# AUGSBURG COLLEGE

# GREENHOUSE GAS EMISSIONS INVENTORY

# FISCAL YEARS 2001–2008


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Environmental Stewardship Committee


January 15, 2009

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# ABSTRACT

Augsburg College's greenhouse gas inventory for fiscal years 2001–2008 includes measurements of the total greenhouse gas (GHG) emissions from all sources on the main campus in Minneapolis, Minn. This inventory was made possible by the use of the Clean Air–Cool Planet calculator (CA-CP) designed and maintained by Clean Air–Cool Planet, Inc.

Based on calculator results, Augsburg College's overall GHG emissions for FY 2007 from all sources were 25,200.5 metric tons of $CO_2$ + $CO_2$ equivalents ($eCO_2$) of $NO_2$, $CH_4$, and F22. By source, the emissions averaged approximately 40% for electricity, 22% for purchased steam, 8% for refrigerant, 3% for natural gas, 5% for faculty and staff commuting, 10% for student commuting, 3% for all air travel, 1% for paper, 1% for waste, and 5% for T&D Losses.

Although our overall emissions increased slowly during the first seven years of the inventory, total emissions increased in FY 2008 alone by 1,000 metric tons as the new Oren Gateway Center and Kennedy Center buildings were put into service with an additional 153,000 square feet of building space. The carbon footprint of the College will increase again by a similar amount when the new Center for Science, Business, and Religion opens at some point in the future. In the meantime, continued improvements to the HVAC systems and deliberate conservation efforts by the campus population could help keep the increases to a minimum.

Before the new building comes online, Augsburg will reduce its carbon footprint by 40% with the purchase of 100% wind power from Xcel Energy that began in June 2008. Additional opportunities revealed by this inventory indicate that replacement of the refrigeration system for the ice rinks would reduce our footprint by at least 8%, or 2120 metric tons of $eCO_2$. Increased commuting by transit, bike, or walking would also result in reductions in our carbon footprint.

Augsburg's results seem higher than the average for other Master's Colleges and Universities that have submitted inventory results so far (20.7 vs. 14.83 metric tons $eCO_2$ per 1,000 square foot of building space), and in-depth analysis is required to determine the significance of the differences.

# GENERAL INTRODUCTION

We are at a critical turning point in the history of life on earth. The decisions we make as a human society and the steps we take (or fail to take) in the next years to reduce our contributions to global warming—as individuals, organizations, companies, institutions, and governments—could well determine the future viability of life on earth.

UN secretary general Ban Ki-moon has called global warming an emergency that must be the world's top priority. Every established scientific body in the world that has said anything about the subject has acknowledged the reality and severity of the threat of anthropogenic (human-induced) climate change. The greatest and most knowledgeable scientists in the world—some of the greatest minds of our time, such as Stephen Hawking, James Lovelock, and James Hansen—have been amongst the most alarmed at the rate of warming and at the growing likelihood that we have, or soon will, reach a point when the warming will take on a life of its own. The basic nature of the planet will then change fairly rapidly to become more lethal to human beings and to most other forms of complex life.

As important as it is for individuals to keep track of their carbon footprints, it is even more crucial for institutions to lead the way in monitoring and reducing emissions of GHGs. This document is essentially a study of the greenhouse gas footprint of Augsburg College. By having a clear idea of the major sources of our emissions, we can develop a truly effective plan to reduce and eliminate their impact.

Obviously an institution such as Augsburg has a far greater *direct* impact than an individual does simply because of its relative size. But the *indirect* impact of such institutions can also be considerable, since all institutions exert influence on the behaviors of the people who work there as well as on other institutions. Colleges in particular have a special role to play in educating people about the dangers of the current climate crisis. Colleges can also model positive ways to implement policies and behaviors that minimize negative impacts on the environment. This education can have a multiplier effect as students and others take the lessons learned to other schools, businesses, and organizations where they study, work, or volunteer.

Augsburg College is deeply committed to building a sustainable urban environment and has begun to take significant measures that could make it a leader in this most vitally important effort. These measures are included in this report, the first systematic attempt at such an inventory in Augsburg's history. It represents a centrally important step in taking responsibility to reduce the chance of runaway global warming.

NOTE: This introduction is excerpted from "Climate Change: A Moment for Reflection," which discusses the challenges faced, includes technical information about greenhouse gases and their impacts, and reflects on the risks to our planet of taking no action. "Climate Change: A Moment for Reflection" is included as Appendix A on page 24.

# INTRODUCTION TO THE GREENHOUSE GAS (GHG) EMISSIONS INVENTORY

## Fiscal Years 2001–2008

Global warming is finally capturing the attention of a vast majority of scientists, politicians, and average citizens after many years of debate, misinformation, and denial. As a result of decades of study, scientists are convinced that if we do not reduce our staggering production of greenhouse gases (GHGs), the earth's temperature will rise to dangerous levels, causing major melting of the earth's ice caps, rising sea levels, increased major storms, and major weather pattern shifts that could threaten the world's food production. With all the dire predictions, nations are now beginning to make real attempts to reduce their production of greenhouse gases.

Thanks to the producers of the Clean Air-Cool Planet (CA-CP) calculator, institutions can now create their own GHG inventory using data collected from utility invoices and other records at their facilities. The most difficult initial task is to collect data from many different departments within an institution and organize it into a form appropriate for entering into the calculator. After that, the calculator's many features allow institutions to view their energy use patterns over time and to see the proportional relationships between various sources of GHGs at their facilities.

The Augsburg College inventory is limited to the buildings on its main campus in Minneapolis, Minn. Spaces not included were those leased for Augsburg for Adults classes in Rochester, Minn., and at the United Hospital facilities in St. Paul, Minn. In addition, some office space was leased at the Crown Roller Mill building in downtown Minneapolis during the construction of the new Oren Gateway Center. Data for these off-campus sites was not available and would be very difficult to report accurately. We used all the calculator's energy and GHG coefficients, and we changed the fuel mix data for purchased steam data to 100% from the region's estimated values per input from our supplier NRG, Inc. We used Version 6 of the Clean Air-Cool Planet calculator that uses the Global Warming Potentials from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report. For specifics on how the CA-CP Calculator works go to: www.cleanair-coolplanet.org.

# METHODS AND DATA COLLECTION

Most of Augsburg College's data for this inventory was gathered from invoices or direct reports from contractors. Invoice data was especially difficult to collect because records were in deep storage, and the data had to be extracted, put into an intermediate form, like Excel spreadsheets, and then later entered into the calculator. Having the data in spreadsheet form also permits additional study in greater detail than required by the calculator, which will help the College plan future greenhouse gas reduction strategies.

## Electricity

Augsburg College gets all of its electricity through Xcel Energy, Inc. Data was collected from invoices, put into spreadsheet form, and reviewed carefully before being entered in summary form into the calculator. Very few invoices were missing; some missing data was retrieved from Xcel, or an average of adjacent months was taken and inserted in the missing slot. This happened rarely, and the estimated values make the totals more accurate than if they were left blank. We used the CA-CP fuel mix data as per the pre- and post-2006 eGRID designations in the EF Electric Map section of the calculator.

## Purchased Steam

Augsburg's steam was produced at a nearby facility, shared with the University of Minnesota-Fairview Hospital, and operated by NRG, Inc. Steam data was primarily from invoice data with the exception of several, multi-month periods. The missing data was found in NRG records and sent to us via e-mail. NRG also notified us that the fuel mix for our steam generation was 100% natural gas and that each 1,000 pounds of steam was equal to one million BTUs (MMBTU)

## Natural Gas

Natural gas was purchased from CenterPoint Energy, Inc. (formerly Minnegasco, Inc.) and most of the data came from invoices, with the exception of a few minor gaps. Reliant Energy (a predecessor to CenterPoint) was able to fill in the gaps with data from their electronic records.

Natural gas is used mostly for heating hot water and heating our athletic dome facility. Our newest building is also heated with natural gas, a move toward more efficient heating than the steam system used for older buildings on campus.

## Refrigerant

Augsburg College has two ice rinks with an aging direct refrigeration system. Invoice data revealed high levels of refrigerant (HFC-22) being replaced throughout the eight-year period of the inventory. Data was supplied by our Ice Arena contract maintenance companies, New Mechanical, Inc. and Gartner's, Inc. There were no gaps in the information collected.

## Fertilizer

Lawn fertilizer was applied by Green Masters, Inc. of Minneapolis, and the data was collected from invoice data that included pounds of fertilizer and percentage of nitrogen (15-20%) per application. There were no gaps in the information collected.

## Paper

Paper usage on campus was not readily available from invoice data. This problem will be corrected in future years' data collection. We relied on an estimate from the director of purchasing that gave our current usage of eight million sheets of copy paper (30% post-consumer recycled content) per year. From that number, usage from previous years was calculated based on a 3% increase in paper usage each year. Only copy paper is tracked in this inventory.

