Minnesota State University, Mankato

Carbon Footprint Update Report 2018

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Prepared for the Environmental Committee by

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The authors bear sole responsibility for any errors found in this report.

Executive Summary

A University's carbon footprint is an accounting of all the greenhouse gases (GHGs) emitted as a result of University activities in one year. Major campus activities contributing to the footprint are: electricity use; natural gas and fuel oil combustion for heating buildings and hot water; and commuting of students, faculty and staff back and forth to campus. MNSU's first carbon footprint, for FY 2012, was developed by the consulting firm Sebesta with funding from the Administration and presented to the Environmental Committee in June 2013.

The Environmental Committee subsequently, with a grant from the Strategic Priorities Initiative fund, hired Sebesta and in partnership with the Urban and Regional Studies Institute and Facilities Management developed a Climate Action Plan for the University during the 2014-15 academic year. An integral part of the Climate Action Plan is a set of strategies for reducing the University's greenhouse gas emissions. As a way of monitoring the success of these strategies, the Environmental Committee took on the responsibility of annually updating the University's carbon footprint. The first update report (CFU2016), which included annual updates through FY 2016, was released in May 2017. This report is the second update report (CFU2018) and includes annual updates through FY 2018, the last fiscal year for which complete data was available.

The major result of CFU2018 is that after adjusting for the effects of weather **the total carbon footprint of the University decreased by 15.6% from FY 2012 to FY 2018.** This decrease had three major causes:

- **The Public Buildings Enhanced Energy Efficiency Program (PBEEEP)** -- 2.9% of the decrease. PBEEEP, a program of the Minnesota Department of Commerce, was brought to campus by Facilities Management. In the MNSU project, energy auditors identified energy-savings changes to heating-ventilation-air conditioning (HVAC) systems of buildings on campus, and Facilities Management implemented these changes in the spring of 2013. The program cost MNSU $13,000 and is saving the University $119,000 a year. PBEEEP preceded the Climate Action Plan; its effects were first noted in CFU2016.
- **The Guaranteed Energy Savings Program (GESP)** – 9.1% of the decrease. GESP was also a program of the Minnesota Department of Commerce and was also brought to campus by Facilities Management. In its project MNSU partnered with the energy service company

Ameresco, whose energy auditors identified energy savings measures on campus. These measures were incorporated into the Climate Action Plan. The most notable was the switching out of fluorescent light bulbs for LEDs across campus; this measure alone accounted for 85% of the energy savings. Implementation was completed in 2017. The cost of the project was $8 million which the University is paying back with its guaranteed energy savings of approximately $400,000 a year over a period of 18 years. After the capital cost is paid off the University will pocket the $400,000 a year in energy savings.

  - For its energy conservation successes with its GESP project, MNSU received a 2018 Clean Energy Community Award from the Minnesota Department of Commerce in March 2018 (one of seven communities so honored) and a 2019 Environmental Initiative Award from the Environmental Initiative of Minnesota in May 2019 (MNSU was the award winner in the Sustainable Leadership: Large Employer category).

- Changes in commuting patterns – 2.8% of the decrease. The changes in commuting patterns that were most responsible for reducing greenhouse gas emissions were more students and faculty walking and fewer driving alone to and from campus. These changes were noted in the first carbon footprint update report (CFU2016). Since then, however, commuter emissions have increased very slightly (by 0.8%), due primarily to a reversal of these trends.

The carbon footprint and its updates benefit the University community in a number of ways:

- Tracking the carbon footprint illustrates the effectiveness of the strategies employed to reduce the University's GHG emissions.
- The GHG emission analysis and the data sets used in the development of the footprint and updates can be of use in student and faculty research projects.
- The baseline footprint and updates demonstrate the University's commitment to addressing the problem of global warming and climate change and show MNSU to be a leader in addressing sustainability issues. Universities and colleges that actively pursue sustainability reap rewards beyond their actual on-campus successes. Prospective students, prospective donors, and faculty alike look favorably upon such commitments. Studies show that prospective students give preference to schools that have made a commitment to sustainability.

Introduction – What's new in this update report

This carbon footprint update report is the first in two years. The previous update report (CFU2016), in May 2017, included data, results and analysis through FY 2016; this new report (CFU2018) adds two new updates, for FY 2017 and FY 2018. The Environmental Committee has now completed six annual updates since Sebesta produced MNSU's first carbon footprint in 2013.

The core of this report is in Sections IV, V, VI, and VII, in which the data for all footprints are summarized, analyzed, and trends noted. A reader who wants to the trends from the most recent updates need read only these sections.

Section I has been renamed, and a few minor revisions have been made to Sections I and VIII. Sections II and III are essentially unchanged from CFU2016. In Appendices A and B, the new results from FY 2017 and FY 2018 are incorporated into the Tables and Figures. The text in Appendix A has been extensively rewritten and expanded upon, and a brief discussion of trends in commuting patterns since CFU2016 has been added to Appendix B. Appendix C is unchanged; no changes have been made in the commuter survey questions since CFU2016. Appendix D, a table with information about the data sources for the footprints, is new in CFU2018.

I. How the MNSU carbon footprint and updates came about

A university's carbon footprint (also known as a greenhouse gas inventory) is an accounting of all the greenhouse gases (GHG) emitted by the university in one year, taking into account all the activities for which the university is responsible. These activities include electricity use, natural gas and fuel oil combustion for heating buildings and hot water, and commuting using motorized vehicles by students, faculty and staff to and from campus. Other minor activities included which contribute only minimal amounts of GHGs to the footprint are use of the University's fleet vehicles, solid waste disposal in landfills, waste water treatment, and fertilizer use. By tracking its carbon footprint a University can determine how its greenhouse gas emissions are changing from year to year.

With this in mind, the MNSU Administration, working with Facilities Management and the Environmental Committee, provided the funding for Sebesta to conduct an initial greenhouse gas (GHG) inventory during Spring Semester 2013 which resulted in a baseline carbon footprint for the 2011 – 2012 academic year (FY 2012). This baseline footprint was seen as a preliminary step in the development of a climate action plan (CAP) for MNSU. The Environmental Committee subsequently received Strategic Priorities Initiative funding for a consultant (Sebesta) to aid in the development of the CAP. The CAP was developed during the 2014-2015 academic year and approved by the Administration the following year. The CAP consists of 25 strategies and 75 action steps grouped into six categories (buildings and energy, transportation, water, waste, purchasing, and education and communication) to reduce the University's GHG emissions and make it more sustainable; the CAP Report can be viewed on the Environmental Committee website at www.mnsu.edu/greencampus .

In agreement with Sebesta, the Environmental Committee took on the task of producing annual updates to the carbon footprint, and Sebesta provided computer tools to the Environmental Committee to do so. In the course of updating the footprint, the Environmental Committee found errors in Sebesta's analysis of the University's commuting emissions and recalculated the baseline footprint. The recalculated baseline footprint is included in the first update report (CFU2016) along with updates through F2016. The current report (CFU 2018) is the second update report. Tracking the footprint has enabled the University to assess the success of strategies in the CAP (most notably, the Guaranteed Energy Savings Plan) as well as other strategies in reducing MNSU's GHG emissions.

II. Greenhouse gases

It is important for institutions such as universities, businesses, cities, states, and countries, and also for individuals to reduce their greenhouse gas emissions, as the overwhelming consensus of climate scientists is that human-caused greenhouse gases are the primary driver of global warming and climate change, the effects of which we are witnessing daily in Minnesota and around the world. The most important of the greenhouse (heat-trapping) gases in the atmosphere is water vapor, but its concentration in the atmosphere depends on weather and climate conditions and is beyond human control. Of the remaining heat-trapping gases, the most important are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These are the gases that are tracked by the University of New Hampshire Campus Carbon Calculator, the computer tool used to calculate the baseline footprint and updates. Of these gases, most of the warming is due to CO_2.

Carbon dioxide is produced by the combustion of fossil fuels: natural gas and fuel oil for heat; gasoline or diesel in motorized vehicles; and in the generation of electricity when it is produced by burning coal, fuel oil, or natural gas. Methane is produced when organic material decays anaerobically, for example, in landfills or in waste water. Nitrous oxide arises from agricultural practices such as the use of fertilizer. Methane and nitrous oxide are both more potent greenhouse gases than carbon dioxide. The global warming potential (GWP) of methane is 25 times greater than that of carbon dioxide, and the GWP of nitrous oxide is 298 times greater. Carbon dioxide, however, is much more prevalent in the atmosphere, where it is present at a concentration of about 400 parts per million, compared to about 2000 parts per billion for methane and 300 parts per billion for nitrous oxide.

In this report, the amounts of methane and nitrous oxide emissions are converted into their carbon dioxide equivalents by multiplying by their GWPs. Carbon dioxide is by far the largest contributor to warming by the University, accounting for >99% of the University's GHG emissions in both the baseline footprint and all the updates.

