Green House Gas Emissions Inventory for FY 2007-2008
Gustavus Adolphus College

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Introduction

This report outlines the estimate of the Gustavus Adolphus College (GAC) green house gas (GHG) emissions for the fiscal year 2007 and 2008. This estimate will be used as the college's baseline for the reduction of climate-changing green house gas emissions and for meeting the requirement of the American College and University Presidents Climate Commitment of which Gustavus is a signatory.

Background and Summary of Results

Over the past two decades the science of anthropogenic climate change began to be a larger focus of national and international debate. In 2007, that topic was given a prominent stage at Gustavus as the college hosted its annual Nobel Conference and focused on energy and climate changes issues. Just prior to that conference, then GAC President Jim Peterson signed the American College and University Presidents Climate Commitment (ACUPCC[1]) and in doing so committed Gustavus to inventorying its green house gas emissions and developing a plan to reduce them by 80% as soon as possible.

In January of 2008, James Dontje, Director of the Johnson Center for Environmental Innovation, presented a review of GAC energy use and greenhouse gas emissions titled "Energy Use and Greenhouse Gas Emission Reduction Plan Gustavus Adolphus College Draft Vers. 1.0"(attached) to the Trustees Finance Committee. That document estimated the 2006 GAC greenhouse gas emissions from natural gas and electricity use to be 22,390 metric tonnes CO_2e[2]. Based on GHG inventory data from another institution, the emissions from other sources were expected to be about 10% of the natural gas and electricity use emissions. The results of the more formal inventory presented here for the FY 2007-2008 show some variations due to changes in emissions factor and an upward revision of the fraction not due to electricity and natural gas use, but the overall picture remains the same—the bulk of our greenhouse gas emissions come from what are called "stationary sources"—electricity and natural gas use.

Table 1 summarizes the FY 2007-2008 GAC Greenhouse Gas Emissions Estimate and the following sections of this report outline the methods and supporting data used to generate these estimates. Note that the word "estimate" is used as a reminder that fundamental uncertainties in the underlying data and emissions factors makes all of these values estimates rather than exact quantities. The use of that word, however, does not imply that these emissions values cannot be used to guide decision-making. Possible errors in the data and the implications of those errors are discussed below.

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[1] See www.presidentsclimatecommitment.org for complete information about the ACUPCC effort.

[2] The British spelling "tonnes" is used to distinguish metric tons (1000 kg or about 2200 pound) from short tons (2000 kg). In subsequent use, the "metric" prefix will be dropped and "tonnes" will mean metric tons and the unit "tons" will refer to short tons.

Approximately 82% of the total 25,239 tonnes CO_2e GAC emissions is from natural gas and electricity use (stationary emissions). A simple sensitivity calculation that assumes an error of plus or minus 50% on all other sources of GHG emissions shows that the stationary emissions percentage would vary from 76% to 90%. The large magnitude of the stationary emissions makes clear that a substantial reduction in GAC GHG emissions will require focused attention on our buildings and how we operate them.

Table 1. Estimates of GAC FY 2007-2008 Green House Gas Emissions

Source[3]	**GHG Emissions (tonnes CO_2e)**
Scope 1	
Stationary Emissions: Natural gas use	8,316
Mobile Emissions: Campus operated vehicles	307
Scope 2	
Stationary Emissions: Electricity consumption	12,474
Scope 3	
Mobile Emissions: Outsourced air travel	2,260
Mobile Emissions: Faculty, staff, and student commuting	1,837
Mobile emissions: Outsourced bus travel	64
Solid Waste	-19
Total	25,239

This emissions inventory will be repeated for FY 2009-2010 under the ACUPCC framework that requires inventories every two years. A part of the repeat effort will suggestions for ways to modify our accounting and other recordkeeping systems to make generating this report a simpler and more automatic process.

