	SID 12- 200W HPS WD OH DED DIST	Finance Dept.	21,120	$620	21,120	$1,843
724782	SID 16-70W HPS WD OH DISTDED	Finance Dept.	102,312	$3,004	102,312	$8,928
724783	SID 17-70W HPS WO OH DED	Finance Dept.	6,960	$204	6,960	$607
724784	SID 18-200W HPS WD OHDEDDIST	Finance Dept.	41,280	$1,212	41,280	$3,602
724785	SID 19-200W HPS WD OHDEDDIST	Finance Dept.	54,720	$1,607	54,720	$4,775
724786	SID 20-70W HPS WD OH DEDDIST	Finance Dept.	7,434	$218	7,800	$680
724787	SID 21-70W HPS WD OH DED	Finance Dept.	5,568	$164	5,568	$486
724788	SID 22 100 W HPS WD OHDED	Finance Dept.	3,444	$101	3,444	$301
724789	SID 24-70& 100W HPS WD OHDED	Finance Dept.	42,576	$1,250	42,576	$3,715
724790	SID 29-100W HPS WD SG OHDED	Finance Dept.	153,012	$4,492	153,012	$13,352
724811	APPLE HOUSE LANE STREETLIGHTSSLID#51	Finance Dept.	3,444	$101	3,444	$301
724827	SID 52-GATEWAY PLACE 400 W HPS ST UG SG	Finance Dept.	29,160	$856	29,160	$2,545
Street Light Districts Total			1,346,304	$39,526	1,343,413	$117,227
MULTI-INTERSECTION BILLING GROUP*						
724188	MISC INTERSECTIONS-100WHPS WDOHDED	Public Works	140,688	$4,131	141,648	$12,361
724189	MISC INTERSECTIONS-100WHPS WDOHSDIST	Public Works	39,360	$1,156	39,360	$3,435
724190	MISC INTERSECT-LTS 0100HPS WDSGOHDED	Public Works	20,664	$607	20,664	$1,803
724191	MISC INTERSECT LTS 100WHP WDOHSQDIST	Public Works	12,792	$376	12,792	$1,116
724193	MISC INTERSECT LTS 200WHP WDSQOHDIST	Public Works	2,880	$85	2,880	$251

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
724194	ALLEY LTS 100W HP WD OHSQ DIST	Public Works	3,936	$116	3,936	$343
724195	CURTIS & S3RD ST W-400WHPS WDSGOHDIST	Public Works	1,944	$57	1,944	$170
724196	MADISON,FRONT,BDWY-200WHP WDSQOHDIST	Public Works	7,680	$225	7,680	$670
724197	ORANGE ST UNDERPASS 400W HPS WDDEDOH	Public Works	5,832	$171	5,832	$509
724198	SACAJAWEA PARK 400W HPSWD SQOHDED	Public Works	1,944	$57	1,944	$170
724199	SOUTH & STEPHENS 250WHPSWD OHDIST	Public Works	1,188	$35	1,188	$104
724200	HIGH PARK&STEPHENS 250WHPS WDSGOHDED	Public Works	6,216	$183	6,216	$542
724201	39TH & RESERVE 200W HPSWD OHSQDED	Public Works	492	$15	492	$43
724202	SOUTH AVE & 31ST-400WHPSWD SQOHDED	Public Works	3,888	$114	3,888	$339
724203	ALLEY BHND SWEETREST 100WHPSV,DIST POLE	Public Works	492	$15	492	$43
724204	GRANT & SOUTH AVE-250W HPS TRILATERAL	Public Works	2,376	$70	2,376	$207
724205	RUSSELL & S 3RD ST-400WHPS STTRILAT	Public Works	3,888	$114	3,888	$339
724325	200WHPS WDOH DED LNCNHILLS &RATTLESNKDR	Public Works	960	$28	960	$84
724331	SCOTT ST AND W BROADWAYST	Public Works	3,888	$114	3,888	$339
724350	SW CRNR SOUTH AND CLARK,200WHPS-DIST	Public Works	960	$28	960	$84
724351	BTWN WYLIE & RTTLESNAK-200W HPS DIST	Public Works	960	$28	960	$84
724352	34TH AND RUSSELL ST-200WHPSDIST	Public Works	960	$28	960	$84
724353	39TH ST AND GHARRETT,200 W HPS, WOOD POL	Public Works	960	$28	960	$84
724537	TRAFFIC SIGNAL-BLINKER TYPE	Public Works	1,416	$42	1,416	$124
724538	TRAFFIC SIGNAL-BLINKER TYPE	Public Works	1,152	$34	1,152	$101
724539	TRAFFIC SIGNAL-BLINKER TYPE	Public Works	3,768	$111	3,768	$329
724563	RATTLESNAKE DR & MTN VIEW200WHPS	Public Works	492	$15	492	$43
724564	RATTLESNAKE DR & PINEVIEW-200WHPS	Public Works	492	$15	492	$43
724565	PROSPECT AND STARWOODINTERSECTIONS	Public Works	1,920	$56	1,920	$168
724566	BURTON & BROADWAY CROSSWALK	Public Works	1,920	$56	1,920	$168
724572	CROSSWALK FLORENCE AND STEPHENS	Public Works	1,920	$56	1,920	$167

