SUSTAINABILITY at UAA

Energy and the Environment at the University of Alaska Anchorage – Fiscal Year 2005

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

Sustainability is a guiding principle at UAA and a cornerstone of everything we do. University of Alaska Anchorage's Strategic Plan, Facilities Master Plan, Academic Plan, Energy Policy, and signed agreements incorporate sustainability. UAA signed the Talloires Declaration in 2004 and the American College and University Presidents' Climate Commitment (ACUPCC) in 2007. Our Strategic Plan 2017 envisions UAA as "a university of first choice distinguished for its commitment to sustainability and environmental responsibility" and lists sustainability and stewardship as two of our core values. The draft Facilities Master Plan envisions a pedestrian, bicycle, and transit-friendly campus with fewer parking lots. It advocates construction of taller buildings built to accommodate change and to as high a LEED standard as is economically feasible, with an emphasis on reducing impact on our natural environment. This plan also emphasizes use of life-cycle costs in preference to initial capital costs to assess the value of systems and materials. The purpose of our Academic Plan includes " . . . to use our resources to serve society, most especially to assure a socially, environmentally, and economically sustainable future."

In furtherance of our sustainability goals, it is important for UAA to calculate and track its progress toward reducing carbon emissions. In 2005, UAA directly and indirectly emitted 48,147.2 metric tons of CO_2 during the 2005 academic year from various sources, including: natural gas for heating (11,904.5 metric tons), purchased electricity (18,064 metric tons), commutes (13,101 metric tons), air travel (2,624 metric tons), fleet use of gasoline/diesel (498 metric tons), study abroad (157 metric tons), and wastewater (12.1 metric tons).

INTRODUCTION

As a signatory to the American College & University Presidents' Climate Commitment (ACUPCC) the University of Alaska Anchorage (UAA) agreed to monitor its greenhouse gas (GHG) emissions by conducting biannual inventories. GHG emissions are the release of gases to the atmosphere, causing the Earth to maintain higher surface temperatures than would occur if the gases were absent (Weart, 2008). In this inventory, some sections of the report measure only carbon dioxide (CO_2). CO_2 is the most prevalent of the greenhouse gases generated from human activity. In other sections of the report GHGs in addition to CO_2 are measured. We specify which is the case in each section of the report. The calculation scope is the UAA main campus, and outlying buildings in Anchorage owned by UAA. The main campus extent in 2005 is shown below in Figure 1. We did not include community campuses in our GHG calculations.

Figure 1: Map of UAA main campus 2005

CALCULATION SCOPE

The following sources were included in determining carbon dioxide equivalent emissions (CO_2e) for UAA's main campus:

1. Fossil fuel consumption of all campus owned equipment including; heating, emergency generators, and university fleet fuels. These data were entered into the Clean Air Cool Planet model whose algorithms calculate CO_2e for all GHGs emitted by these activities.
2. All GHGs emitted from purchased electricity, including power plant generation, and emissions from losses at the power plant and due to power line transmission. These data were entered into the Clean Air Cool Planet model whose algorithms calculate CO_2e for all GHGs emitted by these activities.
3. GHG emissions from wastewater treatment. These data were also entered into the Clean Air Cool Planet model and CO_2e for all GHGs were included.
4. GHG emissions from air travel. A model developed by UAA's Institute for Social and Economic Research (ISER) was utilized to calculate these emissions (Villalobos-Melendez, Gerd, & Fay, 2011). The ISER model calculates only CO_2 emissions.
5. GHG emissions from commuter travel. The ISER model, which calculates only CO_2 emissions, was used for these calculations as well.
6. GHG emissions from students who studied abroad. The ISER model, which calculates only CO_2 emissions, was used for these calculations as well.

Natural Gas Use

Amounts of gas consumed (in ccf) on the main campus and outlying buildings from academic year 2003 through 2010 were provided by the Department of Facilities, Maintenance and Operations at UAA. Housing provided bills for gas consumed (also in ccf) for fiscal year 2005 through 2010. For the sake of consistency, data from 2005 to 2010 were used to generate Figure 2 which displays the annual ccf of natural gas purchased and used for UAA's main campus and outlying buildings in Anchorage, and separately for student housing. Clean Air Cool Planet requires entry of MMBtu for natural gas purchased. The factor used to convert ccf to MMBtu was 0.1027. Main campus ccf usage was 1,544,749 (158,645.72 MMBtu). Housing consumed 645,680 ccf of natural gas (66,311.34 MMBtu). Total ccf and MMBtu for UAA was 2,190,429 and 224,957.06 respectively. Figure 2 shows ccf of natural gas consumed by main campus and housing from 2005 through 2010.

