Macalester College

Greenhouse Gas Emissions Inventory, Fiscal Year 2008-2009

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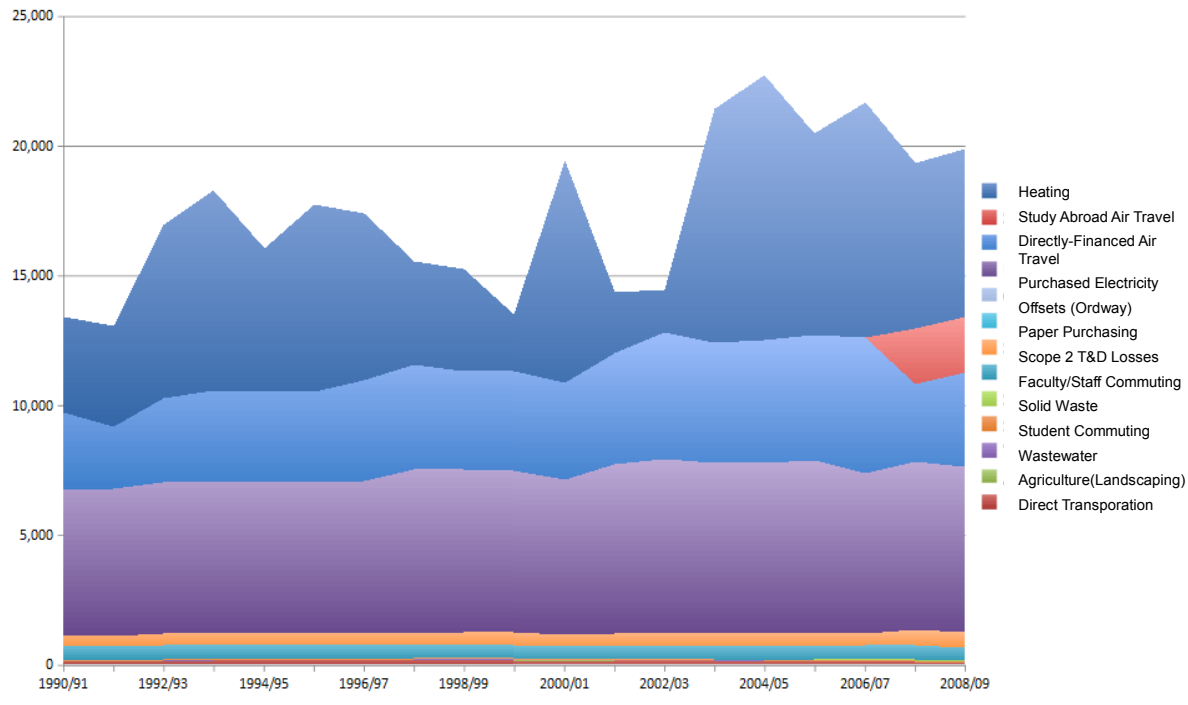
Executive Summary

This report is the second annual update to the Macalester College greenhouse gas emissions inventory conducted by the Environmental Studies Senior Seminar in Spring 2008. While the first project was a comprehensive audit from 1990-2006, subsequent reports such as this only cover detailed Macalester emissions for a single fiscal year, and should be examined in concert with previous audits.

The full report includes:

- 2008-2009 Emissions Inventory
- Organized by emission source:
  - Historical Trends and Analysis
  - Changes in Audit Methodology
  - Update on Initial Report Recommendations
  - New Recommendations
- Climate Action Plan/Strategic Planning

Figure A – Total Emissions by Sector



In the fiscal year 2008-09 Macalester College emitted 19,845.3 metric tons (MT) of carbon dioxide equivalents (eCO_2). These emissions predominantly come from heating, electricity and air travel, as seen below. These emissions represent a 2.5% increase from the 19,362.7 eCO2 emissions in 2007-08. Scope 1 emissions rose .7%, Scope 2 fell 1%, and Scope 3 rose nearly 9% (See Figure A). This apparent increase is in large part due to increased accuracy in data collection and does not represent an actual increase. You will note that most of the change in eCO_2 emissions derives from the Air Travel sections, where data collection is inherently suspect.

Greenhouse Gas Emissions (eCO_2) by Sector[1]

This audit used the Clean-Air Cool-Planet Carbon Calculator Version 6.4, which is divided into three main scopes with 13 types of energy use or emissions that are relevant to Macalester College. Some are relatively recent additions to the Calculator; for these, we do not have historical information. The data include the calculable emissions from all Macalester owned properties, including rental buildings owned by the Macalester High Winds Fund, work-related activities for faculty and staff, and all emissions associated with on-campus housing and activities. It does not attempt to calculate the emissions associated with housing for Macalester students who live off-campus, nor the impacts of students traveling to and from their permanent residences during holidays or summer. All of the units – unless otherwise labeled – are given in Metric Tons of Carbon Dioxide Equivalent (MT eCO_2).

It should also be remembered that though some sections—agriculture (landscaping), wastewater, paper, and solid waste—contribute an almost negligible amount of eCO_2 to our total emissions, they are detrimental to the sustainable cause in many other ways. Progress in these areas, though of secondary importance in this report, should in no way be ignored, and should be striven for ardently. For more information, please see the Macalester Sustainability Plan.

Figure B – Macalester College GHG Emissions per Sector for 2008/09.

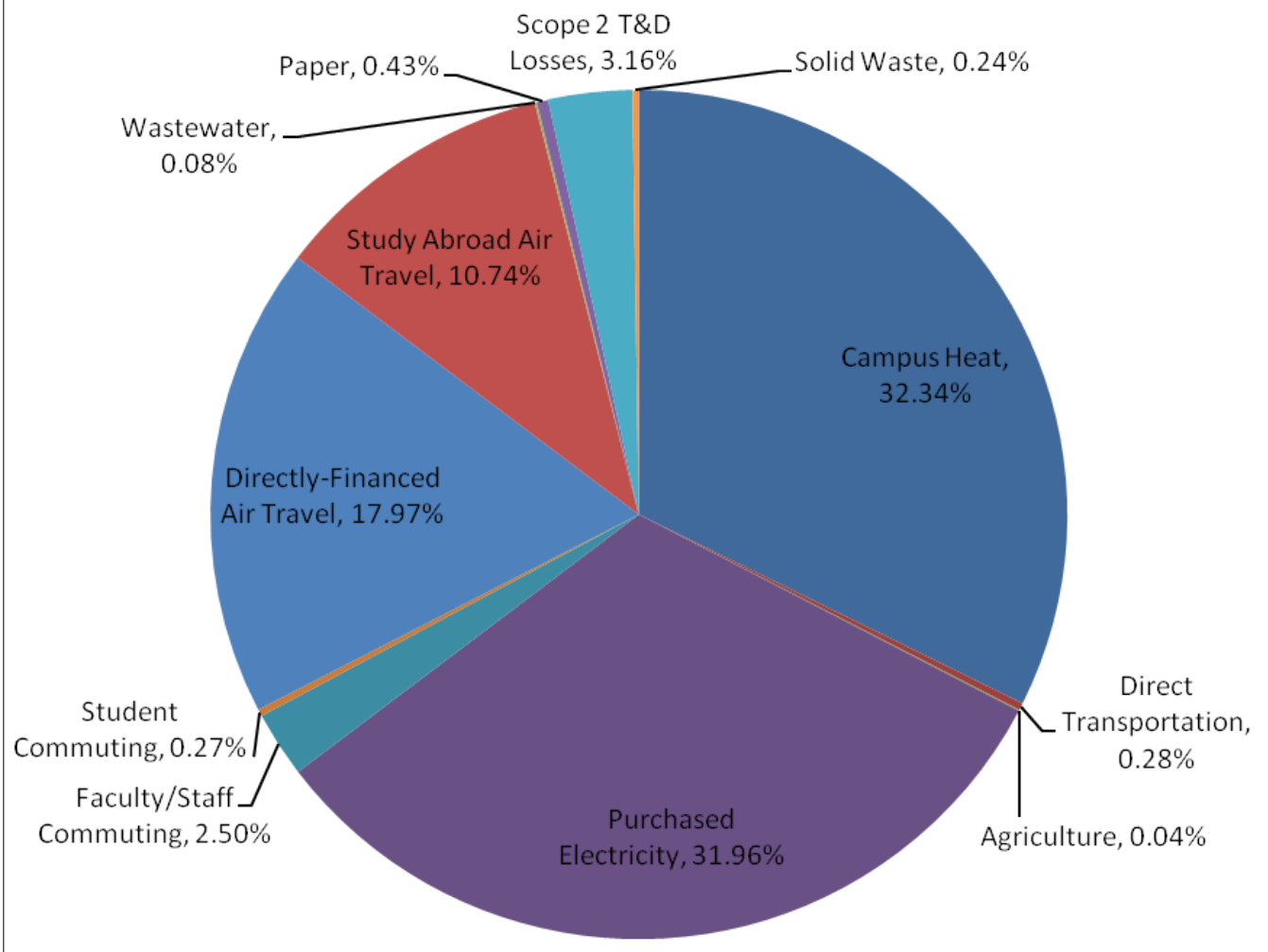


Figure B shows the relative amount each emission source contributes to Macalester's Greenhouse Gas Emissions. Of particular note, since its role is too often ignored in GHG calculations, is the extent to which air travel contributes to our emissions—28.71% of Macalester's total emissions. It should also be noted that this category is the most difficult to measure, so year-by-year changes in miles flown should be taken with a grain of salt.

