2007-08 GHG Inventory

Executive Summary

This report is the first annual update to the Macalester College Greenhouse Gas Emissions Audit conducted by the Environmental Studies Senior Seminar in Spring 2008. While that project was a comprehensive audit from 1990-2006 this report only covers Macalester emissions in the fiscal year 2007-2008, and should be examined in concert with the original audit.

Outline:

1. 2007-2008 Emissions Audit
2. Comparison and Historical Trends
3. Changes in Audit Methodology
4. Update on Initial Report recommendations
5. New Recommendations
6. Climate Action Plan/Strategic Planning

Other Documents:

1. 2008 GHG Emissions Calculator
2. 2007-2008 GHG Figures and Charts – includes data tables and graphs for this years results and historical trends.
3. 2009 Macalester College Institutional Climate Action Plan

2007-2008 Emissions Audit

In the fiscal year 2007-08 Macalester College emitted 19,351 metric tons of carbon dioxide equivalent. These emissions predominantly come from heating, electricity and air travel. This is an 11% reduction from the 21,675 eCO_2 emissions in 2006-07.[1]

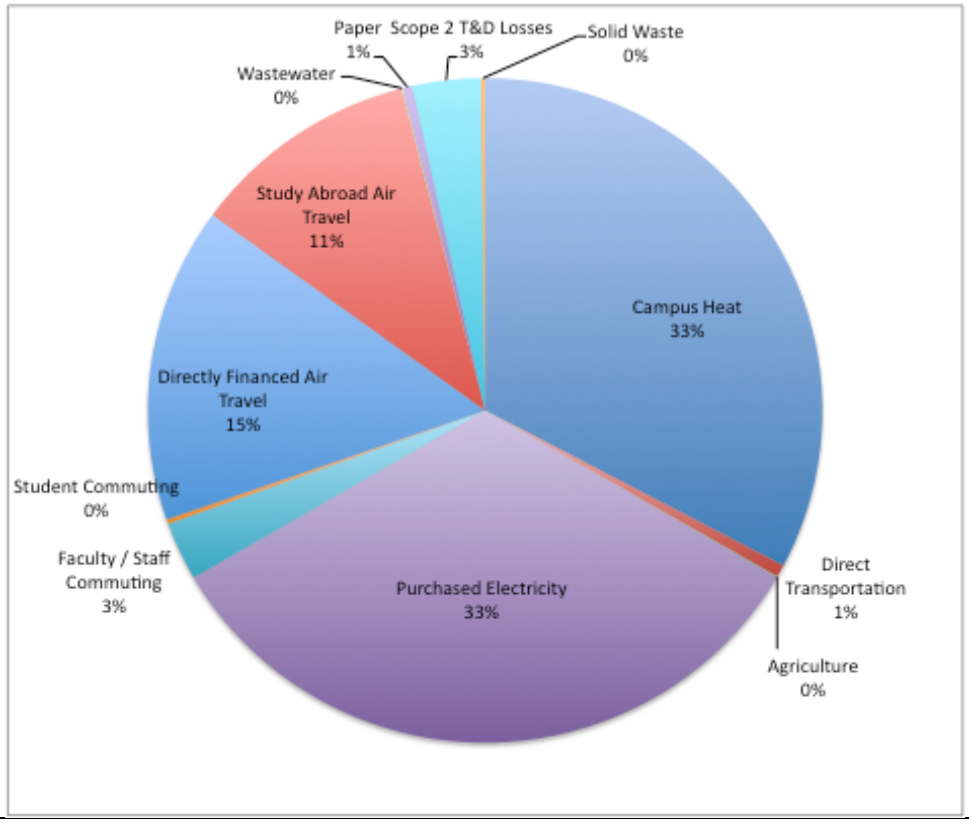

Figure 1.1 Macalester College GHG Emissions per Sector for 2007/08.

Purchased Electricity: 6,482 MT eCO_2 (33% of overall emissions)
In 2007/08 electricity was the single largest source of emissions. This section includes all electricity purchased by the College, including the electricity that runs the main campus chiller plant and air conditioning in the auxiliary buildings. Macalester College purchases electricity from the local utility Xcel Energy. There is a small wind turbine on campus, but on average it produces less than 0.01% of total campus consumption.

[1] **Please Note:** This is in large part due to increased accuracy in data collection and does not represent an actual decline. Section 3: Changes in Audit Methodology explains this changes in detail and should be considered carefully. The 21,675 MT eCO_2 is different than the results reported by the 2008 ES Senior Seminar – this is due to the electricity custom fuel mix changes being applied retroactively.

