Augsburg College

Greenhouse Gas Emissions Inventory: FY2001 – 2008

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Abstract

This greenhouse gas inventory covers Augsburg College's FY 2001-2008 and includes the total green house gas emissions (GHG) from all sources on the main campus in Minneapolis, MN. This inventory was made possible by the use of the Clean Air – Cool Planet calculator designed and maintained by Clean Air – Cool Planet, Inc. The calculator results show that our overall greenhouse gas emissions for FY 2008 from all sources was 21,669 metric tons of CO_2 + CO_2 equivalents (eCO_2) of NO_2, CH_4 and F22.. By source the emissions averaged to be approximately: 41% for electricity, 23% 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 the first 7 years of the inventory, total emissions increase by 1000 metric tons in FY2008 as the new Gateway Center and Kennedy Center buildings were put in service with an additional 153,000 square feet of building space. The carbon foot print of the college will increase again by a similar amount when the new Center for Science, Business and Religion is opened sometime in the future. In the meantime, continued improvements to the HVAC systems and deliberate conservation efforts of the campus population could help keep the increases to a minimum. Before the new building comes on-line we will reduce our carbon footprint by 40% with the purchase of 100% wind energy from Xcel Energy that began in June of 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 will also result in reductions in our carbon footprint. Augsburg's results seem higher than the average for other Masters Colleges and Universities (20.7 vs. 14.83 metric tons eCO_2 per 1000 square foot of building space) that have submitted inventory results so far, but more in-depth analysis will need to be done to determine how significant the differences are.

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 year to reduce our contributions to global warming—as individuals, organizations, companies, institutions, and governments—could well determine the future viability of life on earth. The UN's General Secretary 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 and fairly rapidly change basic nature of the planet to one lethal to human beings and to most other forms of complex life. 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 till 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 part per million (ppm) of the greenhouse gas (GHG) carbon dioxide since human civilization began ten thousand years ago; but we are now at 387 ppm (and rising about 2 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 get across 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 covey 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 gasses (GHGs), especially carbon dioxide emitted by burning fossil fuels such as coal and oil, that are pushing the earth toward a new climactic state, one far less suitable for human and other life.

As important as it is for individuals to keeping track of their carbon footprints, it is even more crucial for institutions to lead the way in monitoring and reducing emissions of the 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 can we 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 that work there and also 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 has begun to take significant measures that could make it a leader in this most vitally important effort. These measures include: purchasing wind power for the coming year through our utility's (Excel Energy) Windsource program, composting food wastes from our cafeteria, engaging in ground-breaking bio-diesel research, engaging in curricular and extra-curricular educational initiatives on the issue, providing and subsidizing passes for public buses, and many other efforts. An important step in any attempt to reduce an institution's emissions of GHG's is to take a careful inventory of the activities and practices that emit the various gasses. This document is the first systematic attempt at such an inventory in Augsburg's history.

(Much of the technical and other general information above and below in this 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 bibliography at the end of the report.)

Greenhouse Gasses (GHGs)

Certain gasses in the atmosphere absorb and reflect heat back to earth that would otherwise 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 lead to concentrations far higher than any seen in a million years, according to data from ice cores. Before people started burning coal and then oil in the 1800's, the concentration of carbon dioxide (CO_2)—the GHG most responsible for the current rise in world temperature—was 280 parts per million (ppm). Ice core records indicate that concentrations remained below 300 ppm for the entire period when human civilizations developed—the last 10,000 years, known as the Holocene. When levels reached 350 ppm in the early eighties, the Arctic Ice Cap started its steady decline—steady, that is, until 2007 when it suddenly collapsed to fraction of its earlier size. At least three factors: 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, and 3) a deeper appreciation of the power of various feedback loops to amplify global warming (see below), have together lead many scientists and activists to target this figure of 350 ppm as the maximum level we need to stay below. As noted above, we have already reached at least 378 ppm and we have been gaining over 2 ppm each year, a rate that has tripled from the below-one-ppm annual increase during the 1990's. Even 350 may be too high, since, as noted, levels had never exceeded 300 ppm during the entire development of human civilization and long before. So the time is late indeed.

As important as CO_2 is as a GHG, some other gasses have much higher warming capacities, though most of the others do not exist in the atmosphere in such large concentrations nor are they being emitted through human activities at such high levels. Methane (CH_4 or natural gas) is over 100 times more powerful as a greenhouse gas when measured over the few years that most of it stays in the atmosphere. (The often-cited figure that methane is 26 times more powerful as a GHG than carbon dioxide is based on a century-long time scale, but that figure is only this low because very little methane remains in the atmosphere so long, while carbon dioxide can stay in the atmosphere for centuries.)

Other important GHG's include:

--Chlorofluorocarbons (CFCs) which are used as refrigerants. These are better known for their role in destroying the ozone layer that blocks harmful UV radiation from reaching the surface of the earth. There are many different types of CFC's and their global warming potentials (GWPs) are *11,000 -17,000 times* more powerful than CO_2 depending on the exact chemical composition of the molecule.

--Nitrous Oxide (NO_2), also known as 'laughing gas,' about 300 times more powerful than CO_2 as a greenhouse gas.

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

While their effects on *global* climate can be catastrophic, these gasses (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. CFC's are inert in all but the most extreme situations (parts 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 activities of modern humans in industrial societies, these GHG's 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 and 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 it falls out as precipitation when concentrations reach a certain point and when other conditions are conducive. But warmer air will hold more water vapor, so as global warming proceeds, driven in the first instance by the other GHG's, 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…..

This cycle, essentially unstoppable once it really gets going, is but one of the many feedback loops (or better ‘extremely vicious cycles’) we are at risk of setting off that could quite rapidly move the planet to a very different 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 effect greenhouse gas 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*).

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

Keep in mind that each of these and all of the succeeding feedbacks also are *feeding back on each other*. One feedback mechanism can change a steady, linear progression to an explosive, exponential burst. Multiple feedbacks further steepen the exponential curve, and these interacting mechanisms make the system difficult to model accurately and can throw off predictions. It is most likely the underestimation of the power of such multiple feedbacks that lead to the (in hindsight) dramatically optimistic IPCC prediction in early 2007 that sea ice would not come close to total melt in the Arctic till 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 that are currently predicted to not occur for decades or centuries—dramatic rises in sea level, major sudden shifts in long standing weather patterns such as the monsoon, interruptions of the Gulf Stream—may suddenly appear on our doorstep unexpected.