Emissions by Category:

Campus Heat: 6,492.0 Metric Tons eCO_2 (32.3% of overall emissions)

Purchased Electricity: 6,415.6 MT eCO_2 (32.0% of overall emissions)

Directly Financed Air Travel: 3,606.2 MT eCO_2 (18.0% of overall emissions)

Study Abroad Air Travel: 2,156.3 MT eCO_2 (10.7% of overall emissions)

Scope 2 T&D Losses: 634.5 MT eCO_2 (3.2% of overall emissions)

Faculty / Staff Commuting: 501.7 MT eCO_2 (2.5% of overall emissions)

Paper Purchasing: 86.0 MT eCO_2 (.43% of overall emissions)

Direct Transportation: 55.4 MT eCO_2 (.30% of overall emissions)

Student Commuting: 53.4 MT eCO_2 (.27% of overall emissions)

Wastewater: 15.1 MT eCO_2 (.08% of overall emissions)

Agriculture (Landscaping): 7.8 MT eCO_2 (.04% of overall emissions)

Solid Waste: 47.5 MT eCO_2 (.24% of overall emissions)

Recommended Actions:

- Continue improving methodology in order to better reflect our progress.
- Avoid offsetting emissions—with the exception of Markim Hall—until all feasible efficiency and energy-reduction improvements have been made.
- When economically advantageous, invest in electrical generation, both on- and off-campus.
- To reduce directly-financed air travel, install and improve telecommuting facilities and offer departmental incentives to make use of them.
- Offer an emissions-offsetting program for Study Away trips.
- After cutting total heating requirements as much as possible, switch to 100% natural gas heating. Continue current behavioral education programs and implement more.

Background Documents:

- 2008-2009 GHG Emissions Calculator Spreadsheet www.macalester.edu/sustainability/data/.
- 2008-2009 GHG Figures and Charts – includes data tables and graphs for this years results and historical trends. www.macalester.edu/sustainability/data/.
- 2009 Macalester College Sustainability Plan, which includes the Institutional Climate Action Plan www.macalester.edu/sustainability/data/.

2008-2009 Emissions Analysis and Trends

The following sections are organized by each category, in order of descending emissions.

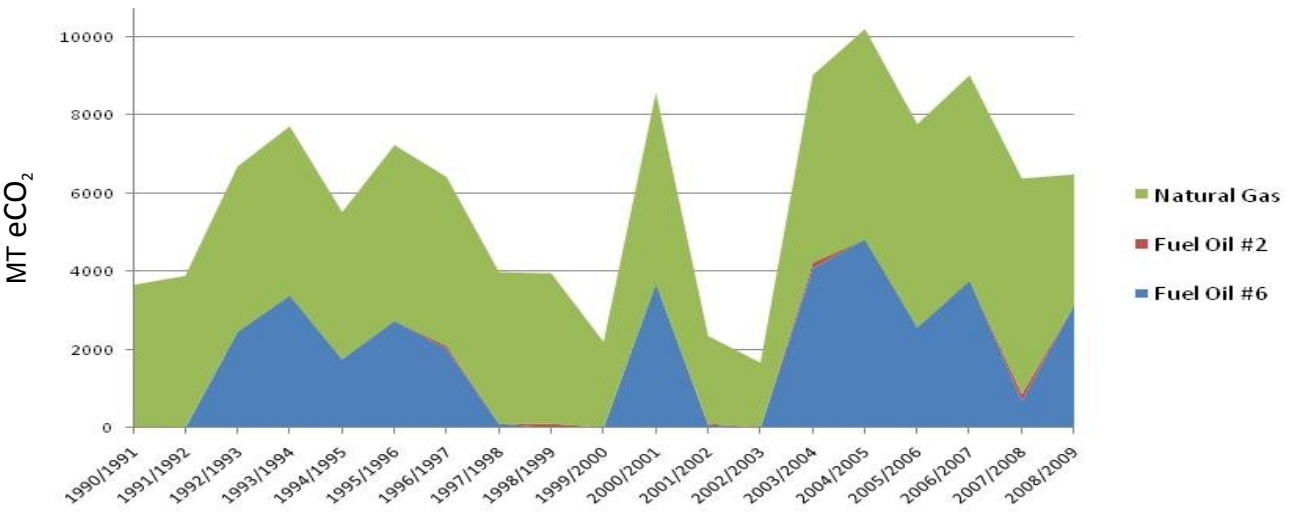
Each section will provide historical data, usually reaching back to 1990, as well as context for the data, since many hidden variables combine to make up each of the resulting emission totals. All of the following graphs, along with others, can be found in the spreadsheet 2008/09 GHG Figures and Charts, available at macalester.edu/sustainability/data.

Campus Heat: 6,492 MT eCO_2 (32.3% of overall emissions)

This category includes all of the fuel—Natural Gas, Fuel Oils #2 and #6—used to heat Macalester's campus throughout the year. Macalester has a central heating plant that burns a mix of these fuels depending on price and availability. In addition to the central heating plant, this total includes all of the natural gas used to heat the auxiliary buildings that are not connected to the steam system. An indeterminate, though likely substantial, portion of this total is consumed in Café Mac and Kagin Commons for food preparation.

As seen in the following graph, this sector is quite erratic; our year-to-year emissions in this category are almost entirely dependent on the number of heating degree days, which will be discussed in detail later.

Figure 1 – Total Heating Emissions by Fuel Source

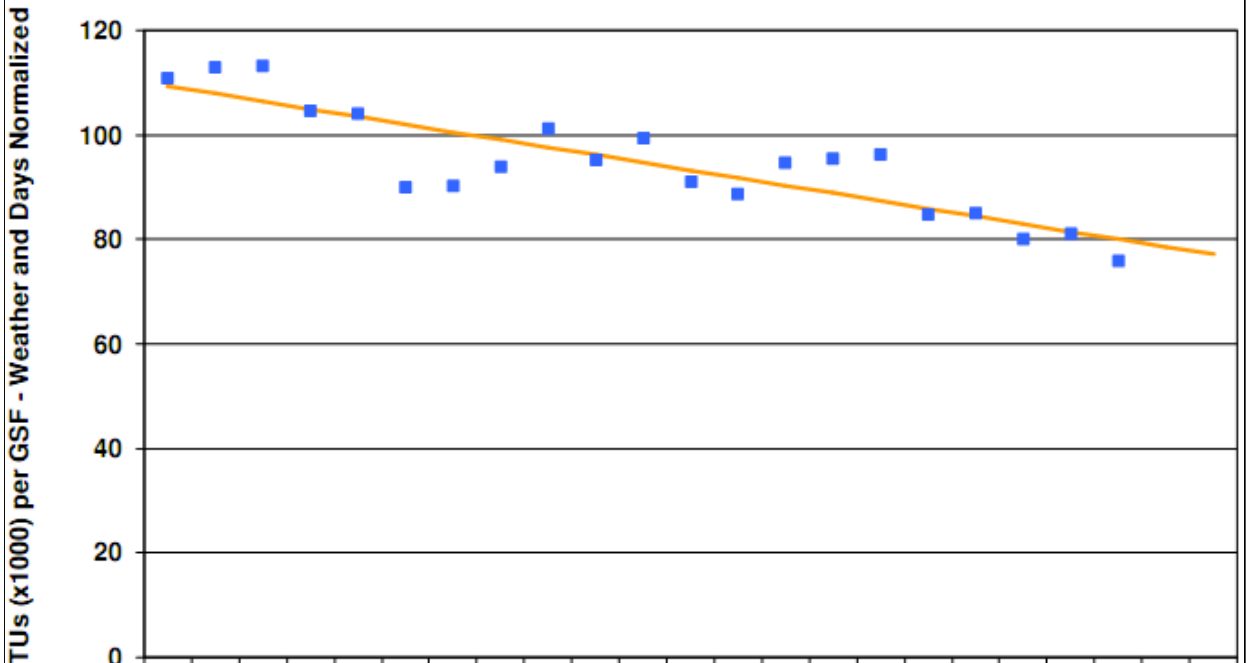


Data compiled by Justin Lee, the 2008 Senior Seminar, and Nick Matzke

Interestingly, Fuel Oil #2 is very rarely used, and can barely be seen on this graph; it only occasionally makes fiscal sense to burn it. In addition, it burns much less cleanly than natural gas, making it a more pollutive choice of fuel. Fuel Oil #6, however, is still used regularly. It produces roughly 1.5 times the eCO_2 emissions as natural gas per BTU, but is often much less expensive to burn. In terms of tangible reductions heating emissions, no clear trend can be gleaned from this raw data, since there is such great variability year-to-year due to weather patterns.

Unlike Figure 1, which shows erratic variations in emission levels—and the attendant BTU consumption—Figure 2 shows a very steady decline. To make the data more reflective of our own weatherizing and efficiency upgrades, a process called 'normalization' was performed. At its simplest, normalization removes excess variables from consideration; in this case, weather and year-length were 'normalized', leaving behind, in this case, kBTU consumption per gross square foot, in a world where weather is the same every year. Leap years are corrected to be 365 days long, as well. This graph, then, is a measure of building efficiency. Peering through this lens, it is apparent that Macalester's BTU consumption—and thus emissions—per gross square foot has been dropping. For more details on normalization, see page 7.