III. Methodology

The major activities tracked for the Minnesota State Mankato carbon footprint and updates were electricity consumption, natural gas and fuel oil combustion for heating, and daily commuting (students, faculty and staff) to and from campus. These three activities produced essentially all (>99%) of campus GHG emissions. Other minor activities which were also tracked were vehicle fleet operations, solid waste disposal in the landfill, waste water treatment, and fertilizer use. The University of New Hampshire Campus Carbon Calculator (UNH CCC), version 8.0, a tool used by hundreds of colleges and universities across the U.S., was used to calculate the carbon footprint. Electricity, natural gas, fuel oil, and waste water treatment data were obtained from the State of Minnesota B3 Benchmarking database, after having been entered by Facilities Management staff. Commuter data were obtained from annual commuter surveys emailed in the spring to all students, faculty and staff. Data on the number of students, faculty, and staff (necessary to scale up the results of the commuter survey to the entire campus) were obtained from the Office of Institutional Analytics and Strategic Effectiveness. Vehicle fleet use, solid waste, and fertilizer data were obtained from Facilities Management staff. See Appendix D for the sources and contact persons for all the types of data required by the UNH CCC.

IV. Greenhouse gas emissions summary

MNSU's carbon footprint and greenhouse gas emissions from major sources for the baseline year FY 2012 and updates to FY 2018 are shown in Table 1 below.

Table 1. MNSU's carbon footprint and greenhouse gas emissions from major sources from FY 2012 to FY 2018, in metric tons of CO_2-equivalent

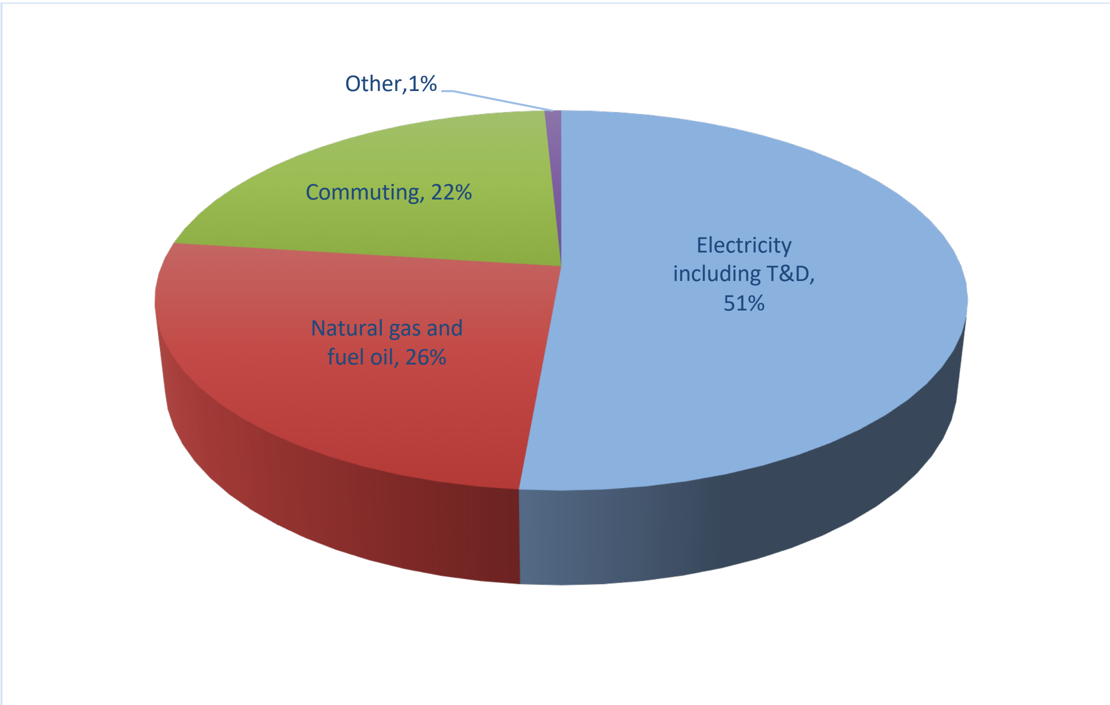
Major Emission Sources	Natural Gas and Fuel Oil	Electricity	T&D[1]	Total Electricity	Commuting			Total Carbon Footprint[2]
					Fac/Staff	Student	Total Commuting	
FY2012	10,970	24,864	1,537	26,401	2,716	8,086	10,802	**48,630**
FY2013	12,234	24,728	1,528	26,256	2,797	7,943	10,740	**49,656**
FY2014	12,852	23,213	1,435	24,648	3,053	7,420	10,473	**48,285**
FY2015	11,632	23,093	1,427	24,520	2,502	7,901	10,403	**46,981**
FY2016	10,908	23,931	1,479	25,410	2,806	6,548	9,354	**45,941**
FY2017	10,915	22,745	1,406	24,151	2,792	7,188	9,980	**45,424**
FY2018	10,924	20,597	1,273	21,870	3,013	6,417	9,430	**42,560**
% change 2012-16	-0.6%	-3.8%	-3.8%	-3.8%	3.3%	-19.0%	-13.4%	**-5.5%**
% change 2012-18	-0.4%	-17.2%	-17.2%	-17.2%	10.9%	-20.6%	-12.7%	**-12.5%**

[1]Transmission & Distribution losses from the power plant to MNSU
[2]The total carbon footprint also includes minor contributions (<1% of the total) from fleet vehicles, fertilizer use, solid waste disposal, and waste water treatment.

V. Relative contributions of major sources of greenhouse gas emissions

Figure 1 below shows the relative contributions of the major sources of GHG emissions in FY2018.

Figure 1. MNSU's greenhouse gas emissions by source, FY 2018



In the Figure, "Electricity including T&D" means the total electricity used on campus plus the electricity lost in transmission and distribution between the power plant and the campus. Likewise, "Commuting" means total tailpipe emissions from all commuters – students, faculty and staff.

The relative sizes of the contributions from the three major sources changed only slightly from FY2012 to FY2018 --

- In FY2012: electricity 54%; natural gas and fuel oil 23%; and commuting 22%.
- In FY2018: electricity 51%; natural gas and fuel oil 26%; and commuting 22%;

The share of emissions from natural gas and fuel oil grew by 3% over this period at the expense of electricity, while the share from commuting remained the same.

VI. Trends in MNSU's carbon footprint

Trends in MNSU's footprint from the baseline year FY2012 and updates to FY2018 are shown in Figure 2 below. Note that the origin of the vertical axis of the plot is at 40,000 metric tons of CO_2-eq (not zero) in order to emphasize the trends in the data.

Figure 2. MNSU's carbon footprint, FY 2012 to FY 2018

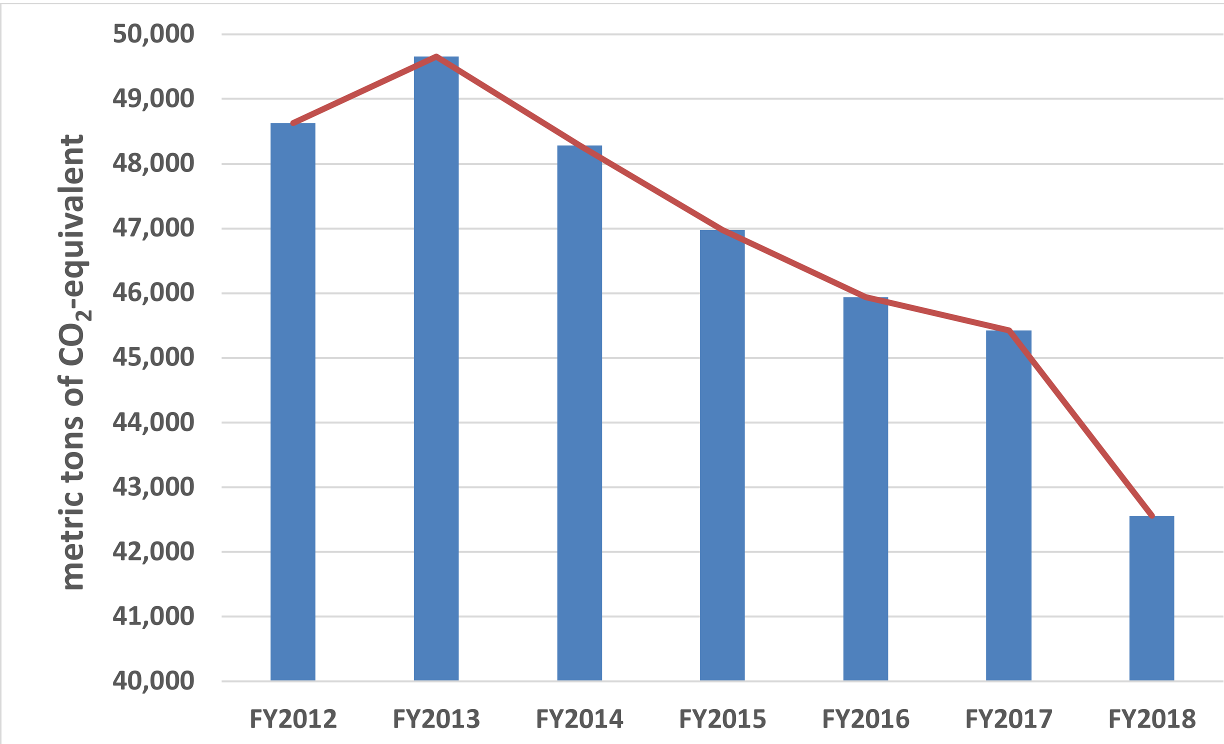


Figure 2 shows a drop in MNSU's carbon footprint of 12.5% from FY 2012 to FY 2018. While impressive, there is a difficulty in interpreting this plot. We'd like to know the effect of efforts at MNSU to reduce the footprint, but the footprint also varies from year to year because of the weather. If a winter is colder than usual, then more natural gas and fuel oil are used to heat the buildings, so GHG emissions from the combustion of natural gas and fuel oil goes up, which means that the carbon footprint does too. Likewise, if a winter is milder than usual, natural gas and fuel oil combustion goes down, and so does the carbon footprint. In other words, <u>weather effects (whether a winter is colder or warmer) mask the effect of strategies to reduce MNSU's footprint</u>.