## Solid Waste and Recycling

Since 2003, Augsburg College has contracted with Allied Waste as our only hauler for trash and recycling; during FY 2001 and 2002, Waste Management was our hauler. Allied Waste provided a monthly total cubic yards (and weight) of trash and recycling collected, based on our standard container sizes and frequency of pickup. Our scheduled hauling volumes have not changed throughout the first eight years of the inventory although they went up slightly when we added the Oren Gateway Center in fall 2007. Data provided by Allied Waste are only estimates, because the extent to which the dumpsters are filled at each pickup can vary considerably from pickup to pickup. In general the number of trash containers, their sizes, and the frequency of pickups match our average school year trash volume. Summer trash volumes are lower than the regular school year, and we estimated that summer volumes would probably be at least 66% lower than during the regular school year. Maintenance trash, collected in 20-yard, on-call dumpsters, is weighed; the results were included in the estimate of yearly trash.

## Campus Vehicles

Augsburg College has had a fleet of 10 vehicles during the last eight years. The grounds crew has a Ford F250 pickup and a GMC plow truck. The maintenance crew has four Chevy S10 trucks and a Ford Ranger, the Campus Kitchen program has a Plymouth van, the Athletics Department has a Ford van, and the Public Safety Department has a Ford Escape hybrid. We currently have no diesel vehicles. The number of gallons of gasoline purchased was extracted from invoices from two regularly used gas stations in our vicinity and totaled by fiscal year. The calculator applied a general mile/gallon factor based on the average for vehicles used at our location.

## Automobile and Air Travel

Faculty and staff airline data was extracted from the business office database, and non-airline costs, such as travel agent fees, were removed for accuracy. Miles were calculated by dividing the total costs by the standard cost-per-mile reported by the U.S. airlines for year 2007, plus 20% to reflect the taxes and fees not included in the these rates, which were reported at www.airlines.org/economics/finance/Cost+Index.htm. Including a 20% increase in cost-per-mile to cover taxes and fees was suggested by ASHEE at www.aashe.org/node/2981.

International student travel was calculated by identifying the number of students traveling to various countries throughout FY 2008. This mileage was applied to previous years, since anecdotal information from staff indicated that FY 2008 was typical, and, for purpose of this study, the miles would be approximately the same. Mileage to each destination was determined from www.world-airport-codes.com/ and then multiplied by the number of passengers to get passenger miles. The same method was used to calculate faculty international travel connected to student trips.

In the case of reimbursed automobile mileage costs for faculty and staff, reimbursed amounts were extracted from the business office database, totaled, and divided by the appropriate cost—$.40 per mile—

throughout the inventory period. The Athletics Department's rental of bus miles for team travel was also entered based on data provided by the department.

### Faculty/Staff and Student Commuting

The commuting population of Augsburg is a large percentage of the overall school population; a good percentage of day students are commuters and all Augsburg for Adults and graduate program students are commuters. The inclusion of faculty and staff raises the percentage even higher. Thus, the inclusion of emissions from commuting is important in looking at overall trends.

In order to determine these emissions, the CA-CP calculator requires a number of inputs. It requires the data to be grouped separately into students, faculty, staff, and then requires the following data for each group: "miles by car," "miles by bus," "miles by commuter rail," and "miles by light rail." Commuter rail is not available in the Twin Cities, so that category's data will be nil.

To find the total number of miles commuted by all of the commuting population at Augsburg, a number of sources and methods were used. In order to find total miles, the total number of commuters had to be determined for each group, along with the number of miles they commute for each trip and how many trips they take in a year.

A survey was given to the commuting population at Augsburg to gauge the percentage of commuters who travel by car, bus, or light rail. The survey also gathered data on the number of days per week each person commutes to Augsburg since different groups commute a different number of times per week. For example, day students travel an average of 4.7 days per week whereas Augsburg for Adults students commuted an average of only two days per week. Lists of the commuting population were compiled from Human Resources to ascertain the number of total commuters from each group. The lists also provided zip codes for each person, making it possible to find the total distance commuted one way for each person using the method described below.

#### Method of Commuting Distance via Zip Code

In order to find the average distance commuted one way for each group, a list of all commuters and their zip codes was compiled by Human Resources for the years 2004 through 2008. Unfortunately, the actual home addresses were not accessible at the time of this study, and zip codes were used as identifiers for their home location. The geographic center of the zip code area was used as the start of their commute, and the general address for Augsburg College became the end point of their commute. These locations were entered into Google Map driving directions as the start and finish to determine the distance, and the fastest route was chosen.

This method of determining the one-way commuting distances for each person raises several concerns:

1. Using the center of each zip code restricts the precision of the results for each person; it is assumed, however, that the data averages out and this is not a major problem.

2. A small percentage of zip codes in the compiled list of commuters indicated commuting distances of hundreds, if not thousands, of miles—obviously a result of incorrect data from Human Resources—and using this mileage would have greatly increased the results. In order to remedy the problem, an artificial maximum commuting distance was introduced in which any distance above the maximum would be eliminated from the calculations of the average commuting distance.

   The effect of varying the maximum distances from 50 miles to 100 miles was assessed. The differences to the average commuting distance for each year for students is shown in Fig. 3, and the percentage of student commuters removed at each threshold of maximum distance is shown in Fig. 4.

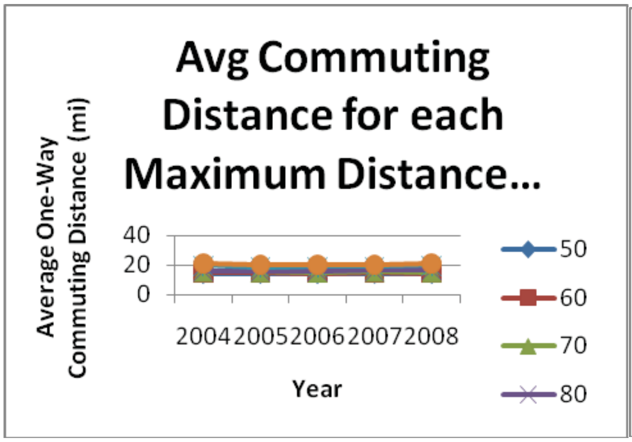


Figure 3

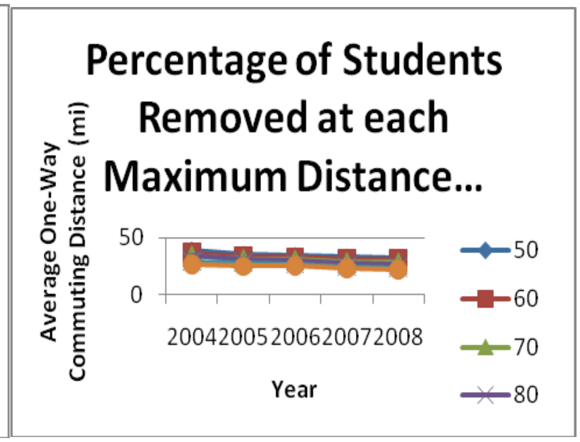


Figure 4

The maximum distance cutoff was decided as 60 miles, since the variations in using the various distances of 60, 50, or 70 were marginal, and the assumption was made that most people would not commute beyond 60 miles, or roughly one hour, to work or school.

The results of the average commuting distance for both faculty/staff and students for 2004-2008 are shown in Table 1. This data was used in conjunction with the total number of commuters for each group to determine the total miles commuted one way for each group.

Table 1

| | Year | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|
| **Average Commuting Distance** | **FacStaff** | **12.12591** | **12.80351** | **12.49502** | **12.52574** | **12.17102** |
| | **Stu** | **16.8427** | **16.06296** | **16.04455** | **16.49378** | **16.45501** |

The next step was to find the variety of options used by both groups to commute to Augsburg, in order to separate the total miles commuted into car, bus, and light rail categories.

Method of Finding the Split of Commuting Options via Survey

In order to find the percentage of students and faculty/staff who commuted via car, bus, and light rail, an online survey of these groups was conducted. The relevant questions asked were the number of days per week each person commutes to Augsburg via car, bus, or light rail, and the total number of days per week the person commutes to Augsburg.

Response to the survey yielded a high number of respondents. Since this survey had never been carried out before, no prior data was available for comparison, so data from this survey was extrapolated to previous years. The respondents totaled 153 people, comprised of roughly of 7% day students, 2.2% Augsburg for Adults students, 7% faculty, and 10% staff. The overall percentages indicated that 73.4% of the campus population traveled alone by car, 12.2% traveled by bus and light rail, 6.2% traveled by bike, and 3.7% walked to campus. This survey will be repeated annually to provide accurate transportation mix data for each year.

In order to develop usable data, the days-per-week numbers for each category (car, bus, light rail) were converted into percentages, as in the percentage of total commuters who use car transportation, the percentage of total commuters who use bus transportation, etc. For the percentage of commuters who use car transportation, for example, this was determined by taking the total number of days a person commutes by car divided by the total number of days the person commutes, and then taking the average of this number for all the commuters. This analysis was done for each category of transportation and for each separate group. Also, the average number of days commuted to Augsburg each week was calculated for each group by taking the average of the total number of days commuted each week by each commuter.

These results were then added to the overall analysis for total miles traveled. The percentages for each category (car, bus, light rail) were multiplied by the total miles commuted one way for each group found above to find the total miles commuted one way for each category for each group. These numbers were then multiplied by the average number of days commuted to Augsburg each week for each group and then doubled to calculate the total number of miles commuted each week for each category and both groups. These numbers were furthermore multiplied by the number of weeks each group would commute to Augsburg (27.4 weeks for students, 48 weeks for faculty and staff). This was done for the years 2004-2008. These calculations yield the final results of total miles traveled by car, bus, and light rail for students, and faculty/staff, with the actual numbers shown in Table 2. These numbers were plugged into the CA-CP calculator for the commuting portion of the transportation section of the audit.