Figure 2 – Weather-Normalized Fuel BTU Consumption per GSF



	FY 88 / 89	FY 89 / 90	FY 90 / 91	FY 91 / 92	FY 92 / 93	FY 93 / 94	FY 94 / 95	FY 95 / 96	FY 96 / 97	FY 97 / 98	FY 98 / 99	FY 99 / 00	FY 00 / 01	FY 01 / 02	FY 02 / 03	FY 03 / 04	FY 04 / 05	FY 05 / 06	FY 06 / 07	FY 07 / 08	FY 08 / 09	FY 09 / 10	FY 10 / 11
ACTUAL	111	113	113	105	104	90	90	94	101	95	99	91	89	95	96	96	85	85	80	81	76		
TREND	109	108	106	105	103	102	101	99	98	96	95	93	92	90	89	87	86	84	83	82	80	79	77

Data compiled by Ed Cook Consulting

Below is Figure 3, a chart containing the data for the above graph, including total kBTU and GSF, 2000/09.

Figure 3 – Weather-Normalized Fuel Consumption per GSF

Fiscal Year	Fuel KBTUs	Fuel Cost	Cost Per KBTU	Billing Days	Fuel KBTUs - Days Norm	Fuel KBTUs - Wthr/Days Norm	Gross Sq Feet	KBTUs per GSF - Days Norm	KBTUs per GSF - Wthr/Days Norm
2008/2009	100,735,921	$672,164	$0.0067	365	100,735,921	100,396,729	1,321,773	76.21	75.96
2007/2008	109,022,000	$1,000,534	$0.0092	366	108,724,126	105,902,935	1,304,773	83.33	81.17
2006/2007	77,067,300	$469,787	$0.0061	365	77,067,300	83,119,148	1,038,457	74.21	80.04
2005/2006	78,282,150	$715,477	$0.0091	365	78,282,150	88,197,776	1,038,457	75.38	84.93
2004/2005	81,052,800	$461,910	$0.0057	365	81,052,800	87,941,327	1,038,457	78.05	84.68
2003/2004	104,530,396	$548,523	$0.0052	366	104,244,794	108,677,607	1,129,773	92.27	96.19
2002/2003	106,465,550	$548,561	$0.0052	365	106,465,550	108,000,192	1,129,773	94.24	95.59
2001/2002	97,156,709	$399,452	$0.0041	365	97,156,709	107,034,066	1,129,773	86.00	94.74
2000/2001	94,701,500	$506,963	$0.0054	365	94,701,500	92,199,134	1,038,457	91.19	88.78
1999/2000	76,959,815	$221,395	$0.0029	366	76,749,542	87,701,068	962,392	79.75	91.13

Some analysis of Figure 3 is due: Looking first at the number of gross square feet, we see a jump in 2001/02 due to the Campus Center's completion. The drop from 2004/05 to 2006/07 is due to the Fieldhouse's demolition, and the large jump in 2007/08 adds the Leonard Center. Next, you will notice that there was a small jump in 2001/02 in energy consumption with the Campus Center, a jump which was far overshadowed by both the consumption fall in 2004/05 and the rise in 2007/08. This large jump, however, is nowhere near as worrisome as it otherwise might be, and a quick glance at the column titled "Fuel kBTUs – Weather/Days Normalized" explains why—before demolition of the old fieldhouse, our overall consumption, normalized for weather and days, was *higher* than after the replacement building, which is 290% the size. While it is slightly disconcerting that the old field house was *that* inefficient, the replacement shows the extensive reductions which can be realized through replacements and extensive retrofits. It should also be noted that during this time some boiler optimization projects were completed, increasing the overall efficiency of the campus-wide heating system.

We have increased our building efficiency in two different ways. First, the replacement of old, inefficient buildings with new, more efficient buildings, most notably Markim Hall, as well as the Leonard Center, has made enormous strides in /GSF efficiency. Second, through investing in efficiency in existing buildings; for example, the HVAC system in Olin-Rice was recently retrofitted to save substantially on both fuel and electricity cost, at a very low cost:savings ratio.

Figure 4 shows the changes in Heating Degree Days (HDD) per year. One HDD is defined as a 24 hour period where the outside temperature is one degree colder than 65 degrees F. Thus, a day where the average 24hr temperature is 40 degrees F would equal 65-40 = 25 HDD. As mentioned earlier, this factor is the one that most drives the unpredictability of our Heating emissions.

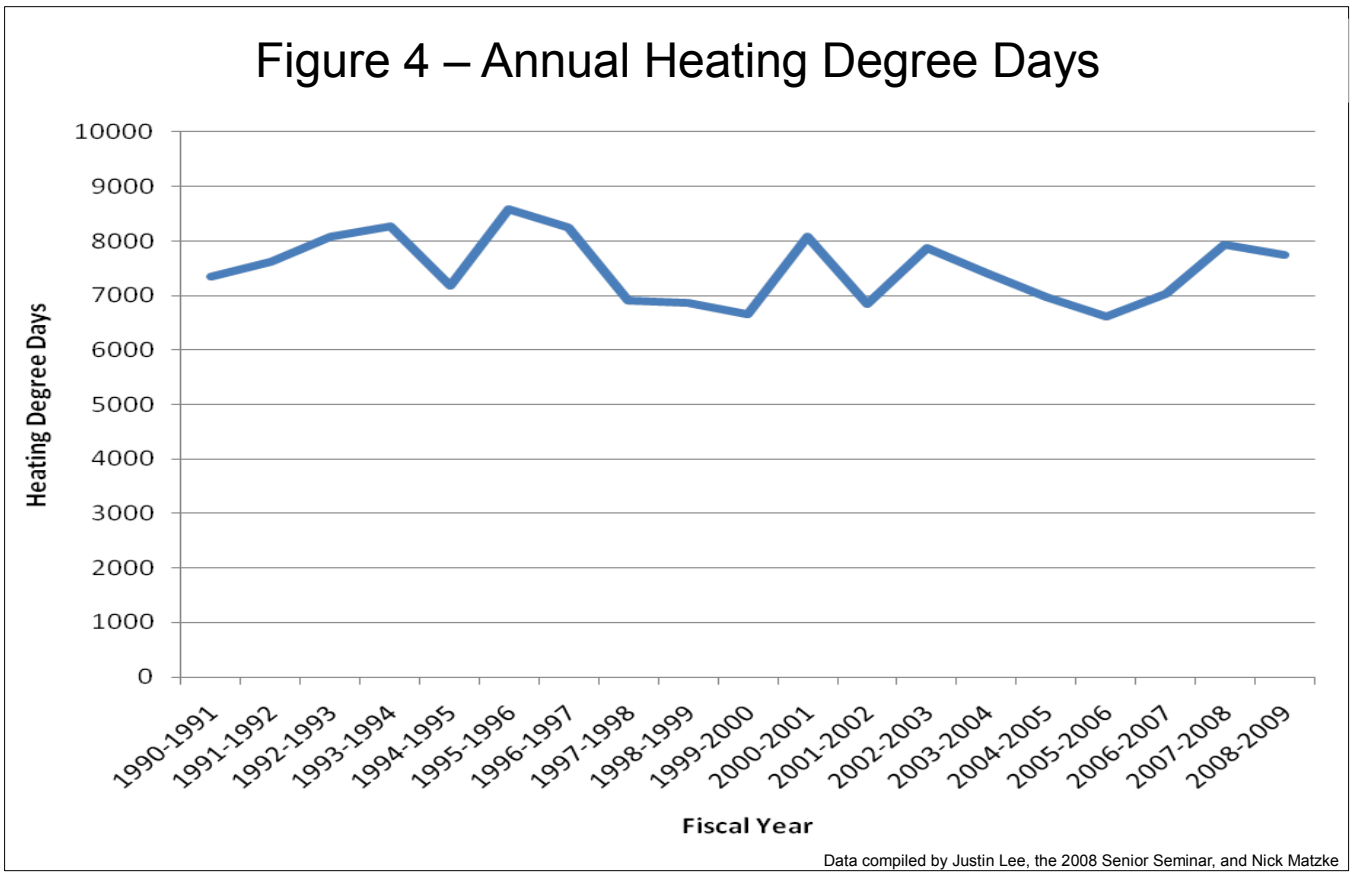
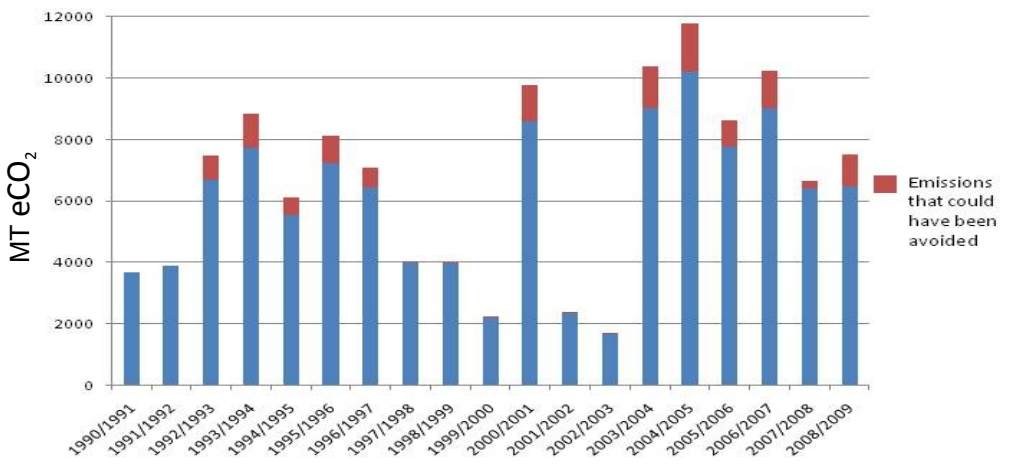