These weather effects can be eliminated from the data by adjusting the natural gas and fuel oil usage for each footprint to what is would have been, had each winter been just as cold as a baseline winter. The baseline winter is taken to be the winter of 2011-12 (FY 2012), and the adjustment for each subsequent winter is made using the heating degree day (HDD) method described in Appendix A. This adjustment *weather normalizes* the update footprints to the baseline winter of FY 2012 and removes the weather variation from the natural gas and fuel oil usage. Table 2 shows what the data in Table 1 look like when these weather-normalization changes are made.

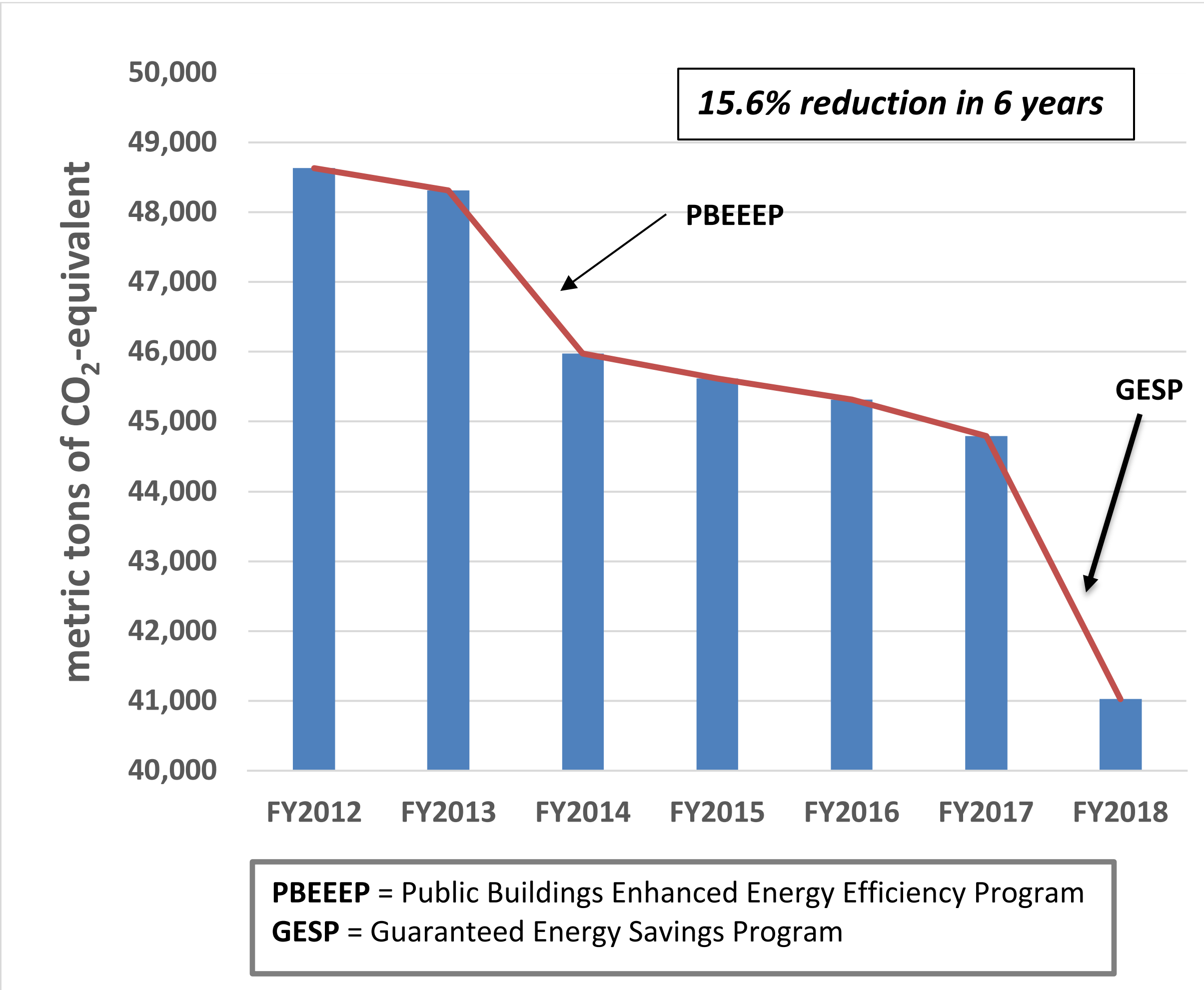
Table 2. MNSU's carbon footprint and weather-normalized greenhouse gas emissions from major sources from FY 2012 to FY 2018, in metric tons of CO_2-equivalent

Major Emission Sources	Natural Gas and Fuel Oil	Electricity	T&D[1]	Total Electricity	Commuting			Total Carbon Footprint[2]
					Fac/Staff	Student	Total Commuting	
FY2012	10,970	24,864	1,537	26,401	2,716	8,086	10,802	**48,630**
FY2013	10,893	24,728	1,528	26,256	2,797	7,943	10,740	**48,315**
FY2014	10,545	23,213	1,435	24,648	3,053	7,420	10,473	**45,978**
FY2015	10,283	23,093	1,427	24,520	2,502	7,901	10,403	**45,618**
FY2016	10,283	23,931	1,479	25,410	2,806	6,548	9,354	**45,316**
FY2017	10,283	22,745	1,406	24,151	2,792	7,188	9,980	**44,792**
FY2018	9,389	20,597	1,273	21,870	3,013	6,417	9,430	**41,025**
% change 2012-16	-6.3%	-3.8%	-3.8%	-3.8%	3.3%	-19.0%	-13.4%	**-6.8%**
% change 2012-18	-14.4%	-17.2%	-17.2%	-17.2%	10.9%	-20.6%	-12.7%	**-15.6%**

The only differences between Table 1 and Table 2 are in the Natural Gas and Fuel Oil column and the Total Footprint column. Trends in the weather-normalized footprint are plotted in Figure 3 on the following page. Trends in the major sources of emissions (natural gas and fuel oil, total electricity, and commuting) are plotted in Figure 4 on page 14. Since the natural gas and fuel oil data in both Figure 3 and Figure 4 are weather-normalized, <u>any trends are due only to actions taken on campus to reduce GHG emissions</u>.

Note that in Figure 3, as in Figure 2, the origin of the vertical axis of the plot is at 40,000 mt CO_2-eq (not zero) in order to emphasize the trends in the data.

Figure 3. MNSU's weather-normalized carbon footprint, FY2012 through FY2018



The total drop in MNSU's weather-normalized carbon footprint from FY2012 to FY2018 was 15.6%, from 48,630 to 41,025 metric tons of CO_2-equivalent. The decreases between FY2013 – FY2014 and FY2017—FY2018 coincide with two major on-campus efforts to reduce energy use and also, therefore, GHG emissions:

- The Public Buildings Enhanced Energy Efficiency Program (PBEEEP), a program of the Minnesota Department of Commerce which was brought to campus by Facilities Management, reduced emissions by 1,393 metric tons of CO_2-eq, a 2.9% drop from the baseline year total;

- The Guaranteed Energy Savings Program (GESP), also a program of the Minnesota Department of Commerce which was brought to campus by Facilities Management, reduced emissions by 4,434 metric tons of CO_2-eq, a 9.1% drop from the baseline year total.

The data in Table 2 also show a third contribution to emissions reductions:

- Changes in commuting patterns of faculty, staff and students, a reduction of 1,372 metric tons of CO_2-eq (a 2.8% drop from the baseline year total).

MNSU's PBEEEP and GESP projects are discussed in more detail below; there is more discussion of the changes in commuting patterns on page 15.

The Public Buildings Enhanced Energy Efficiency Program (PBEEEP)

The Public Building Enhanced Energy Efficiency Program ran from 2009 to 2014. Through this program, public institutions could apply to have their buildings evaluated for possible energy savings. During Spring Semester 2012 energy auditors identified potential energy-savings changes in the operation of the heating-ventilation-air conditioning (HVAC) systems of 18 buildings on campus. Facilities Management implemented the changes at the end of Fall Semester 2012. The net cost of the project to the University was $13,000. As a result of the project, the University reduced its heating and electricity costs by $119,000 a year.

The Guaranteed Energy Savings Program (GESP)

In a Guaranteed Energy Savings project, a public institution in Minnesota partners with an energy service company, which identifies and implements energy conservation measures for the institution's buildings. The institution does not pay the capital cost of the project up front; instead, it pays the cost off in yearly installments using the savings in heating and electricity costs from the project, savings that are guaranteed by the energy service company.

For MNSU's project, the University partnered with the energy service company Ameresco. Ameresco audited 46 campus buildings and identified a number of energy conservation measures. Six of the measures, including LED lighting retrofits in most of the campus buildings and upgrades to the Utility Plant, were implemented in 2017; 85% of the energy savings was from the LED retrofit. The capital cost of the project was $8 million, which MNSU is paying back in installments of approximately $400,000 a year from its energy savings over a period of 18 years. The energy savings are <u>guaranteed</u>: if the energy savings are greater than the installment payment in a given year, the University keeps the difference; if the savings are less, Ameresco makes up the difference.