Table 2

| Students | | | |
|---|---|---|---|
| Year | Miles by Car | Miles by Bus | Miles by Lt Rail |
| 2001 | 4356547.111 | 407486.869 | 118077.7868 |
| 2002 | 4402724.604 | 391377.274 | 124199.3196 |
| 2003 | 4722547.259 | 420502.0544 | 133055.8786 |
| 2004 | 5110897.609 | 447407.3723 | 145826.8606 |
| 2005 | 5151377.036 | 432830.7243 | 151301.4688 |
| 2006 | 5493018.174 | 452177.8151 | 163566.7574 |
| 2007 | 5562727.549 | 442393.0711 | 169343.0232 |
| 2008 | 5781475.177 | 478532.8519 | 171534.0957 |

| | | | |
|---|---|---|---|
| Fac/Staff | | | |
| Year | Miles by Car | Miles by Bus | Miles by Lt Rail |
| 2001 | | | |
| 2002 | 3087916.152 | 398077.2957 | 230219.0018 |
| 2003 | 3157728.981 | 408625.6184 | 233695.6891 |
| 2004 | 3247871.226 | 417930.6244 | 243000.6951 |
| 2005 | 3522405.591 | 449403.3606 | 267842.2227 |
| 2006 | 3607793.966 | 462131.2359 | 272288.5778 |
| 2007 | 2992477.997 | 368857.199 | 241984.2591 |
| 2008 | 3075136.365 | 379575.6786 | 248076.955 |

### Budget Data

The campus budget information provided by the Administrative Accounting Office included both the campus budget and the grant funds received by the College. The campus budget information was straightforward; the grant information covered only federal grants received, not private grants. Energy budget data was calculated based on the sum of the invoice data for electricity, natural gas, and steam.

### Campus Population Data

Faculty and student statistics were taken from the Augsburg College Factbooks from fiscal years 2007 and 2008 to cover data from FY 2001 through 2008. Part-time faculty FTEs (.5 headcount) were added to the full-time faculty complement for each year. Some adjustments were needed to the student data to accurately report students who use only our Minneapolis campus vs. those students who take classes in leased classroom spaces at other locations, e.g., Rochester, Minn., and United Hospital. It was then determined that the Minneapolis campus population was comprised of full-time and part-time undergraduate students, Augsburg for Adult students, all graduate students, and faculty/staff.

The staff data provided by Human Resources included lists of all employees and their zip codes for fiscal years 2004-2008, and information extracted from the IPED data for fiscal years 2002, 2004, 2006, and 2008. FY 2002 staff data was used for FY 2001 and FY 2003 because no specific numbers could be found. Because Augsburg changed its business software in FY 2004, data from previous years could not be accessed easily. Staff data included full-time and part-time administrative employees, students, and stipend positions. All part-time and stipend positions were considered as half time to arrive at a full-time equivalent for those positions.

## Building Square Footage

The director of facilities provided the current building square-footage data. From that data a year-by-year total was determined by adding or subtracting the square footage for buildings as they were put in service or demolished. Total space went from 906,689 sq. ft. between 2001 and 2005, then down to 894,195 square feet in 2006, up to 1,010,189 in 2007, and up again to 1,045,189 in 2008. There are 12,210 net square feet of student science lab and research space, with a very small portion of that being purely research based. All building data was reported in gross square feet.

## CALCULATOR RESULTS

The final year for which the calculator produced graphs is FY 2007 (Fig. 5) and it accurately represents the proportions of GHGs produced for all sources measured. All years in the study show a similar distribution.

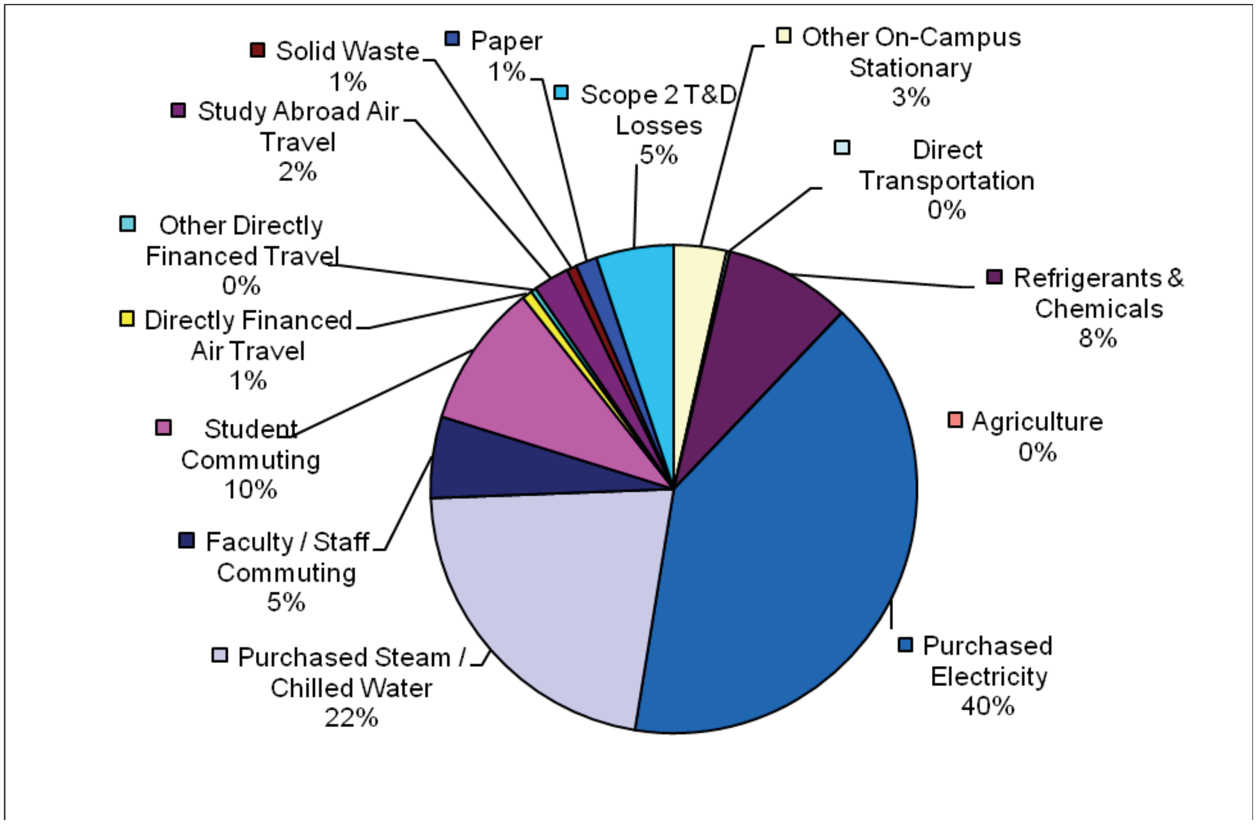


Figure 5 Percentages of GHGs Produced by Sources at Augsburg College FY 2007

### Overview of greenhouse gas emissions

During the eight years of this study, the major sources of GHGs contributed relatively the same proportion of the total GHG output of the College. Electricity ranged from 38% to 41%, purchased steam ranged from 22% to 29%, natural gas ranged from 3% to 4%, and refrigerants ranged from 6% to 12%. The other lesser contributors showed similar ranges. This distribution represents the current operational mode of the College and provides keys to where operational changes could reduce our carbon footprint in the future. Conservation will be the primary method of reducing our GHG emissions from all major sources shown above.

Augsburg's production of GHGs is also readily apparent in Fig. 6 and 7, which show the contributions made by all sources over the time of this study. The first graph (Fig. 6) shows the total emissions by each scope in metric tons ($eCO_2$) from 2001 to 2008, which have remained close to 25,000 metric tons of $eCO_2$. Scopes are a way the CA-CP calculator distinguishes among types of sources. On our campus, Scope One includes on-campus stationary sources (natural gas), direct transportation sources (campus fleet), refrigeration sources (HFC-22) and agricultural sources (fertilizers). Scope Two includes indirect emissions from sources directly linked to on-campus energy use, like purchased electricity and steam. Scopes One and Two comprise the largest portion of our GHG output. Scope Three includes optional emissions from all College-paid and study abroad airfare, and faculty/staff and student commuting emissions.