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
724576	200W HPS DED WOOD POLE HELLGATE HIGH	Public Works	1,920	$56	1,123	$77
Multi-intersections Total			280,908	$8,246	281,071	$24,506
MISCELLANEOUS INTERSECTIONS BILLING GROUP*						
723910	10400 UPLAND TRL RADIO SITE	Public Works	4,711	$430	7,756	$852
724519	FRANKLIN SCHOOL FLASHR JOHNSON & 11TH ST	Public Works	1,226	$36	191	$20
724521	S RUSSELL & S 3RD ST W TRAFFIC CONTROL	Public Works	14,702	$443	14,689	$1,287
724524	LINCOLNWOOD SIGN SID900	Public Works	1,380	$183	1,137	$199
724526	N HIGGINS & SPRUCE ST-TRAFFICLIGHTS	Public Works	24,412	$1,909	5,293	$608
724527	LOWELL SCHOOL FLASHERSHERWOOD & SCOTT	Public Works	946	$29	195	$20
724528	S GRANT AND SOUTH AVEWTRAFFIC SIGNAL	Public Works	15,233	$457	5,816	$512
724531	EDITH & W BECKWITH ROOSEVELT SSHL FLASHR	Public Works	914	$28	186	$19
724561	14TH AND JOHNSON SCHOOLXING FLASHER	Public Works	14,004	$1,112	6,411	$718
724590	W BROADWAY & SCOTT STTRAFFICSIGNAL	Public Works	11,607	$948	13,418	$1,406
908557	3555 MULLAN RD #TRAFSIG	Public Works	18,815	$1,471	13,473	$1,410
1083272	3801 S RESERVE ST #LIGHT	Public Works	7,087	$580	4,789	$557
1194963	39TH ST AND PAXSON ST LIGHTING	Public Works			30,195	$3,042
1206115	3150 NORTHERN PACIFI ST	Public Works			9,916	$1,063
1235311	39TH AND DORE LN HIWAY LIGHTS	Public Works			6,697	$746
1382857	SOUTH AND JOHNSON SIGNAL	Public Works			6,562	$734
1382859	SOUTH AND GARFIELD TRAFFIC SIGNAL	Public Works			11,901	$1,262
1391396	39TH ST AND RESERVE ST SIGNAL	Public Works			1,845	$269
Miscellaneous Intersection Total			115,037	$7,627	140,470	$14,724