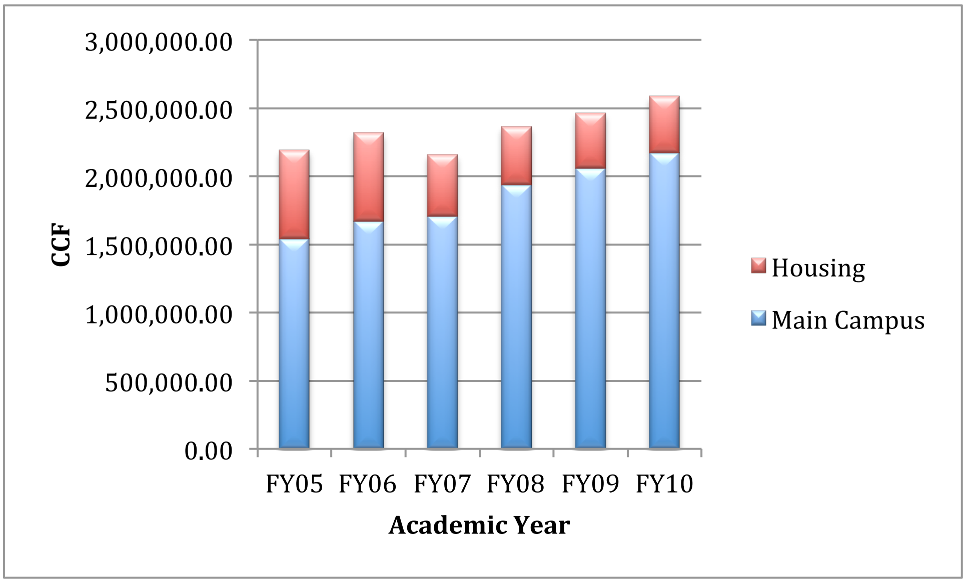

Figure 2: Natural gas purchased for UAA main campus between years 2005-2010

University fleet vehicles utilize unleaded gasoline and diesel. Figure 3 shows annual gasoline and diesel purchased for university fleet vehicles between years 2003 and 2010.

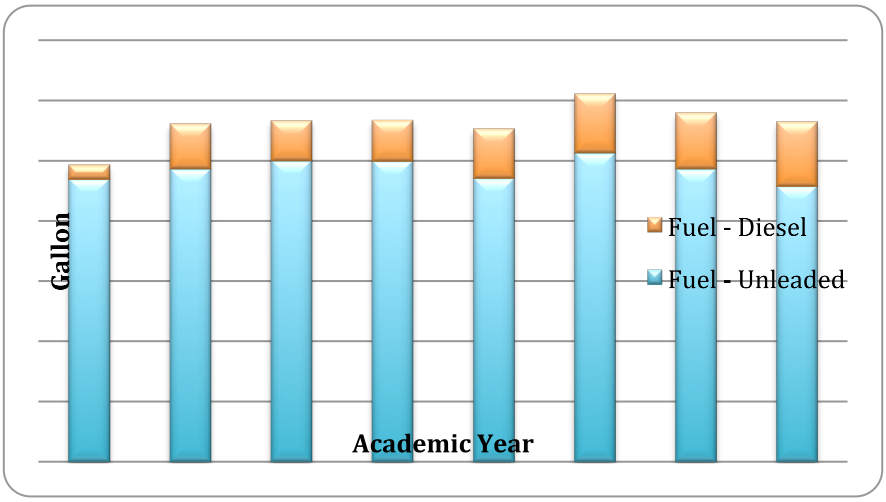

Figure 2: UAA fleet fuel purchased between years 2003-2010

Electricity Use

Electricity bills between academic years 2003 through 2010 were also provided by UAA's Department of Facilities, Maintenance and Operations. Electricity bills for housing from 2005 through 2010 were gathered and entered. Figure 4 illustrates the electricity usage on main campus and in housing for the years 2005 through 2010. In fiscal year 2005, main university campus (including outlying buildings owned by UAA located in Anchorage) utilized 24,837,300 kWh and housing utilized 3,643,013. The total kWh usage in fiscal year 2005 for main campus and housing was 28,479,313.