Some other feedbacks 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 as they become saturated with CO_2 and loose absorption capacities with increased temperatures (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 worlds 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 are now happening to some degree. The last feedback, release of methane hydrates from the Arctic seabed, has been identified as a central mechanism in the extinction events of the past (this is also known as the 'clathrate gun hypotheses). This happened most dramatically during the Permian-Triassic "Great Dying" when some 95% of all life forms on the planet were wiped out. In the fall of '08, a Swedish research vessel detected levels of methane in the arctic waters 100 times above background level, 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 GHG's emitted by humans since the 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 GHG's by human activity will push them all faster and further negate the possibility of them slowing 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. This development would wipe out all life on the planet.

Unfortunately, at this point even a total cessation of new direct emissions of greenhouse gasses would not stop increases in global average temperatures, and not only because of these feedbacks. The inertia in the system and the absorption of heat by the oceans means that there is 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 here 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 CO2 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 actually worth living, one 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 our selves. 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. So our daily patterns and habits feel normal, and it is hard to see many aspects of our daily life as extreme. In no other time in the past have we been—and not 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 wastes. The lives of everyone living today have been lived during the run up to this peak moment. So the experience of absurdly extreme energy and resource use and of the expectation of access to ever more extreme use of the same has shaped our lives and our consciences. We have grown accustomed to ever more extreme 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, food was grown mostly locally and without heavy inputs of chemical fertilizers, herbicides and pesticides. I point this out 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. And 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, involving as they do merely a short-term adjustment period, other adjustments require more active alteration of our infrastructure—walkable communities, farmsteads to accommodate a repopulated countryside, super-insulated homes and businesses, some further development of alternative energies (though this must be a lower priority that increase in efficiency…).

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 as those pointed out above that give some possibility of avoiding the worst consequences of our current and former profligate use of earths sources 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. Is it really unreasonable to call on people to consider changes in their lifestyle that inconvenience them without making their lives the least bit harsh or grueling? 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 fifties. 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?

But again, as important as are 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.

Greenhouse Gas Inventory Introduction

Global warming is now finally capturing the attention of a vast majority of scientists, politicians and average citizens after many years of debate and misinformation and denial. As a result of decades of study the earth scientists are convinced that if we do not reduce our staggering production of greenhouse gases, 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 at reducing their production of green house gases.

Thanks to the producers of the Clean Air – Cool Planet (CA-CP) calculator, any institution can now create their own green house gas inventory using data they collect from utility invoices and other records at their facilities. The most difficult task at first is collecting the data from many different departments within an organization and putting the data into a form appropriate for entering into the calculator. After that, the calculator's many features allow institutions to see their energy use patterns over time and to see the proportional relationships between various sources of greenhouse gasses at their facilities.

The Augsburg College inventory is limited to the buildings on its main campus in Minneapolis, Minnesota. Spaces not included were spaces leased for Augsburg for Adults classes in Rochester, MN and at the United Health facilities in St. Paul, MN. In addition, some office space was leased at the Crown Roller Mill building in downtown Minneapolis during the building 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 regions estimated values per input from our supplier NRG, Inc. We used Version 6 of the Clean Air-Coo 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

At Augsburg College most data 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 and put in an intermediate form like Excel spreadsheets and then entered into the calculator later. Keeping the data in spreadsheet form also permits additional studies in greater detail than the calculator requires but 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 entering summary data into the calculator. Very few invoices were missing but some missing data was retrieved from Xcel or an average of adjacent months was taken and put into the missing slot. This happened rarely and the estimated values would make the totals more accurate than if we left them 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, Cedar- Riverside 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 email. NRG also notified us that the fuel mix for our steam generation was 100% natural gas and that each 1000 pounds of steam was equal to one million BTU's (MMBTU)

Natural Gas

Natural Gas was purchased from Center Point Energy, Inc. (formerly Minnegasco, Inc.) and most of the data came from invoices with the exception of a few minor gaps. Reliant 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 (HFC22) being replaced throughout the 8 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 year's data collection. We relied on an estimate from the Director of Purchasing that gave our current usage of 8 million sheets of copy paper (30% post consumer recycled content) per year. From that number previous years were calculated based on a 3% increase in paper usage each year. Only copy paper is tracked in this inventory.

Solid Waste and Recycling

Augsburg College has contracted Allied Waste as our only hauler for trash and recycling since 2003. Waste Management was our hauler during the FY 2001 and 2002. 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 8 years of the inventory although it went up slightly when we added the Oren Gateway Center in the fall of 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 size and the frequency of pickups matches our average school year trash volume. Summer trash volumes are lower than the regular school year. We estimated that summer volumes of trash would probably be at least 66% lower than during the regular school year. Maintenance trash, collected in 20-yard on-call dumpsters is weighed and the results were included in the estimate of yearly trash.

Campus Vehicles

Augsburg College has had a fleet of 10 vehicles during the last 8 years. Grounds crew have a Ford, F250 and a GMC plow truck, Maintenance has 4 Chevy S10 trucks and a Ford Ranger, the Campus Kitchen program has a Plymouth van, Athletics have a Ford van and the Security Department has a Ford Escape hybrid. We currently have no diesel vehicles. 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 vehicles used at our location.

Automobile and Air Travel

Faculty and staff airline data was extracted from the business office data base and non- airline costs like 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 + 20% to reflect the taxes and fees not included in the rates reported at: www.airlines.org/economics.finance/PaPricesYield.htm.

The 20% increase in cost per mile to cover taxes and fees was suggested by ASHEE at: www.aashe.org/blog/campus-operations/transportation/guidance-on-scope-3-emissions.

On the other hand, international student travel was calculated by identifying the number of students traveling to which country throughout FY 2008 and applying that amount to previous years because anecdotal information from staff indicated that FY 2008 was typical and for the purposes 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 which was $.40 per mile throughout the inventory period. Athletics rental of bus miles for team travel was also entered based on data provided by the Athletics Department.

Faculty/Staff and Student Commuting

The commuting population of Augsburg is a large percentage of the overall school population, with a good percentage of Day Students being commuters and all Augsburg for Adults and Graduate School students being 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 find these emissions, the Calculator requires a number of inputs. It requires the data to be grouped separately into students, and faculty and staff, and then needs 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 needed to be found 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 2 days per week. Lists were compiled of the commuting population from Human Resources to have a number for total commuters from each group. Zip codes for each person were also obtained in that list, making it possible to find the total distance commuted one way for each person using the method described below.