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
TRAFFIC SIGNALS†						
724526	N HIGGINS & SPRUCE ST-TRAFFICLIGHTS	Public Works	24,412	$1,909	5,293	$608
724528	S GRANT AND SOUTH AVEWTRAFFIC SIGNAL	Public Works	15,233	$457	5,816	$512
724530	E BECKWITH & ARTHUR AVES TRAFFIC SIGNAL	Public Works	17,977	$1,411	7,224	$798
724561	14TH AND JOHNSON SCHOOLXING FLASHER	Public Works	14,004	$1,112	6,411	$718
908557	3555 MULLAN RD #TRAFSIG	Public Works	18,815	$1,471	13,473	$1,410
1206115	3150 NORTHERN PACIFI ST	Public Works			9,916	$1,063
1235311	39TH AND DORE LN HIWAY LIGHTS	Public Works			6,697	$746
1382857	SOUTH AND JOHNSON SIGNAL	Public Works			6,562	$734
1382859	SOUTH AND GARFIELD TRAFFIC SIGNAL	Public Works			11,901	$1,262
1391396	39TH ST AND RESERVE ST SIGNAL	Public Works			1,845	$269
Traffic Signal Total			90,441	$6,361	75,138	$8,119
OTHER LIGHTING						
707103	MCCORMICK PARK ROPE COURSE LIGHT	Parks Dept.	960	$29	960	$84
717451	YD LIGHTS-175W MV WD SQOH CO	Cemetery Dept.	3,146	$98	2,904	$253
720786	SHAKESPEARE ST/LIGHT BYGRAVEL PIT	Streets Dept.	3,888	$116	3,888	$340
722477	MCCORMICK PARK LIGHTSFORFIELD	Parks Dept.	17,940	$1,195	19,760	$1,736
722491	BANK ST PARKING LOT LIGHTS	Parking Comm.	5,904	$175	5,904	$515
722504	SOUTHSIDE LIONS PARK	Parks Dept.	7,651	$601	7,475	$809
Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
722505	BARBARA LN PARK-YD LIGHT	Parks Dept.	574	$19	492	$43
722506	BARBARA LN PARK-YD LIGHTS	Parks Dept.	574	$19	492	$43
722559	CARAS PARK-LIGHTS	Parks Dept.	17,855	$1,397	15,401	$1,599

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
722580	SACAJAWEA PARK 100W HPSPT 17FTST	Parks Dept.	492	$15	492	$43
722581	LITTLE MCCORMICK PRK 100WHPSPT17FTST	Parks Dept.	492	$15	492	$43
722582	CITY PARKS AREA LTS 100/200W HPS WDOHDED	Parks Dept.	9,816	$288	9,816	$857
722583	POLICE PARKING LOT-400WHPS STEEL	Public Works Dept.	1,944	$57	1,944	$170
722585	200 BLK W PINE-TWIN 400W WD OHDIST	Parking Comm.	4,128	$206	4,128	$590
722586	200 W PINE-400W HPS ST TWUG,100WHPS	Parking Comm.	5,376	$158	5,376	$469
722587	200 BLK W PINE-400W HPSSQ UGDEDST	Parking Comm.	4,128	$206	4,128	$590
722588	100 BLK W BROADWAY-400WHPS STUGDED	Parking Comm.	3,888	$114	3,888	$339
722590	115 W PINE 175W MV WDOH SQ CO	Parking Comm.	1,776	$52	1,776	$155
722591	EAST OF HIGGINS AVE BR 250W HPSTWSTUG	Parking Comm.	7,164	$210	4,776	$417
722592	UNDER HIGGINS AVE BR 175WMV ORBRSTRUC	Parking Comm.	3,444	$101	3,444	$301
722594	CARAS PARK LOT,ST POLES4-400WS,3-400W	Parking Comm.	13,632	$400	13,632	$1,190
722595	121 W PINE PKG LOT-400WHPS STUND	Parking Comm.	7,776	$228	7,776	$679
722596	1501 39TH ST-175W MV SQST UGPTCO	Fire Dept.	1,599	$51	1,353	$118
722598	110 HICKORY/LEASE LTSPKS&RECSHOP AREA	Parks Dept.	7,800	$229	7,800	$681
722882	WEST CARAS PARKING LOT	Parking Comm.	13,608	$400	13,608	$1,188
722934	PLAYFAIR PARK SKATINGRINK/LIGHTS	Parks Dept.	2,550	$270	0	$88
723900	MCCORMICK LEASE LIGHTS	Parks Dept.	5,784	$170	5,195	$452
724525	WASHINGTON SCH FLASHER BANCROFT & CNTRL	Public Works Dept.	1,293	$38	185	$19
724530	E BECKWITH & ARTHUR AVES TRAFFIC SIGNAL	Public Works	17,977	$1,411	7,224	$798
724562	CORNER OF SOUTH AND BANCROFT-FLASHER	Public Works	1,677	$205	2,529	$337
769134	100 N CALIFORNIA ST #@FTBRDG	Parks Dept.	7,598	$642	6,600	$735
1100856	1305 SCOTT ST #LIGHT	Vehicle Maint. Dept.	2,009	$129	3,888	$339
1235324	RATTLESNAKE SCH FLASHERMOUNTAIN VIEW DR				221	$110