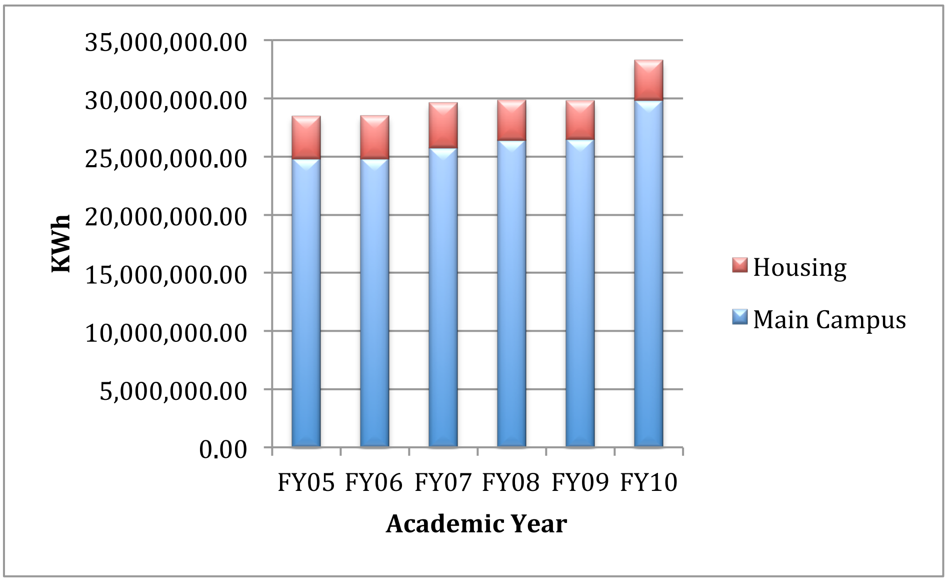

Figure 4: UAA main campus and housing electricity purchased in fiscal years 2005-2010

Wastewater GHGs

The Clean Air Cool Planet model was used to calculate wastewater GHGs. As a result, all GHGs (including but not exclusive of CO_2) emitted by these activities were estimated. All UAA wastewater was processed by Anchorage Water and Wastewater Utility (AWWU), and was treated aerobically. Total gallons of wastewater produced by UAA reported on bills from AWWU were 24,843,560.

Air Travel GHGs

GHG emissions from university funded or official air travel, were also inventoried in compliance with the requirements of the Association for the Advancement of Sustainability in Higher Education's Sustainability Tracking Assessment & Rating System (AASHE STARS). Air travel GHG emissions were estimated using data from Travel Expense Reports (TERs) obtained from UAA's Travel Office. TERs include information on each segment of airplane flights financed or approved by UAA. TERs were separated into two categories: Athletics and non-Athletics. A total sample size of 22.8% of all TERs were taken for fiscal year 2005 (July 1, 2004 to June 30, 2005) and this sample was used to estimate air travel GHG emissions for the fiscal year. The sample size broke down to 16.67% of non-Athletics TERs and 100% of Athletics TERs. One hundred percent of Athletics TERs were sampled because those trips normally involve multiple travellers, and it is necessary to review each of those TERs to determine the number of people travelling. Non-Athletic TERs, on the other hand, rarely involve travel by more than one traveller. Academic year 2005 featured a total of 2,993 air travel trips and 11,262,286 miles traveled.

Commuter Travel GHGs

AASHE STARS requires calculation of GHGs emitted by students and employees commuting to and from UAA in the GHG emissions inventory. In 2008, ISER developed a model for calculating CO_2 emissions from commutes for the purpose of UAA's initial calculation of carbon emissions. That model was refined and updated by ISER in 2010 for purposes of calculating carbon emissions for that year. ISER generously provided the model and their permission for the Office of Sustainability to utilize that model to calculate 2005 emissions from commutes. Total miles commuted in 2005 were estimated to be 22,962,457 miles.

Study Abroad GHGs

Greenhouse gases created by any funded or non-funded international study by UAA students and employees were included in our carbon emission calculation using data attained from Enrollment Services. A total of 47 trips for study abroad were documented during the 2005 fiscal year.