At the end of this report is an acknowledgements section. Preparation of this report would not have been possible without the diligent recordkeeping by many GAC staff members, and their willingness to answer questions when the information was not easy to find. Additionally, several students have made contributions to this effort. The efforts of staff, faculty and students are acknowledged by name in that closing section.

Methodology

The methods used to prepare this report were built upon information found in the ACUPCC guide to greenhouse gas emissions reporting detailed in the ACUPCC website[4]. In addition to the obvious "stationary" and "mobile" designations, that methodology recognizes three "scopes of emissions, which are defined as follows with reference to the types of emissions appearing in the GAC inventory:

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[3] The "Scope" and "Stationary"/"Mobile" designations follow from the ACUPPCC reporting methodology (acupcc.aashe.org/instructions-ghg-report.php) which are explained below.
[4] acupcc.aashe.org/instructions-ghg-report.php

Scope 1 emissions originate directly from equipment owned or controlled by GAC. This includes stationary natural gas fueling heating and cooling equipment on campus, as well as mobile emissions from campus-owned vehicles.

Scope 2 emissions occur indirectly at off-campus locations but are generated as direct consequence of on-campus activity. Electricity consumption falls under this category

Scope 3 emissions are generally emissions generated as a direct result of campus activity which usually take place off-campus. Campus-generated air travel for athletic, academic (including study abroad), and campus business purposes is included here, as is faculty, staff and student commuting; campus-hired bus travel; and solid waste disposal emissions.

For a campus like Gustavus, that has almost all of its buildings within one contiguous area, physical boundary setting for the inventory is trivial, with the exception that natural gas and electricity consumption for several college owned houses adjacent to campus is included in the inventory.

Operationally, the picture is also simple. The off-campus (Scope 2) effects of on-campus consumption (e.g. food and paper) could arguably be included, but the ACUPCC protocol does not include these categories.

A fiscal year reporting period (June 1 to May 31 for the following year) was chosen as it follows the academic year and is congruent with our fiscal reporting system from which parts of the data are derived.

A frequently used tool for campus green house gas emissions inventories is the Clean Air-Cool Planet Calculator.[5] While that Excel-based spreadsheet tool was not used directly in preparing this inventory, it was used as key resource for determining emissions factors and methodologies for estimating quantities where exact data was unavailable. In several instances, the background data and supporting references were used to investigate the appropriateness of particular factors. Unless otherwise specified, emissions factors used in the following sections were taken form the Clean Air-Cool Planet calculator[6]. Full references to the sources of emissions factors, most of them from EPA and other government reports, can be found in the calculator.

The three primary green house gases of concern, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), all have different levels of potency as green house gases, with methane and nitrous oxide being far more potent than the more abundant carbon dioxide. For this report the accepted values from the Clean Air-Cool Planet are used, with methane having 23 times the global warming potential of carbon dioxide and nitrous

[5] www.cleanair-coolplanet.org
[6] Generally, these factors are found on the EF_eCO2 sheet of that calculator.

oxide having 296 times the global warming potential of carbon dioxide. This leads to all emissions data being reported tonnes equivalent of carbon dioxide (tonnes CO_2e).

While the following sections give important details of emissions determinations, questions may arise about specific technical issues. A written narrative "notebook" containing rough notes on the calculations and determinations was kept as the inventory was developed. This narrative is available upon request to the author of this report.

Gustavus Adolphus Greenhouse Gas Emissions by Category

The following sections detail the background data and results for the emissions in each category, with notes on data sources and quality, as well as the relevant emissions factors.

Stationary Emissions: Electricity consumption

Data sources:
The GAC Physical Plant staff maintain an online record[7] of campus utility data. From that record, the GAC 2007-2008 electricity consumption was 15,097,600 KWH.

Data quality:
The KWH consumption number is believed to be accurate. There are occasional meter malfunctions with the St. Peter Municipal Utility system that require estimation of usage values for short periods, but those estimates have been based on historical consumption which has not been wildly variable.