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, so the zip codes were used as identifiers for their home location. The geographic center of the zip code area was taken to be the start of their commute, the general address of Augsburg College being the end of their commute, and the distance was found utilizing the Google Maps Driving Directions service. Both locations were input into the service as the start and finish of the directions, and the fastest route was chosen. This method provided the one-way commuting distance for each person; however a few concerns arise from this method.

First, using only the center of each zip code restricts the precision of the results for each person, however in averaging all the distances it is the assumption that this is not a major problem. Second, a small percentage of zip codes that were compiled in the list of commuters create a commuting distance of hundreds if not thousands of miles. This is obviously an artifact of Human Resources not having correct or updated information for certain commuters. Including these very long and obviously wrong commuting distances in the average would have greatly increased the results, so in order to remedy the problem an artificial maximum commuting distance was introduced in which any distance above the maximum would not be included in the calculations of the average commuting distance. The effects of differing maximum distances from 50 miles to 100 miles were assessed. The effects on average commuting distance for each year for students is shown in Figure 3, along with the percentage of student commuters removed at each threshold due to being above the maximum distance shown in Fig. 4.

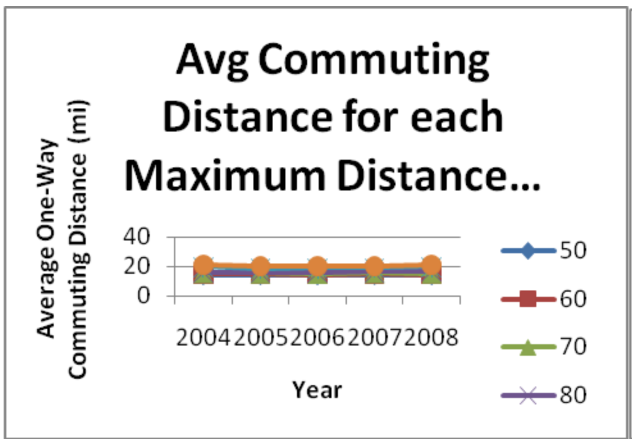

Figure 3

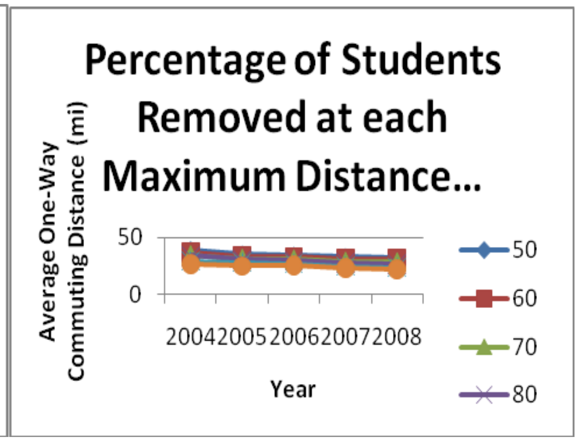

Figure 4

The Maximum Distance Cutoff was chosen to be 60 miles since the affects of choosing 60 versus 50 or 70 etc. are marginal and the assumption was made that most people would not commute beyond 60 miles or roughly 1 hour to work or school. The results of the average commuting distance for both groups for 2004-2008 are in Table 1.

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**

This data was used in conjunction with the total number of commuters for each group to find the total miles commuted one way for each group. The next step is to find the split of commuting options the groups use to get to Augsburg in order to split up the total miles commuted into car, bus, and light rail categories.

Finding the Split of Commuting Options via Survey

In order to find the percentage of students, and faculty and staff commuting via the various transportation options of car, bus, or light rail, a survey was conducted online for Augsburg commuters. 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 was good with a high number of respondents. This survey was never given before so there is no prior data in which to compare or use in the analysis, so the data from this survey was extrapolated to previous years. The total number of respondents was 153 people or roughly 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. In future years this survey will be given again to have accurate transportation mix data for every year.

In order to get the survey results into a usable form the days per week numbers for each category (car, bus, light rail) were converted into percentages, as in the percentage of commuters who use car transportation out of all commuters, the percentage of commuters who use bus transportation, etc. For example this was done for the percentage of commuters who use car transportation 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 travelled as follows. 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 that 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 get us to the final results of total miles travelled by car, bus, and light rail for students, and faculty and staff, with the actual numbers shown in Table 2 on next page. These numbers were plugged into the Calculator for the Commuting section 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

Campus budget information was provided by staff in the business office that included the campus budget and the grant funds received by the college. The campus budget information was straight forward. The grant information only covered 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 ear. Student data needed some adjustments to accurately report students who use only our Minneapolis campus vs. those students who take classes in leased classroom spaces at other locations like Rochester, MN and United Health, Inc. The Minneapolis campus population was then determined to be made up of full time and part time undergraduate students, Augsburg for Adult students, all graduate students, faculty and staff.

Staff data was provided by Human Resources by listing all employees and their zip codes for fiscal years 2004-2008 and by extracting data from the IPED data from 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. Augsburg changed its business software in FY2004 so data in previous years could not be easily accessed. 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. We have 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 GHG produced for all sources measured. All years in the study show a similar distribution.