Figure 5 – Hypothetical Heating Emissions, Using Solely Natural Gas



Data compiled by Justin Lee, the 2008 Senior Seminar, and Nick Matzke

Currently, the Central Heating Plant burns a mixture of fuel oils and natural gas, depending on season, availability, and pricing. To demonstrate the impact that heating fuel choice has on total emissions, the above graph shows the calculated emissions if no fuel oil had been used for campus heating and all heat was provided by natural gas since 1990/01. This was estimated by determining the total heat content of all fuel burned each year, and what the emissions would have been if that heat had come from natural gas. The combination of the two sections is equal to the actual fuel emissions each year. Natural gas has been a larger emitter in the last few years, but that is due to higher total usage. Fuel oil #6 emits 1.5 times the eCO_2 per unit of heat than natural gas and has a disproportionate impact on total emissions.

Recommendations:

•In terms of data collection, this sector of emissions is in pretty good shape. Natural gas data are gathered from utility meters at all campus-owned buildings, and aggregated both by Facilities Services and Xcel Energy, which is a fairly foolproof method of ensuring accuracy. The fuel oils are measured at the point of combustion.

•Efficiency, however, could be further improved in a number of ways. For Fiscal Year 2010-2011, there are plans to both upgrade the steam system's insulation and recommission 16 main buildings across campus. The recommissioning projects will save $77,448 in electrical cost, and $104,826 in heating costs, every year. After Xcel Energy's rebates, these projects are expected to pay themselves back in 1.66 years.

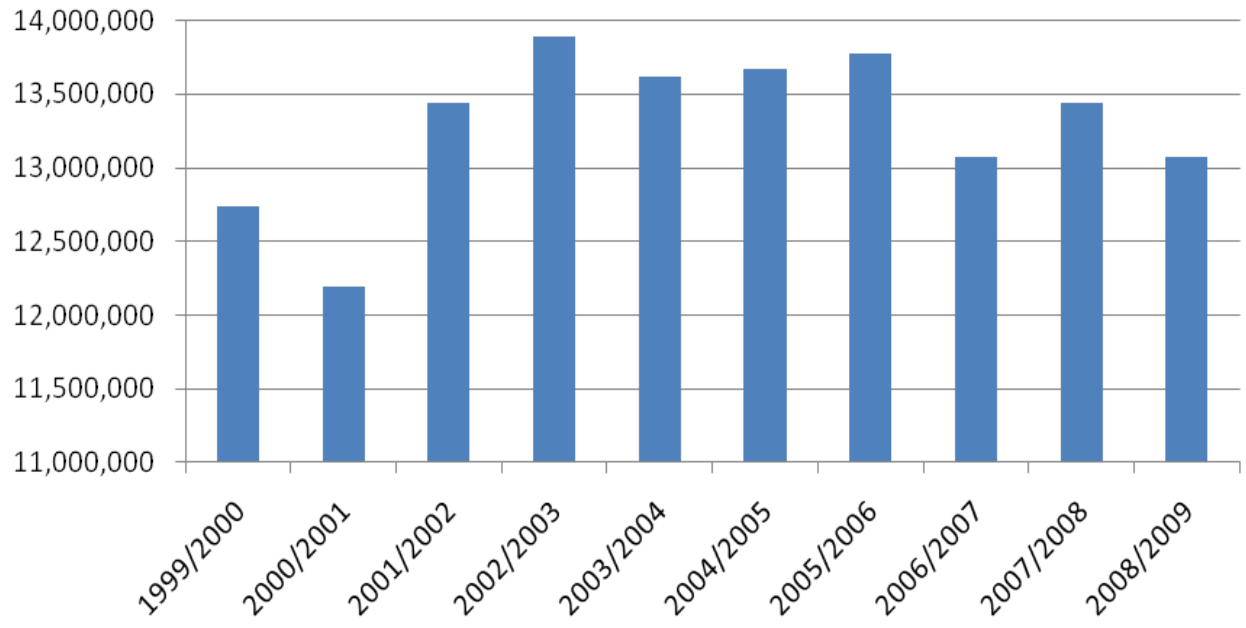
• More extensive building envelope upgrades will be performed as buildings are renovated; next on the list is the Janet Wallace Fine Arts Complex. This will reduce emissions.

•Switching from a mixed fuel base to using solely natural gas would cut emissions significantly, though it would likely increase our heating cost. In light of the prospect of increased cost, this option should be exercised after all possible efficiency gains are realized, to avoid perpetuating the pervasive perception that environmental and economic goals are inherently contradictory.

Purchased Electricity: 6,416 MT eCO_2 (32.0% of overall emissions)

This sector has consistently been one of the largest sources of Macalester's GHG emissions over the last 18 years. Figure 6 shows the total number of kWh purchased annually since 1999/00. This chart does not account for the electricity produced by the wind turbine on-campus, but this is negligible at less than .001% of campus production. The total amount of electricity used on campus has trended down over the last 5 years; it is, however, hard to isolate a single cause. The replacement of old, inefficient buildings with more efficient ones has a large impact, as does Facilities Service's practice of replacing inefficient mechanical and electrical systems in existing buildings. There have also been several student-led efforts over the last 3 years to reduce electrical consumption by encouraging behavioral change.

Figure 6 – Annual kWh from 1999/00 – 2008/09



Data compiled by Justin Lee, the 2008 Senior Seminar, and Nick Matzke

Before analyzing this graph, it is important to note the scale: it appears as though 2000/01 consumption was half what some of the other years was, but in reality was merely 10% lower than even the highest-consumption year. You will note an early rise (from 2001/02 to 2005/06) in annual electrical consumption. We think this largely results from the construction of the Campus Center in 2001/02, and possible issues with meter accuracy during the construction. The new Leonard Center opened in 2008/09. The new facility is much more energy-efficient than the old building—it has a very efficient HVAC system as well as state-of-the-art, efficient lighting distribution, facilitating yet another drop. Other projects that contributed to the drops in electrical consumption are the already-mentioned recommissioning of Olin-Rice and the lightbulb replacement project, which replaced 15,000 32-watt fluorescent tubes with new, low-mercury 25-watt tubes and more efficient (Power Factor >99%) ballasts. In addition, there have been numerous student-led efforts to effect behavioral change that have reportedly achieved short-term energy reductions of between 6% and 12%, but have unknown long-term reductions; it is impossible for us to isolate behavior over long periods of time, since so many other factors also constantly change.

Figure 7 shows the actual eCO_2 emissions over time from Macalester's electricity use. This graph does not precisely follow the total number of kWh because the energy mix that our utility Xcel energy uses each year changes independently of the amount of electricity we consume. This is because Xcel does not produce all of the power that it sells, and the total carbon intensity of its energy supply depends heavily on how much power it purchases from other coal-intensive utilities in the Upper Midwest. This graph should trend down over time, as Xcel is required by Minnesota state law to source 30% of its electrical supply from renewable sources by 2025. For our purposes, we use the mix of electricity sold by Xcel in all of Minnesota.