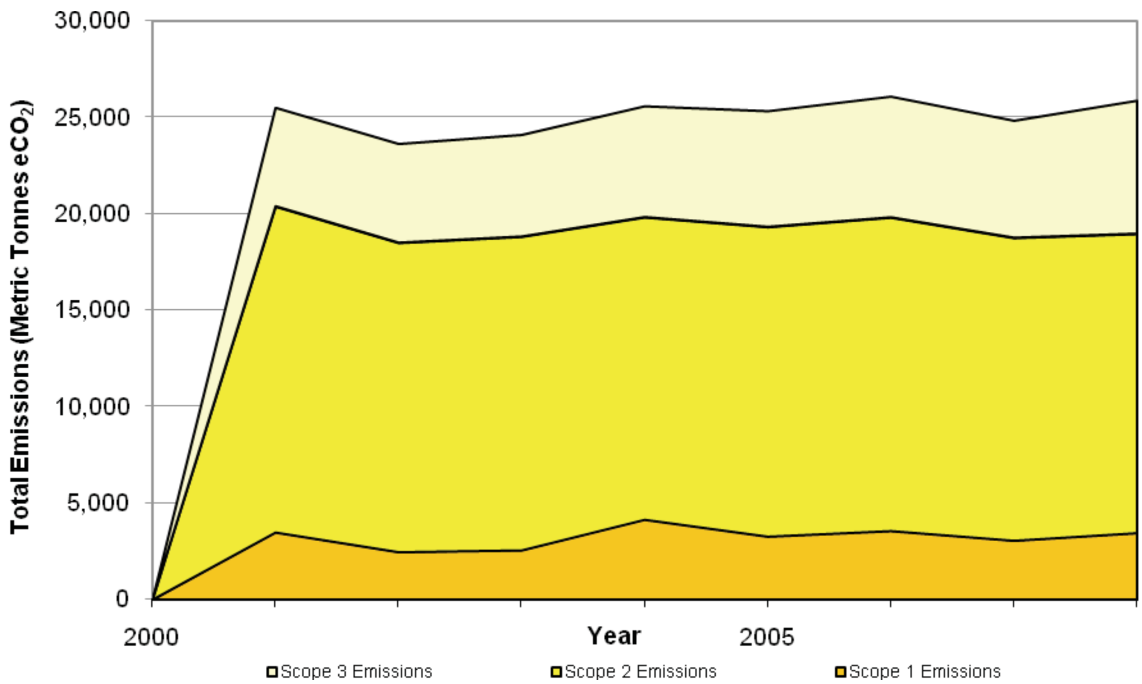


Figure 6 Total Emissions of GHGs by Augsburg College by Scope (FY 2001–2008)

To reveal the GHG output in greater detail by source over time the calculator provides the following graph (Fig. 7).

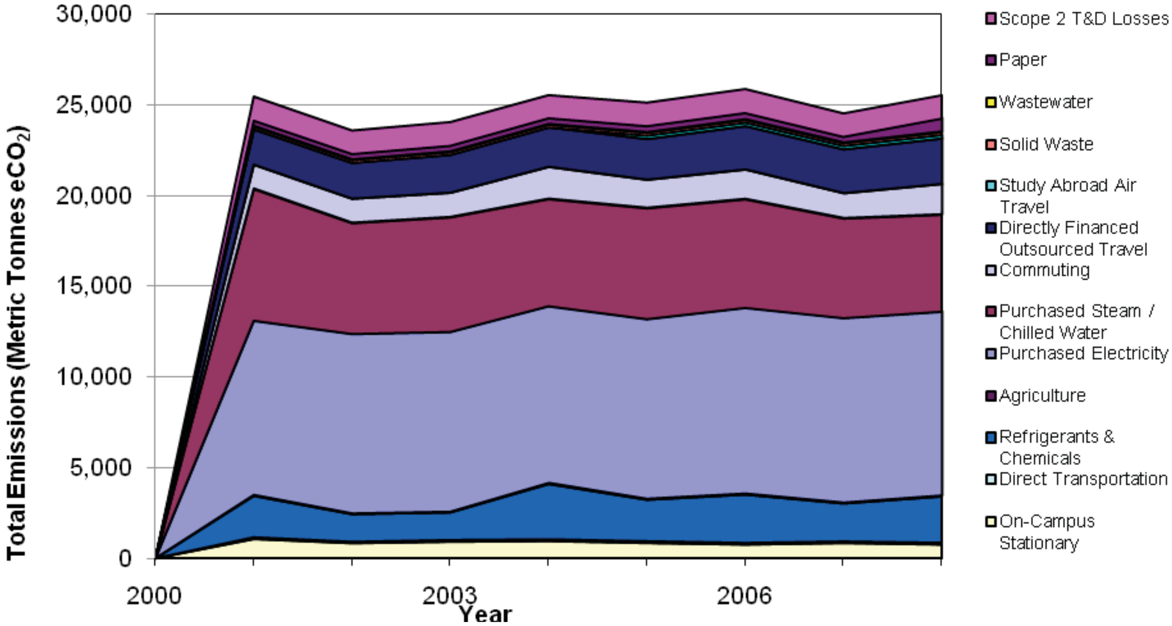


Figure 7 Total GHG Emissions from Augsburg College by source (FY 2001–2008)

The calculator can also present the total energy usage per student, per square foot of building space, and by other sub categories that can be useful in understanding energy use from various perspectives as seen in Fig. 8 and 9.

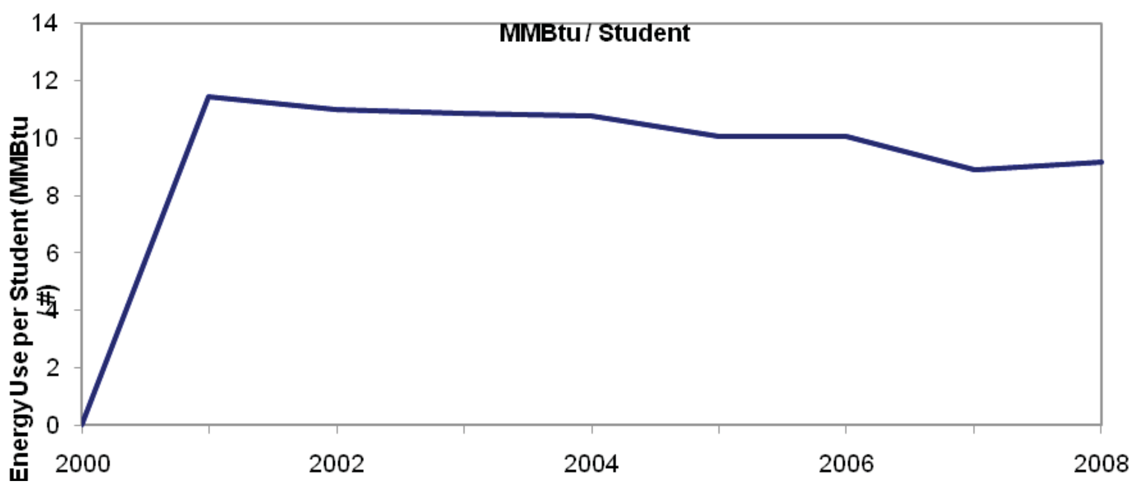


Figure 8  Energy Use per Student at Augsburg College (FY 2001-2008)

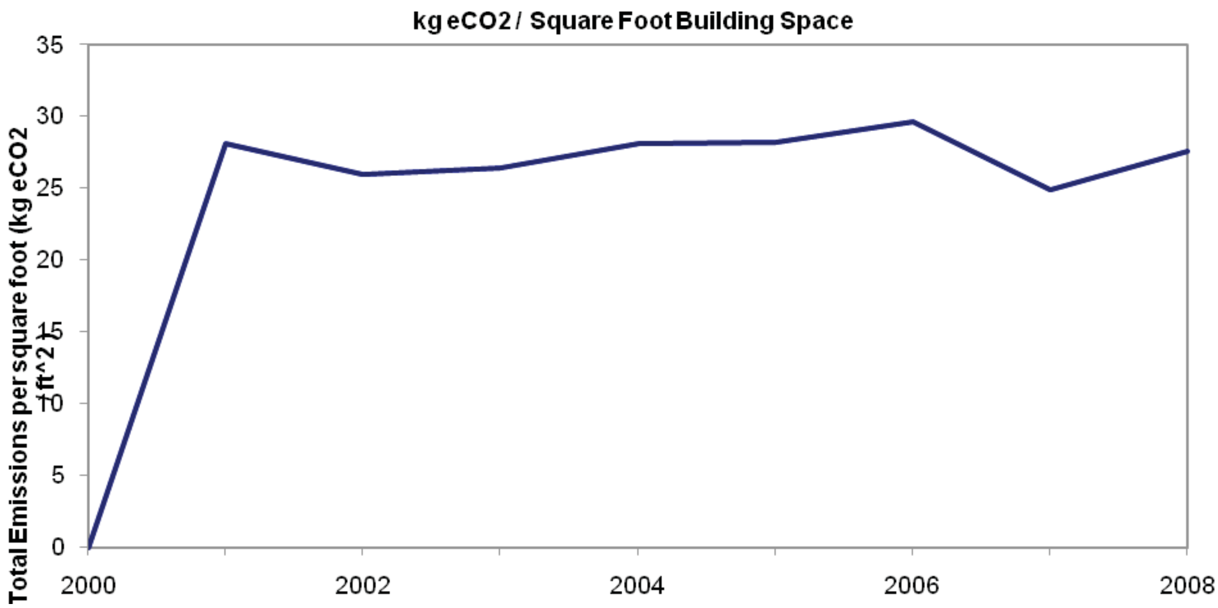


Figure 9  Total Emissions per Square Foot at Augsburg College (FY 2001-2008)