METHODOLOGY

Carbon Coefficient Determination for Electricity

The GHG emissions from generation of electricity vary depending upon the resource mix used. Standard convention requires that all fuels used for electricity generation within a grid system be included in estimating GHGs for that system. The North American Electric Reliability Corporation (NERC) has established the carbon emission coefficient for systems within North America. NERC has broken Alaska down into two subregions: AKGD (South/Central Alaska), in which Anchorage is located, and AKMS (the remainder of Alaska). AKGD's emission coefficient is 1,232.36 lb/MWh and that is the coefficient utilized in this report to calculate GHG emissions from electricity generation.

eGRID subregion acronym	eGRID subregion name	Nameplate capacity (MW)	Net Generation (MWh)	Generation resource mix (percent)										
				Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal	Other unknown/ purchased fuel
AKGD	ASCC Alaska Grid	1,469.1	5,298,411.8	11.7607	7.1296	69.3825	0.0000	0.0072	11.7201	0.0000	0.0000	0.0000	0.0000	0.0000
AKMS	ASCC Miscellaneous	540.4	1,278,241.3	0.0000	29.9131	3.7125	0.0000	0.3812	65.9471	0.0000	0.0461	0.0000	0.0000	0.0000

Figure 3: The resource mix for the AKGD and AKMS subregions (NERC, 2008)

Air Travel

The UAA air travel model was developed by ISER. The model estimates GHG emissions by summing the emissions of individual flight segments. The data for the model were obtained from TERs, which provide detailed itineraries containing all segments within each trip. A trip constitutes all flight segments incurred between the origin of travel and final destination.

The TERs are sorted alphabetically by last name of the person traveling, or by last name of the fiscally responsible traveler (as with group trips, such as athletic or student research teams). TERs are available in hard copy only and 2005 records were stored by Alaska Archives in 17 boxes. Mileage reports for land travel were also stored among the TERs.

The model is structured so that its inputs are airport codes for each airport associated with a trip. For example, a round trip to New York with a connecting flight in Minneapolis would be entered:

ANC MSP JFK MSP ANC

The model determines the geographic coordinates (latitude and longitude) for each airport listed in the TERs using a lookup table providing degree coordinates obtained from the Bureau of Transportation Statistics (BTS) under the Research and Innovative Technology Administration (RITA). Next, the model converts each successive pair of airport codes into a distance in statute miles using the Haversine formula (shown below in Figure 6). This formula gives mathematically and computationally exact results for both short and long spherical distances, and therefore provides more accuracy than the conventional distance formula, which operates on a planar surface. Two versions of the formula are given and it was determined that they yielded identical results. The radius of the Earth is needed for this calculation and it was obtained from the National Aeronautics and Space Administration (NASA).

Version 1:

$$\boldsymbol{R * 2 * \arcsin(\sqrt{a})}$$

$$\text{where } a = \sin\left(\frac{\Delta lat}{2}\right)^2 + \cos(lat1) * \cos(lat2) * \sin\left(\frac{\Delta long}{2}\right)^2$$

$$\text{and R = 3440 nm}$$

Version 2:

$$\boldsymbol{\frac{\arccos(b) * r}{1.852}}$$

$$\text{where } b = \sin(\text{lat1}) * \sin(lat2) + \cos(lat1) * \cos(lat2) * \cos(\Delta long)$$

$$\text{and r = 6371km}$$

Figure 4: The Haversine formula

Each flight segment is categorized by its length: short (fewer than 281 statute miles flown), medium (fewer than 994 statute miles flown), or long (994 or more nautical miles flown). Due to the high-energy cost of takeoff relative to additional miles at cruising altitude, different segment lengths are associated with different levels of average GHG emissions per mile traveled. The number of statute miles for each segment of a trip is then multiplied by the appropriate GHG multiplier to determine the carbon emissions for that segment.

The categorization determinants and the corresponding emissions multipliers were obtained from Clean Air Conservancy, which based their figures on those calculated by the World Resources Institute. Table 1 shows the category parameters and emissions multipliers used in the model.