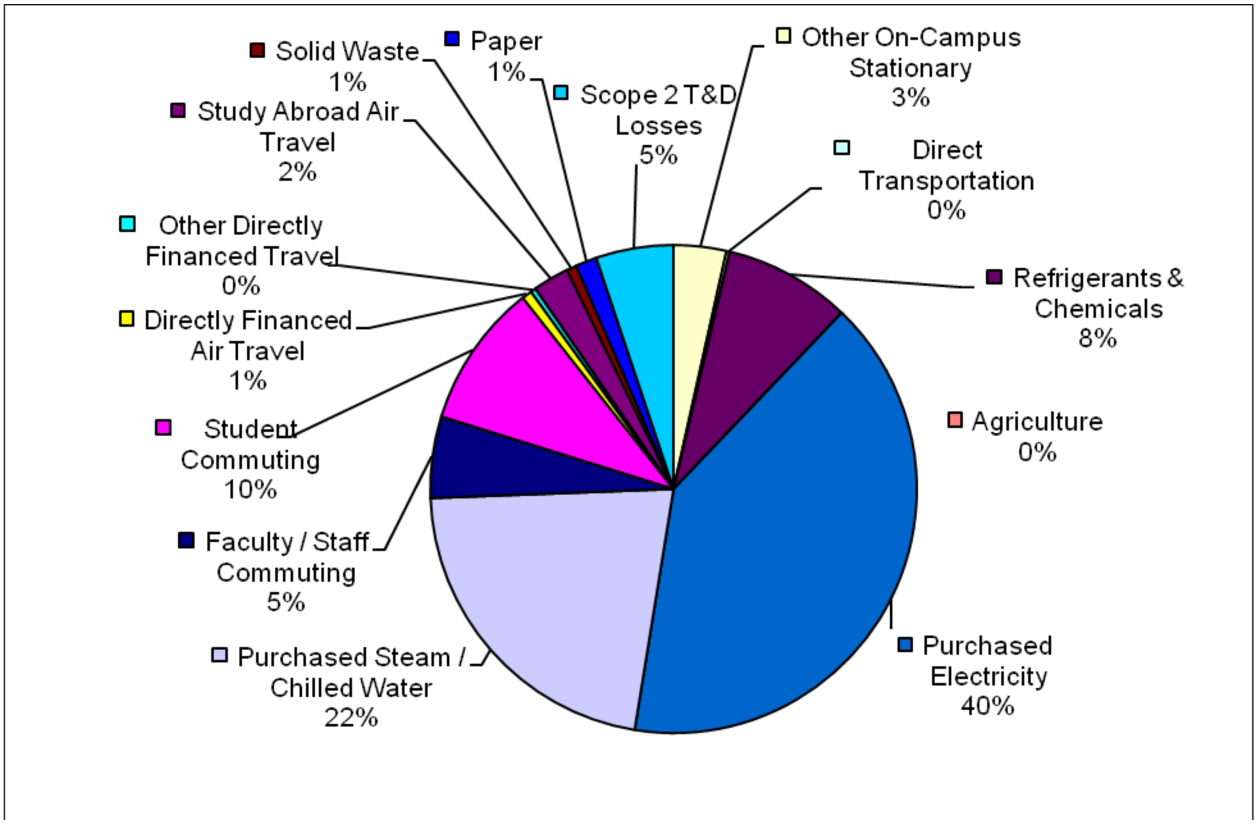

Fig. 5 Percentages of GHG Produced by Sources at Augsburg College FY 2007

During the 8 years of this study, the major sources of GHG 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 the keys to where operational changes can be directed to reduce our carbon footprint in the future. Conservation will be the primary method of reducing our GHG emissions from all the major sources shown above.

Augsburg's production of GHG is also readily apparent in the two graphs below 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 has remained close to 25,000 metric tons of CO_2e. Scopes are a way the calculator distinguishes between types of sources. On our campus Scope One includes: on-campus stationary sources (natural gas), direct transportation sources (campus fleet), refrigeration sources (HCF22) 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 air fare, study abroad air fare and faculty staff and student commuting emissions.