Campus Heat: 6,386 MT eCO_2 (33% of overall emissions)
This includes all of the fuel used to heat Macalester Campus throughout the year. Macalester has a central heating plant that burns either natural gas, fuel oil #2 or fuel oil #6 depending on price and availability. This also includes all of the natural gas used to heat the auxiliary buildings that are not connected to the central plant.

Directly Financed Air Travel: 2,993 MT eCO_2 (15% of overall emissions)
There are two separate air travel categories in the CA-CP calculator. This section includes all air travel directly paid for by Macalester for all students, faculty and staff.

Study Abroad Air Travel: 2,144 MT eCO_2 (11% of overall emissions)
This section calculates the impact of Macalester students traveling abroad for study away programs. While the College does not directly pay for these tickets, the travel is considered integral to the educational experience and the emissions are thus included in campus calculations.

Scope 2 T&D Losses: 641 MT eCO_2 (3% of overall emissions)
Transmission & Distribution Losses 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.

Faculty / Staff Commuting: 555 MT eCO_2 (3% 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.

Direct Transportation: 116 MT eCO_2 (3% 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.

Paper: 87 MT eCO_2 (<1% of overall emissions)
This section tracks the emissions from paper consumption. This is the first year that paper use has been tracked for the GHG emissions audit.

Student Commuting: 44 MT eCO_2 (<1% 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 partly because few Macalester students' own vehicles, and they tend to live close to campus.

Wastewater: 11 MT eCO_2 (<1% of overall emissions)
This section includes only potable water flushed into the sewage system, and does not account for irrigation water or stormwater impacts. The majority of these emissions come from the treatment and incineration of Macalester-produced sewage.

Agriculture: 8 MT eCO_2 (<1% of overall emissions)
The only source of agriculture emissions is fertilizer application on campus lawns.

Solid Waste: 38.6 MT eCO_2
The majority of Macalester's waste is placed in a landfill where methane is captured and burned to produce electricity.

This Audit used the Clean-Air Cool-Planet Carbon Calculator Version 6.2, which is divided into three main scopes with 13 types of energy use or emissions that are relevant to Macalester College. Some of these are new to this version and so Macalester does not have historical information to compare to (please see the "Changes in Methodology" section for more information). This report includes 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)

Comparison and Historical Trends

This section examines the 2007-08 results in relation to the historical trends. All of the following graphs, along with others, can be found in the spreadsheet 2007-2008 GHG Figures and Charts, available at macalester.edu/sustainability/.

Electricity

This sector has consistently been one of the largest sources of Macalester's GHG emissions over the last 18 years. Figure 2.2 shows the total number of kWh purchased annually since 1999/00. This chart does not include the electricity produced by the wind turbine on-campus, but this is negligible at than .001% of campus production. The total amount of electricity used on campus has trended downwards over the last 5 years; however it is hard to attribute this decline to a particular factor. Facilities Services generally installs more efficient equipment when it replaces mechanical and electrical systems, and there have been several student-led efforts over the last 3 years to reduce electrical consumption by encouraging behavioral change. There are possibly other, unknown factors at work as well.