	Maximum Distance (statute miles)	Multiplier (kg CO_2 per statute mile)
Short flight	281	0.2897
Medium flight	994	0.2028
Long flight	none	0.1770

Table 1. Air travel emissions factors
Source: Clean Air Conservancy, Air Travel CO2 Emissions. 2010.

Finally, the CO_2 emissions from all sampled trip segments were summed (total 308.41 metric tons). Because the sample size was 17% of the total population, the total carbon emissions for the sample was divided by 17 to obtain the estimated carbon emissions for air travel for the total population (not including athletics travel) funded by the university. Per trip calculations were completed by dividing the total CO_2 emissions by the number of trips, where the total number of trips was determined via a manual count of TERs in the Alaska Archive. Calculations to determine the total CO_2 emissions per employee were derived in a similar manner. The total number of employees was obtained from the University of Alaska by adding the number of full time and part time employees.

Study Abroad

Study abroad emissions were also calculated. Study abroad encompasses UAA students and employees who were exchanged or funded to study in overseas countries during fiscal year 2005. Calculating CO_2 emissions from travel for study abroad utilized the same methodology as the air travel model described above with the exception that multi-destination data were not included in the calculations because records did not specify this information. Data was retrieved from the Enrollment Services Department.

Travel for University Business

Land travel records identify miles driven for UAA business. These trips were defined as driving a University-owned, rental, or a personal vehicle for University business. This data was manually collected from mileage reports and from TERs and input into a database. All mileage reports included miles driven. TER records have origin and destination information and, in many cases, report miles driven. For cases in which TERs did not include miles driven, the origin and destination were entered into maps.google.com to estimate miles driven and the assumption was made that the traveler had completed a round trip.

Information from these records was entered in the database for every report during fiscal year 2005. In total 659 reports were entered into the database. Based on these records, an estimated total of 105,186 miles were driven for UAA business. The number of miles driven in fiscal year 2005 was multiplied by the emissions factor of 8.8 kilograms of CO_2 per gallon of gasoline to estimate the CO_2 emissions emitted for University travel. The calculation assumes that all miles were driven in vehicles powered by gasoline.

Commuter Travel

The data used in the commuter model was provided by UAA Parking Services Director, Glenna Muncy, and included parking permit data from academic year 2005. For many permits sold we were able to obtain the following information:

- Permit ID
- Permit type
- Vehicle make, model, and year
- Permit buyer's address

For the permit records that did not include address and/or vehicle information, we used a weighted average of miles traveled to campus and/or average miles per gallon to calculate emissions. The number of times permit buyers traveled from their home to campus each week was not available. Since this information was available from data obtained to calculate UAA's 2010 emissions, we made the assumption that the same average number of trips per week were made to campus in 2005 as in 2010.

Distance of Commute

For this inventory, we were able to use full addresses where provided, which included residence number, street, city, and zip code. Address and permit ID fields were estimated using www.geocoder.us, which provided latitude and longitude data for each address. Some addresses were P.O. Boxes and not physical addresses; for these, the centroid latitude and longitude of the zip code was used. Addresses were categorized into three major groups: within Anchorage, within commuting range, and outside of commuting range. The commuting range was defined to the north as far as Palmer and Wasilla, and to the south as far as Girdwood.

Once geo-coded, data for permits were entered into a database. Anchorage addresses totaled 8,219 records and there were 2,008 records within the commuting range. The distance between each address and the UAA campus was calculated using the Haversine formula (explained in the "Air Travel" section, see pages 11-12). However, in order to estimate driving distance, our calculation assumed that streets approximate a grid system and distance was calculated using three coordinates. To illustrate, distance from Point A (representing a student's address) to UAA would be as shown in Figure 7 (below).