Emissions factors:
Determination of emissions factors for electricity is complicated by the fact that utilities in a given region share a grid and exchange power depending on demand, and to some extent. Hence, the emissions factor is some average of all the generating sources in the region. For this factor, the Clean Air-Cool Planet calculator uses values for EPA determined regions where power sharing is deemed to create a regionally valid average for the emissions factor[8]. St. Peter and its generating utility, Southern Minnesota Municipal Power Agency (SMMPA), are in a region known as the MROW for the 2007-2008 time period. The relavant emission factor is 0.0008262106 tonnes CO_2e/KWH.

Green house gas emissions estimate:
From the above data, the GAC FY 2007-2008 green house gas emissions estimate for electricity is 12,474 tonnes CO_2e.

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[7] http://gustavus.edu/physicalplant/utilities.php
[8] This determination is dependent on assumptions about power sharing. The Jan 2008 energy and emissions report focused more on the mix of our local utility and used a different (about 10% higher value) that focused on the generating mix of the SMMPA generating resources.

Stationary Emissions: Natural gas consumption

Description:

Natural gas provides space and water heating energy for all campus operations, with occasional use to drive an internal combustion engine powered air conditioning compressor. The campus also has the capacity to use fuel oil for heating, but this has not occurred in recent years.

Data sources:

The GAC Physical Plant staff maintain an online record of campus utility data. From that record, the GAC 2007-2008 natural gas consumption was 1,571,857 therms[9] or 157186 MMBTU[10]. Natural gas provides space and water heating energy for all campus operations, with occasional use to drive an internal combustion engine powered air conditioning compressor. The campus also has the capacity to use fuel oil for heating, but this has not occurred in recent years.

Data quality:

This data is appears to be of good quality. There may be some slight inaccuracy due to beginning or ending monthly billing periods falling across two fiscal years.

Emissions factors:

The Clean Air-Cool Planet emission factor for natural gas use is 0.0529083 tonnes CO2e/MMBTU.

Green house gas emissions estimate:

From the above data, the GAC FY 2007-2008 green house gas emissions estimate for natural gas use is 8,316 tonnes CO_2e.

Mobile Emissions: Campus operated vehicles

Description:

This category reflects fuel use in all campus operated vehicles and equipment, including Physical Plant vehicles and equipment, motor pool and other campus owned and operated vehicles. It does not capture any private vehicle use that was charged to the college as the accounting system does not report that data in a way that allows it to be extracted from the database.

Data sources:

Physical plant records provided by the Physical Plant staff contained a good record of fuel quantity used from campus fuel storage. Fuel purchased for motor pool vehicles while on the road, and for admissions vehicles, was recorded in dollar amount only. This was converted to gallons using a national average fuel price for the 2007 and 2008 year

[9] 1 therm = 100,000 BTU

[10] 1 MMBTU = 1 million BTU

of $2.988 (average of the value for the two years[11]). Additionally, the Office of Institutional Advancement reported an estimated miles driven value that was converted to gallons use a 22.1 mpg[12] conversion factor. The accumulation of all these values produced an estimated gasoline usage of 30,416 gallons and diesel fuel usage of 3,497 gallons.

Data quality:
Because of the very different ways of reporting the data, there are likely significant errors in this data. Also, the financial reporting system did not capture miles driven in private vehicles but paid for by the college. While the errors make this estimate suspect, the magnitude reported below suggests that even if the error is 100-200%, the overall campus emissions profile will not be dramatically affected.

Emissions factor:
The vehicle greenhouse gas emissions factors used were 0.008921 tonnes CO_2e/gallon for gasoline and 0.010076 tonnes CO_2e/gallon for diesel fuel.

Green house gas emissions estimate:
From the above data, the GAC FY 2007-2008 green house gas emissions estimate for campus operated vehicles is 307 tonnes CO_2e.