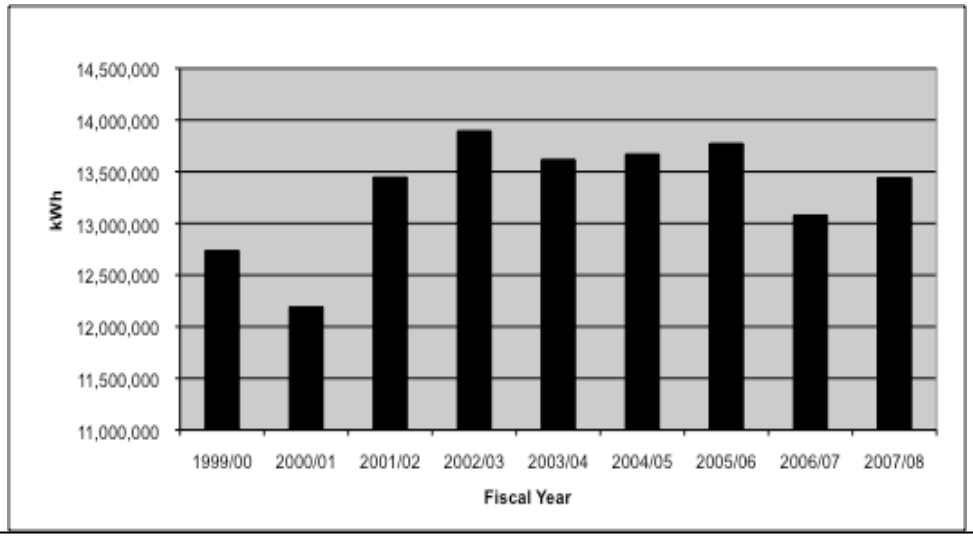

Figure 1.2 Annual kWh from 1999/00 – 2007/08

The next graph (Figure 1.3) shows the actual eCO_2 emissions over time from electricity. This graph is not identical to the total number of kWh because the energy mix that the utility Xcel energy uses each year changes independently of the amount of electricity consumed. 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.

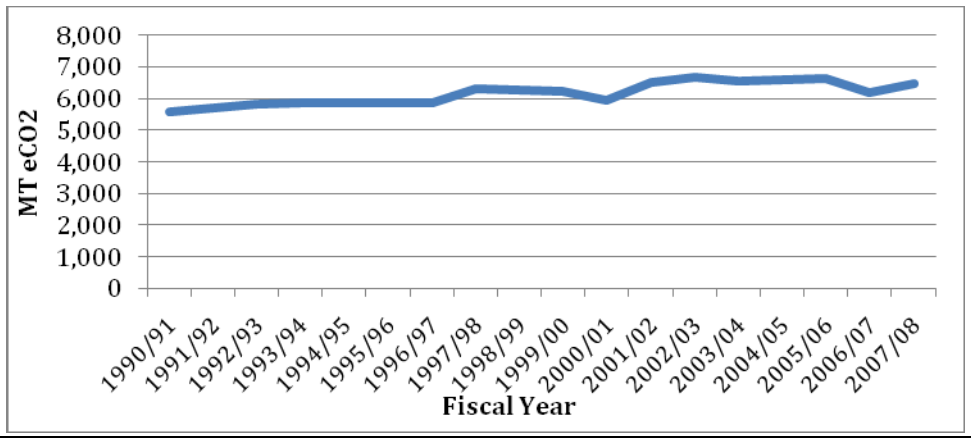

Figure 1.3 Total Electrical Emissions over time in MT eCO_2.

The second largest sector of emissions comes from the Central Heating Plant, which burns a mixture of fuel oils and natural gas, depending on season, availability and prices. The total amount of energy needed to heat campus depends heavily on the weather each winter, which is why this graph can change so dramatically from year to year.[2] 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 CO_2 per unit heat than natural gas and has a disproportionate impact on total emissions.

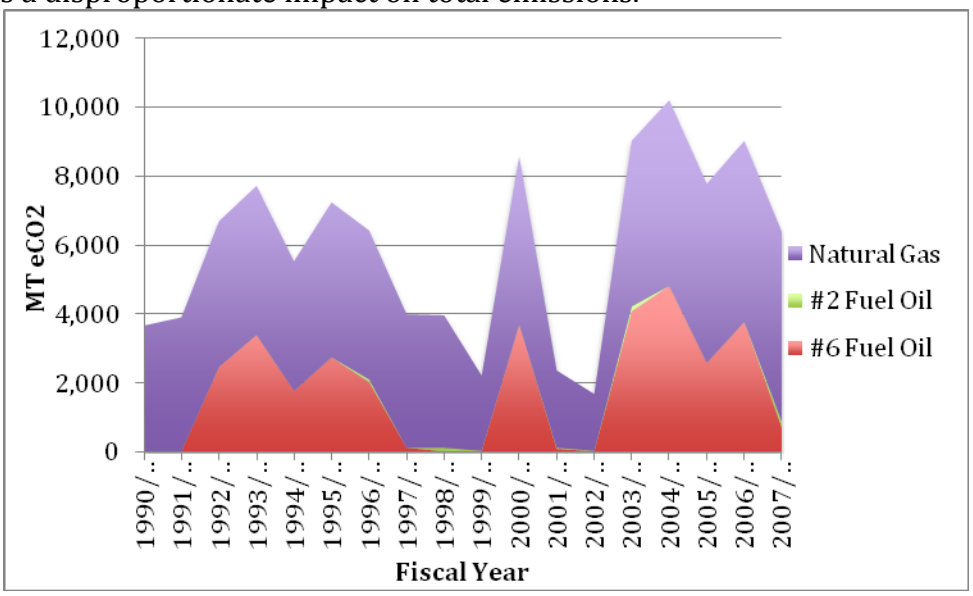

Figure 1.4 Total Heating Emissions by Fuel Source. Fuel oil #2 is barely visible because it is such a small percentage of total fuel used on campus.

