UNIVERSITY OF CAPE TOWN CARBON FOOTPRINT

Analysis carried out by
ENERGY RESEARCH CENTRE

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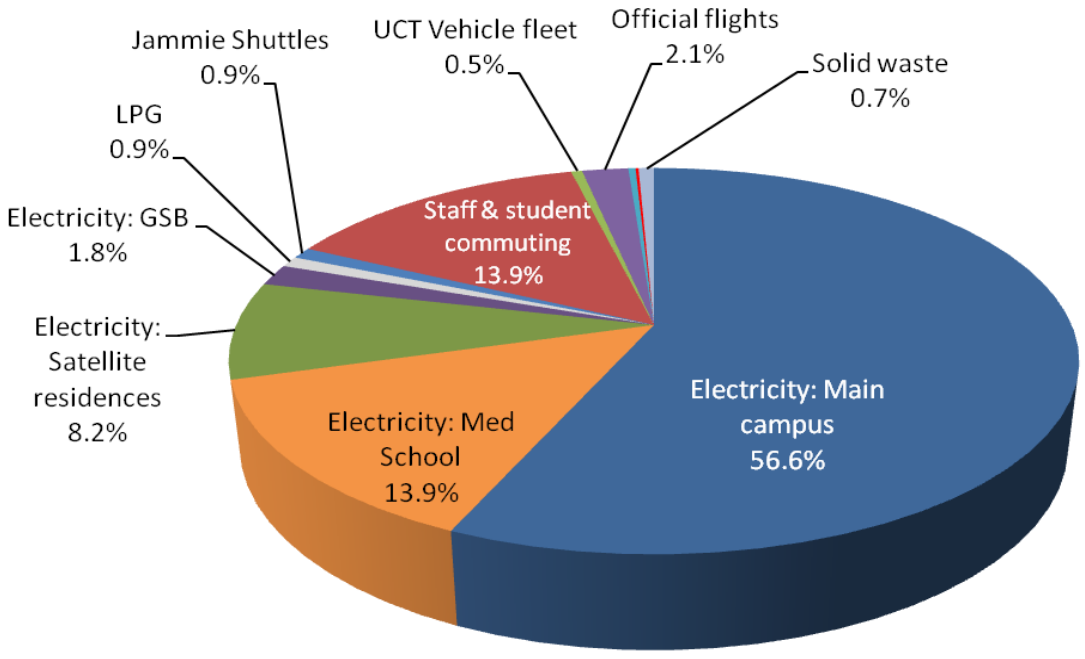
EXECUTIVE SUMMARY

Since signing the Talloires Declaration in 1990, the University of Cape Town (UCT) has been striving to set an example of environmental responsibility by establishing environmentally sound policies and practices, and by developing curricula and research initiatives to support an environmentally sustainable future. One of the most recent efforts in this quest was the release of a *Green Campus Action Plan* for the University of Cape Town by the Properties and Services department in 2008. While the Plan proposed a number of carbon emission mitigation interventions for the university, it also stressed the need to conduct a detailed and comprehensive carbon footprint analysis for the whole university.

The aim of this analysis was to determine the carbon footprint of UCT, not only to give a tangible number with which the university's carbon sustainability level can be compared with other academic institutions, but also to provide the much needed baseline against which future mitigation efforts on university campus can be measured.

UCT's carbon footprint for the year 2007 was found to be about 83 400 tons CO_2-eq, with campus energy consumption, Transportation and Goods and services contributing about 81%, 18% and 1% the footprint respectively. The figure below summarises the carbon footprint of UCT in 2007, showing only the most significant contributors. Electricity consumption contributes about 80% of all the emissions associated with university activities.



UCT's per-capita emissions for 2007 amount to about 4.0 tons CO_2-eq emissions per student. For comparison only, South Africa's 2007 per capita emissions were estimated at 10.4 tons CO_2-eq.

In terms of energy consumption only, UCT's footprint is about 3.2 tons CO_2-eq per student, higher than the National University of Lesotho's value of 0.1 and much lower than Massachusetts Institute of Technology's value of 33.1.

The collection of data was the most difficult part of carrying out this analysis because of unavailability of data and fragmentation of available data on UCT activities; hence it is recommended that all activity data – for electricity consumption on all UCT campuses, LPG consumption, cetylene consumption, UCT fleet, Jammie Shuttle diesel consumption, and waste – should constantly be monitored and updated, on at least an annual basis.

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1. INTRODUCTION

1.1 What is a carbon footprint?

A carbon footprint can broadly be defined as a measure of the greenhouse gas (GHG) emissions that are directly and indirectly caused by an activity or are accumulated over the life stages of a product or service, expressed in carbon dioxide equivalents (Wiedmann and Minx 2007). According to the Intergovernmental Panel on Climate Change (IPCC), there are a total of 18 greenhouse gases with different global warming potentials, but under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto protocol, only the following gases are considered for the purposes of carbon accounting, with others being regulated elsewhere (IPCC 1990; UNFCCC 1997):

- Carbon dioxide, CO_2
- Methane, CH_4
- Nitrous oxide, N_2O
- Hydrofluorocarbons, HFCs
- Perfluorocarbons, PFCs
- Sulphur hexafluoride, SF_6.

There are two main approaches to calculating carbon footprints: top-down and bottom-up methods. While the former is based on input-output data and generally useful for sector level or country level analyses, the latter is based on life-cycle analysis that accounts for emissions of individual items from cradle to grave. For large entities and institutions, it is usually necessary to integrate the two methods for a more comprehensive carbon accounting analysis.

1.2 Why a carbon footprint analysis at UCT

In 1990, under the leadership of Vice-Chancellor Stuart Saunders, the University of Cape Town (UCT) became signatory to the Talloires Declaration, whereby the university was committed to setting an example of environmental responsibility by establishing environmentally sound policies and practices, and by developing curricula, research initiatives and operational systems to support an environmentally sustainable future (Hall and Murray 2008).

In 2001 the Environmental Management Working Group (EWMG) was formed, under Vice-Chancellor Njabulo Ndebele's leadership, to coordinate the implementation of the Talloires

declaration (Rippon 2008). Also, in the quest to fulfil the obligations of the declaration, the then deputy Vice-Chancellor, Martin Hall, developed and published a *Green Campus Policy Framework* for UCT which was adopted by the university's Senate and Council in May 2008. This framework laid out key objectives and targets that should be addressed by a green campus action plan in the quest to reduce the university's carbon footprint (Hall and Murray 2008).

Immediately after the release of the Framework, the university's Properties and Services Department released a *Green Campus Action Plan*. The Action Plan presented a list of prioritized sustainability actions classified into the following ten categories: energy, water, indoor environmental quality, solid waste, carbon emissions, transport, emissions (to water and land), construction, landscaping and biodiversity and institutional changes. While the Plan proposed a number of carbon emission reduction interventions, it also stressed the need to conduct a detailed and comprehensive carbon footprint analysis for the entire university (Rippon 2008).

There has also been a growing interest in environmental and sustainability issues among UCT students in recent years, and this led to the establishment of UCT's Green Campus Initiative (GCI) in 2007. This student-led volunteer organisation has gained wide recognition on campus for running various projects and programmes that promote recycling, carpooling, bicycle use and the use of public transportation in the quest to reduce carbon emissions. Starting in 2008, the GCI has also been running annual "Green Week" campaigns; these are dynamic and informative week-long campaigns that promote "green" lifestyles and sustainability issues on campus. With a membership roll of over 1000 students and UCT staff in 2010, the organization hosts a "Vula" website which provides a central forum and information source on "green" issues (University of Cape Town 2009).

In brief, determining the university's carbon footprint is a critical step in achieving the goal of sustainability at the university. Knowing the university's carbon footprint will not only give a tangible value which can be compared with those of other academic institutions, but will also provide a much-needed baseline against which future mitigation efforts on campus will be measured.

This report presents the results of the university's carbon footprint analysis, showing all significant contributing activities. The report also compares the university's carbon footprint with that of other academic institutions, both locally and internationally.

2. OVERALL METHODOLOGY

In the scoping phase of this project a carbon footprint conceptual framework was developed with the aim of comprehensively characterising all activities, products and services within the university that are envisaged to contribute significantly to its carbon footprint. A secondary objective was to also improve the resolution of boundary definitions through a consistent and clear grouping of all components of the carbon footprint. In the analysis phase of the project, this conceptual framework evolved into a methodological framework through which the footprint was finally determined. This methodological framework is shown in Figure 1 below.