Mobile Emissions: Faculty, staff, and student commuting

Description:
This category reflects the cumulative emissions impact of faculty, staff, and student daily commuting to campus. Following ACUPCC protocol, it does not account for residential student travel to and from campus at the beginning of the semester, or for trips away from campus on the weekend—student commuting focuses on students who do not live on campus but travel there on a daily basis.

Data sources:
Gustavus Human Resources staff provided a list of campus addresses (minus names) for all employees. The MapQuest online mapping service[13] was used to estimate commuting distances for employees. Total annual mileage for employees was then computed on the assumption that the average employee commuted to campus five days a week for 42 weeks a year (this was based on school year commuting for faculty and staff plus partial staff and faculty commuting during the summer). The resulting value was divided by the previously cited commuting value of 22.1 mpg to get 177,303 gallons of gasoline use per year.

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[11] http://tonto.eia.doe.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mg_rt_p2&f=a
[12] The Input_Commuter page. The value is for commuting miles per gallon for 2007 and 2008.
[13] www.mapquest.com

For student commuting, Residential Life staff reported 533 off-campus students with an estimate that they all live within 15 miles of campus. Assuming an average six mile commute (due to multiple trips/day), six days per week of traveling to campus, and 33 weeks of commuting, student as well the previous gas mileage factor, student commuting consumes 28,652 gallons of gasoline.

Total commuting gasoline consumption is thus 205,955 gallons.

Data quality:
As the data source descriptions should have made clear, the final gasoline consumption figure is highly sensitive to the assumptions. As there is no reliable data on how often people commute, the length of the work year, whether they carpool or not, there could be significant error in this value. Future work may require the use of a survey to get a more accurate number.

Emissions factor:
The vehicle greenhouse gas emissions factor used was 0.008921 tonnes CO_2e/gallon of gasoline.

Green house gas emissions estimate:
From the above data, the GAC FY 2007-2008 green house gas emissions estimate for faculty, staff, and student commuting is 1837 tonnes CO_2e.

Mobile Emissions: Outsourced air travel

Description:
This section captures the emissions generated indirectly by air travel originated from official campus activities, including student travel abroad, faculty development paid for by the college, athletics and extra curricular activities, and official staff travel. It does not account for personal air travel by faculty and staff.

Data sources:
Finance staff made several database queries to capture air travel miles. These were scrutinized to avoid duplicate reporting and non-air travel expenses to produce a dollar estimate of air travel expenses of $480,427.

Following a methodology reported by the American Association of Sustainability in Higher Education (AASHE)[14], this dollar figure was converted to estimated air travel miles using a 2008 airline industry value for miles traveled per doller spent[15] plus a 20% allowance for taxes. Because of high rates of student travel abroad plus a hockey team trip that year, the composite value that combines domestic and international travel was used. The resulting value, $0.1651/mile, combined with GAC air travel expenses, produces an estimate of air travel miles of 2,911,679 miles.

[14] www.aashe.org/blog/guidance-scope-3-emissions-pt-2-air-travel
[15] www.airlines.org/economics/finance/PaPricesYield.htm

Data quality:
There were clearly questions by the Finance office staff of how well the database queries capture airline travel. In addition to not being sure all air travel entries were captured, they noted that not all entries exclude hotel and ground transport. Athletic program staff noted that a large team hockey trip to Europe most certainly included hotel and ground transport, so an adjustment was made in that value.

Emissions factor:
The air travel emissions factor was 0.000776336 tonnes CO_2e/mile of air travel.

Green house gas emissions estimate:
The GAC FY 2007-2008 green house gas emissions estimate for air travel is 2260 tonnes CO_2e.

Mobile Emissions: Outsourced bus travel

Description:
This component focuses on motor coach travel to college-related events.

Data sources:
The athletic program was the only clearly defined generator of bus travel. The athletic program staff used their records to generate a value of 38,149 miles of bus travel, with bus occupancy undefined.

Data quality:
As it was drawn from actual invoices, the athletic program value should be reliable. What is less clear is whether other campus departments were also involved in bus charters. This was probably the case for off-campus study programs, but there was not a clear reporting channel for this data.