[2] It is also possible that some fuel usage was not recorded in the past. Steps are being taken to ensure that all energy usage is tracked accurately in the future.

To demonstrate the impact that heating fuel choice has on total emissions figure 1.5 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.

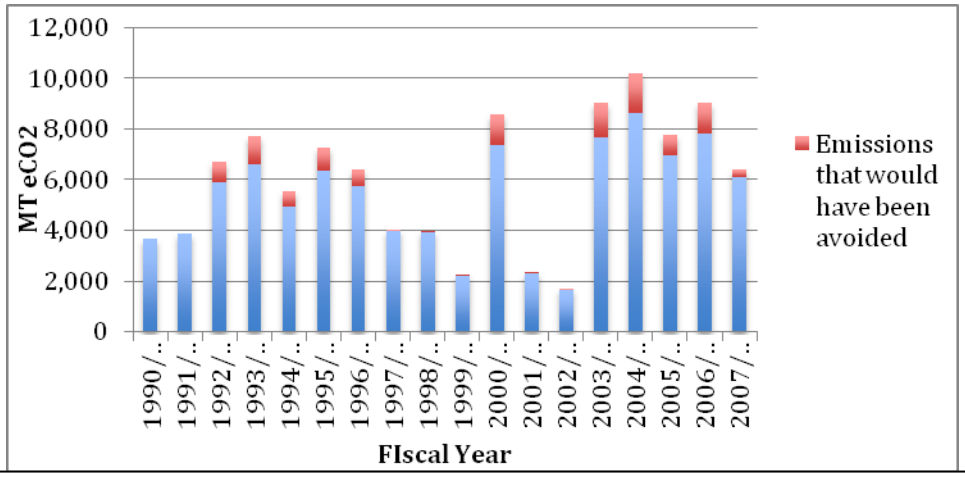

Figure 1.5 Annual Heating Emissions if all Fuel Oil was replaced with Natural Gas.

The next graph shows the changes in Heating Degree Days (HDD) per year. One HDD is defined as a 24 hr 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.

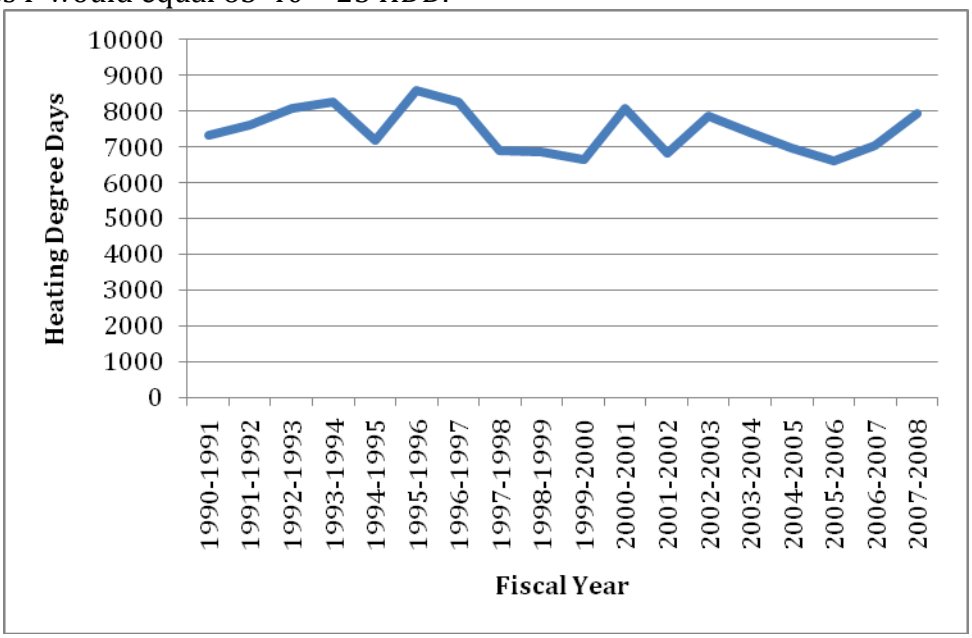

Figure 1.6 Annual Heating Degree Days

Figure 1.7 below shows the total emissions annually since 1990/91 by each individual sector of emissions tracked in the CA-CP calculator. A careful examination will reveal that the total variability in annual emissions is driven predominantly by changes in heating. The rest of the emission sectors remain relatively stable year-to-year.