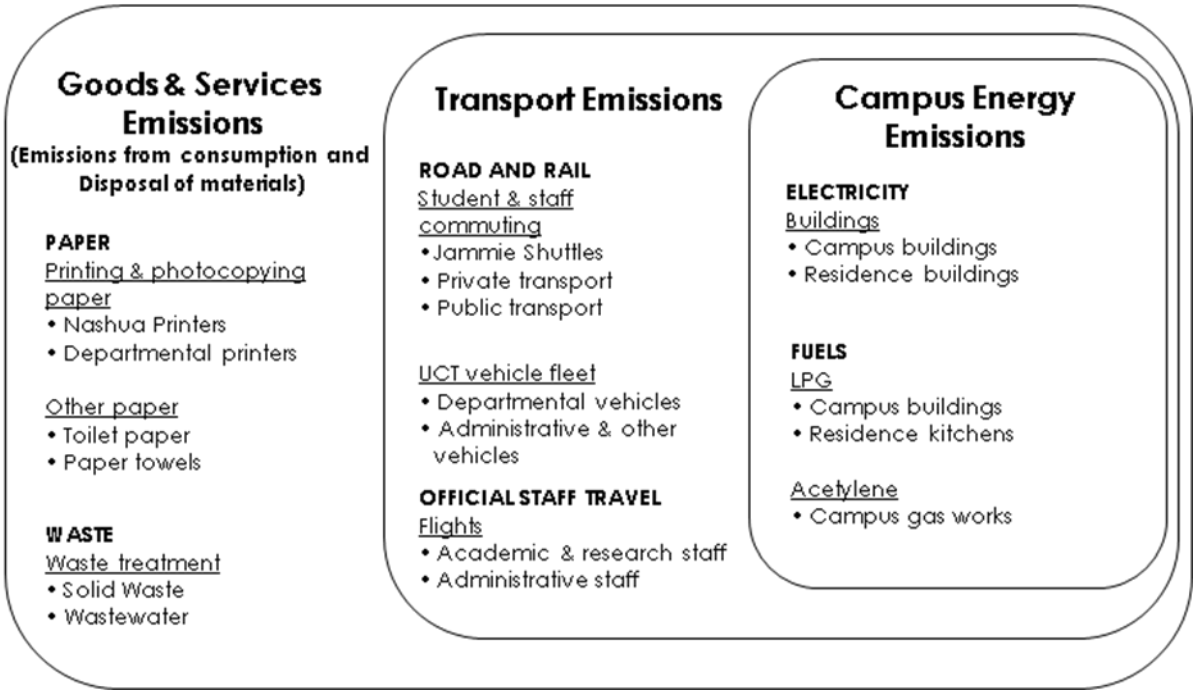

Figure 1: UCT carbon footprint methodological framework

The methodological framework categorises UCT's carbon emissions as follows:

- *Campus energy emissions*

This section encapsulates all GHG emissions that originate from direct energy consumption on the university campuses. This is primarily divided into contributions from the consumption of electricity and other fuels.

- *Transport emissions*

All emissions that emanate from UCT-related student and staff travelling fall under this category. This covers emissions from commuting to and from UCT, and also those from vehicles owned by university departments and student bodies. Emissions from the

university-owned Jammie Shuttle fleet, which provides commuting services for UCT students and staff between campuses and within areas close to the main campus, are also included. All emissions from medium- and long-haul staff flights (e.g. travel to conferences, symposia and workshops outside the city of Cape Town) are classified under this category as well.

- *Goods and services emissions*

This section captures GHG emissions associated with goods and services consumed by the university. In the scoping stages of this project, this category included emissions from a range of products and services delivered to the university (e.g. packaging, paper products, chemicals, equipment, waste disposal services etc), but as the project evolved it was found that only emissions associated with the consumption of various types of paper and the treatment of waste were significantly large enough to be included in the analysis (Letete and Guma 2007).

2.1 Basis and emission factors

The initial estimation of UCT's carbon footprint was carried out in 2007 using available data for that year, and only covered direct emissions and vehicle fleet emissions. In the two subsequent years of this project the task was to update the categories that had already been covered and to analyse the rest of the categories using, as far as possible, data for the year 2007. Where data for 2007 was unavailable, various estimation methods were employed to extrapolate the results to that year, and whenever data for other years was also available it was used to carve an emissions time series for that category.

As much as possible, South Africa specific emission factors were used in this analysis and in cases where such data was unavailable, standard IPCC emission factors and methods were then prioritised. Where emission factors could not be obtained from these two sources, other relevant publications were used.

3. DIRECT EMISSIONS

3.1 Electricity

There are two distinct methods by which electricity is supplied to UCT:

- **UCT substations** – There are two UCT substations that are directly fed by Eskom. The first and biggest is located on lower campus (next to Baxter Theatre), and services the whole of the lower campus, middle campus and upper campus,

including the residences located within these campuses. The second is located in the Medical School campus and it services that campus and the residences in it.

- **Directly by the municipality** –These are for all "satellite" buildings and campuses of UCT. They include all residences and administrative buildings which are not located on lower, middle, upper nor medical campus.

Data for electricity supplied directly by the municipality was only available for the Graduate School of Business (GSB), located at the Victoria and Alfred Waterfront, and its satellite residence buildings. Electricity consumption data for Hiddingh campus and all non-residential satellite campuses could not be obtained.

Electricity data for each of the two substations from 2003 to 2008 and for the GSB from 2008 to October 2009 was obtained from UCT's Properties and Services Department, while electricity consumption data for satellite residential buildings was obtained from the finance office of the university's Student Housing department.

UCT's Breakwater campus houses the GSB and the University-owned Breakwater Lodge which offers accommodation for tourists. As of 2010, the university has been receiving a single electricity bill for both the GSB and the Lodge. But since the Lodge activities are not university-related, the Breakwater campus finance manager suggested allocating only 46% of this electricity consumption to UCT's carbon footprint.

Electricity consumption for satellite residences was only available in monetary terms from January 2007 to October 2007 for all flats, thus consumption for the months of November and December had to be estimated. Consumption for November was then assumed to be equal to the average consumption for all the preceding months, while consumption for December was assumed to equal that of December 2006. Also, to convert the monetary data to energy consumption, it was assumed that all flats were eligible for municipality's free basic electricity of 50kWh per flat per month.

To determine the carbon footprint associated with the use of electricity on campus, the amount of electricity in kWh was multiplied by the CO_2 emissions factor obtained from Eskom's 2006 report (Eskom 2007). A transmission loss factor of 5.58%, specific for the Western Cape, and a distribution loss factor of 1.74% (*Engineering News* 2007; Eskom 2007) were used to account for the losses from generation plants to UCT. The resulting electricity emission factor used in this analysis was 1.054 kg CO_2/kWh.

Figures 2 and 3 below show monthly electrical energy consumption by the Main campus and the Medical campus respectively from 2003 to 2008, while Figure 4 shows electricity consumed by the GSB at the Breakwater campus between January 2007 and October 2009.