Awards won by MNSU's Guaranteed Energy Savings Program project

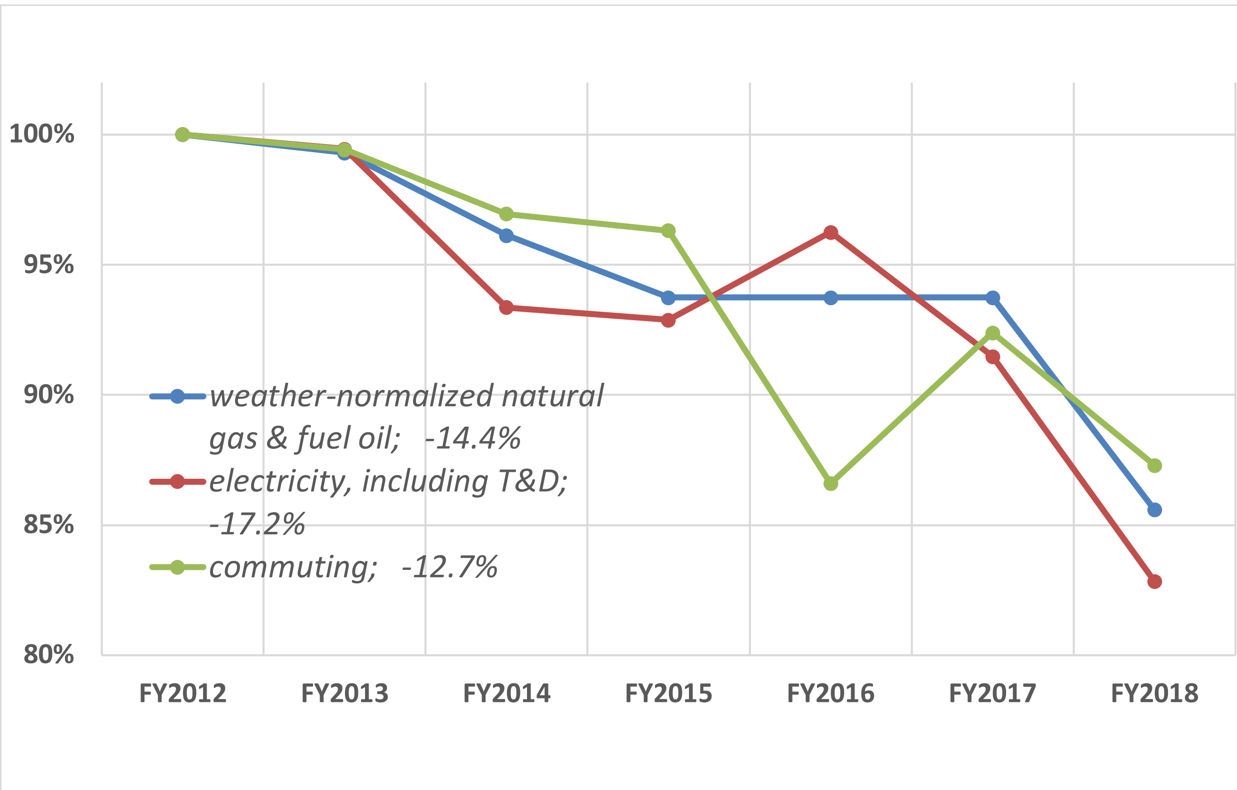
For its energy conservation efforts with the Guaranteed Energy Savings Program, MNSU received a 2018 Clean Energy Community Award from the Minnesota Department of Commerce at the Clean Energy Resource Teams (CERTs) conference in St. Cloud in March 2018; it was one of seven communities in Minnesota so honored.

MNSU also received a prestigious 2019 Environmental Initiative Award for its Guaranteed Energy Savings project. Environmental Initiative, a nonprofit organization that works with business, nonprofit and government leaders to develop collaborative solutions to Minnesota's environmental problems, honors people and teams who have worked to address environmental challenges in Minnesota. MNSU was the award winner in the Sustainable Leadership: Large Employer category. The award was presented at a ceremony in Minneapolis in May 2019.

VII. Trends in greenhouse gas emissions from major sources

Trends in each of the three major sources of greenhouse gas emissions may also be examined, and are shown in Figure 4 below. Weather-normalized natural gas and fuel oil data are plotted to eliminate weather effects and capture only trends from efforts to reduce emissions. Note that in Figure 4 the origin of the vertical axis of the plot is at 80% (not zero) in order to emphasize the trends in the data.

Figure 4. Trends in MNSU major sources of greenhouse gas emissions, FY2012 to FY2018 (baseline = 100%)



Electricity

The drop in electricity emissions from the electricity baseline value was the greatest of the three major sources at 17.2%. Drops between FY2013—FY2014 and between FY2017—FY2018, due to the PBEEEP and GESP initiatives, respectively, are evident in the plot.

Natural gas and fuel oil

The drop in weather-normalized natural gas and fuel oil emissions from its baseline value was 14.4%. As in the case of electricity, drops between FY2013—FY2014 (PBEEEP) and between FY2017—FY2018 (GESP) are evident in the plot.

Commuting

Although commuting emissions were down by 12.7% in FY 2018 compared to FY 2012, they have increased slightly (by 0.7%) since FY2016. Analysis of the commuter survey data shows that more students have been driving alone and fewer walking since FY2016, reversing somewhat the trend seen in the previous update report, CFU2016. Since students make up more than 90% of the commuters, they are the largest factor in the increase, although the same reversal of the earlier trend was seen for faculty and staff as well, and staff driving alone hit an all-time high of 87.2% in FY2018. Complete results from the commuter surveys are shown and discussed in Appendix B.

VIII. Benefits to MNSU of the baseline carbon footprint and the updates

The most obvious benefit of the baseline carbon footprint and updates to MNSU is that by looking at the trends, the University can measure progress in reducing the University's carbon footprint and identify the strategies that are effective in reducing emissions.

A second benefit is that the report may stimulate interest and generate research ideas among students and faculty on campus. Here are a few examples of research questions related to MNSU's carbon footprint:

- Electricity usage is weather-related, just as natural gas and fuel oil usage is. In the summer, more electricity is required for air-conditioning on hot and humid days than on cooler and less humid days. Is it possible to determine how much electricity is used for air conditioning and study the weather-related and non-weather-related uses of electricity separately?
- The addition of new buildings on campus such as the Clinical Sciences Building and the new Dining Hall, suggests the use of metric tons of CO_2-equivalent / square foot as another metric for year-to-year comparisons. What would this metric show about changes in the energy efficiency of the MNSU building stock?
- The Green Transportation Fee has resulted in more and more bus rides by students, faculty and staff on bus routes that serve the campus. Can the effect of the Green Transportation Fee be seen in bus ridership data from the commuter surveys?
- There is some uncertainty in the commuting emissions calculated from the commuter surveys because only a sample of the campus population participates in the surveys. Can the uncertainties in the survey results be quantified?

Other questions are limited only by the imaginations of students and faculty.

Finally, the support of the University for the baseline carbon footprint and the climate action plan, and the awards won for the University's Guaranteed Energy Savings project are testaments to MNSU's commitment to work toward sustainability, one of the foremost challenges faced by the world community in the 21st century. Universities colleges that actively pursue sustainability reap rewards beyond their actual on-campus successes. Prospective donors look favorably upon such commitments. Current faculty members see more meaning in their work and choose to stay at such institutions.

Prospective faculty members select such schools above others in making career choices. And studies show that prospective students give preference to schools that have made a commitment to sustainability. The University should proudly promote its sustainability successes.

IX. A recommendation

MNSU has made great strides in meeting its Climate Action Plan goals. The University has reduced its GHG emissions by 15.6% compared to the baseline year FY 2012. It has achieved this primarily by means of the Public Building Enhanced Energy Efficiency Program (PBEEEP) and the Guaranteed Energy Savings Program (GESP) and because of changes in commuting patterns. The University has achieved statewide recognition for its sustainability efforts: the GESP project, one of the strategies in the Climate Action Plan, has won two statewide awards.

Yet more remains to be done. The threat of a changing climate is real, and will have devastating effects on the lives of our children and grandchildren unless we as a society take further action now, and everyone must do their part. We recommend that MNSU continue its environmental leadership by addressing the fourth strategy in its Climate Action Plan: renewable energy. We strongly recommend that MNSU consider options with all due speed for the production of renewable energy on campus.

Appendix A. Weather normalization of heating data

MNSU's natural gas and fuel oil usage for a particular fiscal year are normalized to the baseline year by using a *heating degree day* method. The idea of a *heating degree day* is based on the observation that the colder it is outside, the more heat is required to keep the inside of a building at a baseline temperature, taken to be 65 °F. Furthermore, the heat required increases in proportion to the difference between 65 °F and the outside temperature. A heating degree day (HDD) is defined as the difference between the average temperature on a particular day during the heating season and 65 °F. For example, if the average outdoor temperature is 35 °F on January 15, 2017, then the number of HDDs for this day is 30; if the average temperature on January 16, 2017, is 5 °F, then the number of HDDs for this day is 60, and it will take twice as much heat to heat a building on January 16 as it does on January 15. Adding up the heating degree days for every day in the year that heat is required yields the number of HDDs in a heating season (defined as July 1 through June 30 but primarily November 1 through March 31 here in Minnesota).