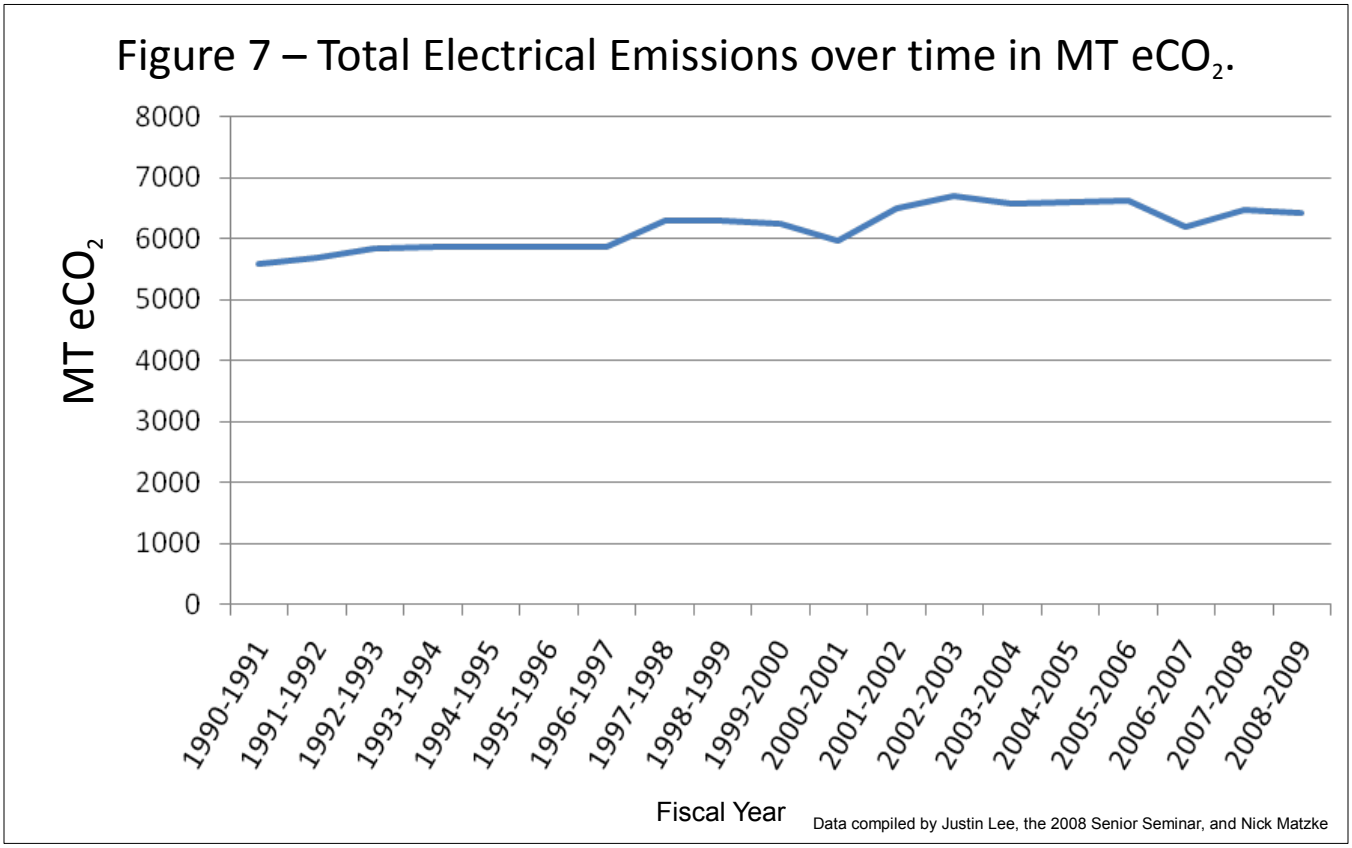


Figure 8 displays the fuel mix used by Xcel in Minnesota for the past four years. We are unsure as to the exact cause of the variation in the figures, but we believe part of the cause is an excess of generation capacity, permitting the company to elect to either burn natural gas or import coal power from out-of-state. These prices fluctuate greatly year-by-year, and so too does the fuel mix.

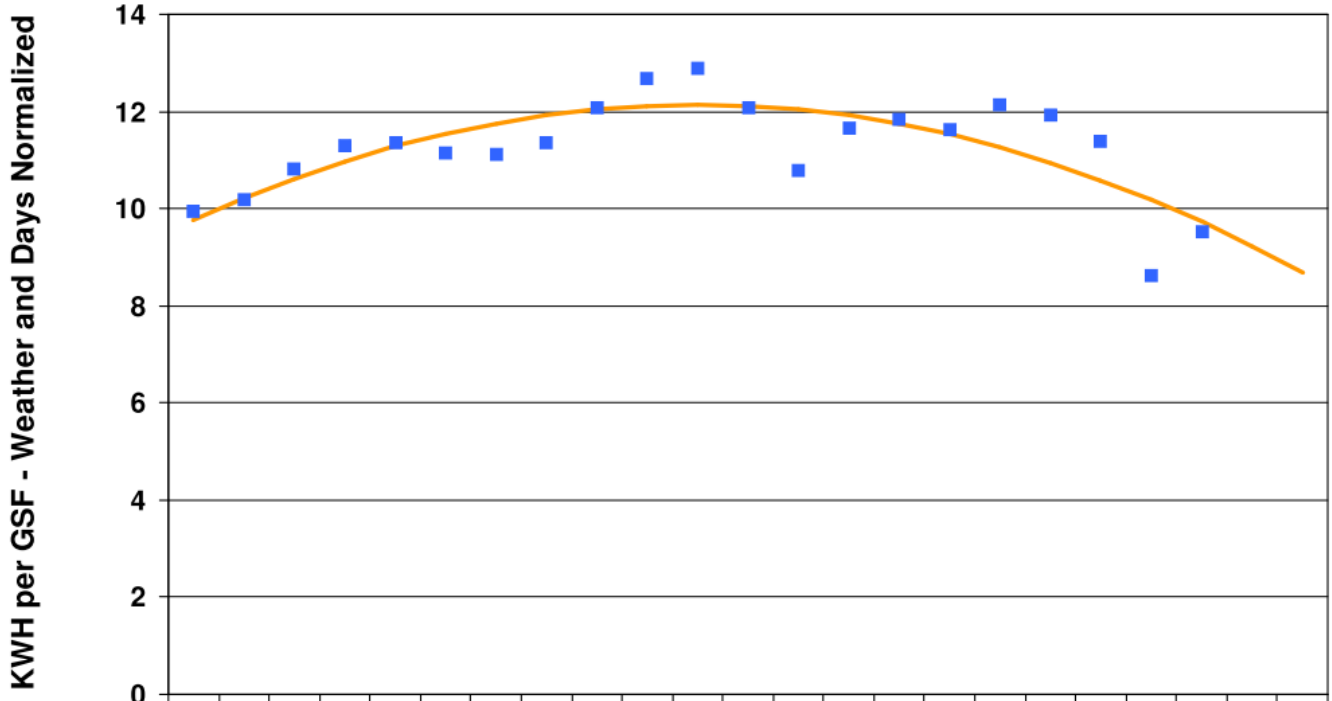
Figure 8 – Fuel Mix

	2005-06	2006-07	2007-08	2008-09
Coal	43.5%	41%	43.5%	47.5%
NG/Oil	12.5%	16.5%	13%	5.75%
Nuclear	27.5%	27.5%	27.5%	27.7%
Hydro	5%	8.5%	7.5%	8.55%
Biomass	1%	2.5%	2.5%	2.6%
Wind, Solar, etc.	10.5%	4%	6%	7.65%

Data from Xcel Energy

Figure 9 is possibly the most important graph, and certainly the most telling of our efforts. It essentially takes our total electrical usage and accounts for weather—mostly due to increased air conditioning load. It further divides it by GSF to yield a measurement of building electrical efficiency. This produces a similar effect as Figure 2 seen on page 2, in that it allows year-to-year comparison without the need to hold side-by-side graphs of weather and GSF data.

Figure 9 – Electricity Consumption per GSF – Normalized for Weather and Days



	FY 88 / 89	FY 89 / 90	FY 90 / 91	FY 91 / 92	FY 92 / 93	FY 93 / 94	FY 94 / 95	FY 95 / 96	FY 96 / 97	FY 97 / 98	FY 98 / 99	FY 99 / 00	FY 00 / 01	FY 01 / 02	FY 02 / 03	FY 03 / 04	FY 04 / 05	FY 05 / 06	FY 06 / 07	FY 07 / 08	FY 08 / 09	FY 09 / 10	FY 10 / 11
ACTUAL	9.94	10.2	10.8	11.3	11.4	11.2	11.1	11.4	12.1	12.7	12.9	12.1	10.8	11.7	11.9	11.6	12.1	11.9	11.4	8.61	9.53		
TREND	9.76	10.2	10.6	11	11.3	11.6	11.8	11.9	12.1	12.1	12.1	12.1	12	11.9	11.8	11.5	11.3	11	10.6	10.2	9.73	9.22	8.67

Data compiled by Ed Cook Consulting

Expanding on the explanation given on page 2 of this report, the weather normalization[1] process uses a multiple linear regression analysis. The largest, and by far the most important, consideration in this analysis is the number of cooling degree days, in terms of its effect on campus cooling load. The result of the normalization, shown above, is a measure of the efficiency of our buildings. It does necessarily remove any consideration of absolute consumption, which effect can mean that if it not used in conjunction with absolute figures, it can lead readers to assume that total emissions have dropped, when indeed they may not have. For example, between 06/07 and 07/08, our efficiency increased greatly (see below), but at the same time, our GSF rose by nearly 300,000ft, and our total weather-normalized consumption likely[2] actually rose.

1. Understanding of weather normalization provided by Ed Cook, a consultant hired by Macalester College.
2. It is, however, unknown whether our consumption did indeed rise during that time; a meter may have been incorrect, which we suspect to be the source of the abnormally low consumption seen in 2007/08.

Originally, when the Environmental Studies students calculated electrical generation emissions for 1990-2006 they used the average carbon intensity provided by the calculator for the Mid-Continent Area Power Pool (MAPP)—the regional sub-grid that Macalester draws its power from. This sub-grid stretches from western WI to eastern Montana down through Nebraska. The other states in this region use a coal-heavy fuel mix to generate electricity, whereas Minnesota has a large proportion of nuclear and hydro, as well as a state-mandated Renewable Energy Standard of 30% by 2020 for Macalester's utility Xcel Energy.