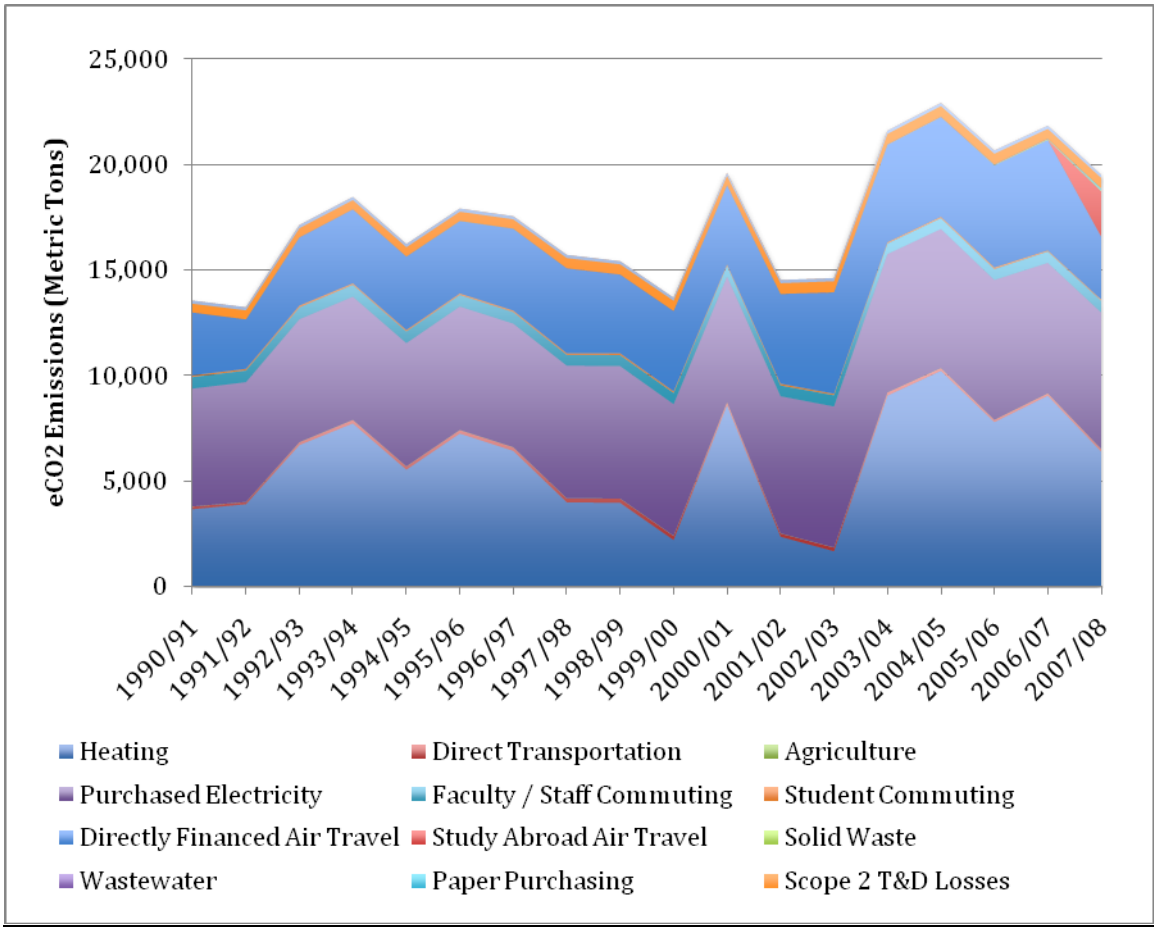

Figure 1.7 Total Annual Emissions by Sector

Transportation

Transportation is a general 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.