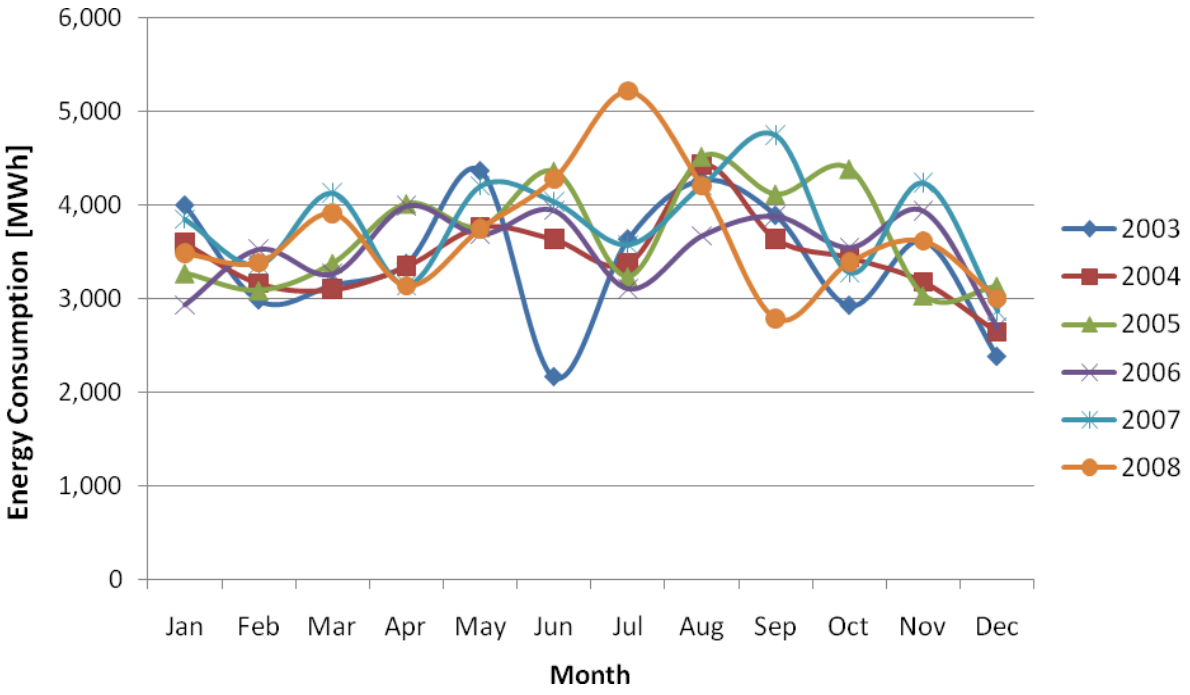

Figure 2: Monthly electricity consumption on UCT's Main campus

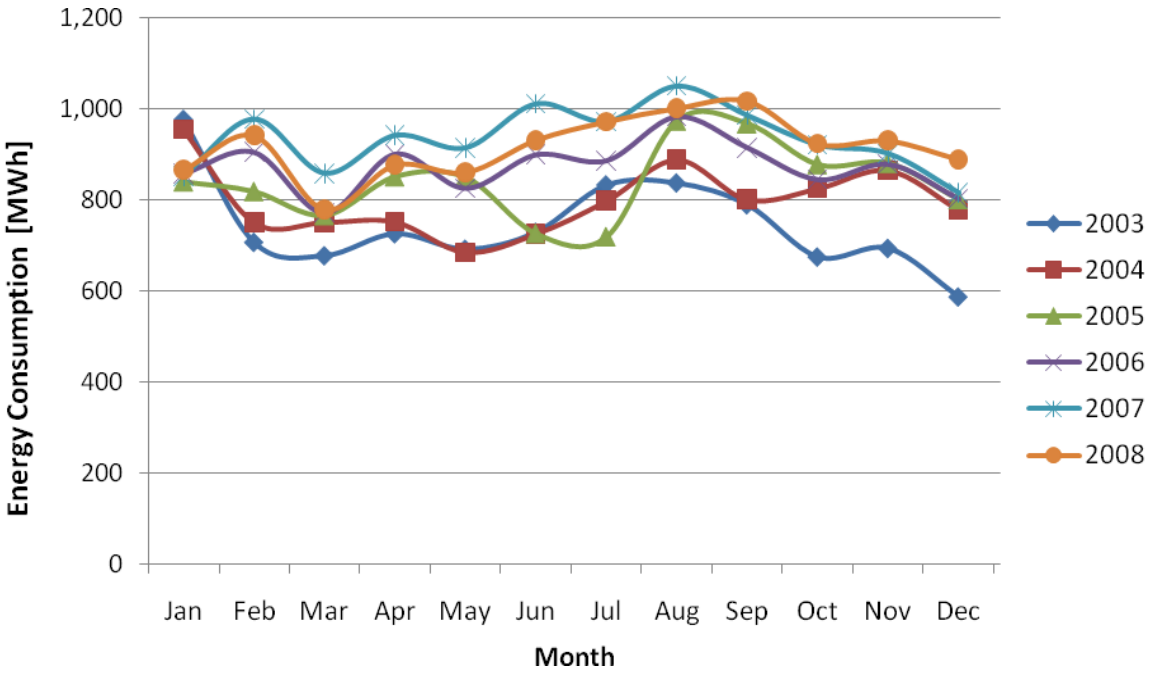

Figure 3: Monthly electricity consumption on UCT's Medical campus

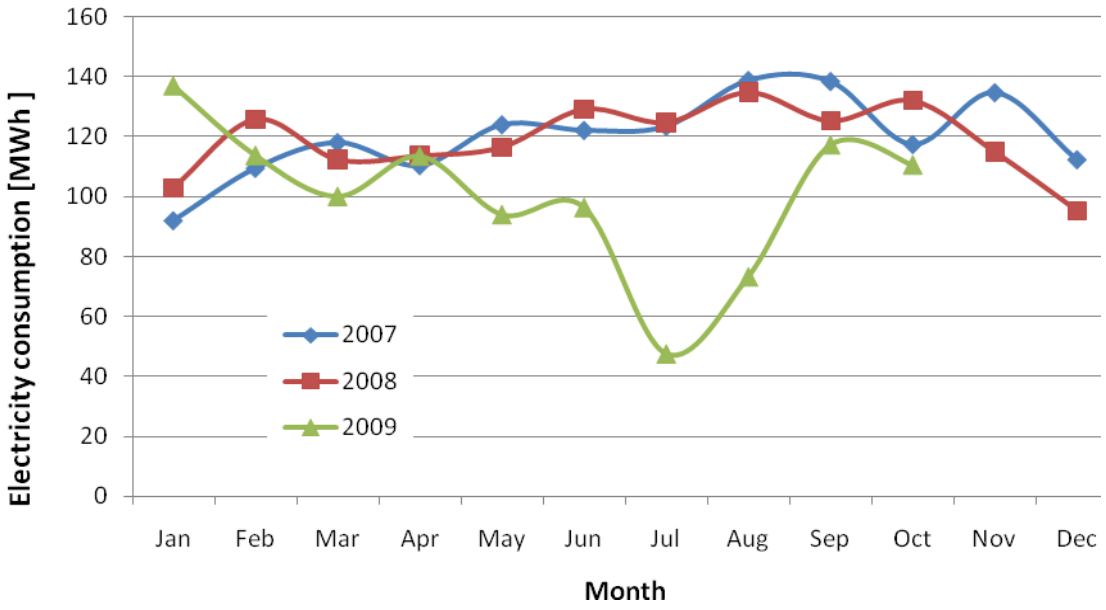

Figure 4: Monthly GSB electricity consumption attributable to UCT

Figure 5 shows the emissions from the Main and Medical campuses from 2003 to 2008, together with GSB campus emissions for 2007 and 2008 only. GHG emissions from electricity consumed on Main, Medical School and GSB campuses range from about 52 300 tonnes CO_2-eq in 2003 to about 61 400 tonnes CO_2-eq in 2007, while CO_2 emissions from electricity consumed in satellite campuses for the year 2007 were estimated at 6 900 tonnes CO_2-eq. Figure 6 below shows the monthly electricity consumption by UCT satellite residences in 2007.

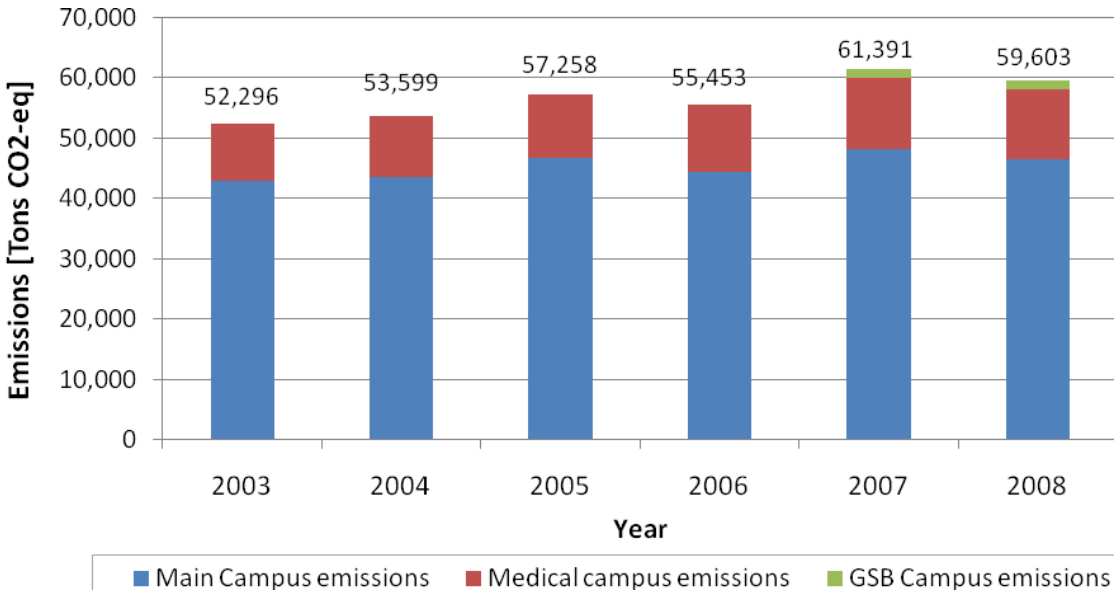

Figure 5: Carbon emissions from electricity consumption on Main, Medical and GSB campuses

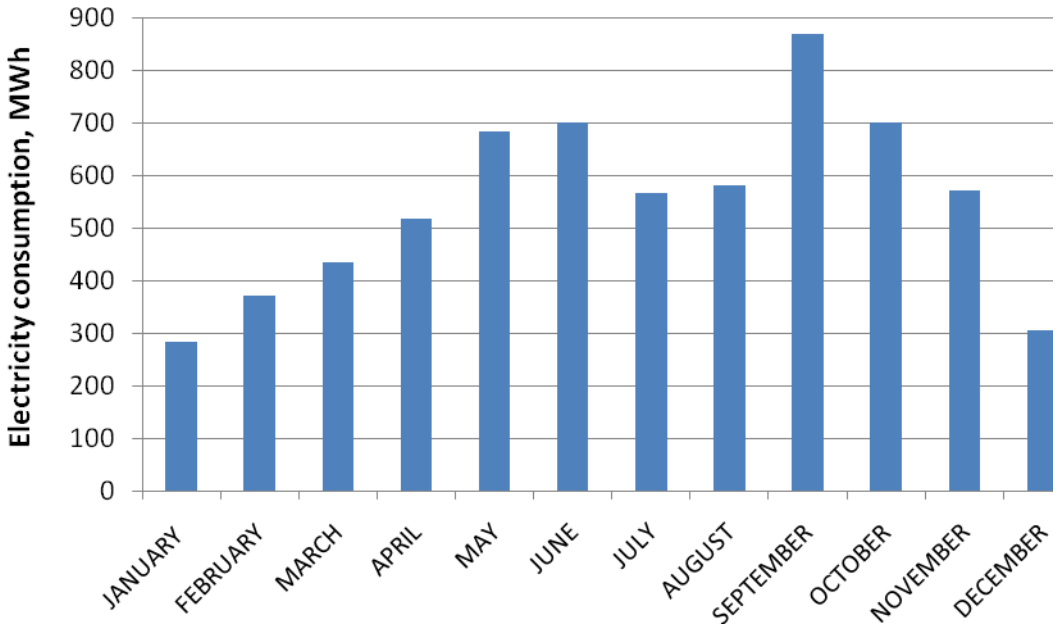

Figure 6: Electricity consumption in all UCT satellite residence campuses for 2007

Electricity consumption contributed a total of 68 300 tons to the university's carbon footprint in 2007, 70% of which was from the Main campus, 18% from Medical School campus, 2% from the GSB and the rest from satellite residential buildings (Figure 7).