In light of this discrepancy, for 2007-08 and 2008-09 Xcel Energy's Minnesota fuel mix was isolated to see how it differs from the regional average and the carbon intensity of the electricity actually used by the College. In comparison to the rest of the MAPP sub-grid which averages nearly 80% coal, Xcel Energy only generates around 47% of its electricity from coal. When entered into the calculator, this custom fuel mix dropped our electrical emissions in 2007-08 by 4,621 MT eCO2, or nearly 41%. *This custom fuel mix was applied retroactively through 1990.* The percentage of coal will continue to decrease in accordance with the MN Renewable Energy Standard. Under this legislation Xcel Energy is required to generate 30% of its total electricity from renewable sources by 2020, and a total of 25% must be wind-generated.

Methodology Recommendations:

The Annual Energy Report that Facilities Services puts together each year has historically only included the individual usage for the largest buildings on campus and the total energy purchased by the College. It has not included the energy use of the auxiliary rental properties owned by the Macalester High Winds Fund, or a monthly record of the energy use for each building on campus. It has also not included the water usage per month per building. This makes data collection for the greenhouse audit unnecessarily difficult and could be very helpful if modified to include all energy use on campus.

Facilities Services has not yet changed the format of the Annual Energy Report, but it has begun to track and record each individual energy bill per building per month for electricity, heat and water. This will create a database that will be far more accurate and useful to compile the information for the annual Greenhouse Gas Emission Audit, and to calculate the potential savings for individual efficiency projects and provide information feedback to enhance behavioral change. It is recommended that the Energy Report be permanently changed to include all of the information needed for the greenhouse audit, as this will have the added benefit of creating a database of energy usage for calculating the savings of future efficiency projects. This will also allow students and classes to use this information in a real-world application in their classes.

The High Winds fund is a thorny problem for calculating our emissions. Foremost is the dilemma on whether or not we should even include them in our calculations; because the properties are rented out, the tenants may consider the electrical and heating emissions to be Scope 1 and 2 of their own. As measured by the calculator, these emissions are Scope 1 and 2 for us as well. The second problem is tied as well to the fact that we rent them out. The tenants are the custodians of the energy bills, and Macalester has no implicit right to the bills. In order to find the usage, we must either go through a lengthy process asking tenants' permission, or go through Xcel's energy representative to get the aggregated data in anonymous form. Both options are highly labor-intensive, and may not be worth the effort, given that Macalester may not even be responsible for the emissions. For the coming years, auditors should examine the set rules for GHG collection, and make decisions based on that.

Electricity-Saving Recommendations:

Lighting: The Department of Energy estimates that about 25% of electricity used in office buildings is used for lighting. This number is probably slightly lower for Macalester, since we have residential and research space as well. Regardless, a lot of electricity—probably more than $200,000 yearly—is used lighting the College. To reduce this amount, we need to do two separate things:
first, increase the efficiency of lighting—that is, increase the useful lumens per watt. Macalester recently completed a switch-out of 15,000 inefficient fluorescent tubes, saving thousands of dollars every year. It needs to make more progress on other types of lighting, however; many areas still employ halogen bulbs, which are among the most inefficient methods of lighting still sold. The main reason we still use these is that capital cost is extremely low. Alternatively, many other types of lighting could be utilized. Most of the halogen bulbs are used in areas where spot-lighting is required, meaning tube fluorescents are useless. CFL bulbs could be used in these applications. Though not yet financially feasible—though feasibility could be possibly be shown using a full life-cycle analysis—LED bulbs will soon become the standard for high-efficiency lighting replacements.
Second, reduce the overall hours of lighting. Macalester also must make efforts to reduce the lighting itself. Now, it must be noted that I don't mean we should all wander around in the darkness—we shouldn't. Lighting unused areas, however, is essentially pointless and should be minimized. The main instruments here will be occupancy sensors, which have the ability to shut lights off after a specified period of non-occupancy. For example, a dorm pilot project is being done for FY 2010/11 to switch the lights in the hallways and lounges; it is projected to save about $1000 yearly, and have a payback of less than three years. This should be replicated across campus, and in the cases of the office buildings, the rest of the building systems should be tied in to these sensors, shutting off vents when rooms are empty, saving on heating emissions as well. Worth looking into is the combined effect LED lighting and occupancy sensor control can have; alone, each produces large savings, but together, they could be even more effective. This is because LED bulbs don't suffer from reduced life with frequent switching, meaning no-occupancy intervals could be shortened to as little as thirty seconds, rather than the fifteen minutes recommended for fluorescent bulbs.

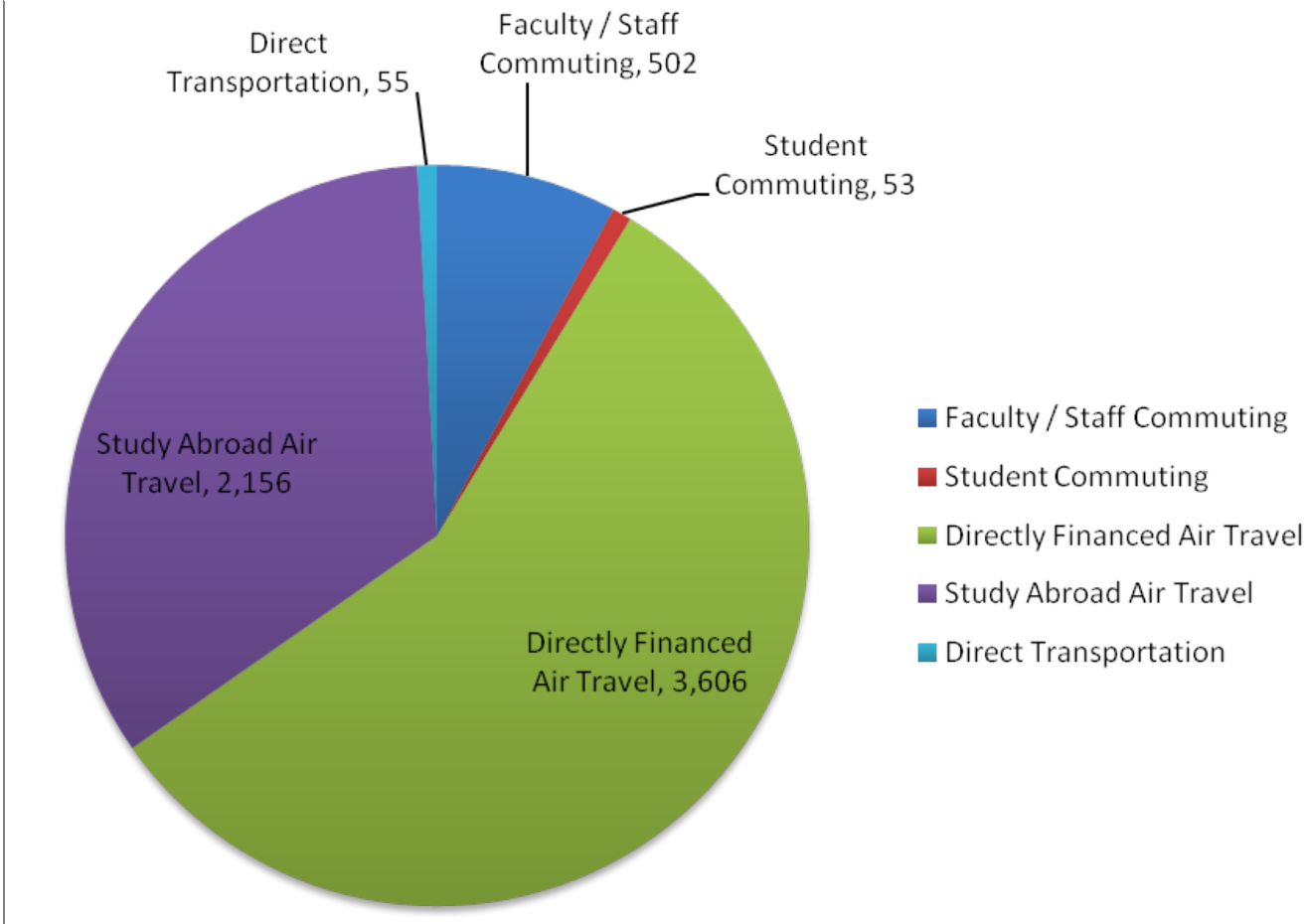
Production: It is generally considered financially imprudent for a non-profit to attempt to generate its own renewable electricity, since it is unable to take advantage of any tax credits offered by the government. On the other hand, if done through a lease-to-own agreement with a for-profit third party, such an arrangement could be effective. This type of arrangement would be beneficial to both our finances and our Greenhouse Gas Emissions, and should be considered every year or two, so the College can make that investment as soon as financially wise.

Personal Factors: Individual student and faculty involvement can be just as effective as technological efficiency improvements. A few years ago, students at Macalester started the Minnesota Campus Energy Challenge. The challenge is to reduce overall energy consumption by as much as possible over the course of each February, and to reduce it more than any of the other participating schools. For the 2008/09 fiscal year, the competition yielded a 12% reduction over the previous February. It should be noted however that the weather normalization for this competition is performed by students at a liberal arts college. In addition to competitions to increase awareness, the College should encourage more efficient appliances; refrigerators are supposed to use about 50% of electricity in a dorm room, so a policy encouraging or mandating Energy Star appliances would be highly effective. Power strip management awareness should also be incorporated.