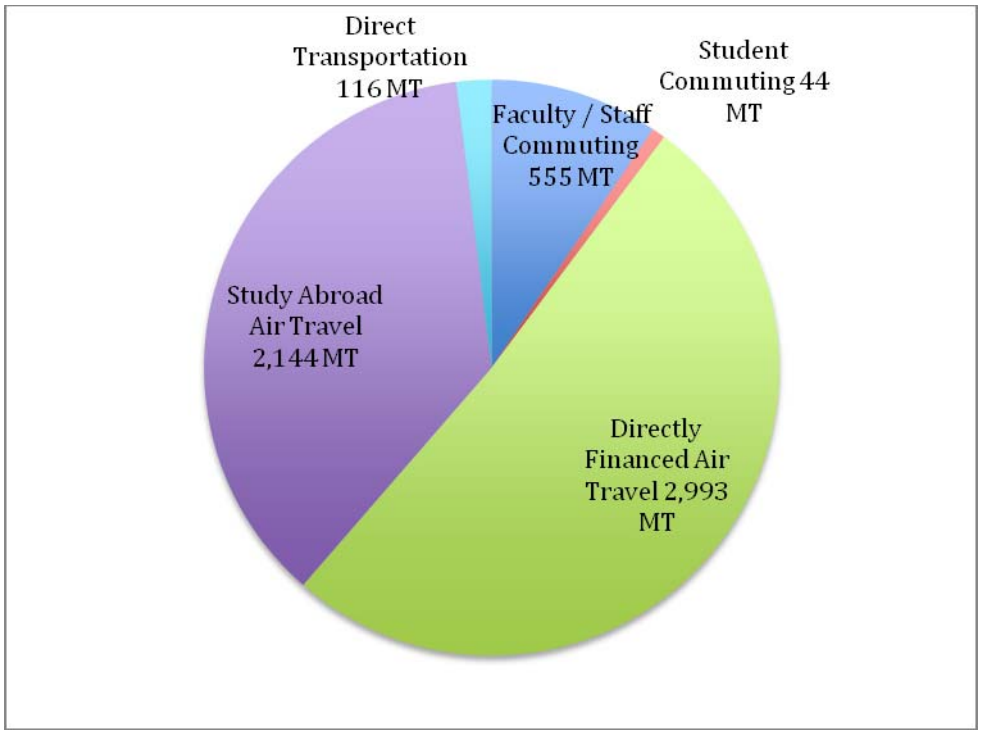

Figure 1.8 Transportation Emissions by Sector (MT eCO_2)

The "Directly Financed Air Travel" category includes all flights paid for by Macalester College. This includes flights to and from conferences, meeting with potential donors, recruitment and admissions, etc. The way that this data is calculated changed significantly in the last year - please see Section 3 Changes in Audit Methodology for more information. Part of this data change was the addition of the Study-Away Airline travel category, which appears only in the most recent year in Figure 1.9.

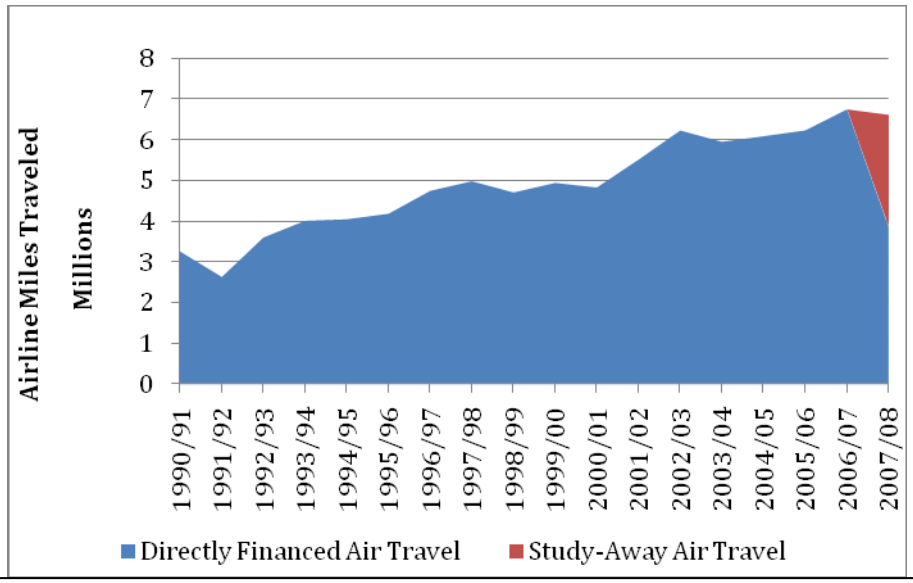

Figure 1.9 Annual Total Airline Miles Traveled

Changes in Audit Methodology

The difference in net emissions between 2006-07 and 2007-08 appears to be a significant 11% reduction. Much of this reduction cannot be attributed to actions taken by Macalester College, but instead comes in large part from two significant improvements in data collection. There also two new sources of emissions that have been added in this version of the calculator.