Emissions factor:
The Clean Air-Cool Planet calculator based bus emission factors on a passenger mile basis. Since our data is for vehicle miles, a fuel consumption value 6 mpg[16] was used to produce a value of 6,358 gallons of diesel fuel consumed. The aforementioned value of 0.010076 tonnes CO_2e/gallon for diesel fuel was then used to calculate the emissions generated.

Green house gas emissions estimate:
The GAC FY 2007-2008 green house gas emissions estimate for outsourced bus travel is 64 tonnes CO_2e.

Solid waste

[16] http://en.wikipedia.org/wiki/Fuel_efficiency_in_transportation

Description:
The processes for waste disposal, either destruction through some form of incineration or decomposition in a landfill, produce green house gas emissions. The interesting twist in this category is that incineration of waste, or the more refined processing the produces refuse derived fuel (RDF) for power generation can actual generate a small reduction in green house gas emissions through the replacement of fossil fuels and the elimination of methane production in landfills. And if waste is landfilled, methane recapture and burning, or use for power generation, can reduce the impact markedly.

Data sources:
The Physical Plant website cited above was used to obtain a solid waste value for the FY 2007-2008 of 522 tons. This was an average of the 2007 and 2008 years.

Data quality:
Outside of lapses in collecting and recording data that cannot be quantified, this data appears to be reliable.

Emissions factor:
A local recycler and GAC alumna[17] with intimate knowledge of local waste handling procedures estimates that nearly 100% of the GAC waste is processed into RDF. The system rate is 91.66%, but since that includes a component of industrial waste that cannot be turned into RDF, this source believes 100% of our waste becomes RDF. For RDF waste the emission factor from Clean Air-Cool Planet calculator is a credit of 36.67 tonnes CO_2e/ton of waste

Green house gas emissions estimate:
The GAC FY 2007-2008 green house gas emissions estimate for solid waste is a credit of 19 tonnes CO_2e.

Reporting Recommendations

As the discussions of data quality above highlight, changes in campus accounting and recordkeeping procedures would improve the quality of future green house gas emissions inventories and make future reports easier to prepare.

All of the challenges lie in quantifying our mobile emissions of all types. Recommendations for each area are presented here.

Campus operated vehicles
The data kept by Physical Plant staff was very clear and detailed for vehicles under their control. Had it been complete, it would have enabled a very accurate green house gas emission profile for, in most cases, each vehicle. But fuel purchase with fuel cards while

[17] Larry Biederman of LJP Enterprises.

off-campus were not tied to the vehicles and resulted in the need to fall back to a global fleet estimate. Physical plant staff has begun an effort to improve the records although there may still need to be some work done to get all data at the same level.

For vehicles not under Physical Plant stewardship, primarily Admissions and Institutional Advancement, there needs to be a more detailed system for capturing fuel use or miles driven.

Likewise, there should be a system for capturing travel in private vehicles that is paid for by the college.

Outsourced air and ground transport
There should be a system for consistently capturing air travel miles paid for by the college, and differentiating it from ground transport and other travel costs. This is probably most important in regards to off-campus study and athletics, but the same framework should be applied to all travel.

Commuting
The student working on estimating emissions from commuting developed plan to use GIS techniques to streamline the preparation of this estimate. If that technique can be developed it will facilitate commuting estimates.

The number of trips taken by commuters, however, is still only a rough estimate. A survey of commuting habits should probably be undertaken to improve the accuracy of this estimate by quantifying the typical number of commuting trips per year.

Overall recommendation
With the abovementioned improvements in recordkeeping and data collection, it should be possible to make preparation of this greenhouse gas emission inventory a routine operation that is generated at the end of each year in the same way that we prepare overviews of institutional data.

Making the transition to this routing inventory of greenhouse gas emissions will probably require a Cabinet level commitment to institutionalize this effort.

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