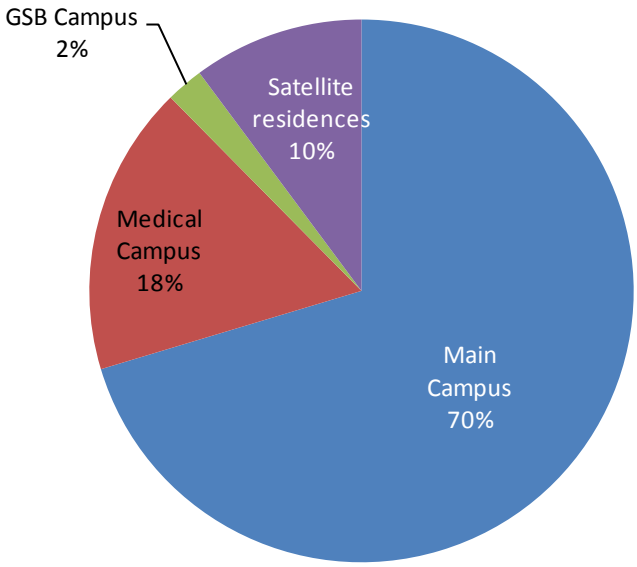

Figure 7: Distribution of UCT's emissions from electricity consumption in 2007

3.2 Liquefied petroleum gas

At UCT Liquefied petroleum gas (LPG) is used for cooking in residence kitchens and for academic research purposes (e.g. fuelling laboratory burners and heaters). For its LPG

needs, the university is currently serviced through bulk LPG delivery to four storage tanks on the university campus, and portable LPG cylinder deliveries, primarily on an ad hoc or emergency basis.

AFROX Ltd is the university's LPG vendor. For each of these two types of deliveries, quantities of LPG ordered for the January – October 2007 were obtained from the UCT Finance Department. The net calorific value (OECD-IEA 2004) was used to determine the amount of energy released at combustion. Using the IPCC 2006 guidelines emission factor (IPCC 2006), the amount of CO_2 released could therefore be calculated. Average figures were used for November and December, based on the average monthly consumption between January and October. The results showed that LPG contributed a total of 755.2 tonnes of CO_2-eq emissions to the university's carbon footprint for 2007, with bulk gas and handigas making up about 97% and 3% of the emissions respectively.

3.3 Acetylene

Acetylene at UCT is used for laboratory work and maintenance (e.g. welding, etc). Air Liquide (Pty) Ltd is the vendor. Quantities of acetylene ordered for the period of January – October 2007 were obtained from the UCT Finance Department. The amount of CO_2 released was thereafter calculated based on reaction stoichiometry for the combustion reaction for acetylene in air:

$$2C_2H_2 + 5O_2 = 4CO_2 + 2H_2O$$

The reaction was assumed to occur to completion, and kinetic effects were not considered. Average consumption values for the period of January to October were assumed for the last two months of the year. The analysis showed that a total of 0.693 tonnes of CO_2-eq emissions were due to the use of acetylene on campus during the year 2007.

4. TRANSPORT EMISSIONS

4.1 Jammie Shuttles

Jammie Shuttle fuel data for the period of September 2007 to June 2009 was obtained from the Production manager in the university's Properties and Services department. It was given as diesel consumption quantities on daily basis, extracted from the computer emailing system records of the diesel supplier. Shuttle diesel consumption for January – August 2007 was estimated based on an average ratio of September - December 2007 consumption to consumption over the same period in 2008. IPCC inventory methodology and emission factors were then used to determine the resulting carbon emissions (IPCC 2006).

Figure 8 below shows the emissions profile of the Jammie Shuttles for the period of January 2007 to June 2009. The total emissions from the Jammie Shuttles for 2007 and 2008 were estimated at 802.8 and 1013.3 tons of CO_2-eq respectively, while for the period of January – June 2009 the emissions were about 553.3 tons CO_2-eq. The expected trend is observed in CO_2 emissions per annum for all the years, showing reduced emissions in January, June and July, November and December due to reduction of the number of shuttles operating in the vacation period.

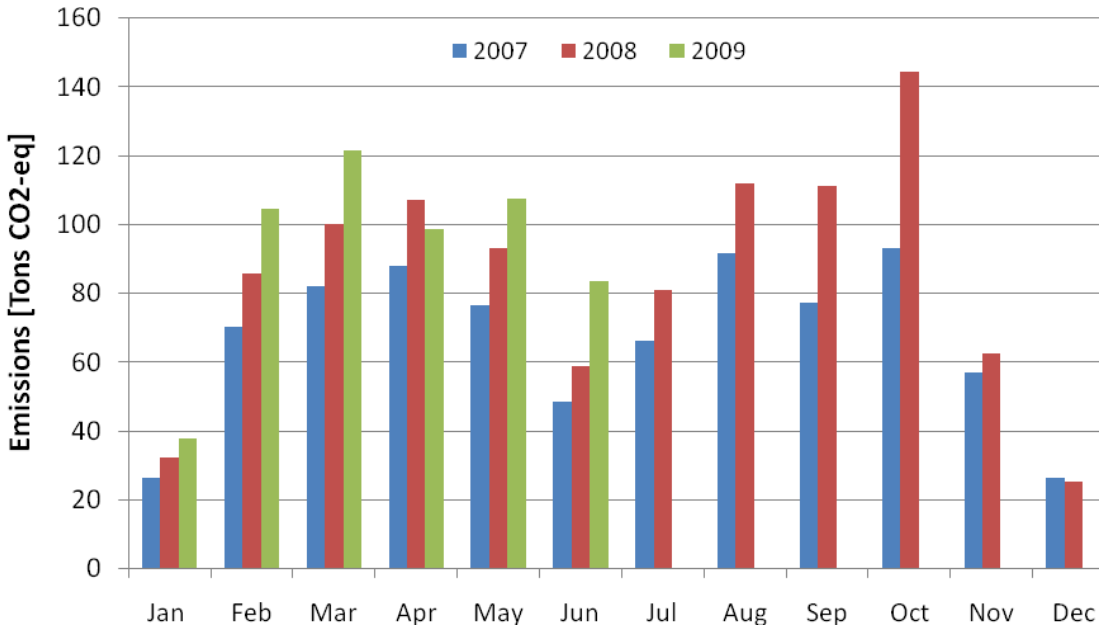

Figure 8: Carbon dioxide emissions from diesel consumption in Jammie Shuttles

4.2 Student and staff commuting

A transport survey was conducted for university staff and students in 2009 to determine the distribution of modes of transport used for commuting daily to the university campus and the distribution of areas of residence. In the survey, the various residential areas were grouped together based on their relative distance from the university, and the resulting distribution was applied to the university's 2007 student and staff statistics (University of Cape Town 2009). The distances were then converted to CO_2 emissions using the emission factors associated with the relevant transport modes. A copy of the survey is given in Appendix A.

In the analysis it was assumed that buses carry 60 passengers while taxis carry 15 passengers. Fuel consumption was assumed to be 9.5 L/100km of petrol for all private cars and taxis, 4.0L/100km of petrol for motorbikes and scooters and 40.0L/100km of diesel for public buses (Landy online 2008; SACAN 2008). It was also assumed that there are 21 working days per month. Standard IPCC emission factors for diesel and petrol were used for cars, taxis and busses, while a per capita emission factor of 30 gC per passenger-km was assumed for passenger trains (Penner, Lister et al. 1999).

A total of 2077 students and members of staff responded to the survey, and Figure 9 below shows the distribution of the major modes of transport used daily for commuting to and from the university campuses.

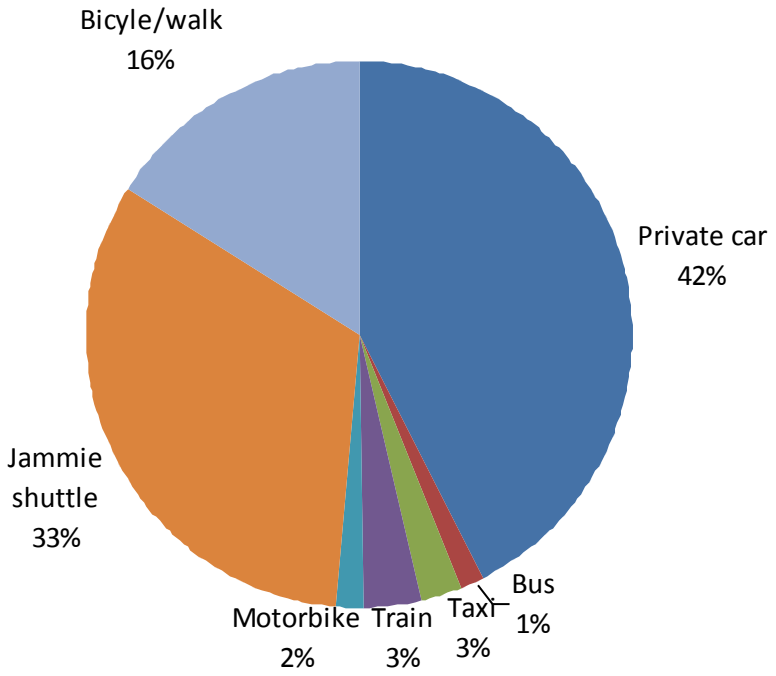

Figure 9: Distribution of daily commuting modes by students and staff

Only about 16% of the UCT community commute to campus carbon-free, while about 33% use the Jammie Shuttle. More than 40% of the UCT community drive to campus daily.