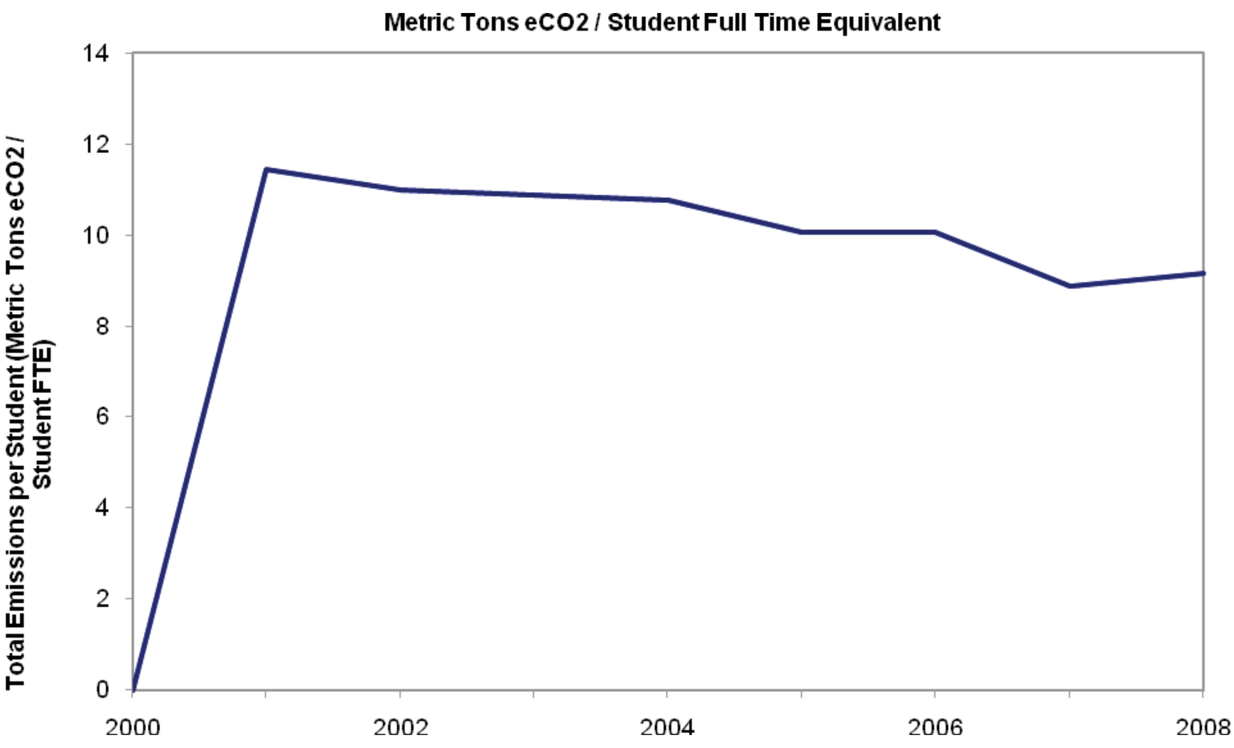


Figure 10  Augsburg College Metric Tons $eCO_2$ per Student Full-Time Equivalent (FY 2001-2008)

### Electricity usage

Although percentages and trends can be useful to evaluate the relative contributions of various segments of the operational whole, they do not help in identifying specific trends in those segments in real terms like MMBTUs. In the case of electricity usage, Fig. 11 shows a steady but slow increase of electricity usage up until 2007 then a sharp bump up of two million MMBTUs. The most reasonable explanation for this increase is the addition of the new Oren Gateway Center, a 118,000 square-foot multi-use building on the north side of campus, and Kennedy Center, a 35,000 square-foot athletic building with offices, classrooms, exercise rooms, and locker rooms on the east side of campus.

On the other hand, usage decreases over the years were realized as a result of installing more energy efficient light bulbs and adding motion detection equipment to shut off lights in classrooms when they are not in use. New, variable frequency motors were installed to reduce HVAC use of electricity. Several small houses on campus were torn down to make room for parking and new buildings, which contributed to some decrease in electrical usage.

Electricity use increases were a result of continuous increases in the presence of student-owned computers and appliances, campus computers, and digital information screens during the eight-year period. In addition, steady increases in student, faculty, and staff populations would logically increase electrical usage. It would be very difficult to determine exactly how much each of the above changes affected the overall electricity usage, but the end result has been a gradually increasing usage until the dramatic rise when the new buildings were added to campus.

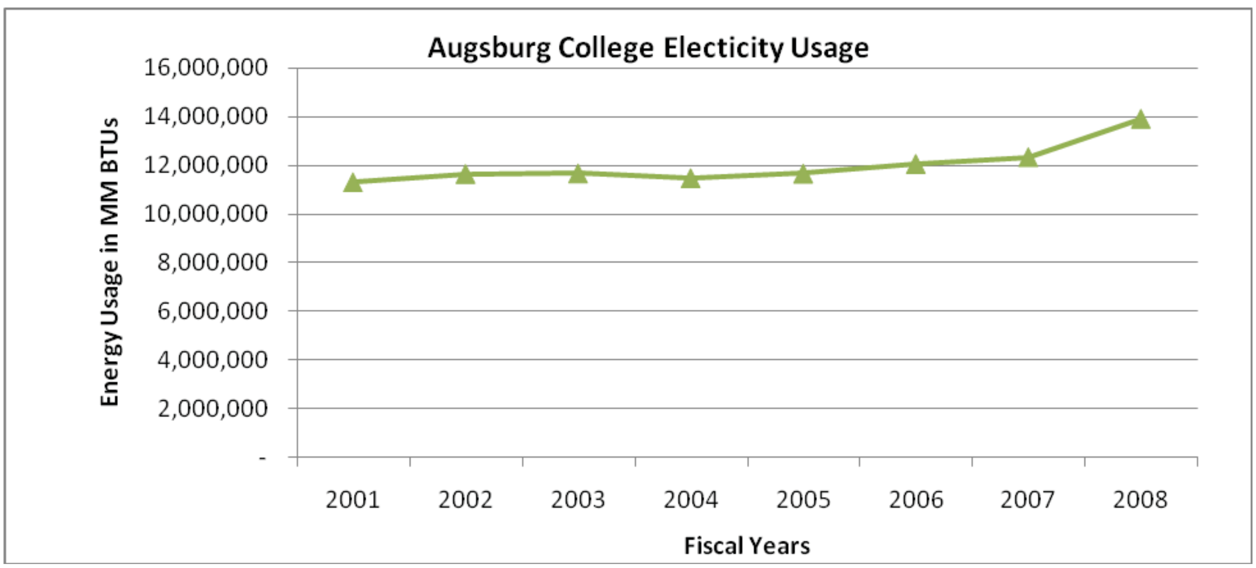


Figure 11 Electricity Usage at Augsburg College in KWH ( FY 2001–2008)

### Natural gas and steam usage

Natural gas and steam usage is represented in Fig. 12 (steam upper line, natural gas lower line). Natural gas and steam usage seem to correlate slightly with the variations in the heating degree days (Fig. 13) and also with the addition of the Oren Gateway Center and Kennedy Center buildings in 2007/2008. New buildings on campus are being fitted with natural gas heating and hot water systems, which are more efficient than using steam as in the older campus buildings. Natural gas is also used to heat the athletic dome in the winter months. Steam usage varied between 75,000 and 85,000 MMBTUs during the eight-year period, and natural gas usage varied between 19,000 and 20,000 MMBTUs.

Purchased steam usage went down slightly over the period, but has increased sharply since FY 2007, possibly correlating with the increase in heating degree days as shown in Fig. 13. Maintenance efforts to fix steam traps, improve the integrity of heating/cooling zones, and make better use of the campus energy management system can be credited for the reduced steam usage up to FY 2007 and possibly for a less dramatic increase in usage in FY 2008.

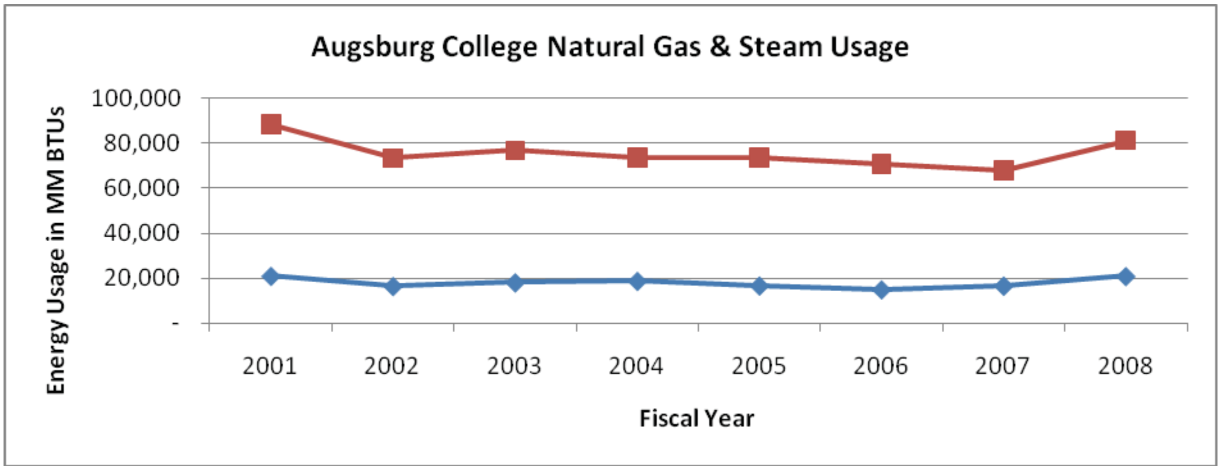


Figure 12 Augsburg College Natural Gas and Steam Usage (FY 2001-2008)
(Steam is the upper line; natural gas is the lower line)