A simple example illustrating the weather normalization of heating data

The amount of heat energy required to heat a building for an entire heating season depends on the number of HDDs in the heating season. It also depends on how well insulated the building is, the efficiency of the furnace, etc., that is, on the *thermal properties* of the building. But if the thermal properties of a building do not change from year to year, the heat required to heat the building in successive heating seasons is <u>proportional</u> to the number of HDDs in a heating season. Let's illustrate with an example. Suppose Mr. A, a homeowner in Mankato, lives in a modest house heated by a natural gas forced air furnace. He tracks his natural gas use and finds that in the winter of 2011-12 (FY 2012) he used 60,000 kBtu[1] of natural gas; he also notes that were 6000 HDD in this heating season. The next year (FY 2013) he used 70,000 kBtu of natural gas and there were 7000 HDD in the heating season. To save some money, he put more insulation in his attic during the summer of 2013; the next heating season (FY 2014) had 7000 HDD just as in the previous year, but he used only 63,000 kBtu of natural gas because of the additional insulation, and in the heating season after that (FY 2015) there were 6000 HDD and his natural gas usage fell to 54,000 kBtu. We summarize this in the table below:

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[1] A kBtu, or kilo-Btu, is a unit of heat energy. The unit of energy commonly used for natural gas is the *therm*. One therm is 100 kBtu, so 60,000 kBtu is 600 therms. We use kBtu instead of therms so that we may more easily compare the heat from natural gas and from fuel oil later in this Appendix.

Table A1. Weather dependence of the annual natural gas usage of a typical home

Year	Annual HDD	Annual natural gas usage, kBtu
FY 2012	6000	60,000
FY 2013	7000	70,000
FY 2014	7000	63,000
FY 2015	6000	54,000

This is a hypothetical example but the values of annual HDD and annual natural gas usage are typical for southern Minnesota. A plot of the annual natural gas usage versus annual HDD is shown in Figure A1 below.

Figure A1. Weather dependence of the annual natural gas required by a typical home

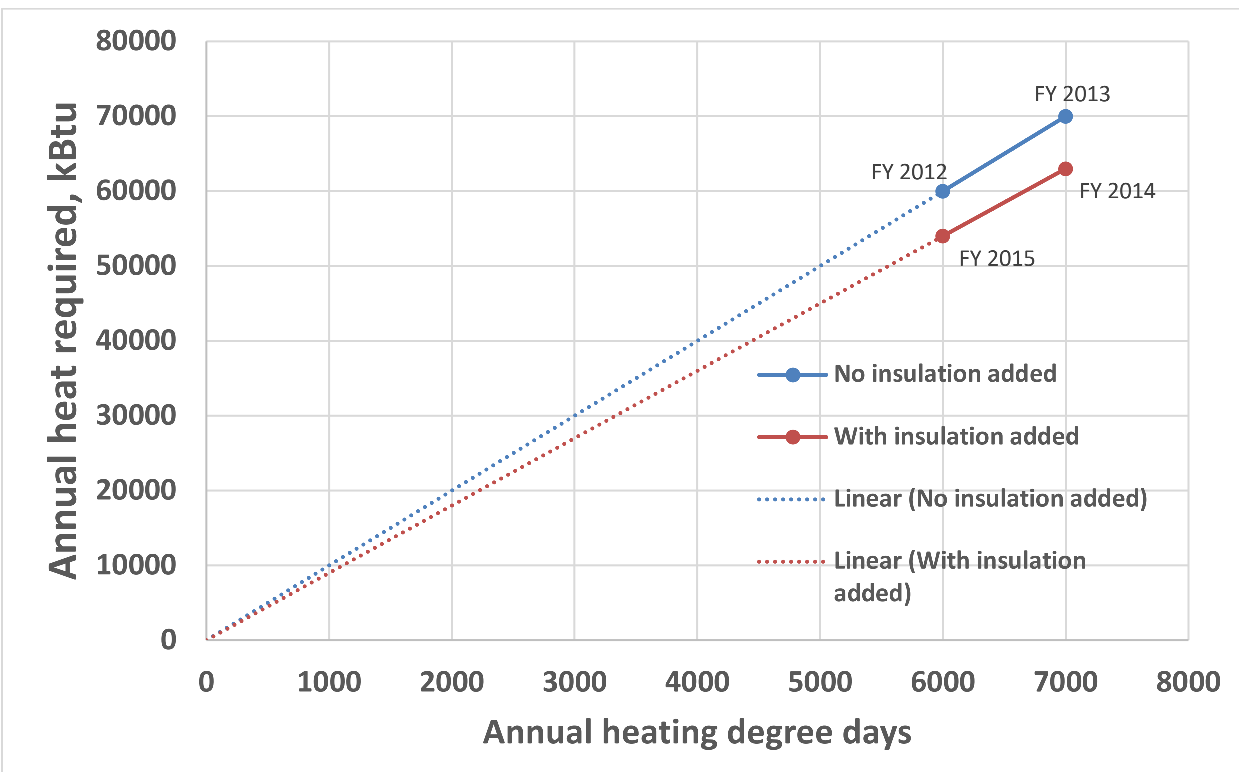


Figure A1 shows the heat required by the house in a year plotted as a function of the number of heating degree days in that year, one point for each year. We see from the graph that in the two years before the insulation was put in the attic, the annual heat required was proportional to the annual HDD: the two blue points lie on a line through the origin. This is expected, since no changes to the thermal properties of the house were made during this period. The two red points for the years after the extra insulation was installed also fall on a straight line through the origin, so after the insulation is installed, the annual heat required was also proportional to the HDD, but the red line is lower than the blue line, because the extra insulation made the house more energy efficient. The house used 10% less natural gas than before, as we can see by comparing the natural gas usage for FY 2012 and FY 2015, which are both at HDD = 6000. Since HDD is the same for FY 2012 and FY 2015, the winters for these years had the same severity, so we'd expect the natural gas usage to be the same, had it not been for the energy-savings improvement in the summer of 2013. Likewise for the points at HDD = 7000, for FY 2013 and FY 2014, which are both at HDD=7000. The winters for these two years also have the same severity, but 10% less natural gas is used in FY 2014 than in FY 2013 because of the energy-savings improvement.

Mr. A would also like a plot of the natural gas usage of his house by year, so that he can see directly the drop in energy use because of the insulation he installed in the attic. The problem is that the natural gas usage varies from year to year with the weather, which obscures the effect he's looking for, so he *weather-normalizes* his natural gas usage. To do this, he takes FY 2012 as the baseline year, then adjusts his annual natural gas usage for succeeding years to be the same as if each succeeding winter was just as cold as the winter of 2011-12 (FY 2012), the baseline winter, or in other words, as if each succeeding winter had as many HDDs as the winter of FY 2012. For FY 2015, that's easy because FY 2015 and FY 2012 both have 6000 HDDs, so no adjustment in the natural gas usage for FY 2015 is necessary. For FY 2013 and FY 2014, he has to make an adjustment. First considering FY 2013, he wants to adjust its natural gas usage to what it would be if its heating season had 6000 HDD as for FY 2012, rather than the 7000 HDD it actually had. But for the period from FY 2012 to FY 2013 the thermal properties of the house are constant, so the annual natural gas usage is proportional to the annual number of HDDs. We can set up a proportion:

weather adjusted natural gas usage in FY 2013 / 6000 HDD = 70,000 kBtu / 7000 HDD

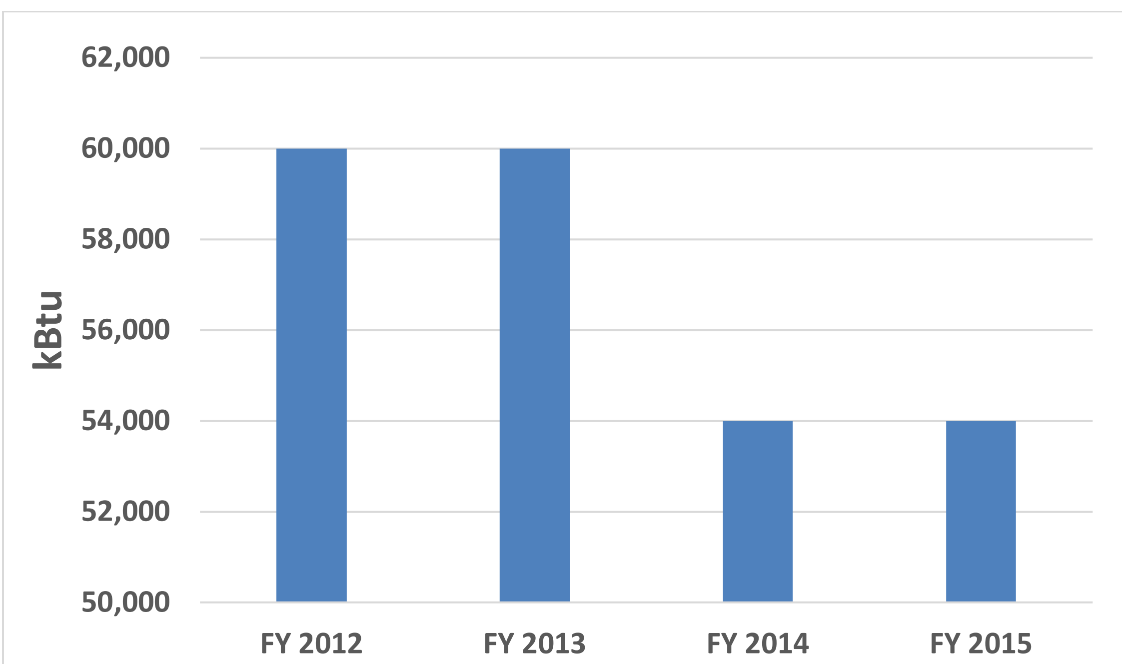
so the weather adjusted natural gas usage for FY 2013 is 60,000 kBtu. The weather-adjusted point on the graph for FY 2013 therefore coincides with the FY 2012 baseline point. We can think about the weather adjustment in this way: as long as the thermal properties of the house remain constant, the point for each year will move up or down the proportionality line on the graph, depending on the number of HDDS in that year. Similarly for FY 2014: to weather-normalize the FY 2014 natural gas usage, slide the FY 2014 point down its proportionality line to HDD = 6000. Doing this we find that the weather-normalized natural gas usage for FY 2014 is 54,000 kBtu. In the table below the annual natural gas usage is compared with the weather-normalized annual natural gas usage.