The total emissions resulting from commuting of students and staff for 2007, excluding emissions from the Jammie Shuttles, were found to be about 11 837 tonnes of CO_2-eq. Figure 10 below shows that more than 92% of these emissions are attributable to the use of private vehicles and motorcycles, while public transportation only accounts for about 7.5%.

The main issues that came out of the survey were that the Jammie Shuttles do not go to most of the areas where people live, so a lot of people depend on either public or private transportation. People living closer to the university who use private cars have spoken of the unreliability of the Jammie times, especially in the morning.

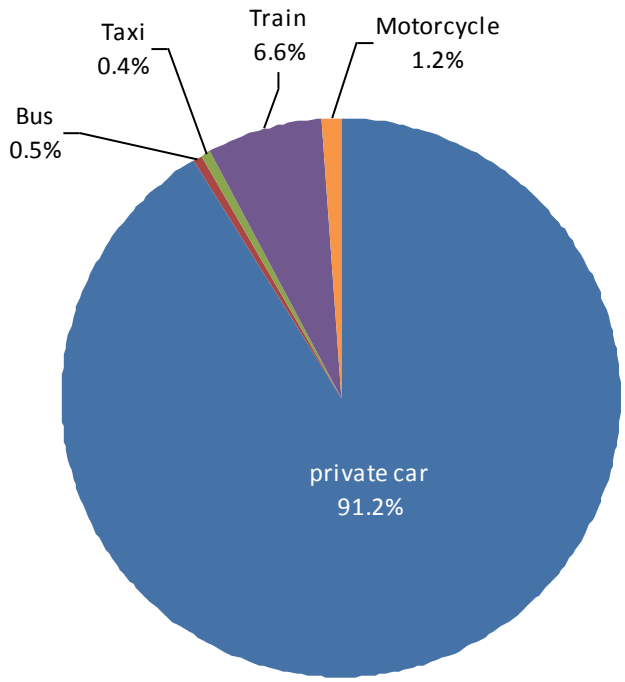

Figure 10: Distribution of carbon emissions from daily commuting to campus (excluding emissions from Jammie Shuttles)

4.3 UCT vehicle fleet

UCT vehicle fleet fuel payments are facilitated through the Bankfin petrol card system in which vehicle users purchase fuel at filling stations on the card and then submit their receipts

at the end of each month. Each card is linked to a university account and cost centre (affiliated to the department to which the car pool is issued) which then gets debited with the claimed amount. Claimed and processed monetary payment data for fuel ordered from January to August 2007 were obtained from the UCT Finance Department, and the average fuel price in rands per litre for coastal conditions was used (DME 2007) to calculate the volume of fuel consumed. The density of the fuel (OECD-IEA 2004) was used to convert these figures to a mass basis for each fuel type, after which the net calorific value (OECD-IEA 2004) was the used to determine the amount of energy released at combustion. Using the IPCC emission factor (IPCC 2006), the amount of CO_2 released could therefore be calculated. Average figures were used for September to December as calculated based on the average monthly consumption between January and August.

UCT vehicle fleet was found to contribute a total of 424.8 tonnes of CO_2-eq to the university's emissions, with petrol and diesel amounting to about 333 or 78% and 92 or 22% respectively (Figure 10).

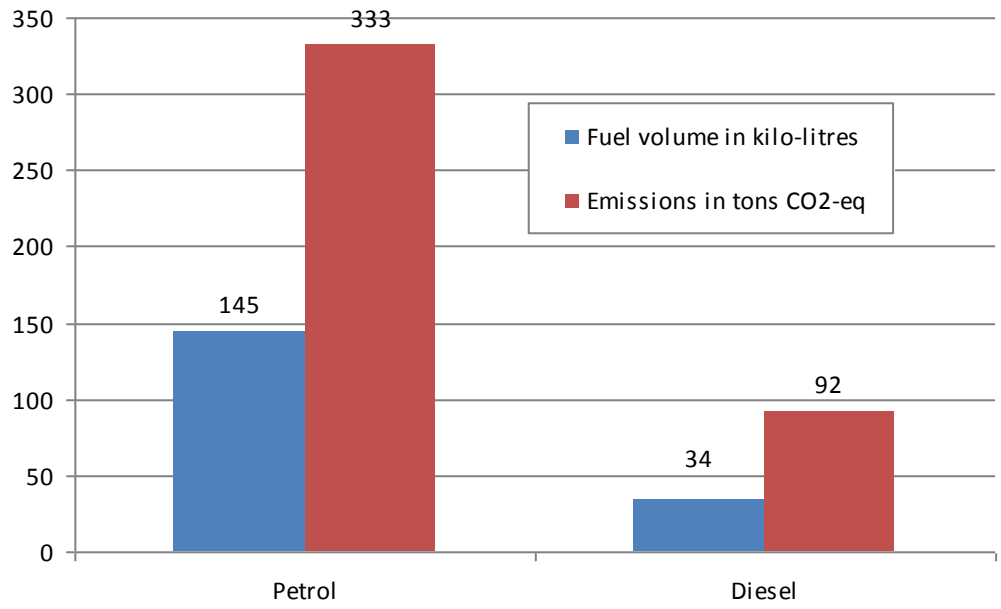

Figure 11: Fuel quantities and resulting emissions from UCT vehicle fleet for 2007

4.4 Official flights

Flights for official UCT business are not booked through a single travel agent or administered centrally by a single university department, instead each department, sometimes even each person within one department, uses a different travel agent, and hence obtaining flight data for the entire university is an impossible task. Travel insurance for

official international trips, however, is administered centrally by the UCT travel insurance office, and this is the office that provided data on the international trips taken for official UCT business for the year 2007.

To estimate the emissions associated with each international trip, flight distances obtained from Travel Math were used, together with a long haul flight emission factor of 0.15 ton CO_2-eq per passenger per 1000 km (SACAN 2008; Travel Math 2009). A total of about 11.9 million passenger-kilometres were flown internationally for UCT official business in 2007, resulting in CO_2 emissions of about 1 800 tonnes. As can be seen from Figure 12 below, trips to Europe and North America made up about 76% of these emissions while trips within Africa only contributed about 8.6%.

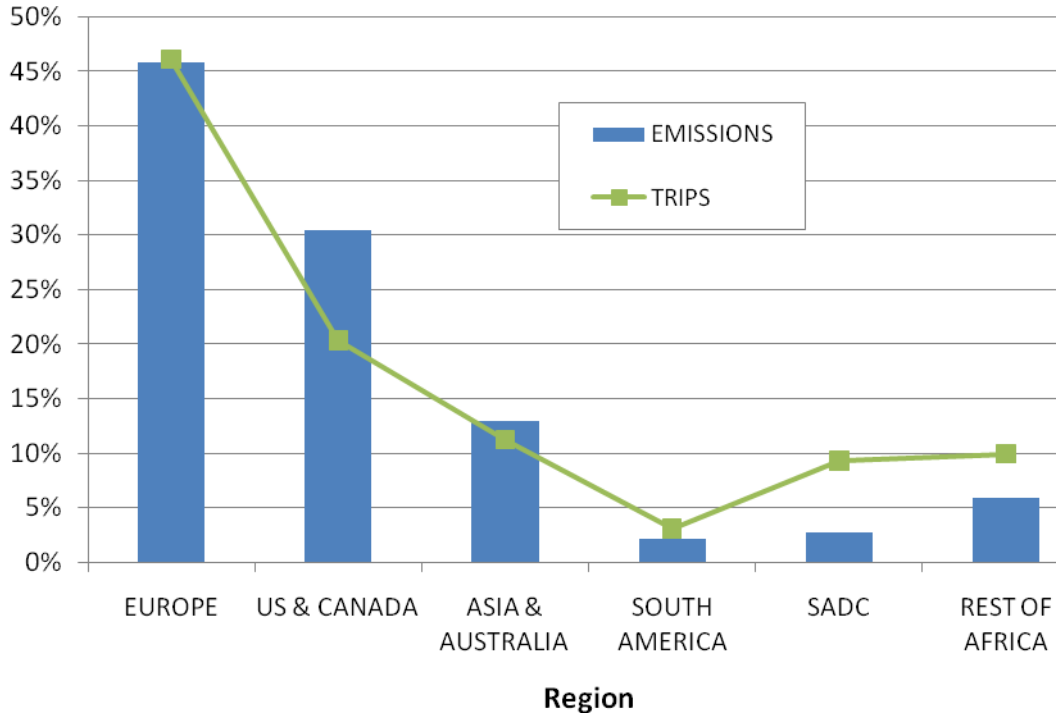

Figure 12: Distribution of trips and emissions from international official flights in 2007

It must be noted that because of unavailability of data on domestic flights for official UCT business, the emission value reported in this section is an underestimation of the actual UCT carbon footprint resulting from official flights.