Acct. #s by Light Group	Account Name/Description	Billing Address	2003 Electric Use (kWh)	2003 Electric Costs ($)	2008 Electric Use (kWh)	2008 Electric Costs ($)
1388900	SUSSEX BEND STREET LIGHTS	Public Works			6,565	$729
1435593	MADISON ST BRIDGE	Parks Dept.			7,455	$825
1578276	RUSSELL ST PEDESTRIAN XING AT 11TH				960	$84
1638725	PINEVIEW DR PARK LIGHTS	Parks Dept.			410	$100
Other Lighting Total			184,443	$9,242	182,937	$17,866
GRAND TOTAL			1,926,692	$64,641	1,947,891	$174,324

** Multi-intersection and Miscellaneous Intersection billing groups are reported as Intersection Lighting in the body of the report.*

† Traffic signal accounts are subset of other lighting types; individual accounts are duplicates and are not included in grand total.

Appendix O-1: Electricity Use (kWh) and Costs ($) by Department for Other Miscellaneous NorthWestern Energy Accounts for the City of Missoula, FY03 and FY08

Dept/ Acct. #	Account Name	FY03 kWh	FY03 Electric Costs ($)	FY08 kWh	FY08 Electric Costs ($)
Cemetery Dept.					
717574	1600 RODGERS ST #30 IRR	22,057	$2,412	25,600	$2,916
717583	CITY CEMETARY-60HP IRR	35,040	$3,542	39,200	$4,873
Parking Comm.					
722516	115 W PINE ST #SPRINKL	0	$82	0	$67
722564	N PATTEE & E FRONT STS-YDLT	180	$89		
722593	100 E PINE ST #LIGHTS	3,840	$113		
722792	N HIGGINS AVE PARKINGLOT-500BLOCK	10,656	$313		
722843	420 N HIGGINS AVE #LIGHT	1,944	$57		
1239681	CARAS PARK [control gate]			1,052	$191
Parks Dept.					
100409	CARAS PARK W TENT PLAZA	16,980	$723	12,300	$1,874
100451	300 S 4TH ST	21,370	$1,225	19,122	$2,734
485788	FRANKLIN PARK	2,570	$274	5,384	$614
506228	SPARTAN PARK SWIMMINGPOOL	39,410	$2,445		
721176	SPURLOCK RD	329	$77	14,279	$1,424
722464	FORT MISSOULA/SOUTH AVE60HP IRR	26,380	$3,764	36,240	$5,210
722466	BOYD PARK / IRR TIMER	2	$82	4	$88
722472	PLAYFAIR PARK BASEBALL DIAMOND 40HP IRR	22,027	$2,737	30,887	$3,919
722485	WHITAKER PARK	838	$144	1,422	$226
722487	GREGORY PARK	18	$84	15	$89
722489	GREGORY PARK-SPRINKLER CON-TROLS	0	$82	0	$88
722492	LINCOLN PKWY SOCCER FIELDBE-HIND 1220	0	$82	0	$88
722493	TIMBERLANE & HERITAGESPRINKLER SYSTEM 1	6	$83	0	$88
722494	PLAYFAIR PARK RESTRMSLITTLE LEAGUE FLD	178	$94	229	$111
722495	PLAYFAIR PARK SKATINGRINK PUMP	9,892	$1,543	13,378	$1,482
722502	ANDERSON PARK SPRINKLERBLAINE & HIGGINS	2	$81	1	$88
722508	NORTHSIDE PARK-RESTROOMS	203	$94	463	$133