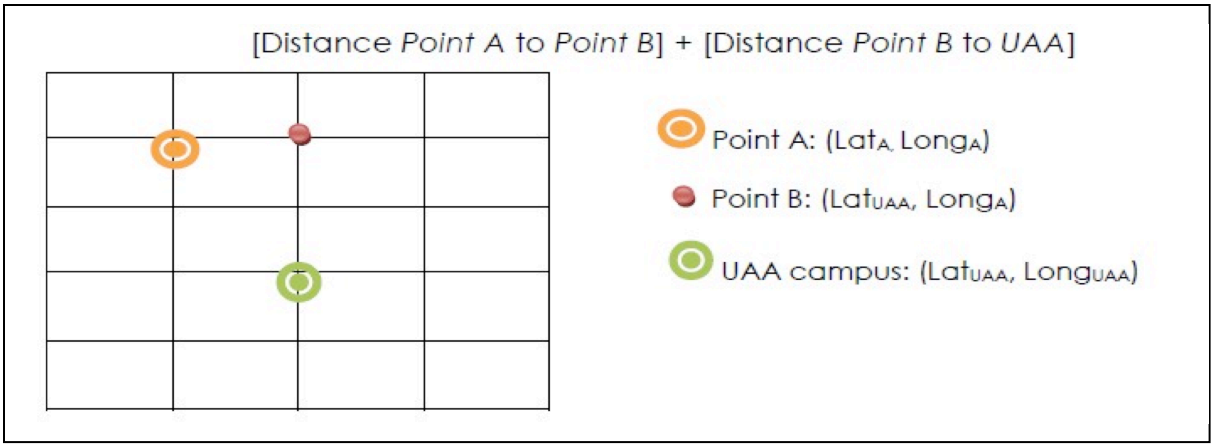

Figure 5: Calculating distance to UAA

Fuel Efficiency

Fuel efficiency data from 1985 to 2005 was obtained from the U.S. Department of Energy, which records the number of city and highway miles per gallon for each vehicle make and model sold in the U.S. Fuel efficiency varies from year to year for most vehicle models, therefore, when the information was available, we used specific year data for each permitted vehicle.

Parking permit applicants reported their own vehicle make, model, and year. Some vehicle information in the permit did not match precisely with the official name in the fuel efficiency database; in these cases, we standardized the naming conversions. For example, in a case where a model year was missing, the closest year of the same model within the fuel efficiency database was used. Again, if the data did not include a description of the vehicle, the weighted average of the miles per gallon realized by vehicles driven to campus was used to estimate miles per gallon.

Commutes Outside and Within Anchorage

Fuel efficiency changes with driving conditions. Miles per gallon in the city are usually different from highway driving. To account for this, two entry points were identified for all commuters driving from outside of Anchorage:

1. The intersection of Muldoon and Highway 1 to the north, and,
2. New Seward Highway and Rabbit Creek to the south.

Emissions between the commuter's address and these points were calculated using highway fuel efficiency and city miles per gallon for distances within Anchorage.

Number of Commutes

The 2010 commute model utilized additional questions in the parking permit application which provided data used to calculate the average number of days per week applicants drove to campus. In 2010, 80% of all applicants answered these questions. This information was used to: (1) classify each commuter by type (i.e. faculty/staff, adjunct faculty, emeritus, retired staff, student, housing resident, vendor, VIP, visitor), (2) estimate the total number of commuters, and (3) calculate the average number of days per week each commuter type drove to campus. Also, data indicated that students only commute to campus while classes are in session, generally, during spring and fall semesters with some also attending summer classes. Overall, employees come to the campus throughout the year net a few weeks of vacation time. Hence the 2010 commute model calculations assumed the number of commutes enumerated in Table 2 below.

Permit Type	Days/Week	Weeks/Year	Days/Year
Student	3.8	32	122
Faculty/Staff	3.7	50	184
Adjunct/Emeritus/Retired Faculty	2.8	50	138
VIP/Vendor/Visitor	1.8	50	88

Table 2. Days per year commuting to UAA campus

Source: UAA Parking Permit data; ISER Calculations. December, 2010.

We made the assumption that the number of times traveled to campus was the same in 2005 as in 2010.

RESULTS

Total Carbon Equivalent Emissions

After the above analyses and calculations were completed, CO_2e emissions were obtained from the Clean Air-Cool Planet model for natural gas, purchased electricity, electricity losses, and for emissions from wastewater. These calculations included all GHGs and were expressed in terms of metric tons of CO_2e. The commuter and air travel models were used to calculate only CO_2 emissions from commuting and air travel miles, respectively. Table 3, shows the amount of CO_2 emissions from different sources and each source's percentage contribution to the total amount of CO_2 emitted. Estimated carbon emissions from all sources at UAA totaled 48,147.2 metric tons. Figure 8 illustrates the percentages of carbon emissions contributed from different sources. The largest fraction of total CO_2 emissions on UAA's main campus, originated from electricity use. The second highest CO_2 contributor was commutes to campus—emitting 27% of the total CO_2 emissions at 13,101 metric tons. Wastewater accounted for the least carbon emissions occupying just 0.0003% of the total CO_2 emitted.