5. EMISSIONS FROM GOODS AND SERVICES

5.1 Paper

Three types of paper were covered in this analysis: printing and photocopying paper, toilet paper and paper towels.

- *Printing and photocopying paper*

At UCT printing and photocopying services are managed in two different ways: The most common is the use of Nashua-owned machines and paper, while the other is through department-owned machinery and consumables. The former contributes a much larger portion compared to the latter because it is used by all undergraduate students and most departments have reverted to it; and because it is centrally managed activity data was relatively simpler to obtain. Because the latter group is not managed at any one point, data could not be obtained, and was not included in the carbon footprint analysis.

It was not possible to obtain data on the consumption of printing paper for the year 2007 from Nashua, so 2009 data was used for analysis, with the assumption that printing paper consumption has not increased significantly since 2007. This data, however, was only available for the period of January 2009 – July 2009, and therefore the consumption rate for the rest of the year (August-December 2009) was assumed to be the average of the seven preceding months. Here a mass of 5 grams was assumed for each sheet of A4 paper.

- *Toilet paper and paper towels*

Consumption data on toilet paper and paper towels was obtained from Supercare Cleaning Services – a company responsible for procuring cleaning materials and carrying out all cleaning services on campus. For both items, data was only available for the period of January 2007 – October 2007; hence consumption for the rest of the year had to be assumed. For toilet paper a weight of 227 g/roll was used, while a size of 240 mm x 330 mm and a specific gravity of 38.18 gsm were used in the analysis for paper towels(3PIN 2009; WIPO 2009).

To obtain the carbon emissions associated with all types of paper, a life-cycle emission factor of 1200 kg CO_2-eq per tonne of paper was applied to the mass consumption data (Dias, Arroja et al. 2007). Figure 13 below shows the emission contribution of each type of paper to the university's carbon footprint for the year 2007.

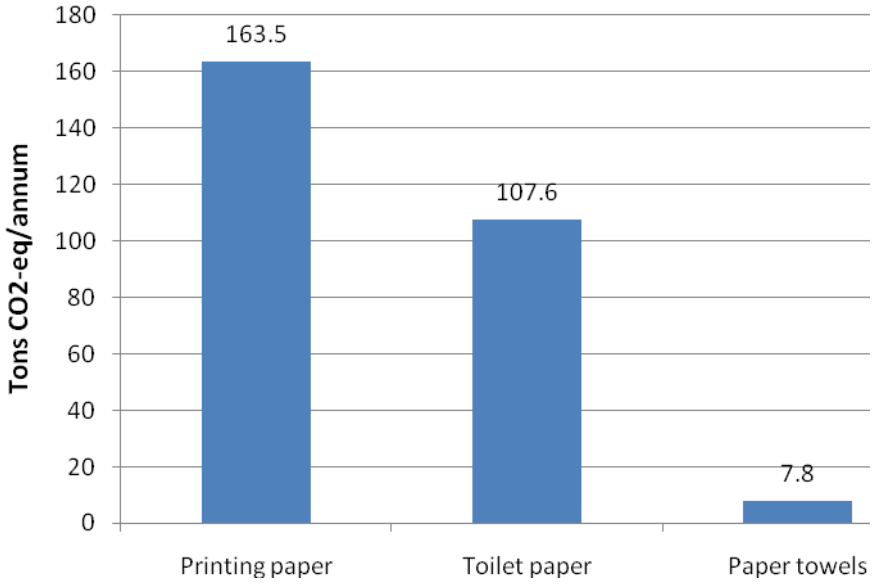

Figure 13: Life-cycle emissions from the use of paper on UCT campuses in 2007

5.2 Solid waste

As with printing paper, there was no record of the quantities and types of solid waste removed from the university for the year 2007. Only starting in 2009 was a recycling company called *Wasteman Recycling* contracted by the Properties and Services department to remove waste from UCT premises, recycle all recyclables and to keep a record of all quantities involved. Even then, only data for the months of April, May and June was available, and an average quantity for these months was assumed for all other months.

The IPCC 2006 method for estimating the generation potential of CH_4 emissions from solid waste was used and converted to CO_2 emissions using a global warming potential of 25 for methane (IPCC 2006). The results showed that solid waste contributes about 595.1 tonnes of CO_2-eq emissions per annum to the university's total carbon footprint. These are only emissions associated with the wet waste that is taken to the landfill, and assumes that all the recyclables are actually recycled and do not contribute to UCT's carbon footprint.

5.3 Wastewater

Only sewerage disposal data for the period of January – August 2007 was available from the university's department of Properties and Services, hence extrapolation using the monthly average was necessary to estimate sewerage data for the last four months of the year.

The IPCC 2006 method for estimating CH_4 emissions from wastewater was used, together with an average chemical oxygen demand of 58 mg/l for all Western Cape wastewater

treatment plants in 2007 (City of Cape Town 2009). Anaerobic treatment of wastewater with no methane recovery and a global warming potential of 25 for methane were also assumed. The contribution of wastewater to the total carbon footprint of the university was then found to be about 113.1 tonnes of CO_2-eq per annum for 2007.

6. TOTAL UCT CARBON FOOTPRINT

Table 1 below shows the total carbon footprint of the University of Cape Town for the year 2007. University activities for the year of 2007 led to the release of about 85,000 tons of CO_2-eq emissions to the atmosphere, with about 80% of those emissions coming from the consumption of electricity alone. Daily commuting to campus and official international flights were the second and third most carbon-intensive activities at the university in 2007 with contributions of 14% and 2% respectively.

Table 1: UCT's carbon emissions for the year 2007

Category	Emissions source	Emissions [tons CO_2-eq/yr]	% Contribution
Campus energy	Electricity: Main Campus	48 061.7	56.59%
	Electricity: Medical School Campus	11 810.5	13.91%
	Electricity: Graduate School of Business	1 518.4	1.79%
	Electricity: Satellite residences	6 936.6	8.17%
	LPG	755.2	0.89%
	Acetylene	0.7	0.001%
Transportation	Jammie Shuttles	802.8	0.95%
	Staff and student commuting	11 837.2	13.94%
	UCT vehicle fleet	424.8	0.50%
	Official flights	1 790.4	2.11%
Goods & Services	Printing paper, toilet paper, paper towels	278.9	0.33%
	Wastewater	113.1	0.13%
	Solid waste	595.1	0.70%
TOTAL		**84 925.5**	**100%**

Figure 14 is an overview of UCT's carbon footprint, highlighting only the most significant contributors (greater than 0.5%), while Figure 15 shows the contribution of the different categories.

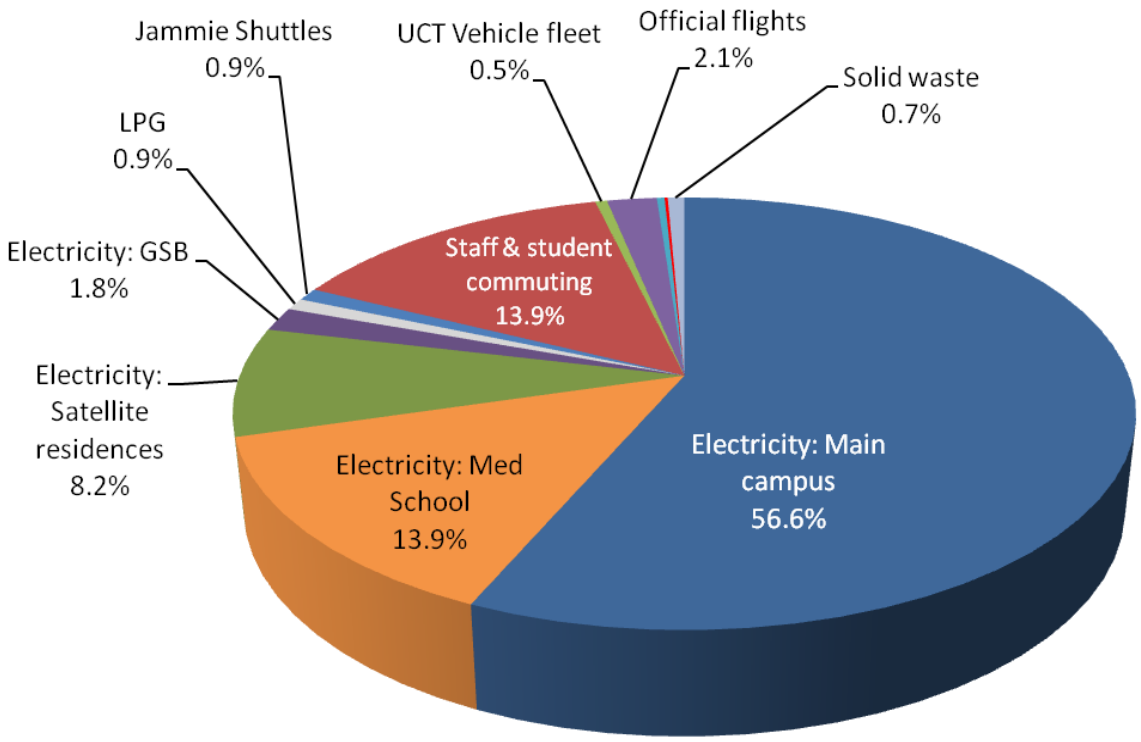

Figure 14: Overview of UCT's carbon footprint for 2007

Of the three categories of UCT's carbon footprint methodological framework, outlined in part 2, energy has the largest share of GHG emissions at 81%, followed by transport at 18% and goods and services with 1%.