Transportation: 6373 MT eCO_2 (32.1% of overall emissions)

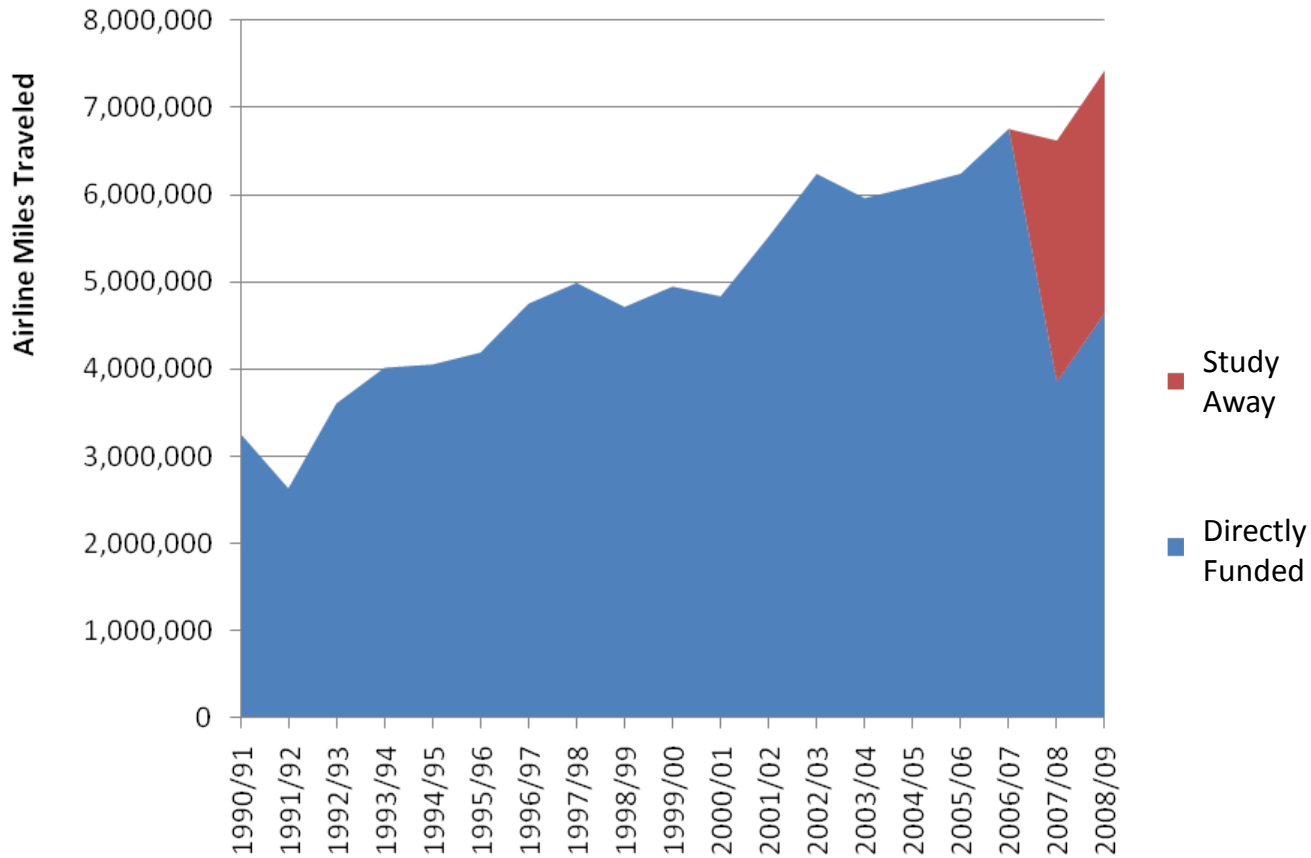
Transportation is the broad category that contains five different sectors in the CA-CP calculator; Directly Financed Air Travel, Study Abroad Air Travel, Faculty/Staff Commuting, Direct Transportation and Student Commuting. Please note that the emissions from students traveling from their permanent residences to and from Macalester are not included; nor are emissions from students, faculty, and staff making non-commuting trips.

Figure 10 – Transportation Emissions by Sector (MT eCO_2)



The “Directly Financed Air Travel” category includes all flights paid for by Macalester College, and the “Study Abroad Air Travel” category covers all miles flown on the way to and from a study away destination. The directly financed category includes flights to and from conferences, meeting with potential donors, recruitment and admissions, etc. The way that these data are calculated changed significantly in the last year - please see page 12 for details. Part of the overall data change was the addition of the Study-Away Airline travel category, which appears only in the most recent two years; prior to that, study away miles were wholly ignored.

Figure 1.9 Annual Total Airline Miles Traveled



The CA-CP calculator currently requests the actual miles traveled for its calculations, which the school does not track as a part of its accounting procedures. In order to calculate the total miles it is necessary to estimate the relationship between dollars spent and miles – with varying degrees of accuracy. The following page describes in great detail the process used to determine the total miles traveled.

2006/07:

The Environmental Studies students took the total amount of money spent on airfare and applied a $/mile ratio calculated by the US Department of Energy. Since there were two different $/mile ratios for domestic vs. international flights the team had to decide what percentage of flight were domestic and what were international. They estimated that 88% of flights were domestic and 12% international. This projected that Macalester faculty and staff traveled 6.7 million miles, adding a total of 5,240.7 MT of eCO_2 to our emissions.

2007/08:

The air travel calculations for 2007-08 were done in more detail by students from the 2009 Geography Senior Seminar. They used Procurement records to track the destination of each airline trip and individually calculated each flight directly paid for by the school for faculty and staff. This study calculated a total of 1.88 million miles, with an average of 4.27 miles per travel dollar spent. Since only 49% of the total College air travel expenses were expended through the P-card system this miles/$ ratio was applied to the rest of the air travel budget, which calculates a total of 3.85 million miles traveled. Although there appears to be a reduction of 2.9 million miles, or 2,251 MT eCO_2, there were no discernible changes in Macalester employees' travel habits and thus the reduction is due to changes in calculation methodology.

2008/09:

The estimate for the 2008-2009 air travel emissions utilized Procurement records from May '09 to track dollars per mile. These records, after controlling for baggage and agent fees, yielded a ratio of 18.75 cents per mile, or 5.3 miles per dollar. This ratio was then applied to the rest of Macalester's airline expenditures, again accounting for baggage and fees. There is a rather high margin for error here, since cost per mile presumably varies during the year; Procurement's new data collection software was not set up properly, making unavailable the full year's P-Card data, though, so a workaround was developed. This workaround used the total dollar amount charged to the airline account code, subtracted baggage and agent fees (using the percentage calculated for May). Next, the ratio of 18.75 cents per mile was applied, yielding a total of 4,645,144 miles. This was a total increase of 789,612 miles, or 20.4%, over 07-08. We suspect that this change was the result of a change in the metrics used and a result of the poor data quality, and not actually representative of an increase in the total number of miles flown.

Travel Accounting Procedure

The accounting codes for air travel did not distinguish between international and domestic flights prior to 2007. This made it very difficult to calculate emissions using the US Department of Energy miles/travel dollar ratios. The account codes have now been changed so that international and domestic flights are recorded in separate categories automatically. There has been significant lag, however, in staff and faculty using the appropriate codes, so relying on the changed codes is not yet a good idea. In addition, the accounting codes for ground transportation previously recorded all travel related expenses such as gas, parking, rental fees and tolls in one category. In order to calculate the emissions from Macalester funded ground travel it is necessary to track the gas purchases separately. This account code has now been divided into a separate fuel purchase code, and a parking/tolls code. These accounting changes do not take effect until June 1st 2009, and thus will first apply to the 2009-10 audit. As with the air travel codes, many faculty and staff are not yet accustomed to using the new codes, so any data is suspect for the time being.

Study Away Airline Travel:

Since the first year study away air travel was included in the GHG Inventory (2007/08), there have been no substantial changes in methodology. In 2007/08, students flew a total of 2,762,240 miles. In 2008/09, student flights associated with study-away totaled 2,777,538 miles, emitting 2156.3 MT eCO_2. This module tracks the total miles flown by students traveling to and from study away programs. Since the school does not pay for these flights there is very limited information about the travel plans for each individual student, so a set of assumptions was created to make estimation possible. All of the students were assumed to fly from Macalester directly to and from the city where their study-away program was located. This does not take into account the fact that many students likely fly from their permanent addresses to and from their study abroad locations. This calculation is thus likely an underestimation of the actual miles flown. For more information on these calculations please see Appendix III – the 2009 Macalester Transportation Study. For fiscal year 2009/10, students were asked to record the miles flown on their own, allowing us to take into account their actual departure point. This should greatly increase the accuracy of this section.

Scope 2 T&D Losses: 634.5 MT eCO_2 (3.2% of overall emissions)

Transmission & Distribution Loss is the energy that is wasted by the long distance transport of electricity. This is the first year that this has been calculated separately from the Purchased Electricity category. This category is very much up to the utilities to address—through the implementation of smart grid technology, it has been asserted that these losses can be cut substantially—but the College would be able to address this in two different ways: First, by simply reducing our electricity consumption, this category will drop by the same percentage. Second, we can produce our own electricity. There was a student push for installing cogeneration equipment on campus a few years ago—when the boilers are next replaced, this option should be explored again. Production of solar and wind energy on campus would have nearly zero T&D losses, as well.