Table A2. Weather-normalized annual natural gas usage of a typical home

Year	*Annual natural gas usage, kBtu*	*Weather-normalized annual natural gas usage, kBtu*
FY 2012	60,000	60,000
FY 2013	70,000	60,000
FY 2014	63,000	54,000
FY 2015	54,000	54,000

Mr. A's graph of the weather-normalized annual natural gas usage versus time looks like this:

Figure A2. Weather-normalized annual natural gas usage of a typical home by year



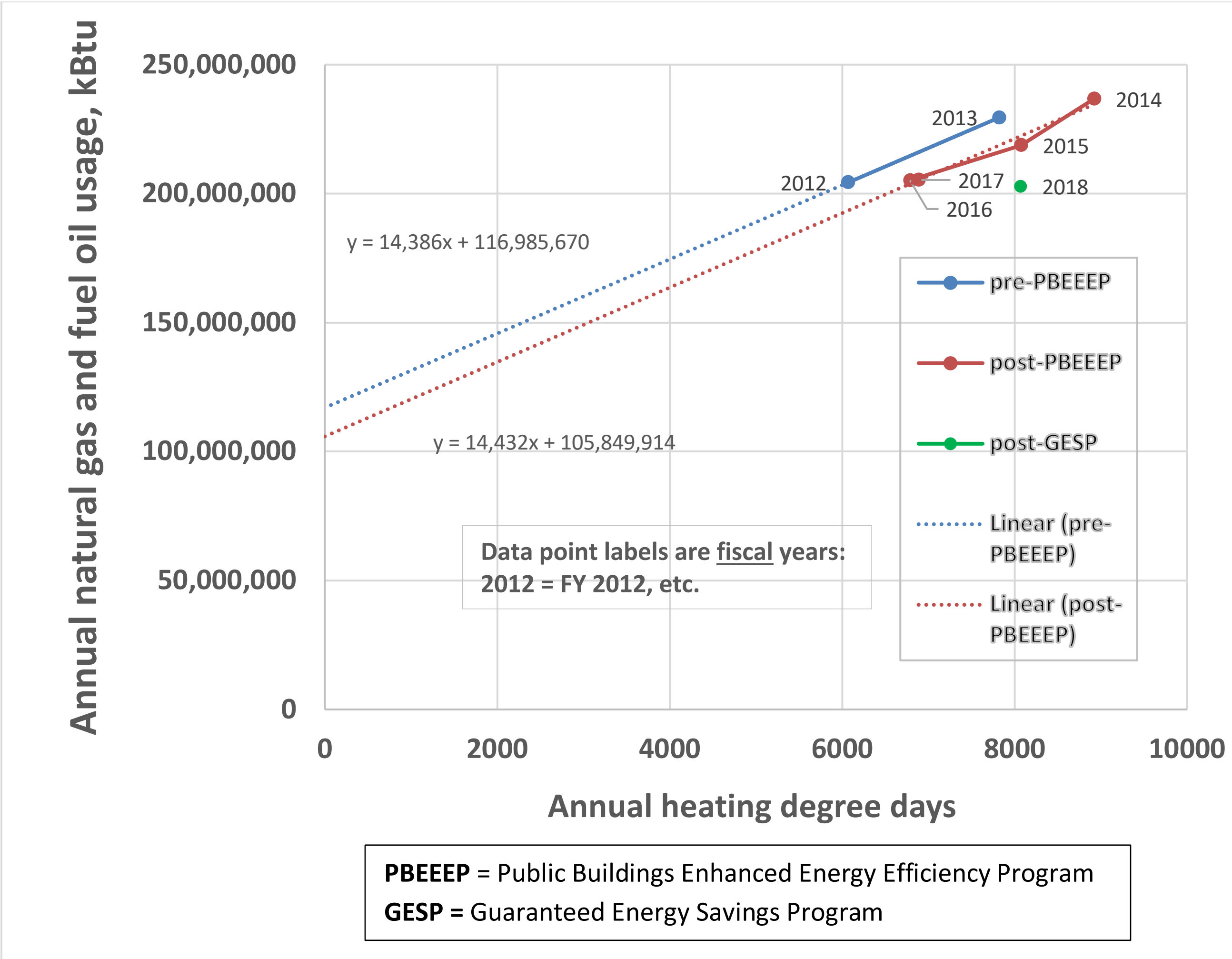
Since the effects of weather have been normalized out, we see clearly from the graph that the weather-normalized annual natural gas usage decrease by 6,000 kBtu in FY 2014, when the baseline is taken to be FY 2012. The energy savings from the insulation is also clearly evident from the graph and is 6,000 kBtu a year. We can also find the energy savings directly from the graph of heat required vs HDD: it is the vertical distance between the blue and red lines at the value of HDD of the baseline year point, FY 2012. Reading the value directly off the graph, we find again that it is 6,000 kBtu a year.

Weather-normalization of the MNSU heating data

We can use the method of the previous example of the house to weather-normalize the annual heat required by the buildings at MNSU. Now we're looking at a collection of buildings rather than just a single building, but the same ideas apply. Figure A3 shows the heat required by all campus buildings in a particular fiscal year versus the number of HDDs in that year, one point for each fiscal year from FY 2012 to FY2018. As in the simple example of the house, there are two straight lines in the plot, a blue line, which is a linear fit to the points for FYs 2012 and 2013, and a red line below it, a linear fit to the points for FYs 2014 to FY 2017. The equations for the best-fit lines are also shown on the Figure. There is also a point below both lines for FY 2018. In the Figure, the red points are "post-PBEEEP;" they're for fiscal years after the heat energy- savings measures of the Public Buildings Enhanced Energy Efficiency Program project were put in place, and the green point, labelled "post-GESP," is for FY 2018, after the heat-energy savings measures of the Guaranteed Energy Savings Program project were implemented. It's important to remember that in both PBEEEP and GESP there were energy-savings measures to reduce <u>both</u> the use of natural gas and fuel oil <u>and</u> the use of electricity. In this discussion we're concerned <u>only</u> with the heat energy-reducing measures of these projects.

There are differences between the two lines in Figures A3 and A1. In Figure A3 the two lines don't pass through the origin, as they did in the simple example of the house; the reason is that the Utility Plant, where the heat for the campus is produced, itself requires a substantial amount of heat to operate, independent of the ambient temperature and roughly the same from year to year at somewhat more than 100 million kBtu. If this heat were subtracted out, the two lines would come close to passing through the origin. A second difference is that in Figure A3 the two lines don't converge to a point on the vertical axis, as they did in the simple example of the house. To explain this, recall that in the example that the reason there are two lines and not just one is because of the energy-savings measure of putting more insulation in the attic. This caused a break in the line, resulting in the red line being

Figure A3. Weather dependence of annual heat required by MNSU, FY 2012 to FY 2018



below the blue line. This energy-savings measure is temperature-dependent; insulation in the attic saves more energy when it's colder, and the energy savings is proportional to HDD. The distance between the two lines is the energy saved, so they converge and meet at the origin. On campus it was the PBEEEP (Public Buildings Enhanced Energy Efficiency Program) project that reduced heat energy use between FY 2013 and FY 2014; the PBEEEP measures that reduced heat energy use were implemented in the spring of 2013. The heat energy-savings measures of PBEEEP were temperature-independent; they saved the same amount of heat energy regardless of the ambient temperature, and because of this, the red line in Figure 3A is just the blue line shifted straight down, by the amount of the energy savings. The heat energy saved by PBEEEP can be read directly off the graph: it's the vertical distance between the point for FY 2012 (the baseline year) at HDD=6071, and the red line below it, and has a value of about 12.5 million kBtu a year.