Dept/ Acct. #	Account Name	FY03 kWh	FY03 Electric Costs ($)	FY08 kWh	FY08 Electric Costs ($)
722510	NORTHSIDE BALL PARK	2,010	$1,092	2,285	$1,678
722526	LITTLE MCCORMICK PARK	5	$79	7	$89
722528	WESTSIDE PARK	60	$86	100	$93
722535	JEANNETTE RANKIN PARKMADI-SONST BRIDGE	0	$82	0	$88
722538	BONNER PARK	236	$100	676	$155
722540	BONNER PARK BAND SHELL	4,411	$406	6,163	$695
722548	SACAJAWEA PARK	5,741	$495	4,291	$506
722557	MCLEOD PARK 1600 BLK NORTH AVE WEST	19	$84	8	$89
722561	KIWANIS PARK	540	$119	682	$156
722566	MARKET PLAZA-END OF NHIGGIN-SAVE	3,738	$358	3,504	$429
722568	JACOBS ISLAND PARK-7.5HP IRR PUMP	1,650	$378	2,556	$531
722584	SPARTAN PRK POOL 100WPTLSQ UGMVSTCO	984	$29		
722790	ROSE PARK VIETNAM MEMORIAL & SRINKLERS	6,866	$589	6,965	$769
722855	VAN BUREN WALKWAY	4,191	$393	6,023	$681
722856	RUSSELL PARK W #PUMP	1,643	$100	2,577	$222
722867	ORANGE ST WALKWAY	1,086	$163	1,188	$205
722869	SKYVIEW PARK CORNER HILLVIEW & SKYVIEW	0	$81	0	$88
722879	100 CHESTNUT ST #SPKLR	24,005	$2,448	24,617	$3,083
722888	CARAS PARK WEST SIDE IRRIG TIMER	2	$82	1	$88
722903	CARAS PARK-WEST OF RYMAN	3,888	$114	3,888	$339
722988	WAPIKIYA PARK TEMP IRR CLOCK	0	$81	0	$88
723000	520 N CALIFORNIA ST #PARK	0	$82	6	$89
723072	Un-named	6,908	$595	6,936	$767
723159	ROSE PARK 10HP PUMP THREEPHASE	3,253	$195	5,602	$482
723566	MCCORMICK PARK-POOL	73,630	$7,066		
769705	END OF HICKORY STREET, WEST OF RAILROAD TRK	966	$152	1,418	$227
831109	1300 BRIDGECOURT WAY #TIMER	0	$82	0	$88
865167	CORNER OF RAYMOND AND LINDA VISTA	19	$84	157	$103
975952	STEPHENS AVE MEDIAN AT BICK-FORD	0	$82	0	$88
995790	STEPHENS AVE LANDSCAPED ME-DIAN	16,560	$1,052	15,120	$1,321

Dept/ Acct. #	Account Name	FY03 kWh	FY03 Electric Costs ($)	FY08 kWh	FY08 Electric Costs ($)
1014888	CORNER 23RD & GARLANDIRRIGA-TION TIMER	76	$40	62	$36
1019050	GREENOUGH PARK POND	0	$82	2,696	$349
1147292	W OF WEEPING WILLOW DR,SPRINKLERS	0	$5	0	$88
1387678	BROOKS ST AND RUSSELL LAND-SCAPE			0	$88
1388904	SUSSEX BEND LANDSCAPE			0	$88
1430409	MCCORMICK WALK PATH			17,437	$1,799
1430795	NW CNR OSPREY PARK			3,783	$459
1476982	5200 BIGFORK RD #SPRNKLR			0	$88
1519523	LINDA VISTA BLVD #SPKLR			11,459	$1,212
1539063	3205 FORT MISSOULA RD #RESTRM			1,590	$211
1547090	MCCORMICK PARK IRR			22,841	$1,675
1583320	MCCORMICK PARK/ROPES COURSE			880	$77
1616182	803 W GREENOUGH DR			7,103	$773
1675676	PINEVIEW PARK-SID 902			669	$86
Public Works Dept.					
723568	WATER WORKS HILL-TOWER RADIO BL	10,831	$879	2,930	$313
724394	MISC LT 39TH/LUX/ARROWHEAD	574	$20		
724520	EMMA DICKINSON SCH FLASHER 3RD & CURTIS	150	$7		
724522	VAN BUREN AND LOCUST SCHOOL FLASHER	650	$20		
724523	SPEED SIGN	812	$25		
724583	PAXSON ST AND 39TH ST	400	$13		
724586	BURTON ST AND W BROADWAY ST FLASHER	521	$17		
Streets Dept.					
100404	800 W BROADWAY ST #SHOP	22,620	$795		
717131	800 W BROADWAY ST	9,732	$290		
717138	727 W PINE ST	1,221	$170		
Vehicle Maintenance Dept.					
1088855	1305 SCOTT ST #PMPPLGN	11,448	$904	19,175	$1,973
Total		435,368	$40,241	384,971	$48,853