	Metric Tons	Percentage
Electricity	18,064	37.5%
Electricity Losses	1786.6	3.7%
Natural Gas	11,904.5	24.7%
University Fleet	498	1.0%
Commutes	13,101	27.2%
Non-Athletics Air Travel	1,892	3.9%
Athletics Air Travel	732	1.5%
Study Abroad	157	0.3%
Wastewater	12.1	0.0003%
Total	48147.2	100.00%

Table 3: Carbon emission sources and percentage of total

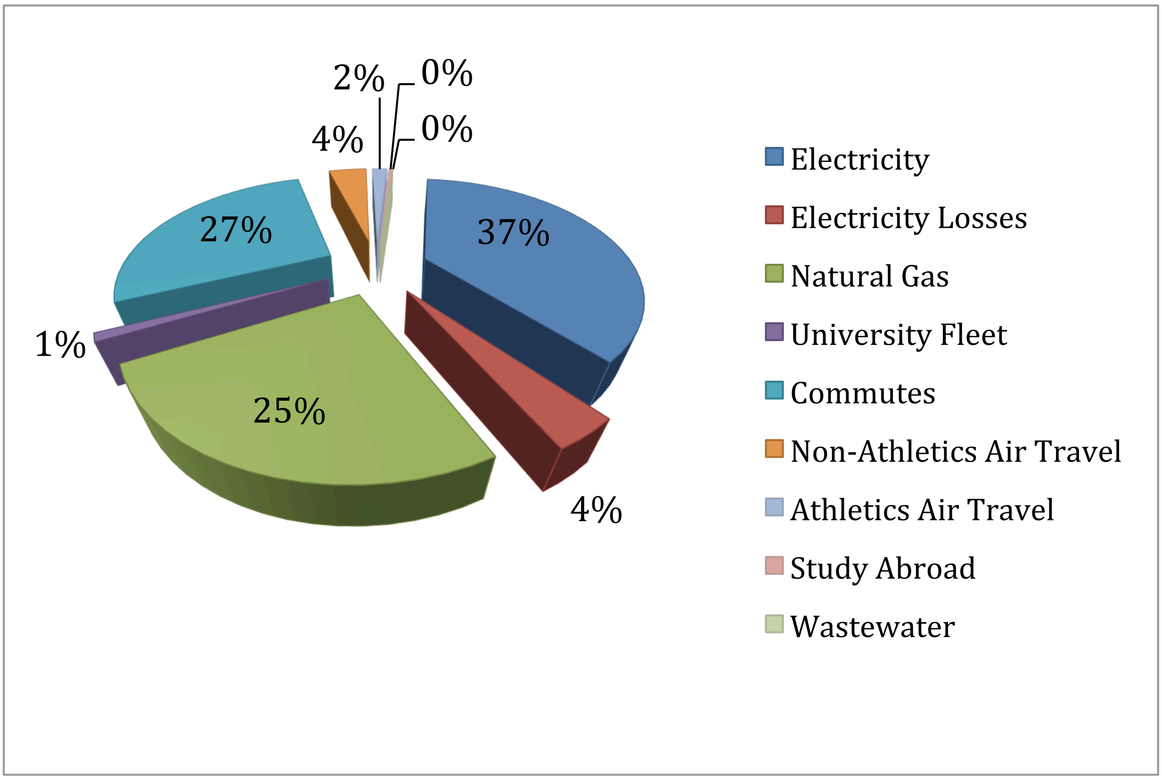

Figure 6: The percentages of CO_2 emissions from different sources

From the total CO_2 emissions, we can calculate emissions per person. The total number of students attending, and faculty and staff employed by UAA in fiscal year 2005 was obtained from Institutional Research data. Carbon emissions attributable to each person using the campus will vary depending on how much time a given individual spends on campus, so campus users were weighted using the following formula:

- On-campus residents = 964
- Non-residents, full-time students, faculty and staff = 6,195
- Non-residents, part-time students, faculty and staff = 12,435

Total weighted campus users from academic year 2005

$= (1 \times 964) + (0.75 \times 6{,}195) + (0.5 \times 12{,}435)$

$= 6{,}237.75$

Table 4 shows the amount of carbon emissions per weighted user for the carbon emissions that were calculated. From Table 4 we can see that carbon emissions from electricity usage per weighted user was 1,331.95 kilograms. Study abroad ranked the lowest with per weighted user emissions at just 9.62 kilograms.