The second program that led to campus-wide heat energy savings during the time covered by this study is the Guaranteed Energy Savings Program (GESP). The heat energy-savings measures in the GESP project were for the most part implemented in 2017 between the FY 2017 and FY 2018 heating seasons, so the point for FY 2018 on the graph lies below the red line. The GESP heat energy-saving measures were also independent of temperature, just as the PBEEEP measures were. The heat energy saved by GESP can therefore also be determined graphically. The line through the FY 2018 point (not shown in the Figure) is parallel to the red line above it for the same reason that the red line is parallel blue line, because the amount of heat energy saved by GESP did not depend on temperature. The heat energy saved by GESP is the vertical distance between the red line and the line through the FY 2018 point, measured at HDD=6071, the heating degree day value for the baseline year FY 2012. The value of the heat energy saved by GESP so obtained is about 19.3 million kBtu a year.

In our simple example of the house, we used Figure A1 to weather-normalize the heat required by the house in a particular heating season by sliding the point for that heating season down its line to the baseline value of HDD (6000 in the example). This works because the line gives us the annual heat required by the house for a given value of annual HDD, provided the thermal properties of the house don't change. Applying this simple graphical method to the buildings on the MNSU campus using Figure A1, we slide the point for FY 2013 down its blue line until it coincides with the baseline point FY 2012 at HDD=6071, and read off the heat required from the vertical axis of the graph. Similarly, we slide the points for FYs 2014-17 down the red line to HDD=6071, and slide the point for FY 2018 down its line (not shown on the graph), parallel to the other two, to HDD=6071. The values of the weather-normalized annual heat required for the campus so obtained are shown in Table A3 below.

The annual heat required for the campus comes from the combustion of natural gas and fuel oil. In our simple example of the house, we made an adjustment in the annual natural gas required to get the weather-normalized annual natural gas. On campus, this adjustment is not so straightforward, because the heat required comes from two sources, the combustion of both natural gas and fuel oil. The amount of heat MNSU gets from fuel oil, however, is much smaller than that from natural gas. Fuel oil for heat is used only during extreme cold weather emergencies when Centerpoint, the University's natural gas supplier, requires MNSU as well as other large users to switch from natural gas to fuel oil to avoid a natural gas shortfall in Centerpoint's system. But this happens only rarely. In no year considered in this study was the heat from fuel oil more than 5% of the total heat required by MNSU, and in three years (FYs 2015-17) no fuel oil was combusted at all. Since in every year of this study fuel oil contributed only

Table A3: Weather-normalized annual heat required by MNSU

Year	*Annual heat required, kBtu*	*Weather-normalized annual heat required, kBtu*
FY 2012	204,323,156	204,323,156
FY 2013	229,541,837	204,323,156
FY 2014	236,789,513	193,466,586
FY 2015	218,792,514	193,466,586
FY 2016	205,161,017	193,466,586
FY 2017	205,292,382	193,466,586
FY 2018	202,937,482	174,116,778

a fraction of the total heat, when making the adjustment in the annual heat required to get the weather-normalized annual heat required, only an adjustment in the natural gas usage was made. The weather adjusted natural gas usage and the fuel oil usage were then input to the University of New Hampshire Campus Carbon Calculator v8 to calculate the weather-normalized annual greenhouse gas emissions for natural gas and fuel oil found in Table 2 and in Figure 4 in the body of the report. Even though fuel oil plays a small role, its effects are evident. Fuel oil is a dirtier fuel than natural gas. Producing 1 kBtu of heat by burning fuel oil results in more carbon dioxide than producing 1 kBtu of heat by burning natural gas; the *emission factor* of fuel oil is greater than that of natural gas. The use of fuel oil increased the entries in the Natural Gas and Fuel Oil column in Table 2 noticeably. Had no fuel oil been burned in FY 2014, the weather-normalized annual GHG emissions would have been 10,283 metric tons of CO_2-eq, not 10,545 mt CO_2-eq. Had no fuel oil been burned at all, one would see only three distinct entries in the Natural Gas and Fuel Oil column, decreasing as one goes down the column, just as for the Weather-normalized annual heat required entries in Table A3 above.

Appendix B. Commuter surveys

Greenhouse gas emissions from commuting were estimated using a commuter survey that was emailed to all members of the University community every spring. Respondents identified themselves as students, faculty or staff, and were asked the distance of their typical round-trip commute to campus and the mode of transportation they typically used to get to campus on each day of the work week, Monday through Friday. Modes of transportation included in the survey were: drive alone, carpool, bus, bike and walk. There were also three responses to choose from if the respondent didn't commute on a particular day: telecommute; compressed work week, day off; and don't commute this day. From the responses the percentage of each mode of commuting and the average round-trip commuting distance of each motor vehicular mode for students, faculty and staff were calculated. The percentage of each mode of commuting and average commuting distances for all motor vehicular modes of commuting are shown in Tables B1 and B2 for students, faculty and staff for all years in which surveys were conducted. These percentages and average distances, along with data on the total number of students, faculty, and staff at MNSU, were then input to the University of New Hampshire Campus Carbon Calculator v8, which calculated the total greenhouse gas commuting emissions for all students, faculty and staff, under the assumption that the survey responses were representative samples of students, faculty, and staff.

The first commuter survey was conducted in the spring of 2013. Since Sebesta conducted the first commuter survey in the spring of 2013 at the same time they did the first footprint (the baseline, for FY 2012) the results of the spring 2013 survey were used to determine the commuter emissions for the previous year FY 2012 as well as for the first update of the footprint in FY 2013.

Two other questions were also asked, to aid in formulating strategies for reducing commuting emissions: If you drive alone, indicate the reason for doing so; and, Which commuting programs/incentives would be most effective in switching your primary commuting mode away from driving alone? The commuter survey questions are shown in Appendix C.

Table B1. Commuting trips at MNSU by percent of each mode of commuting

Students	**Drive Alone**	**Carpool**	**Bus**	**Bike**	**Walk**	**Tele commute**	**Compressed Week**	**Don't Commute**	**Total Not Commuting**
2018	29.5%	4.3%	12.2%	0.9%	37.5%	1.6%	0.1%	13.8%	15.5%
2017	28.6%	3.8%	14.6%	2.1%	34.9%	0.8%	0.3%	14.7%	15.8%
2016	24.9%	4.0%	13.0%	1.1%	41.2%	0.9%	0.1%	14.7%	15.7%
2015	28.2%	3.7%	14.3%	2.2%	36.4%	1.6%	0.2%	13.4%	15.2%
2014	27.8%	3.9%	12.6%	3.4%	38.7%	0.5%	0.3%	12.7%	13.5%
2013	30.2%	4.2%	13.3%	3.9%	34.2%	1.7%	0.3%	12.2%	14.2%
Faculty	**Drive Alone**	**Carpool**	**Bus**	**Bike**	**Walk**	**Tele commute**	**Compressed Week**	**Don't Commute**	**Total Not Commuting**
2018	69.1%	6.9%	1.0%	1.0%	9.7%	5.7%	0.2%	5.9%	11.9%
2017	72.0%	2.2%	1.7%	1.9%	8.2%	3.2%	0.2%	9.5%	12.9%
2016	62.5%	6.1%	4.3%	0.2%	13.7%	4.3%	0.7%	8.3%	13.3%
2015	67.6%	5.4%	0.7%	2.0%	12.3%	4.0%	1.6%	6.5%	12.1%
2014	74.1%	2.4%	1.8%	2.7%	10.0%	3.3%	0.8%	4.9%	9.0%
2013	68.8%	6.7%	1.6%	3.8%	6.6%	4.1%	0.3%	8.1%	12.5%
Staff	**Drive Alone**	**Carpool**	**Bus**	**Bike**	**Walk**	**Tele commute**	**Compressed Week**	**Don't Commute**	**Total Not Commuting**
2018	87.2%	4.0%	0.6%	2.6%	3.4%	0.2%	0.2%	1.8%	2.3%
2017	83.9%	5.1%	1.7%	2.3%	5.5%	0.9%	0.2%	0.3%	1.5%
2016	82.5%	7.8%	1.4%	2.9%	3.6%	0.8%	0.1%	0.9%	1.8%
2015	76.8%	11.6%	1.1%	1.9%	6.6%	0.6%	0.6%	0.6%	1.9%
2014	82.0%	6.2%	0.8%	3.0%	5.3%	0.9%	0.3%	1.5%	2.7%
2013	83.7%	7.8%	1.0%	2.9%	3.0%	0.4%	0.2%	1.0%	1.7%

Table B2. Average commuting distances for different modes of commuting

Students	**Drive Alone**	**Average Round trip Drive distance, mi**	**Carpool**	**Average Round trip Carpool distance, mi**	**Bus**	**Average Round trip Bus distance, mi**
2018	29.5%	24.2	4.3%	24.2	12.2%	4.8
2017	28.6%	27.6	3.8%	27.6	14.6%	3.8
2016	24.9%	28.6	4.0%	28.6	13.0%	3.4
2015	28.2%	30.7	3.7%	30.7	14.3%	3.5
2014	27.8%	28.9	3.9%	28.9	12.6%	3.4
2013	30.2%	28.3	4.2%	28.3	13.3%	3.9
Faculty	**Drive Alone**	**Average Round trip Drive distance, mi**	**Carpool**	**Average Round trip Carpool distance, mi**	**Bus**	**Average Round trip Bus distance, mi**
2018	69.1%	25.7	6.9%	25.7	1.0%	4.0
2017	72.0%	22.8	2.2%	22.8	1.7%	5.5
2016	62.5%	24.1	6.1%	24.1	4.3%	4.8
2015	67.6%	24.7	5.4%	24.7	0.7%	8.0
2014	74.1%	26.7	2.4%	26.7	1.8%	8.0
2013	68.8%	22.6	6.7%	22.6	1.6%	10.9
Staff	**Drive Alone**	**Average Round trip Drive distance, mi**	**Carpool**	**Average Round trip Carpool distance, mi**	**Bus**	**Average Round trip Bus distance, mi**
2018	87.2%	23.9	4.0%	23.9	0.6%	4.0
2017	83.9%	21.9	5.1%	21.9	1.7%	5.3
2016	82.5%	23.4	7.8%	23.4	1.4%	3.7
2015	76.8%	17.7	11.6%	17.7	1.1%	3.1
2014	82.0%	21.1	6.2%	21.1	0.8%	8.0
2013	83.7%	21.5	7.8%	21.5	1.0%	6.3

In Table B3 below is shown the number of student, faculty and staff respondents for each of the surveys. As can be expected in any survey, not all respondents answered the questions as anticipated. If, when asked, Select the mode of transportation you typically use to get to campus each day, the respondent selected more than one answer for one or more days of the work week (Monday through Friday), or no answer at all, or did not answer the question, What is the distance of your typical commute?, then the response was disregarded and not used in the analysis. Only responses with exactly one answer for each day of the week and an answer to the distance question were used in the analysis. Both the total response rates and the correctly done response rates are given in Table B3.