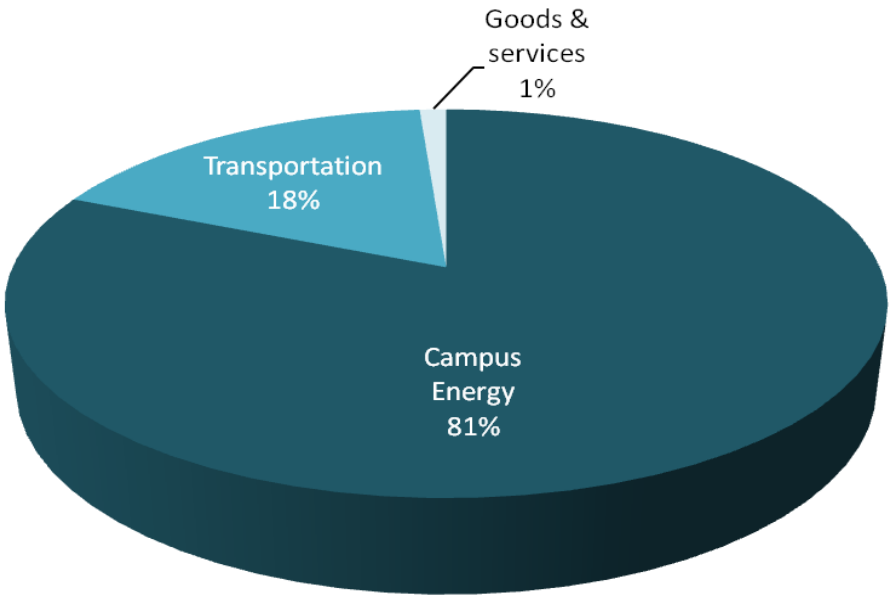

Figure 15: Distribution of UCT's carbon footprint by category

7. BENCHMARKING AGAINST OTHER UNIVERSITIES

Information on the carbon footprints of other South African universities could not be found; instead the carbon footprint of UCT was compared to those of international universities which have published such studies. Figures 16, 17 and 18 show this comparison. Specifically, Figure 16 compares the emissions per capita from direct energy consumption (excluding transport emissions) of the different universities, and UCT is found to be at 3.2 tons CO_2-eq per student, well below the average of 8.4. What seems interesting in the figure is that all American universities have higher per capita emission values than UCT while the two British universities and the National University of Lesotho perform better than UCT. A table of calculations and data sources can be found in Appendix B.

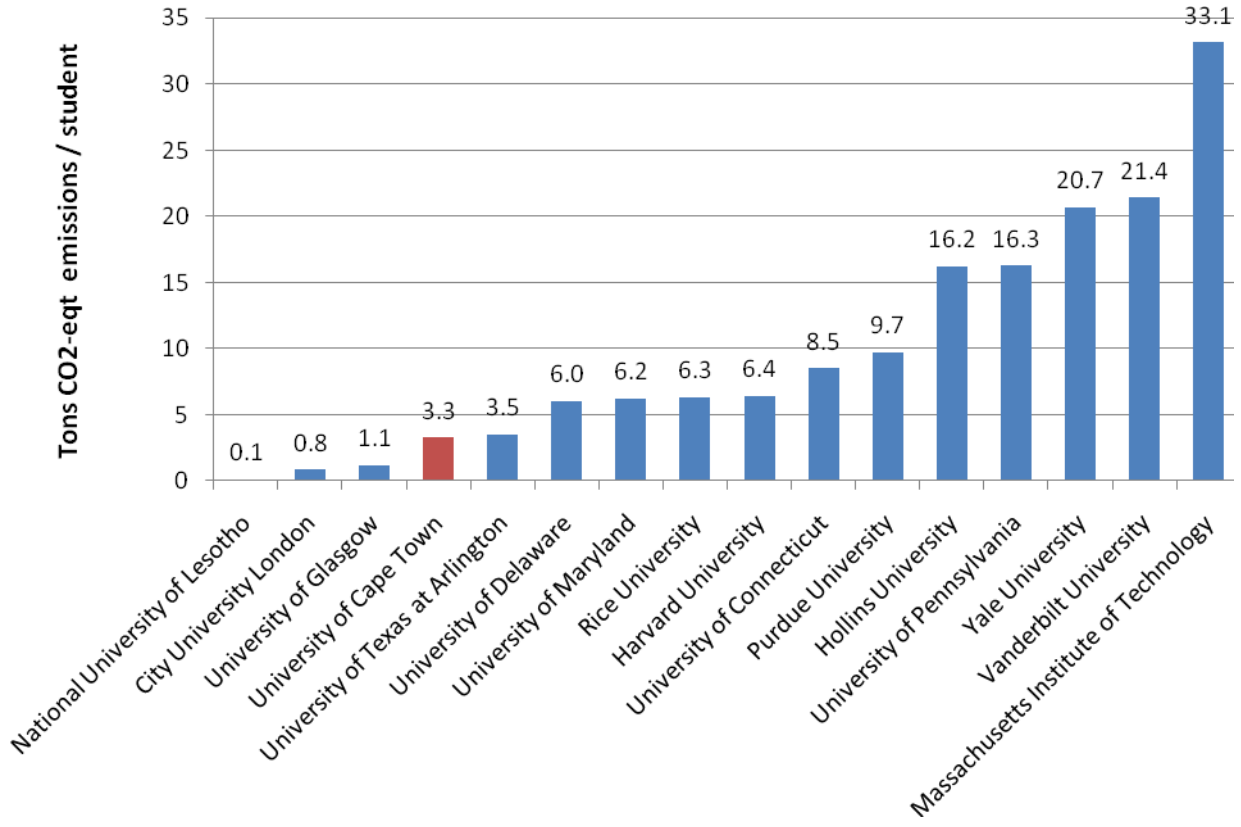

Figure 16: Per capita emissions from energy consumption of different universities[1]

[1] All data for year 2007 with the exception of University of Glasgow (2006), University of Texas Arlington (2005), Yale University (2002) and Massachusetts Institute of Technology (2003).

Of the universities compared in Figure 16, only nine could further be compared in terms of emissions from sectors other than direct energy use. Figure 17 below compares UCT's emissions from transportation, waste and other sources with those of other universities, while Figure 18 compares the total annual carbon footprints of these universities per student.

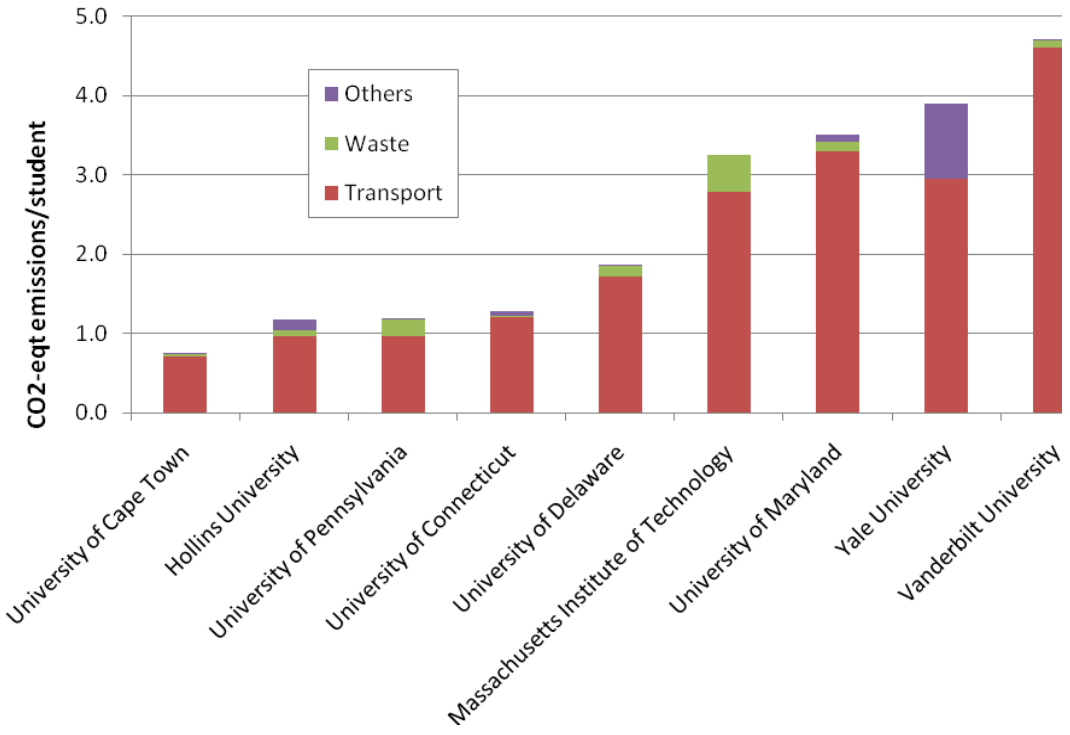

Figure 17: Per capita emissions from transport, waste and other sources for different universities