Data Collection Improvements

Airfare

The CA-CP calculator 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 how many miles flown each dollar spent represents – with varying degrees of accuracy.

Last year the student auditors 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.

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.

Electric Generation

The second significant methodological change comes from an adjustment in the carbon intensity assumptions for Macalester's purchased electricity. When the student auditors calculated electrical generation emissions last year they used the average carbon intensity provided by the calculator for the Mid-Continent Area Power Pool (MAPP)– this is 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 predominantly use coal to generate electricity, while 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.

This year we isolated Xcel Energy's fuel mix 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 43% of its electricity from coal. The total Xcel generation mix for all generated and purchased electricity can be found in Appendix I. When we entered in this custom fuel mix for our utility our electrical emissions in 2007-08 dropped by 4,621 MT eCO_2, or nearly 41%. The custom fuel mix was only calculated and entered for the last three years. 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 2025, and a total 25% must be wind generated.

Clean Air – Cool Planet Calculator Additions for 2007-08

The CA-CP Calculator version 6.2 also adds Paper and Study Abroad Travel sections that were not included in the 1990-2006 Macalester Carbon Audit.

Paper

Paper purchases contributed 87 MT eCO_2 in 2007-08. 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 calculator does not have an input location for 30% recycled paper, so the 50,350 lbs were entered in the 25% recycled content section. The paper use records for years previous to 2007/08 were no longer available, so it was not possible to retroactively update the calculator.

Study-Away Travel

Student flights associated with study-away emitted 2,144 MT eCO_2 in 2007. 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 layovers en-route, nor 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.

Update on Initial Report Recommendations

Data Recommendations

Annual Energy Report

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.

Energy Efficiency

The Macalester Carbon Audit 1990-2006 made a general recommendation to study buildings and HVAC systems on campus to determine what energy efficiency gains could be made through upgrades and new infrastructure investments. Macalester is currently undergoing two large studies that will provide detailed information about ways to save energy and money. The first is a study of the boilers in the Central Heat Plant and the distribution system that supplies steam to all of the main buildings. This study is being done for free as a pilot project with the local utility Xcel Energy.

The second project is a detailed recommissioning study of the largest 16 structures on campus. When completed this report will lay out all of the various options that Macalester has to invest in energy efficiency on campus. These studies should be used to create a five-year infrastructure investment plan to reduce energy use, costs and emissions. Macalester College has the capacity to fund efficiency projects even in this tough economic climate due to its sizable endowment and good credit rating. Rather than an additional cost in a difficult budget situation, energy efficiency should be viewed as an investment with a high rate of return to the College.

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 DOE miles/travel dollar ratios. The account codes have now been

changed so that international and domestic flights are recorded in separate categories automatically.

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.

Solid Waste, Refrigerants, and Food

These three sections all suffered from poor data availability last year, and there has not been much improvement in these areas this year. The tons of solid waste produced is reported by the waste vendor Veolia Environmental Services but there are regularly gaps in these reports which makes it difficult to accurately track waste generation on campus.

Refrigeration still does not have any information listed, because the College does not have a database of this information. The only update to this section is that the Central Chiller plant was replaced this winter and now uses HCFCs instead of CFCs. This will reduce the effect on the ozone layer, however it is unclear what impact this will have on campus global warming impact.

Macalester's food provider Bon Appétit is currently working on a company-wide assessment of the GHG footprint of their operations. It is hoped that in the future Bon Appétit will be able to provide Macalester with an invoice detailing the total emissions associated with food services, but that is not yet feasible.

New Recommendations

Data Recommendations

Refrigeration

Facilities Services needs to establish a clear and accurate tracking system to record leaks of refrigerant chemicals into the atmosphere. While the HCFCs in the new Chiller Plant are an improvement in terms of ozone pollution, they are very powerful greenhouse gases and so any escape of refrigerant has a disproportionally large impact on emissions. It is necessary to record the total amount of refrigerant that leaks out into the atmosphere each year, both to ensure compliance with EPA regulations and to calculate the effect on the greenhouse audit.

Fertilizer

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 lbs of fertilizer applied each year and the nitrogen content, as the nitrogen oxides as the main source of fertilizer-based global warming impact.

Electricity

The Sustainability Office should continue to factor in the Xcel generation percentages for all electricity sold to the College per year to account for the future changes in fuel mix required by the Minnesota Renewable Energy Standard. This increaser in the amount of renewable energy sources in MN will help Macalester to reach carbon neutrality – at least in terms of its electrical consumption.