Table B3. Commuter Survey response rates and correct response rates

Students	Total	Responses	Response Rate	Correct Responses	Correct Response Rate	Correct Responses/Responses
2018	13,075	837	6.4%	652	5.0%	77.9%
2017	13,396	797	5.9%	617	4.6%	77.4%
2016	13,477	860	6.4%	658	4.9%	76.5%
2015	13,630	940	6.9%	703	5.2%	74.8%
2014	13,745	889	6.5%	633	4.6%	71.2%
2013	13,765	698	5.1%	566	4.1%	81.1%
2012	14,014					
Faculty	**Total**	**Responses**	**Response Rate**	**Correct Responses**	**Correct Response Rate**	**Correct Responses/Responses**
2018	711	111	15.6%	101	14.2%	91.0%
2017	735	107	14.6%	93	12.7%	86.9%
2016	760	107	14.1%	89	11.7%	83.2%
2015	759	132	17.4%	111	14.6%	84.1%
2014	761	126	16.6%	102	13.4%	81.0%
2013	754	159	21.1%	146	19.4%	91.8%
2012	746					
Staff	**Total**	**Responses**	**Response Rate**	**Correct Responses**	**Correct Response Rate**	**Correct Responses/Responses**
2018	833	185	22.2%	176	21.1%	95.1%
2017	854	181	21.2%	175	20.5%	96.7%
2016	819	180	22.0%	174	21.2%	96.7%
2015	848	182	21.5%	158	18.6%	86.8%
2014	881	199	22.6%	132	15.0%	66.3%
2013	861	240	27.9%	231	26.8%	96.3%
2012	824					

Discussion and trends

In Table B1, some comparisons among students, faculty and staff stand out for all years of the survey:

- Students lead in four modes of commuting: Walk, Total not commuting, Bus, and Bike.
- Faculty generally lead in two modes: Telecommute and Compressed Week
- Staff generally lead in two modes: Drive and Carpool

There are also some notable trends from FY 2013 through FY 2016:

- For students, there is a 5.3% decrease in Drive Alone, which is roughly matched by a 6.8% increase in Walk.
- Also for students, there is a 2.7% increase in Don't Commute and a 1.5% increase in Total not Commuting.
- For faculty, there is a 6.3% decrease in Drive Alone, which is roughly matched by a 7.1% increase in Walk.

Since students make up approximately 90% of the campus population, most of the 13.4% decrease in overall commuting emissions from FY 2013 through FY 2016 is a result of changing patterns in student commuting. Fewer students are driving alone, and more are walking or simply not coming to campus at all on a particular day. Increasing numbers of faculty walking rather than driving alone also contributes somewhat to the overall decline.

New in the FY 2018 report

Although commuting emissions were down 12.7% in FY 2018 from the baseline year of FY 2012, they increased slightly from FY 2016, the time of the previous report, when they were down 13.4% from the baseline year, as seen in Figure 4 and Table 2. This is most likely due to a significant reversal of trends seen in FY 2016.

From FY 2016 to FY 2018 –

- For students, there was a 4.6% increase in Drive Alone, roughly matched by a 3.7% decrease in Walk.
- This increase in students driving alone was roughly compensated for by a decrease in the average driving alone round-trip commute distance for students from 28.6 miles to 24.2 miles.

- Faculty driving alone was up by 6.6%, while the faculty average driving alone round-trip commute distance increased slightly from 24.1 to 25.7 miles.
- Staff driving alone hit an all-time high of 87.2% in FY 2018.

It is again useful to note that since students make up more than 90% of the commuters, it is the students who have the largest influence on commuting emissions.

Appendix C. Commuter Survey Questions

As part of our effort to calculate Minnesota State Mankato's environmental impact, we are seeking your input to assess the current commuting habits of students, staff, and faculty to campus. The following survey asks about your typical commuting practices. The survey should take approximately 3 minutes – please fill out the information below by April 22, 2016.Students: Enter your email address at the end of the survey for a chance to win a $25 gift card to the campus Barnes and Noble bookstore. Thank you in advance for your cooperation and assistance with this program!

1. How do you classify your role at MSU, Mankato?

❍ Student
❍ Staff
❍ Faculty

2. Do you live on Campus?

❍ Yes
❍ No

3. What is the distance of your typical commute in miles (one way only)?

❍
❍ 1-2.9 miles
❍ 3-4.9 miles
❍ 5-9.9 miles
❍ 10-14.9 miles
❍ 15-19.0 miles
❍ 20-24.9 miles
❍ 25-29.9 miles
❍ 30-39.9 miles
❍ > 40 miles

4. Select the mode of transportation you typically use to get to campus each day of the Monday through Friday work week. If you use multiple modes of transportation, choose the one you use for the greatest distance. If you do not travel to campus on a typical day, select one of the options indicating why (Telecommute, Compressed Work Week, Don't Commute This Day). You should only have 5 (five) check marks, one for each day of the work week.

	Mon	Tue	Wed	Thur	Fri
Drive Alone	❑	❑	❑	❑	❑
Carpool (more than one person in vehicle)	❑	❑	❑	❑	❑
Bus	❑	❑	❑	❑	❑
Bike	❑	❑	❑	❑	❑
Skateboard	❑	❑	❑	❑	❑
Walk	❑	❑	❑	❑	❑
Telecommute	❑	❑	❑	❑	❑
Compressed work week day off (4/40, 3/36, 9/80)*	❑	❑	❑	❑	❑
Don't Commute This Day	❑	❑	❑	❑	❑

*Compressed work week is an option for staff; it is defined as working a standard number of hours in fewer than five days by working longer hours (i.e., four 10hour days).

5. If there is another mode of transportation that you occasionally (but not typically) use that you did not select in Question 4, choose the mode from the list below. Indicate the percent of time you use the secondary mode over the course of a year in Question 6.

❍ Drive Alone
❍ Carpool
❍ Bus
❍ Bike
❍ Skateboard
❍ Walk
❍ Telecommute
❍ Compressed Work Week
❍ Other (please specify) ____________________

6. What percent of time do you use this secondary source?

______

7. If you Drive Alone, indicate the reason for doing so (select all that apply)

- ❑ Need car for errands
- ❑ Saves time
- ❑ Classes in different location on campus
- ❑ Want car for emergencies
- ❑ No one to carpool with
- ❑ Save money
- ❑ Need car for work
- ❑ Need car because of children
- ❑ No public transit stops near where I live
- ❑ Other ____________________

8. Which commuting programs/incentives would be most effective in switching your primary commuting mode away from Drive Alone (select all that apply).

- ❑ Guaranteed ride home for emergencies
- ❑ Higher Drive Alone parking costs
- ❑ Carpool incentives (reduced parking costs or reserved parking for carpoolers)
- ❑ Assistance finding carpool partners
- ❑ Secure bike racks/lockers
- ❑ Assistance finding bike routes to campus
- ❑ Bike repair options on campus
- ❑ Subsidized transit passes
- ❑ Increased public transit service
- ❑ More options related to class scheduling
- ❑ More classes offered through distance learning
- ❑ Shower facilities on campus
- ❑ Other ____________________

9. Students: Enter your email address for a chance to win a gift certificate to the campus Barnes and Noble bookstore (optional)

Appendix D. Data requirements for the carbon footprints

Table D1. Data sources and contacts

Data	Source	Contact
Natural gas & fuel oil consumption	B3 Benchmarking website http://mn.b3benchmarking.com	
Electricity usage	B3 Benchmarking website http://mn.b3benchmarking.com	
Commuting data	Commuter survey	Gary Urban, Business Services
University data – full & part-time students, faculty, & staff (for commuting analysis)		Sharifun Syed, Institutional Analytics & Strategic Effectiveness
University fleet		David Cowan & Helen Walters, Facilities Services
Solid waste	Waste reports	Jason McCue & Beth Rorvig, Building Services
Waste water	B3 Benchmarking website http://mn.b3benchmarking.com	
Fertilizer use		Bruce Leivermann, Physical Plant