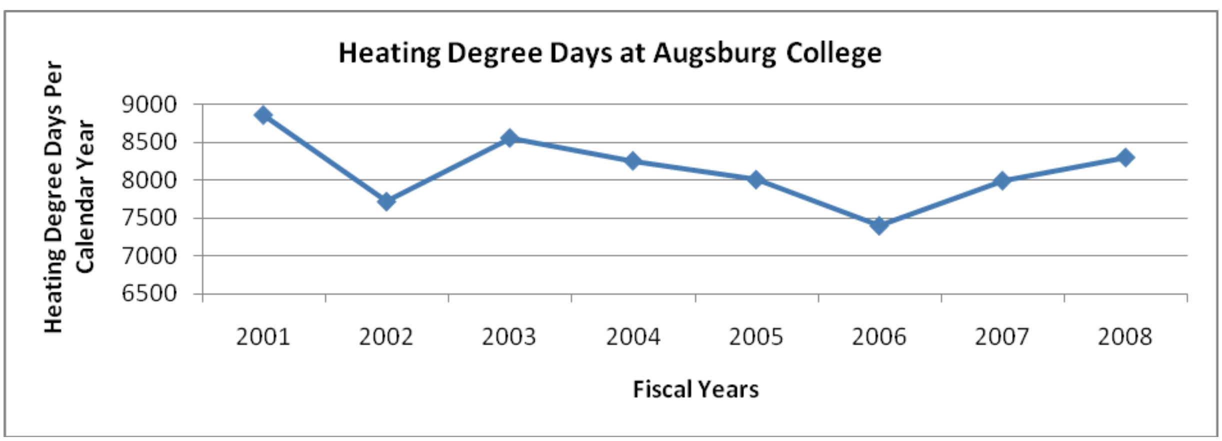


Figure 13 Augsburg College Heating Degree Days (FY 2001–2008)

### Refrigerant usage

The next most important source of GHGs at Augsburg College is the ice arena direct refrigeration system. The system is well beyond its reliable lifetime of 15 years, and frequent upgrades and rehabilitations barely keep up with the problems that develop. The College recently contracted an analysis of the system's condition by Stevens Engineers and Planners and now has a schedule of planned improvements that could result in better performance. Over the past eight years, 10,625 pounds of R-22 refrigerant (Chlorodifluoromethane) have leaked from the system and had to be replaced. During the last fiscal year (2008) 1,375 pounds were replaced, which represents the lowest amount replaced in the last eight years.

According to the European Chemical Industry Council (CEFIC), this R-22 refrigerant has a global warming potential (GWP) of 1,700 (http://www.cefic.be/activities/hse/rc/guide/09.htm). This high GWP explains the relatively high percentage of $eCO_2$ contributed by the refrigerant on the graph in Fig. 5; it also represents a clear example of where Augsburg can reduce its GHG footprint considerably, albeit with a hefty price tag. In addition to the high cost of a new refrigerant system, the report mentioned that new indirect refrigerant systems are less efficient and will cost more to operate, posing more difficult questions about the ongoing costs to operate the ice rink system.

### Student and Faculty/Staff Commuting

The next lowest source by percentage is that of student commuting. Some progress has occurred in the last few years by encouraging students to use transit and other transportation alternatives to the single occupant vehicle for commuting to campus. According to survey data, the percentage of overall campus population using transit is near 15%, close to the estimate based on transit pass sales described below.

We know that more Augsburg commuters are using transit as evidenced by dramatically increasing sales of monthly all-you-can-ride passes (Fig. 14 and 15). The dramatic increase between FY 2007 and 2009 is a result of high gas prices and a large 50% subsidy of all passes by Metro Transit and Augsburg College. We instituted a student Go-To transit semester pass in FY 2006 that also resulted in increased transit usage. During the average week, 4,408 people (faculty, staff, and students) commute to campus. Full-time student transit riders use 141 Go-To semester passes on average, and there are on average 42 monthly transit users (faculty, staff, and students) who commute daily by transit. In addition another 125 people use the cash value transit passes on a less frequent basis, but probably use transit several times a week.

This estimate of transit users based on pass sales reveals a transit usage percentage of only 7% of the overall campus population. If resident students are eliminated (since they walk to class) and Augsburg for Adults students and graduate students are removed (since the majority of them will drive under any circumstance), the percentage of students and faculty/staff using transit in FY 2008 was 308 of 1955, or 16% of the adjusted population of potential transit users. A small percentage of the campus population (possibly 3%) commutes by bike or walks, even better for the environment than transit usage. In any case, the use of environmentally-friendly modes of commuting is increasing at Augsburg, but will need more transit use by the campus population if the GHGs generated by commuting are to decrease in the future.

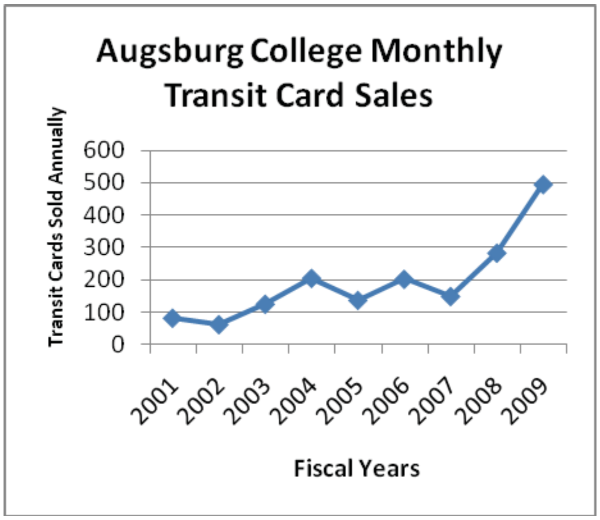


Figure 14 Augsburg Monthly Transit Card Sales

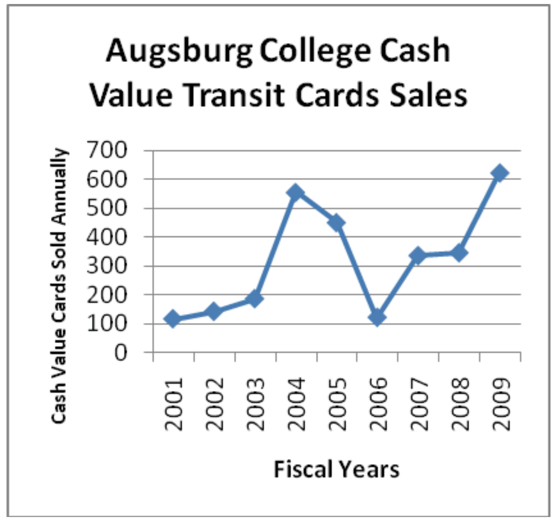


Figure 15 Augsburg Cash Value Card Sales

Improvement will continue by keeping the Go-To Transit Pass and the subsidized monthly passes for faculty and staff, by more effective education about the negative impacts of single occupant vehicle commutes on the air quality, by in the increasing demands for parking, and with the rise in basic cost of education. As the number of new buildings increases and available space decreases, future students will have to weigh increased parking costs against the relative incovenience of using transit, car pooling, biking, or walking to campus. Hopefully the campus population, by weighing the social, environmental, and financial costs of single occupant vehicle commuting, will choose the least damaging alternatives, thus allowing the campus carbon footprint to decrease.

### Faculty/Staff and Student Air Travel

Combined faculty, staff, and student air travel totaled 3%, based on data available from 2005 through 2008. Although this is a relatively small amount, some opportunity for conservation exists if the campus population seeks less damaging alternatives when possible. Another option for achieving carbon neutrality on the Augsburg campus is to purchase carbon offsets to offset the $eCO_2$ produced by our air travel.

### Transmission and Distribution Losses

Transmission and distribution losses (T&D Losses in the CA-CP calculator) are set by the particular engineering parameters of the energy systems used and cannot be modified without changing the source, type, or amount of energy being used. The $eCO_2$ created will always be a factor in the overall footprint.

### Paper and Solid Waste

At Augsburg College the data on paper use and waste collected remained steady primarily because the College hasn't had adequate measurement procedures in place in past years. Although both of these GHG sources constitute but a small percentage of the total (1% each), the percentage might be higher if more accurate data were available. In the case of paper, only an estimate of the copy paper used on campus was provided. Other forms of paper, e.g., envelopes, publications, and sanitary products, were not included, all of which have some GHG production associated with them and their distribution systems.

In the case of the College's waste stream, only estimates were available, and the percentage of the total GHG production might be greater with more accurate measurement. The accuracy of the data can also be distorted, for example, by the water content of trash being weighed. Several total campus weighings are planned this year with Allied Waste to see if some weight averages for our particular type of waste can be established.

Another factor concerning waste production on campus is the impact that recycling and composting have had on our overall GHG production statistics. We have operated a successful recycling program on campus since the early 1990s, keeping useful materials out of landfills and supporting new industry based on recycled materials.

It might be useful if the CA-CP calculator could find a way to include recycling into the mix of data being supplied, especially if it could be put into the context of an "offset." The calculator provides a place for on-campus composting, but not for composting of campus materials done at an off-campus site, which is the case at Augsburg. We have composted all of our yard waste for over 10 years, and we began composting our kitchen and dining organics in September 2008. Since we are not permitted to do large-scale composting on campus because of our location in the middle of the city, we chose the off-campus alternative rather than landfilling the material.