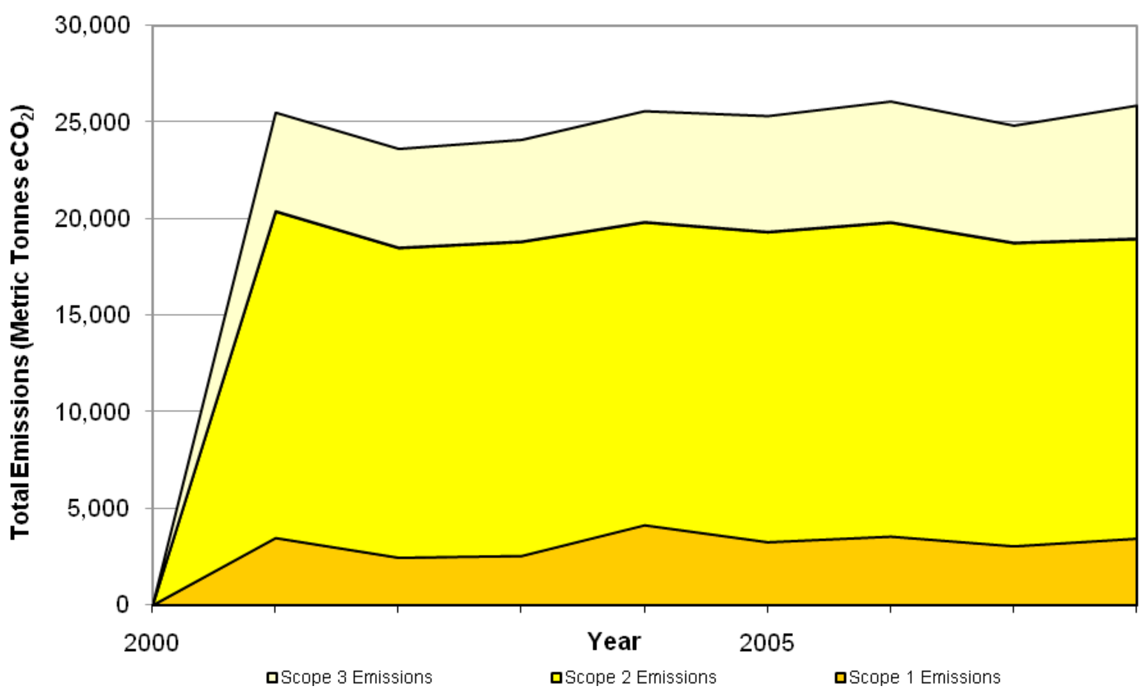

Fig. 6 – Total Emissions of GHG by Augsburg College by Scope – FY 2001 – FY 2008

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

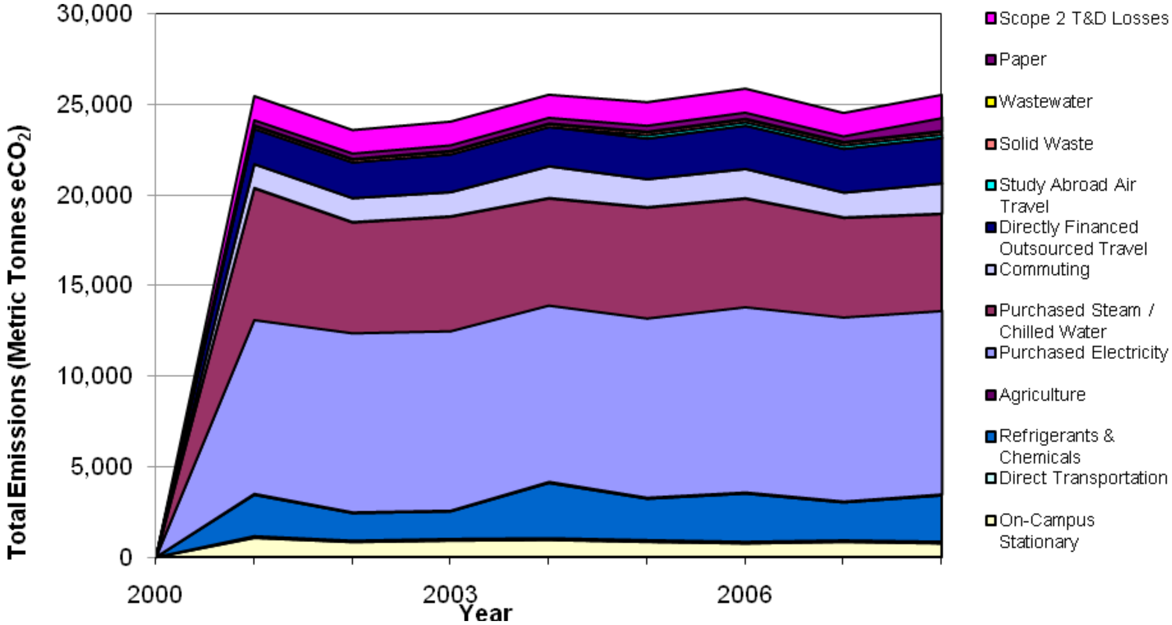

Fig. 7 Total GHG Emissions from Augsburg College by souce – FY 2001 – FY 2008

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

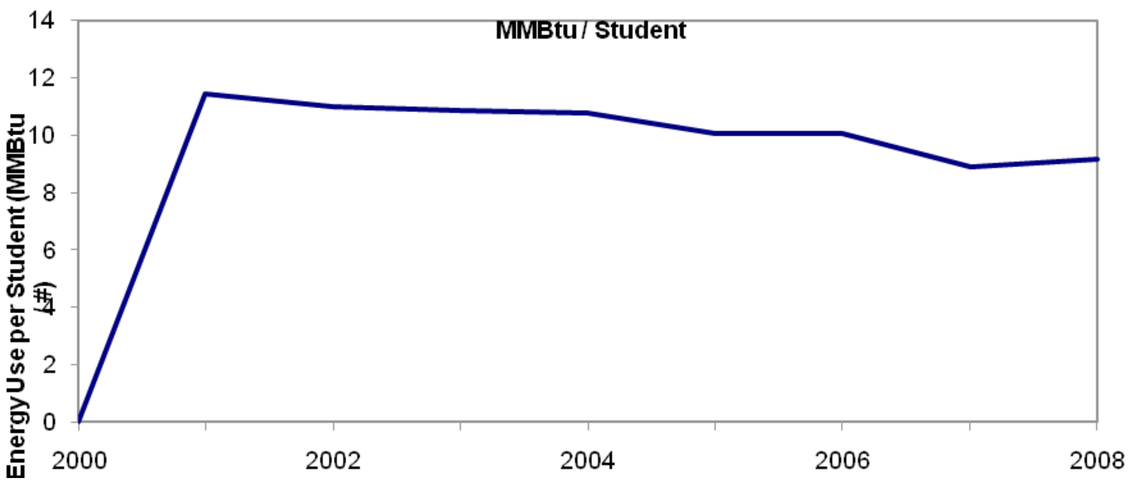

Fig. 8 Energy Use per Student at Augsburg College (FY 2001-200

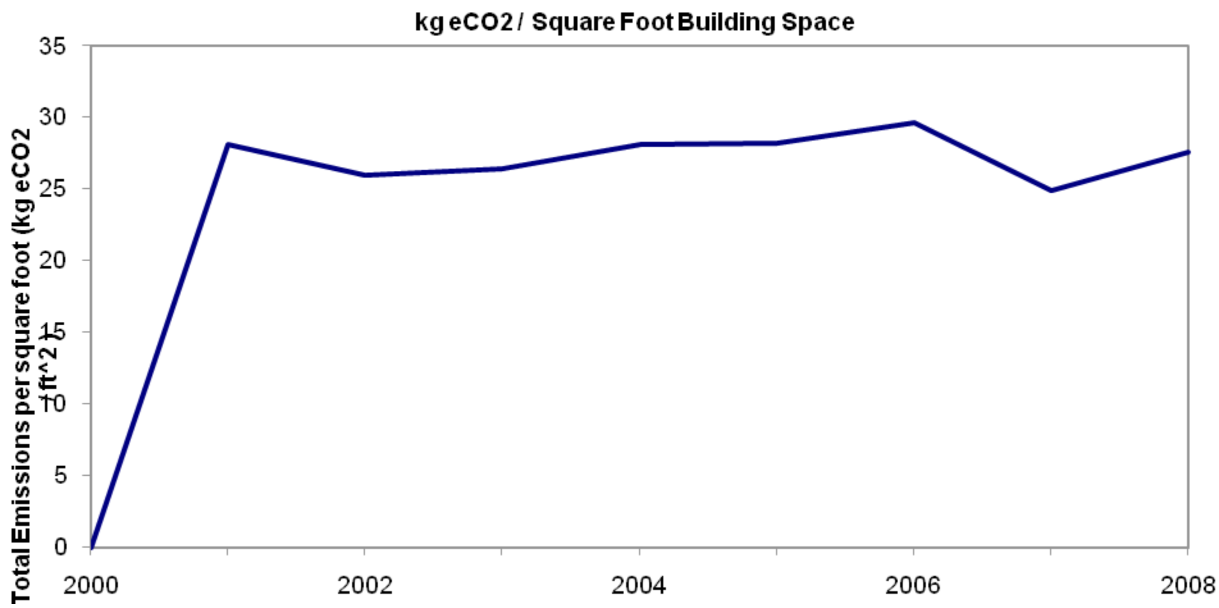

Fig. 9 Total Emissions per Square Foot at Augsburg College (FY 2001-2008)