Faculty / Staff Commuting: 501.7 MT eCO_2 (2.5% of overall emissions)

This is an estimated calculation of the fuel used by faculty and staff commuting to and from work and on work-related local travel throughout the year. While this is usually a large percentage of the average employee's personal emissions, it is a very small percentage of Macalester College emissions. This is because most employers don't run student dorms, research facilities, and food services. Also, many employees in a 'normal' office do not travel quite as often.

This year we estimated our commuting emissions based on a survey and report conducted by Damian Goebel of St. Paul Smart Trips. The basic finding was that 67% of employees drive alone; 3% take mass-transit; 4% carpool; and 24% either bike or walk. Notice that our bike/walk percentage is rather high for an employer. This is because Macalester has taken great pains to attract faculty and staff to live in the surrounding area—the High Winds fund is dedicated to community-building investment, part of which goes toward programs to attract Macalester's employees to the area. Subsidized bus passes are also available to all members of the Macalester community. To further reduce emissions in this area, the college recently (Spring '10) added a pre-tax commuting benefit. In the future, Macalester would be well-served by eliminating free parking, which amounts to a huge subsidy for individualized vehicular transport. The switch would financially and aesthetically benefit Macalester as well, since the College could convert less-demanded parking spaces to either green space or new buildings, and would no longer be faced with the upkeep of as many lots.

Paper Purchasing: 86 MT eCO_2 *(.43% of overall emissions)*

Paper purchases contributed 86 MT eCO_2 in 2008-09. This is calculated from the number of pounds of paper of various levels of recycled content that is used each year. The records of total paper purchased were obtained from our Document Services contractor Loffler. In total, 21,926 lbs of paper with no recycled content, and 50,350 lbs of paper with 30% recycled content were used by all staff and faculty departments across campus. Please see Appendix II. The paper use records for years previous to 2007/08 were no longer available, so it was not possible to retroactively update the calculator. Though the highest post-consumer content for fiscal year 2008/09 was 30%, for FY 2009/10 the campus made a switch to 100% post-consumer recycled content which utilized no chlorine bleaching. Though Macalester does have a centralized paper purchasing program, it is possible that individual departments purchase outside this program; these purchases are unknown and thus not included here. As briefly mentioned earlier, paper purchases are one of the areas of our greenhouse gas emissions that contributes a relatively minor amount of eCO_2. However, there are many effects of paper usage not considered by the Calculator, including environmental and social costs to both deforestation and the manufacturing process. The Calculator also fails to account for toner and ink usage, both of which are environmentally hazardous. As a result, though this category is secondary to larger categories in terms of GHG emissions, it ought not be neglected.

Direct Transportation: 55 MT eCO_2 *(.30% of overall emissions)*

Direct Transportation is a measure of the emissions of all campus-owned vehicles, or non-airplane travel directly paid for by the school. This covers emissions from Facilities Services vehicles, the van fleet, buses for field trips or sports teams, etc. Currently, Macalester's vehicle pool consists of 6 large vans, which have their uses. There is not, however, any easy access to smaller vehicles for College use. The HourCar program, which has a site near our campus, is supported by the College, but drivers must be certified by the program, which takes time and money, and is a larger hassle than using the College fleet, since so many people are already van-certified. I recommend we either make HourCar easier for both student organizations and faculty/staff, or provide one or two small vehicles as part of our fleet.

Student Commuting: 53.4 MT eCO_2 *(.27% of overall emissions)*

This includes all Macalester student transportation to and from their off-campus residences during the academic year. This number is very small in part because few Macalester students own vehicles, and also because they tend to live close to campus, making even the vehicle-dependent commutes shorter than average. This number could be further reduced by eliminating the subsidy we provide for individual motorized transportation in the form of free parking spaces.

Wastewater: 15 MT eCO_2 *(.08% of overall emissions)*

This category accounts for the emissions caused by the 29,616,125 gallons of wastewater produced by Macalester in fiscal year 2008/09. The vast majority of the emissions comes from the filtering of solid matter and the subsequent incineration and landfilling. A small portion comes from energy expended in pumping and a few other areas. These emissions can be minimized only indirectly; since we do not treat our own wastewater, the only way to reduce these emissions is to reduce our wastewater flow. Installing low-flow aerators, low-flow toilets and shower heads, and addressing stormwater runoff can have an enormous impact here.

Agriculture (Landscaping): 8 MT eCO_2 *(.04% of overall emissions)*

Our only source of agriculture emissions is fertilizer application on campus lawns. Modern fertilizer is largely synthesized from natural gas, and requires huge energy input. This category will slowly be addressed as Macalester's new Landscaping Master Plan, which incorporates low-maintenance, low- or no-irrigation plantings, to make the campus as sustainable as possible.

The amounts of fertilizer applied per year at the moment are an estimate and have not changed for the last few years. While the impact from this sector of emissions is relatively small, it also has an impact on water quality – which is particularly relevant given Macalester's location very close to the Mississippi River. There should be a clear record of the total number of pounds of fertilizer applied each year and the nitrogen content, as the nitrogen oxides as the main source of fertilizer-based global warming impact.

Solid Waste: 48 MT eCO_2 *(.24% of overall emissions)*

In fiscal year 2008/09, Macalester produced 427 short tons of undiverted waste. The majority of Macalester's waste (320 short tons) was placed in a landfill where methane is captured and burned to produce electricity. A small amount (107 short tons) was transported to a waste-to-energy plant. As with paper purchasing, this category, though relatively small, is quite important; beyond greenhouse gas emissions, any method of disposing of waste is quite harmful. To begin with, landfills are generally quite huge, taking up what is often good land, either for agriculture or natural uses. Landfills also have a rather large risk of leaking hazardous chemicals—think mercury, cyanide, and many other man-made hazardous compounds—which often then leach into human groundwater supply, causing health problems. Even ignoring their ability to leak and cause human health crises, landfills have a strong depressive effect on the land around them largely due to their noxious fumes; property values drop, and when located near or in a population center, the surrounding area often becomes an area of urban blight. All told, these are not effects a forward-thinking institution like Macalester wants to foster.

On the data side of things, our data collection for solid waste is sometimes spotty; Veolia Environmental Services, our contracted trash hauler, does provide us with monthly weight data, but there are often gaps in the data. By amending the contract to ensure that no more data gaps happen, we could be much more precise in this category.

Refrigeration (Unknown)

The refrigeration category still does not have any information listed, because the College does not have a database of this information. There are two main places that refrigerants can leak: the chiller plant, and food service. The chiller plant recently underwent a retrofit, replacing the CFCs with HFCs, which are less harmful to the environment. It is not known what type of refrigerant Bon Appetít uses. A system should be set up to record leaks into the air, both so we can use the data for our own GHG emissions inventories and to ensure that we comply with EPA regulations.

Food (Unknown)

Macalester does not track food purchases for the purpose of measuring eCO_2 emissions. We contract through Bon Appetít, which does make a strong effort to be as sustainable as possible; they have a responsible fisheries policy, and they attempt to source at least 20% of their budget locally, among other initiatives.

Data Summary:

In the fiscal year 2008-09 Macalester College emitted 19,845.3 metric tons of carbon dioxide equivalents, largely due to heating, electricity and air travel. These emissions represent a 2.5% increase from the 19,362.7 eCO2 emissions in 2007-08. Scope 1 emissions rose .7%, Scope 2 fell 1%, and Scope 3 rose nearly 9%. This apparent increase is in large part due to increased accuracy in data collection and does not represent an actual increase. Most of the change in eCO_2 emissions derives from the Air Travel sections, where data collection is inherently suspect. On the whole, it appears as though Macalester is likely on a long-term downward slide in emissions, as was seen in Figure A.

In terms of methodology, certain measures—notably air travel—need to be tightened up and improved. In the case of air travel, this can be done by convincing a greater percentage of employees to make use of the P-Card system rather than check reimbursement, as well as by making regular data pulls from Payables' new system. On the whole, however, our data collection procedures are much more accurate than they were even a few years ago, and they will continue to improve, making our GHG estimates quite reliable.

Final Recommendations:

- Continue improving methodology in order to better reflect our progress.
- Avoid offsetting emissions—with the exception of Markim Hall—until all feasible efficiency and energy-reduction improvements have been made. By offsetting emissions for a price, we are sending the message that sustainability is expensive; this perception should be avoided.
- When economically advantageous, invest in electrical generation, both on- and off-campus. This would include solar PV, wind turbines, and solar hot water. These technologies are not yet financially viable, however, and should be monitored, either each year or every other year, so we can utilize them as soon as they become good investments.
- To reduce directly-financed air travel, install and improve telecommuting facilities and offer departmental incentives to make use of them. In addition, two methods to decrease emissions could be utilized. First, offer a college-subsidized offset program, to encourage departmental offsets by reducing their cost to departments. Second, encourage flying on certain airlines and certain planes, since efficiency does vary widely. At least one study has also shown that flying at night produces more warming through the contrails, so encouraging employees to fly by day would be effective as well.
- Offer an emissions-offsetting program for Study Away trips. Due to financial constraints, this would likely be a voluntary program, but perhaps the same college-subsidized offset program for employees could be used for students as well. In addition, students should be made aware of the effects of their emissions, though no effort should be made to curtail these trips, since the educational value almost definitely outweighs the emissions.
- After cutting total heating requirements as much as possible, switch to 100% natural gas heating.
- Continue, enhance, and supplement current behavioral education programs.