	Total Metric Tons	Per Person (kg)
Electricity	15,754	1,331.95
Natural Gas	8,420	711.89
University Fleet	498	42.09
Commuter	13,101	1,107.65
Air Travel	2,624	221.85
Study Abroad	157	9.62

Table 4: CO_2 emissions - total and per weighted user

Air Travel Results

UAA air travel generated 2,624 metric tons of CO_2 emissions during fiscal year 2005; this is equivalent to an average of 0.68 metric tons of CO_2 per each UAA sanctioned trip (given 2,993 trips). It also equates to an average of 0.88 metric tons of CO_2 emissions per trip for all travel funded by UAA (including travel by the Athletics Department). UAA's air travel inventory is summarized, below, in Table 5.

	UAA	Per Trip	Per Employee	Per Student
Total Miles flown	11,262,286	3,710	3,672	792
kg CO_2	2,624,083	677	856	185
Metric Tons CO_2	2,624	0.68	0.86	0.18

Table 5: Air travel results summary

Source: UAA Travel Office Records

Commuter Travel Results

A commuter model, and UAA mileage reports were used to estimate GHG emissions from people commuting to UAA. Our model estimated 22,962,457 miles were driven by UAA commuters during fiscal year 2005, and 22,857,271 miles were driven in road trips by UAA travelers. Commuting and land travel resulted in a combined total of 13,101 metric tons of CO_2 emitted into the environment during fiscal year 2005. Table 6 shows the total number of trips by land and average CO_2 emitted for each type of trip. Figure 9 depicts the total miles traveled and percentage of total by each commuter type.

	CO_2 per trip	Total trips
Anchorage	0.81	8,219
Suburbs	2.74	2,008
Travel for UAA Business	2.75	336

Table 6: Commuting emissions and number of trips

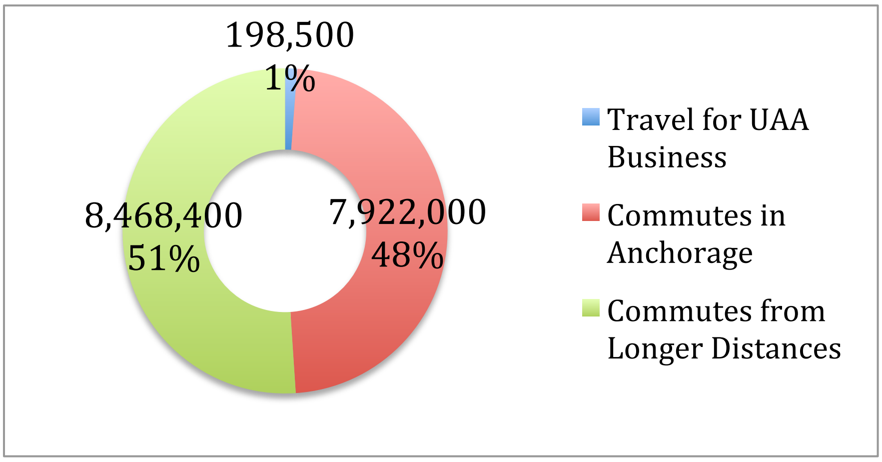

Figure 9: Total miles traveled and percentage of total

The average CO_2 emissions from students commuting within Anchorage was 0.6 metric tons. Student commuters from Anchorage suburbs averaged 2.3 metric tons of CO_2 emissions.

IMPROVEMENTS AND RECOMMENDATIONS

Future GHG inventories would benefit from electronic TERs. Preferably, each trip paid for by the university should be added to a spreadsheet which identifies each airport visited and the number of travelers. This will increase accuracy of the calculations and allow the model to calculate figures for the entire population, rather than a sample.

Study abroad will become more and more important due to UAA's fast growth in both international students attending UAA and study by UAA students at other schools. In the future, if records from Enrollment Services include notes detailing which overseas universities and cities were traveled to, the accuracy of our calculations would increase.

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