Appendix O-2: Natural Gas Use (Dth) and Costs ($) by Department for Other Miscellaneous NorthWestern Energy Accounts for the City of Missoula, FY03 and FY08

Dept/ Acct.#	Account Name	FY03 Dth	FY03 Gas Costs ($)	FY08 Dth	FY08 Gas Costs ($)
Parks Dept.					
506228	SPARTAN PARK SWIMMING-POOL	684	$3,529		
721176	SPURLOCK RD			4.5	$131
723566	MCCORMICK PARK-POOL	2,504	$11,457		
Streets Dept.					
717131	800 W BROADWAY ST	2.6	$123		
Total		**3,191**	**$15,109**	**4.5**	**$131**

Appendix O-3: Annual Electricity and Natural Gas Usage and Costs for Other Miscellaneous NorthWestern Energy Accounts for the City of Missoula, FY03 through FY08

Energy Type	FY03	FY04	FY05	FY06	FY07	FY08
Electricity						
Use (kWh)	435,368	461,174	394,821	415,043	385,637	384,971
Costs ($)	$40,241	$48,878	$46,284	$48,170	$46,235	$48,853
Natural Gas						
Use (Dth)	3,191	2,811	3,562	3,245	695	4.5
Costs ($)	$15,109	$23,737	$33,680	$33,011	$7,730	$131
Total Costs						
Costs ($)	**$55,350**	**$72,615**	**$79,963**	**$81,182**	**$53,966**	**$48,984**

Appendix C1: City of Missoula Purchased Energy (Electricity and Natural Gas) Costs in 2009 Dollars by Sector, FY03 and FY08

Sector	FY03	FY04	FY05	FY06	FY07	FY08
Buildings	$120,986	$276,401	$283,723	$331,113	$448,564	$596,970
Wastewater	$78,524	$333,536	$341,409	$356,337	$391,272	$454,401
Lighting	$76,228	$155,674	$166,148	$169,643	$172,869	$177,032
Other Misc.	$65,271	$83,566	$89,329	$87,786	$56,632	$49,745
Grand Total	**$341,010**	**$849,177**	**$880,609**	**$944,880**	**$1,069,338**	**$1,278,148**

Appendix C2: City of Missoula Municipal Energy Use (MMBTU) by Sector, FY03 and FY08

Sector	Energy Use (MMBTU)				
	FY03	% Total	FY08	% Total	% Change
Wastewater Treatment	22,711	28.6%	30,944	27.6%	36.3%
Municipal Buildings	16,136	20.3%	37,136	33.1%	130.1%
Municipal Fleet	18,457	23.3%	22,459	20.0%	21.7%
Employee Commuting	10,694	13.5%	13,418	12.0%	25.5%
Lighting	6,575	8.3%	6,679	6.0%	1.58%
Misc. NWE Accounts	4,676	5.9%	1,318	1.2%	-71.8%
Water	91	0.11%	169	0.15%	85.7%
Total*	**79,340**	**100.0%**	**112,123**	**100.0%**	**41.3%**

** Note: Values may not precisely add up due to rounding.*

Please contact us to share your ideas

Mayor John Engen
406-552-6001
mayorstaff@ci.missoula.mt.us

Bruce Bender, *Chief Administrative Officer*
406-552-6001
bbender@ci.missoula.mt.us

Ginny Merriam, *Public Information/Communications Officer*
406-552-6007
gmerriam@ci.missoula.mt.us

Chase Jones, *Conservation Grants Coordinator*
406-258-4908
cjones@co.missoula.mt.us

Jack Stucky, *Vehicle Maintenance Superintendent*
406-552-6387
jstucky@ci.missoula.mt.us

Prof. Robin Saha, *Environmental Studies Program, The University of Montana*
406-243-6285
robin.saha@mso.umt.edu

THE GARDEN CITY
MISSOULA
HUB OF FIVE VALLEYS

Special thanks to photographer Jackie Corday,
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