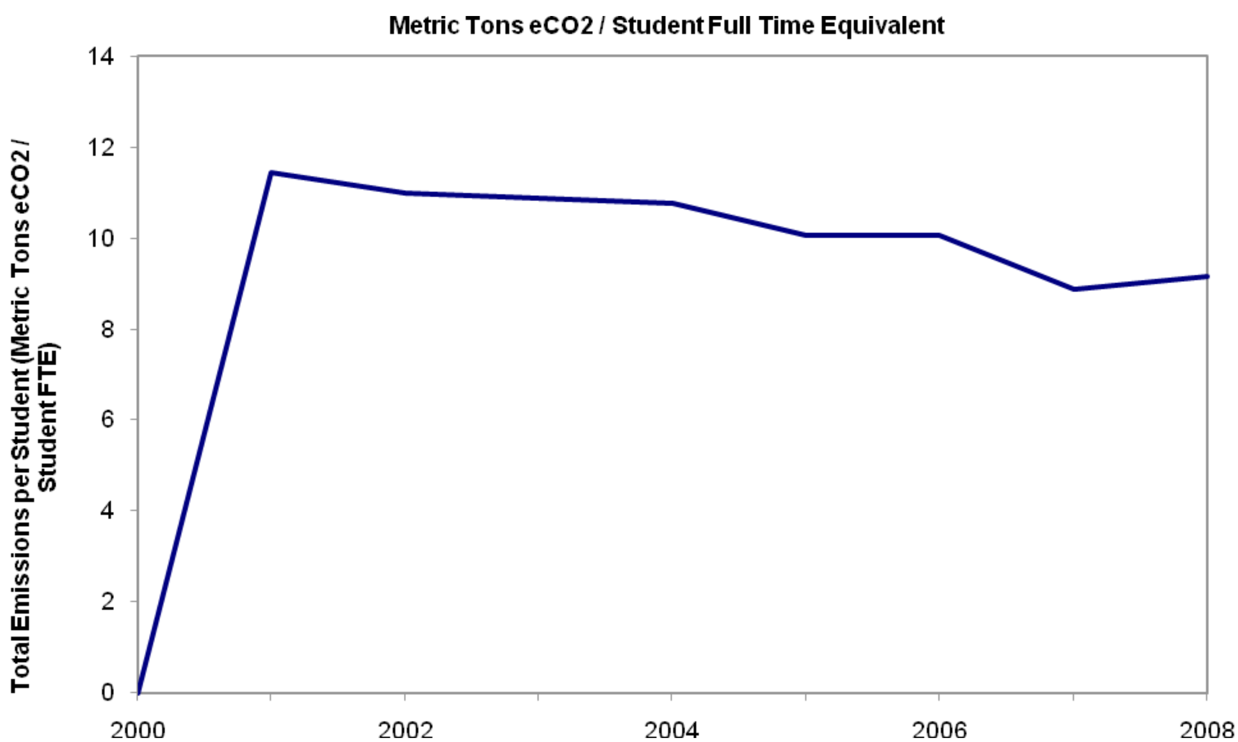

Fig. 10 Augsburg College Metric Tons eCO2 per Student Full Time Equivalent (FY2001-2008

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, Figure 11 shows a steady but slow increase of electricity usage up until 2007 then a sharp bump up of 2,000,000 MM BTUs. The most reasonable explaination for this increase is the addition of the new Oren Gateway Center a 118,000 square foot multi-use building on the norht side of campus and a 35,000 square foot Kennedy Center 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. There also were several small houses on campus that were torn down to make room for parking and new buildings and those actions 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 public relations bulletin flat screens throughout the 8 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 mentioned changes affected the overall electricity usage but the end result has been a gradually increasing usage up until the new buildings were added to the campus.

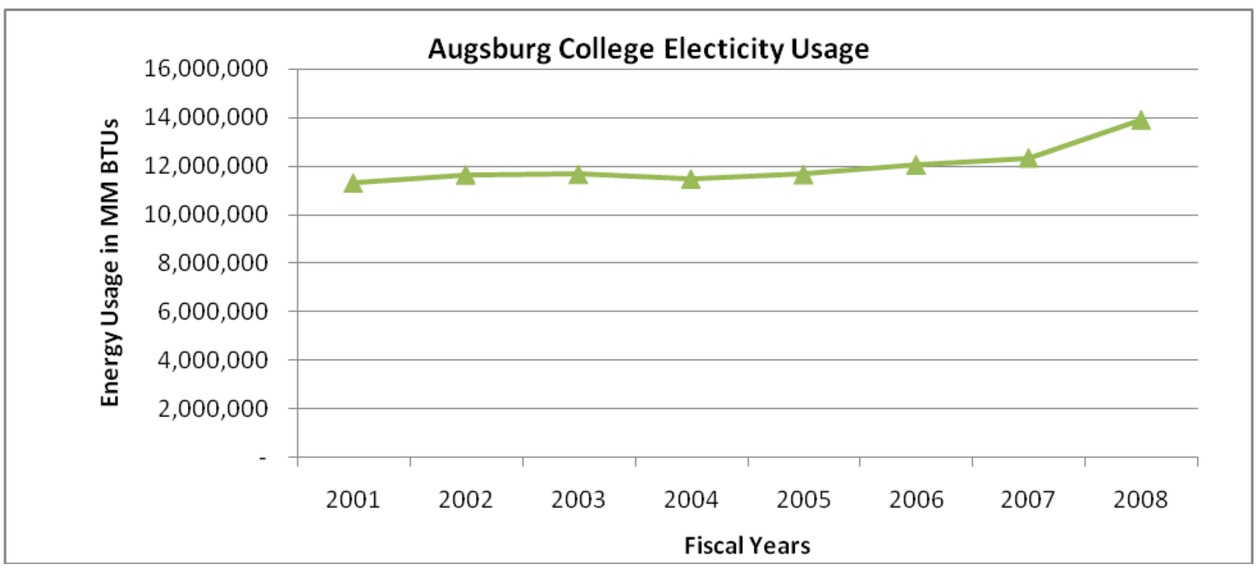

Fig. 11 Electricity Usage at Augsburg College in KWH (FY 2001 – FY 2008)

Natural gas and steam usage (Fig. 12, next page) during the first 7 years seem to correlate slightly with the variations in the heating degree days as shown ing Fig. 13 on next page and also with the addition of the Oren Gateway Center in 2007 in which natural gas is now being used for heat and hot water. Natural gas is used in other buildings for hot water and in the athletic dome for heat.