### Results Compared to Other Colleges

Augsburg College's gross $eCO_2$ emissions in 2007 were 24.1 metric tons per 1,000 square feet of building space. According to the average data provided by the American College and University Presidents Climate Commitment (ACUPCC) web site www.presidentsclimatecommitment.org this is above the current averages from GHG inventories for Master's Colleges and Universities (14.83) and slightly above the highest category called Special Focused Institutions (SFI) at 24.04.

Augsburg has just a few new buildings at present; most of the campus buildings were built during the 1970s or earlier, and it would be expected that our energy consumption and the associated $eCO_2$ generated would be higher than colleges with all new buildings containing efficient heating systems and excellent insulation. Our location in the northern United States can also explain higher heating energy usage in the winter and possibly less electricity for air conditioning in the summer. Augsburg also has two ice rinks with an aging refrigeration system that added an extra 2,120.5 metric tons of $eCO_2$ into the atmosphere in FY 2007. Augsburg also has an air dome for the athletic field that is operated six months a year but isn't listed as building space for the campus. Whatever the specifics, precise comparison of Augsburg's carbon footprint to averages or direct comparison with other colleges is problematic. Our goal remains to reduce our own carbon footprint based on the information provided by this and future greenhouse gas inventories.

# CONCLUSION

Participating in the Presidents Climate Commitment and completing this greenhouse gas inventory are major steps in quantifying Augsburg College's impact on the environment with measurements of our specific GHG sources. Although we have worked actively to reduce our carbon footprint since 2000 through energy conservation improvements, reduced paper use, increased recycling, composting, natural landscaping, water conservation techniques, promotion of public transit, carpooling, biking, walking to work, and other initiatives, this is the first time we could measure and present our footprint data in a single concise document. It represents a real milestone in our efforts to reduce our negative impact on the environment. With this data we now have the basic information we need to begin making major, measured efforts to reduce our carbon footprint. We are certainly indebted to Clean Air-Cool Planet, Inc. for developing the calculator and making it available to the college community.

Over the years of this study, Augsburg College's overall production of GHGs remained relatively stable around 25,000 MMBTUs. This is remarkable given the increase in our on-campus population (all faculty, staff, resident, and local commuting students), from a low of 3,507 in FY 2001 to a high of 4,393 in FY 2008. The decreased total GHGs produced per student from 11.2 to 9.2 MMBTUs per full-time student equivalent is likely due to the increase in campus student population from 2,760 to 3,576. These are positive indicators of how our college makes use of our facilities and how well we achieve reductions in our overall GHG production.

As the College campus continues to increase with new construction, the total $eCO_2$ from natural gas will continue to increase, but hopefully at a lesser rate given more energy-efficient building techniques. We do expect a major jump in electrical and natural gas use when a new Center for Science, Business, and Religion is built in the near future, but its LEED (Leadership in Energy and Environmental Design) certification should signify a big improvement over our current science building.

We will reduce our carbon footprint by 40% (approximately 10,000 MM tons of $eCO_2$) as a result of purchasing 100% of our electricity as Windsource power from Xcel Energy beginning in FY 2009. Continued engineering improvements to our heating and air conditioning systems will help reduce the impact of those systems on the environment even farther.

With the CA-CP calculator we now have an instrument with which we can measure the state of our environmental impact and a tool for planning meaningful action to reduce those impacts to a minimum. As we move forward to achieve carbon neutrality on our campus, we can use the CA-CP calculator to study options, costs, and the results of changes made in order to help us determine what the most effective changes are and decide when to make them. Our greatest challenge is to change the College culture concerning transportation, especially the daily commuter choices, but we must also continue efforts to reduce waste, increase recycling and composting, maintain efficient HVAC systems, and develop daily operational methods that are less harmful to the environment. At some point we may need to consider the use of carbon offsets to reach full carbon neutrality, but first we will address the sources of GHGs we can immediately and directly change.

As the results of this greenhouse gas inventory are studied and discussed by decisionmakers on our campus, we believe that the need for and our ability to achieve a more carbon neutral campus will be made clear. Our decisionmakers include faculty, staff at all levels, students, alumni, and members of the Board of Regents. All have a part in how our campus currently impacts the environment and all will have a role in developing a plan toward carbon neutrality.

# APPENDIX A

## CLIMATE CHANGE: A MOMENT FOR REFLECTION

With each year and even each month new evidence comes forward that indicates that the crisis is much, much worse than was thought. The major report of the International Panel on Climate Change (IPCC) that came out in early 2007, dire as it was, was shown to be hopelessly optimistic. Total loss of Arctic sea ice, an event that the report had predicted could not happen until late in this century and likely much later, nearly happened that very summer and is now thought sure to happen within a decade.

In the last few months, leading scientists have concluded that we have already passed crucial thresholds: the atmosphere had not exceeded 300 parts per million (ppm) of the greenhouse gas (GHG) carbon dioxide since human civilization began 10,000 years ago; but we are now at 387 ppm (and rising about two ppm per year), a level that already has condemned us to an ice-free Arctic in the next few years.

The consequences of this extreme alteration of the basic nature of the planetary system are largely unknown, but sure to be dramatic. Reducing the chance of crossing further tipping points that could send the earth into catastrophic, runaway climate change needs to be the top priority of all individuals, institutions, and governments on earth for the foreseeable future as we move rapidly toward an energy system that does not involve burning carbon-based fossil fuels.

The next tipping points could set off truly catastrophic events—release of gigatons of powerful GHGs from terrestrial and submerged tundra, and shutdown of the oceans' thermohalide conveyor belt (Gulf Stream) leading to near total death of sea life, events associated with four of the five major extinctions since complex life began on earth. The stakes could hardly be higher.

No metaphor seems powerful enough to convey the depth and urgency of this crisis—our house is on fire; we are on fire; we are teetering on the brink of an abyss; we are driving off a cliff; we have dug ourselves a very deep hole and the walls are collapsing on us; we are on the track with a locomotive coming. Language fails to communicate adequately the global, permanent, absolute, and immediate nature of the catastrophe crashing down around us.

Most people are now familiar with the idea of a personal carbon or environmental footprint—the impact one individual's activities have on global warming or on the sustainability of the planet's systems as a whole. On sites such as www.myfootprint.org (created and maintained by Redefining Progress), people can answer a series of questions about their living space, travel patterns, diet, and other habits and get some idea of their environmental impact. Myfootprint states this impact in terms of acres of land needed to support them and numbers of earths that would be needed to sustain all humans in that lifestyle—the average for Americans being seven earths. Other sites, such as www.carboncounter.org specifically measure how much an individual's lifestyle contributes to the emissions of the greenhouse gases (GHGs), especially the carbon dioxide emitted by burning fossil fuels such as coal and oil, that are pushing the earth toward a new climatic state, one far less suitable for human and other life.

**Greenhouse Gases (GHGs)**

Certain gases in the atmosphere absorb and reflect heat back to earth rather than allow it to radiate into space. A certain level of GHGs is essential to maintain a habitable atmosphere. But recent increases in these gases, mostly from the burning of fossil fuels, has led to concentrations far higher than any seen in a million years. Ice core records indicate that concentrations of GHGs remained below 300 ppm over the last 10,000 years, known as the Holocene, until people started burning coal and then oil in the 1800s.

When levels reached 350 ppm in the early 1980s, the Arctic ice cap began its steady decline—steady, that is, until 2007 when it suddenly collapsed to a fraction of its earlier size.

At least three factors combined have led many scientists and activists to target the figure of 350 ppm as the maximum level permissible:

1) this dramatic melting of what has been a stable feature of the planet for millennia

2) a closer examination of the prehistoric correspondence between GHGs and climate change

3) a deeper appreciation of the power of various feedback loops to amplify global warming (see below).
We have already reached at least 378 ppm and we have been gaining more than two ppm each year, a rate that has tripled from the below-one-ppm annual increase during the 1990s. Given that levels never exceeded 300 ppm during the entire development of human civilization and long before, even 350 may be too high. So we are already late indeed.

As important as $CO_2$ is among the GHGs, some other gases have much higher warming capacities, although most of them do not exist in the atmosphere in such large concentrations and are not being emitted through human activities at such high levels. Methane ($CH_4$, or natural gas) is more than 100 times as powerful as a GHG when measured over the few years most of it remains in the atmosphere. (The often-cited figure that methane is 26 times more powerful as a GHG than carbon dioxide is based on measurement over a century, but that figure is this low only because very little methane remains in the atmosphere that long, as compared to carbon dioxide, which can remain for centuries.)

Other important GHGs include:

- Chlorofluorocarbons (CFCs), used as refrigerants, are better known for their role in destroying the ozone layer that blocks harmful UV radiation from reaching the surface of the earth. The global warming potentials (GWPs) of the many different types of CFCs are *21–11,700 times* more powerful than $CO_2$, depending on the exact chemical composition of the molecule.

- Nitrous Oxide ($NO_2$), also known as "laughing gas," is about 300 times more powerful than $CO_2$ as a GHG.

- Ozone ($O_3$), important in the upper atmosphere to block UV radiation, is a major local pollutant at ground level, but a relatively weak GHG, only about one-fourth the radiative forcing of $CO_2$.