Solid Waste

The waste vendor for Macalester College is Veolia Environmental Services. While Veolia does provide Macalester with monthly weights for its waste pick-ups there are often gaps in the data. Facilities Services should work with Veolia to improve the accuracy of the data collection, and could perhaps require data reports in the waste contract to ensure accurate reporting.

Air Travel

The air travel study done by the 2009 Geography Senior Seminar students used the information recorded in the Procurement Card system. This information is very easy to obtain and work with, and should continue to be used in the future. However, only about half of the total air travel purchases made in 2007-08 were run through the P-card system. The Sustainability Office should work with the Procurement Office to encourage more participation in the P-card system.

Paper

The paper information this year only includes the purchases that were placed with Document Services. While it is believed that most of the paper purchases on campus are ordered this way, it is also possible that individual

departments are ordering paper through Corporate Express. This should be examined next year to see how accurate the current numbers are. Also, while there have been rumors that all of the campus is using 30% recycled paper only 71% of the recorded paper purchases actually contain recycled content. This is likely due to the decentralized nature of procurement on campus, and this percentage will most effectively be raised through an education campaign targeted towards department coordinators, or an institutional requirement that Document Services only provide 30% recycled content paper.

Other Recommendations

The 2009 Environmental Studies Senior Seminar has spent the last semester developing recommendations for the Macalester College Institutional Climate Action Plan for the Presidents Climate Commitment. Rather than duplicate their efforts with a list of GHG emission reducing suggestions please refer to the Macalester College Action plan, which will be released at the end of the 2009 Spring Semester. This will be a part of a larger Sustainability Plan for Macalester College.

Appendix I

Generation Sources of Electricity sold by Xcel Energy

	2005-06	2006-07	2007-08
Coal	43.5%	41%	43.5%
NG/Oil	12.5%	16.5%	13%
Nuclear	27.5%	27.5%	27.5%
Hydro	5%	8.5%	7.5%
Biomass	1%	2.5%	2.5%
Wind	10.5%	4%	6%

Appendix II

Paper Usage

Paper Size	Total # Sheets	# Sheets (30% recycled)	# Sheets (nonrecycled)	Recycled Paper	
8.5 x 11	7,010,000	5,000,000	2,010,000	71%	of total
8.5 x 14	42,000	15,000	27,000	36%	of total
11 x 17	67,380	8,000	59,380	12%	of total

This spreadsheet includes all paper used by or ordered through Document Services in Fiscal Year 2007-2008.

	Total Recycled Paper	Total NonRecycled Paper	Total Pieces of Paper
	5,023,000	2,096,380	7,119,380
		71%	campus recycled paper

Calculations for weight of 30% recycled paper

Paper Size	Total Sheet Count	# of Reams	Ream Weight *	Total Weight (lbs)
8.5 x 11	5,000,000	10000	5	50000
8.5 x 14	15,000	30	6.35	190.5
8.5 x 17	8,000	16	10	160
			Total Weight Rec. Paper	50350.5

#20 8.5 x 11 (30%)	8.5 x 14 (30%)	11x17 (30%)
5,000,000	15,000	8,000

Calculations for weight of non-recycled paper

Paper Size	Total Sheet Count	# of Reams	Ream Weight *	Total Weight (lbs)
8.5 x 11	1,969,000	3938	5	19690
8.5 x 14	44,000	88	6.35	558.8
8.5 x 17	83,380	166.76	10	1667.6
			Total Weight Non-Rec. Paper	21916.4

* Ream weight is assumed to the same as #20 paper for all of the numbers below. It is complicated to calculate each of the heavier weights, and their relative contribution is minimal

20# white 81/2x11	81/2x14 20#white	11x17 20# white
1,510,000	17,000	17,000

20# color 81/2x11	81/2x14 20# color	11x17 20# color
290,000	4,000	18,000

24# white 81/2x11	81/2x14 24# white	11x17 24# white
75,000	4,000	9,000

60# color 81/2x11	81/2x14 60# color	11x17 60# color
64,000	2,000	7,000

65# color 81/2x11	81/2x11 67# white	81/2x11 67# color
25,000	9,000	18,000

70# color 81/2x11	11x17 70# color	81/2x11 80# white
2,000	1,000	10,000

11x17 80# white	81/2x11 80# glossy	11x17 80# glossy
3,000	7,000	4,380

NCR
17,000