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

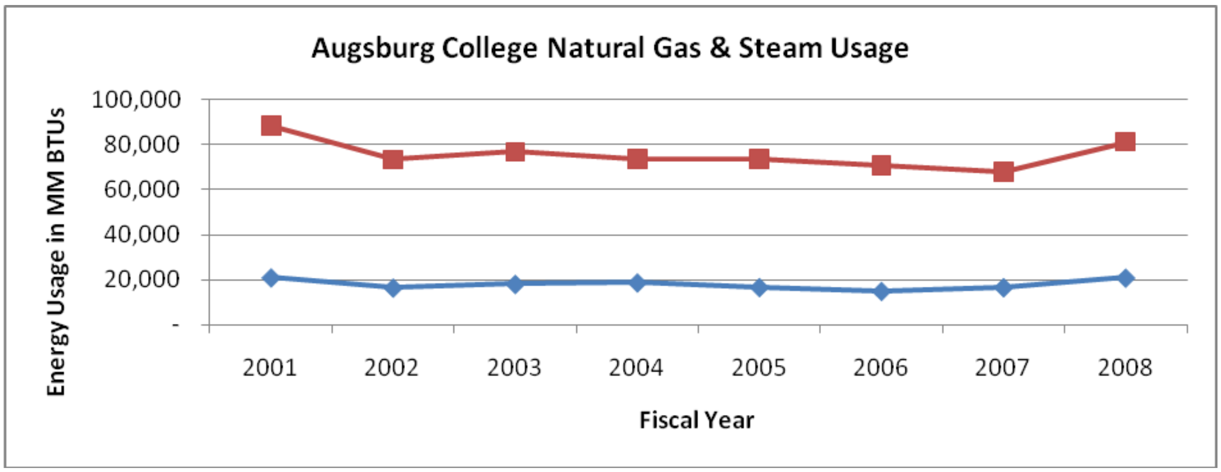

Fig. 12 Augsburg College Steam and Natural Gas Usage (FY 2001-2008)

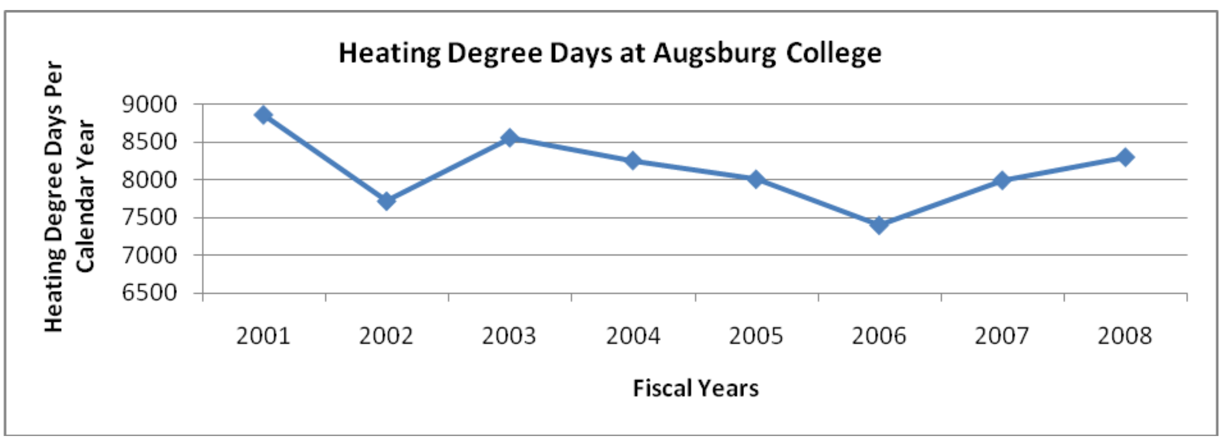

Fig. 13   Augsburg College Heading Degree Days (FY 2001 – FY 2008)

Refrigerants

The next most important source of GHG at Augsburg College is the ice arena direct refrigeration system. The system is well beyond its reliable life time of 15 years and frequent upgrades and rehabilitations bearly keep up with the problems that develop. The college recently contacted an analysis by Stevens Engineers and Planners of the system's condition and now has a schedule of planned improvements that could result in better performance. Over the past 8 years 10,625 pounds of R22 refrigerant (Chlorodifluoromethane) has leaked from the system and had to be replaced. During the last fiscal year (2008) 1375 pounds were replaced and that was the lowest amount replaced in the last 8 years. Our R-22 refrigerant has a global warming potential (GWP) of 1700 as per the web source at: www.engineeringtoolbox.com/r22-properties-d_365.html. This high GWP explains the relatively high percentage of eCO_2 contributed by the refrigerant on the graph in Fig. 5 and it also represents a clear example of where we can reduce our GHG footprint considerably albeit with a hefty price tag. Besides the high cost of a new refrigerent system, the report mentioned that the new indirect refrigerent systems are less efficient and will cost more to operate which poses more hard questions about the ongoing costs of operating the ice rink system.

Student, Faculty and Staff Commuting

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

We know that more faculty, staff and students are using transit as evidenced by dramatically increasing sales of monthly all-you-can-ride passes (Fig14 and 15 on next page). The dramatic increase around FY 2007 to 2009 is a result of high gas prices and a dramatic 50% subsity of all passes by Metro Transt and Augsburg College. We also instituted a student Go-To transit semester pass for students in FY2006 that also resulted in increased transit usage. During the average week 4408 people (faculty, staff and all students) commute to campus. Full time student transit users averages 141 Go-To semester pass users, and there are on average 42 monthly transit users (faculty, staff and students) who commute daily by transit. In addition there are another 125 people who 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% transit users in the overall campus population. On the other hand if resident students are eliminated, since they walk to class and Augsburg for Adults and graduate students are taken out of the equation, since the majority will drive under any circumstances, the percentage of students and staff using transit in FY2008 was 308 of 1955 or 16% of the adjusted population of potential transit users. There are also a small percentage of the campus population (possibly 3%) that commute by bike or walking which is even better for the environment than transit usage. In any case, environmentally friendly modes of commuting is increasing at Augsburg but more people need to start using these alternatives if the GHG generated by commuting is to decrease in the future.