While their effects on *global* climate can be catastrophic, these gases (except for ozone, a serious urban pollutant) do not generally pose major risks to *local* populations. Concentrations of carbon dioxide can be many times the average atmospheric concentration in, for instance, a crowded classroom, without causing ill effects to those in the room. CFCs are inert in all but the most extreme situations (e.g., portions of the upper atmosphere, especially at certain times of year) and can be breathed without harm. Nitrous oxide is, of course, regularly used as a general anesthetic, especially by dentists.

Because of the activities of modern humans in industrial societies, these GHGs have reached much higher concentrations in the atmosphere than their pre-industrial levels.

**Feedbacks, Vicious Cycles, Runaway GW, and Warming in the Pipeline**

The other most important gas that holds warmth on the earth beyond those just discussed is water vapor. Concentrations of water vapor have not changed dramatically over the centuries because the vapor falls as precipitation when concentrations reach a certain point and when weather conditions are conducive. But warmer air will hold more water vapor, so as global warming continues, driven by other GHGs, water vapor will play a bigger role in warming the planet. This additional warming from water vapor will allow for yet higher concentrations of vapor in the air, leading to yet greater warming, and so on.

This cycle is essentially unstoppable once it is launched and is but one of the many feedback loops (or "extremely vicious cycles") we are at risk of setting off that could rapidly change our planet's climatic state. Earlier periods of warming saw alligators and other tropical species living in the Arctic. It is thought that water vapor was such an effective GHG in those periods that it retained sufficient heat through the half-year-long Arctic night to sustain such creatures (Peter Ward, *Under a Green Sky*).

Another feedback loop, involving changes in reflectivity, or albedo, can start when reflective snow and ice melt reveal more sun-absorbing, heat-radiating soil or sea. The greater warmth generated by the newly exposed soil or water melts more snow or ice, revealing more soil, which heats up under the sun and melts more snow, and so on. This process happens every spring in nature's natural course. But with added forcings from GHGs, far northern latitudes are seeing the most dramatic warming on the planet, largely because of such feedbacks.

Each of these and all of the succeeding feedback loops also are *feeding back on each other*. One feedback mechanism can convert a steady, linear progression to an explosive, exponential burst. Multiple feedback loops further steepen the exponential curve; these interacting mechanisms make the system difficult to model accurately and can throw off predictions. In hindsight, it is likely that the underestimation of the power of these multiple feedback loops led to the dramatically optimistic IPCC prediction in early 2007 that sea ice would not totally melt in the Arctic until late in this century if not much later—ice that is now poised to totally melt away any year now. Many now wonder what other consequences currently not predicted for decades or centuries—dramatic rises in sea level; major, sudden shifts in long-standing weather patterns such as the monsoon; and interruptions of the Gulf Stream—may suddenly appear on our doorstep unexpectedly.

Some other feedback loops involve:

- release of carbon from normal soils as they dry out under scorching heat
- release of carbon from forests as they dry up and catch fire
- release of carbon from the oceans during increased temperatures, as they become saturated with $CO_2$ and lose absorption capacities. (Approximately half of the $CO_2$ that has been emitted by human activity has been absorbed into the oceans.)
- reduced capturing and sequestering of carbon as plankton populations die from oceans acidified by the $CO_2$ they have absorbed. (Acidification of oceans and loss of plankton—which form the basis for the ocean food chain and provide about half of the world's oxygen—are global crises in their own right, independent of global warming.)
- release of methane in enormous quantities from Arctic tundra as it thaws
- release of methane in many times more enormous quantities from submerged tundra (known as methane hydrates or clathrates)

All of these feedback loops are now occurring in some degree. The last feedback mentioned above—release of methane hydrates from the Arctic seabed—has been identified as a central factor in extinctions of the past (also known as the "clathrate gun hypotheses"). This happened most dramatically during the Permian-Triassic "Great Dying" when approximately 95% of all life forms on the planet were wiped out. In fall 2008, a Swedish research vessel detected levels of methane in Arctic waters 100 times above background level, i.e., methane that was coming from the seabed. The methane from this one source is estimated to contain enough carbon to more than match the warming power of GHGs emitted by humans since before the Industrial Revolution.

We can't know if some as-yet-unknown mechanism will slow or stop these feedback loops. Certainly, further emissions of GHGs by human activity will both increase their speed and reduce the possibility of slowing them down. Very recently, James Hansen, the top climatologist at NASA, suggested that, given all these feedbacks, it is not impossible for the planet to end up in a Venus-like state, with temperatures globally in the hundreds of degrees. If this were to occur, all life on the planet would be wiped out.

Unfortunately, even a total cessation of new direct emissions of greenhouse gases today would not stop increases in global average temperatures, and not only because of these feedback loops. The inertia in the system and the absorption of heat by the oceans mean that there are already two more degrees of warming "in the pipeline" even if we were to miraculously stop emitting all global warming gasses today. Furthermore, another two or more degrees would already be upon us but for the shading effects of fine particles (or "aerosols") that industry is emitting into the atmosphere every year. The "Catch 22" is that a major source of these "global dimming" aerosols is the generation of electricity from dirty coal plants. We need to shut these down as soon as possible because of their enormous contribution to $CO_2$ levels, but this will doom us to an immediate rise in global temperature, since all the particles fall out of the air within days or weeks unless constantly replenished. It has been proposed that they be injected into the atmosphere by other means as a desperate attempt at global engineering, but they also contribute to the acidification of the oceans and to respiratory problems in children. It is an indication of the desperation and hopelessness of many scientists that they are now contemplating such measures.

**A Moment for Reflection**

Ultimately this is a deeply spiritual moment. It is a time to reflect on who we are, what we are for, and what our deepest values are. It is a time to consider how we got here and how we want to proceed. And it is a time to adjust our activities and lifestyles to reflect our deepest values and principles. A small liberal arts college is arguably one of the best places to engage in this type of open collective reflection. Certainly, the general commercial culture does not encourage such reflection.

Modern consumer society has encouraged us to define ourselves by our material possessions—the cars we drive, the clothes we wear, the technical gadgets we use. This material orientation has left many with a deep sense of dissatisfaction with their lives and disconnection from the world. While sometimes more physically demanding, a life focused less on possessions and more focused on preserving a habitable planet for future generations is one that is more deeply fulfilling. Reconnecting with our values, with our neighbors, and with the earth promises not only to heal the earth, but also to heal our communities and ourselves. But getting there will ultimately require some adjustments.

It is difficult, though, for many otherwise-reasonable people to contemplate these adjustments. We are living in the most extreme moment in history, but we are *inside* our time. Our daily patterns and habits feel normal, so it is hard to see many aspects of our daily life as extreme. In no other time in the past have we been—and at no time in the future will we be—extracting as many resources from the earth and dumping so much waste in the earth's "sinks." But the earth can no longer supply ever-greater quantities of resources, and its sinks can no longer absorb ever-greater quantities of our waste. The lives of everyone living today have been lived during the run up to this peak moment. So our *experience* of extreme energy and resource use—and the *expectation* of continued access to increasing energy and resource use— has shaped our lives and our consciences. We have grown accustomed to ever more excess. Anything else seems an unwelcome and extreme curtailment.

Yet the adjustments needed merely require changes in lifestyle, change toward a lifestyle that was the norm for most people before just a few decades ago (and still for much of the world's population) when no one flew, no one had cars, meat was more of a treat for most than a staple, and food was grown mostly locally without heavy inputs of chemical fertilizers, herbicides, and pesticides. It's not to say that these were ideal times—they weren't by any means. But lifestyle choices that now seem extreme have in fact been the norm through almost all of human existence. We can change all these patterns and still live very comfortable, fulfilling lives. In fact, a local, organic, mostly plant-based diet, and a lifestyle that includes daily, extensive walking have been shown to be much healthier than the standard American diet and sedentary lifestyle.

While these are in some ways the easiest, since they involve just a short-term adjustment period, other changes require more active alteration of our society's infrastructure. These include walkable communities, farmsteads to accommodate a repopulated countryside, super-insulated homes and businesses, some further development of alternative energies.

Given the accelerating rate of change of all kinds, a future without major changes is simply not an option. The questions are: Will these be changes that allow us to avoid the worst consequences of our current and former use of earth's resources and sinks? Or will we try to continue to live as we have, and further doom ourselves, our children, and the living planet to unmitigated catastrophes?

If our country were under attack by a determined and powerful enemy, surely everyone would be willing to make major sacrifices to save their children, their homes, and their nation. Global warming is an attack on all of these and more—it is an attack on the future, not just of children, homes, and countries, but also on prospects for a viable planet. It has been estimated that, with equitable distribution of the burdens and benefits, everyone on the planet could live at approximately the lifestyle of the average Parisian in the 1950s. Does that sound like a burden too heavy to bear to at least hold out the possibility of a livable planet for ourselves, our children, and for the rest of life?

Despite the importance of the changes that individuals make, the actions of institutions like Augsburg are of even greater importance. This study of the College's emissions of GHGs represents a centrally important step in doing our part to reduce the chance of runaway global warming.

(Much of the technical and other general information above in this general introduction can most easily be found on line at www.realclimate.org, a site run by professional climatologists, or in the excellent, well-documented reports to be found at www.carbonequity.info , especially the most recent, *Climate Code Red*, now available in book form. Other sources are included in the List of References.)

APPENDIX B

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