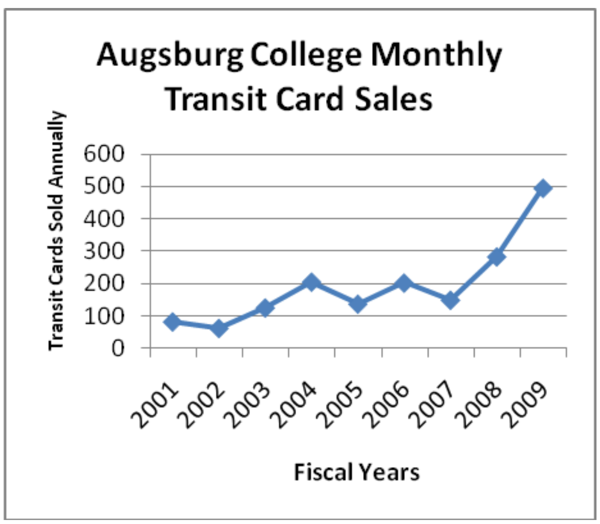

Fig. 14 Augsburg Monthly Transit Card Sales

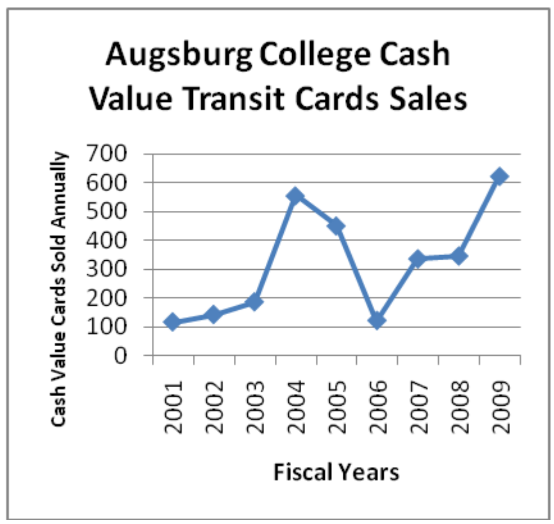

Fig. 15 Augsburg Cash Value Card Sales

Improvement will continue by keeping the Go-To Transit Pass and 50% discounts for faculty and staff in place in future years and by more effective education about the negative impacts of single occupant vehicle commutes on the air quality, parking demand and the basic cost of education. As the number of new buildings increase 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, weighing the social, environmental and financial costs of single occupant vehicle commuting will choose the least damaging alternatives and the campus carbon footprint will 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 it does offer some opportunity for conservation if the campus population seeks less impactful alternatives whenever possible. The other option, if we are to achieve 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 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, Solid Waste

At Augsburg College the data on paper use and waste collected remained steady primarily because we didn't have adequate measurement procedures in place in past years. Both sources of GHG although a small percentage of the total (1% each) they might have been a higher percentage if we had more accurate data. In the case of paper, we only provided an estimate of the copy paper used on campus. We did not other forms of paper including envelopes, publications and sanitary products all of which have some GHG production associated with them and their distribution systems.

In the case of our waste stream, all we had was estimates and so the percentage of the total GHG production might be greater with more accurate methods of measurement. Weighing trash, on the other hand introduces the variable of water content of the trash which can also distort the accuracy of the data. We plan to do several total campus weighings with Allied waste this year to see if we can establish some weight averages for our particular type of waste.

Another factor with our waste production on campus is the impact that recycling and composting have on our overall GHG production statistics. We have opperated a successful recycling program on campus since the early 1990,s, keeping useful materials out of landfills and supporting new industry based on recycled materials. It might be useful to find a way to include recycling into the mix of data being supplied for the calculator especially if it can be put into the context of a "offset".

The calculator provides a place for on campus composting but not composting of campus materials done at an off-campus site which is the case at Augsburg College.

We have composted all of our yard waste for over 10 years and we began composting our kitchen and dining organics in September, 2008. We are not permitted to do large scale composting on campus because of being in the middle of the city but 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 1000 square feet of building space which according to the average data provided by the American College and University Presidents Climate Commitment (ACUPCC) web site: http://www.acupcc.aashe.org/data-views.php, is above the current averages from GHG inventories for Masters Colleges and Universities (14.83) and slightly above the highest category called Special Focused Institutions (SFI) at 24.04. Augsburg has only a few new buildings at present and most of the campus buildings were built during the 1970s or before so it would be expected that our energy consumption and the associated eCO_2 generated would be higher than some other colleges that have all new buildings with 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 for 6 months a year but isn't listed as building space for the campus. Some campuses have all new buildings with excellent insulation and heating systems, other colleges like Augsburg have most of their buildings built in the 1970s or earlier. Whatever the specifics, precise comparison of Augsburg's carbon footprint to averages or direct comparison with other colleges is problematic. What we can do is work to reduce our carbon footprint based on the information we get from this and future green house gas inventories.

Conclusion

Participating in the Presidents Climate Commitment and completing this green-house gas inventory is a major step in quantifying our impact on the environment with measurements of our specific GHG sources. Although we have actively been working to reduce our carbon footprint since 2000 through energy conservation improvements, reduced paper use, increase recycling, composting, natural landscaping, water conservation techniques, promotion of public transit, car pooling, biking and walking to work and other initiatives, this is the first time we could measure and present our footprint data in a single consise document. It is 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, and measured efforts to reduce our carbon footprint. We are certainly endebted to Clean Air- Cool Planet, Inc. for developing the calculator and providing it to the college community.

Over the years of this study, Augsburg College's overall production of GHG remained relatively stable around 25,000 MM BTUs which is remarkable since our on-campus population (all faculty, staff, resident and local commuting students) increased from a low of 3507 in FY 2001 to a high of 4393 in FY 2008. The increase in campus student population from 2760 to 3576 is more than likely responsible for the decreased total GHG produced per student that ranged from went from 11.2 to 9.2 MM BTUs per full time student equivalent. These are good signs about how our college makes use of our facility and how we well we achieve reductions in our overall GHG production.

As the college size continues to increase with new construction, the total eCO_2 from natural gas will continue to increase but hopefully at a lesser rate thanks to new 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 forseable future, but with a LEED (Leadership in Energy Design) certified building we are expecting it to be a big improvement over our current science building that was built before energy conservation was a major concern.

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 energy from Xcel energy starting at the beginning of this fiscal year 2009. Continued enginering improvments to our heating and airconditioning systems will help reduce the impact of those systems on the enviroment even further.

It is because of this CA-CP calculator that 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 in the future. As we go forward in this great challenge of achieving carbon neutrality on our campus, we can use the CA-CP calculator to study options, costs and results of changes we might make and therefore find the most effective changes to make and when to make them. Our biggest challenges will be with changing the college culture around transportation expecially daily commute choices but we must also continue efforts to reduce waste, increase recycling and composting, maintiaining efficient HVAC systems and developing methods of daily operation that are less harmful to our environment. At some point in this journey we may have to address the issue of using carbon offsets to reach full carbon neutrality but first we will consider those sources of GHG that we have immediate and direct means to change.

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

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