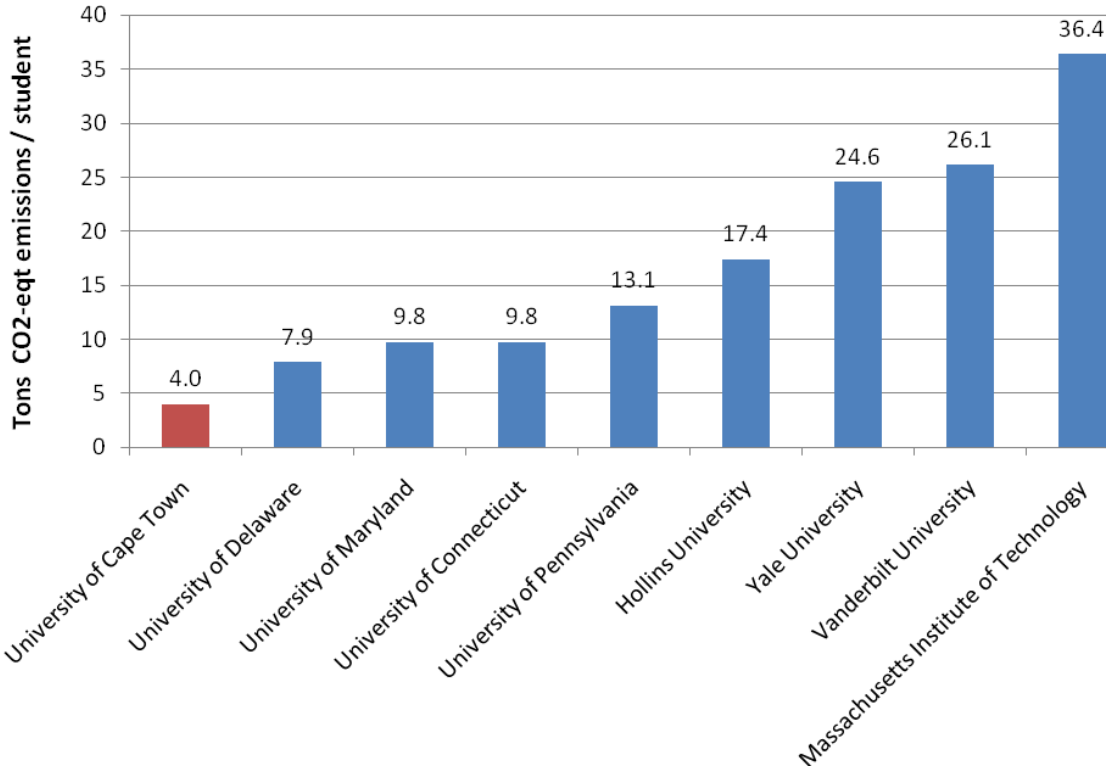

Figure 18: Comparing the total per capita emissions of the different universities

It is clear from both Figures 17 and 18 that UCT outperforms all the other universities included in the analyses in terms of emissions intensity.

It is worth noting that UCT's value of 4.0 tons CO_2-eq/student is rightly lower than the country's 2007 per capita emissions estimate of 10.4 tons CO_2-eq/capita (Appendix C) because the former only reflects the student's carbon footprint associated with the university activities.

8. QUALITY CONTROL AND UNCERTAINTY

It is good practice to analyse the quality of a GHG inventory and to give an indication of the confidence level in the reported results. Ideally statistical models are used to accurately quantify the uncertainties in individual variables of the inventory (emission factors, activity data, etc.) and then to aggregate them to the total inventory, but for this report only a qualitative analysis of the confidence level in the data was carried out.

Three confidence levels were used in this analysis:

- Low – high uncertainty in data quality
- Medium – Some uncertainty in the quality of the data
- High – very low uncertainty in the quality of the data

8.1 Electricity emissions

There is high confidence in the electricity consumption data obtained from the municipality and the Properties and Services department, especially for the latter because a consistent time series could also be mapped out from as far back as 2003. However, there is medium confidence in the allocation method used for GSB electricity consumption, the emission factor reported by Eskom and the associated transmission and distribution loss factors. Also, electricity consumption data for Hiddingh campus and other non-residential satellite campuses was not available for inclusion in the analysis, hence contributing to the decrease in confidence level of the total contribution of electricity usage to the university's carbon footprint.

8.2 LPG and acetylene emissions

For both LPG and acetylene, there is high confidence in the consumption data provided, but a model had to be used to estimate consumption for the last two months of the year, leading to a medium overall confidence in the activity data. An IPCC emission factor, with a relatively low uncertainty, was used in the case of LPG, leading to an overall medium confidence level in the LPG emissions. For acetylene, however, there is relatively low confidence in the assumptions used for estimating the emission factor, resulting in a low overall confidence level in the emissions value.

8.3 Jammie Shuttles and UCT vehicle fleet

The confidence level in the fuel consumption data obtained for both the Jammie shuttles and the UCT fleet is relatively high, but activity data for the last two months had to be estimated in the case of UCT fleet, which results in a medium overall confidence here.

8.4 Commuting

The sampling method used to determine the distribution of modes of commuting by students and members of staff inherently carries high uncertainties. This, together, with the many assumptions made regarding vehicle efficiencies, distances travelled and the frequency of using certain modes of transport leads to a low confidence level in the emissions associated with commuting to campus.

8.5 Official flights

The data used for estimating official international flights only contained the destinations of the travellers, and many assumptions had to be made regarding the actual routes taken. This, together with the assumptions made regarding plane efficiencies and their associated emission factors render the overall confidence level in the resulting emission estimate low. Also the fact that only flights where travellers had applied for UCT travel insurance have been included in the analysis further decreases the level of confidence in the total contribution of official flights to the carbon footprint of the university.

8.6 Paper

Confidence in the paper consumption data used for the analysis in this report is of medium level, because only a fraction of the printing paper consumption data could be obtained. But because of the large number of assumptions involved in the method used and the fact that the life-cycle emission factor used was based on manufacturing processes in Portugal, the overall confidence in the emissions estimate is low.

8.7 Waste

While there is high confidence in both the wastewater data obtained from the Properties and Services department and the wastewater emission factor that was determined based on wastewater treatment practices in Cape Town, the fact that wastewater data for half of the year had to be estimated leads to medium confidence in the overall wastewater emissions. In the case of solid waste, very poor quality data was supplied by the recycling company, hence confidence in the resulting emissions estimate is low.

9. RECOMMENDATIONS FOR FUTURE CARBON FOOTPRINTS

The greatest difficulty in carrying out this carbon footprint analysis was the availability of data, most of which was either totally unavailable, partially complete or had to be collected from various scattered sources in and around the university campuses. Table 2 below summarises the problems encountered in obtaining the different pieces of data and the recommended actions for improving the analysis method.

In general, all activity data – electricity consumption in all UCT campuses, LPG consumption data, Acetylene consumption data, UCT fleet data, Jammie Shuttle diesel consumption and waste data – should constantly be monitored and updated, at least on a yearly basis.

Table 2: Recommendations for improving UCT's carbon footprint analysis method

Sector	Problems	Recommendations
Satellite campus electricity	• Data for non-residential satellite buildings unavailable • Electricity data for Hiddingh campus unavailable	• Electricity consumption data for all campuses of UCT to be monitored centrally and updated regularly
Travel	• Data for domestic official flights unavailable • Data for official car hire unavailable	• Database of all official travel should be kept and updated regularly
Printing paper	Paper consumption data for department- owned machines unavailable	• Either paper consumption data to be monitored at faculty level, OR • All printing and photocopying on campus to be handed over to Nashua
Solid waste	• Data not well monitored • Dry waste (recyclables) data too aggregated	• Solid waste data to be constantly monitored • Data to be more disaggregated for different recyclables
UCT statistics	• UCT student and staff statistics on UCT website not up to date	• Student and staff statistics to be constantly monitored and updated on the UCT website

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APPENDICES

1. UCT Carbon Footprint Transport Survey

1. Are you a student or staff?

1. Student
2. Staff

2. Are you Male or Female?

3. Male
4. Female

3. If **STUDENT**, What is your year of study?

5. 1st Year
6. 2nd Year
7. 3rd Year
8. 4th Year
9. 5th Year
10. Post graduate
11. Post doctoral
12. Other

4. If **STAFF**, What type of work do you do?

13. Lecturer / Senior Lecturer
14. Associate Professor / Professor
15. Junior / Senior Researcher
16. PASS
17. Other

5. Facucty to which you belong:

18. Commerce
19. EBE
20. Health Sciences
21. Humanities
22. Law
23. Science
24. Other

6. Do you live in university accommodation or private accommodation?

University Accommodation Private Accommodation

7. What means of transportation do you normally use to come to campus?

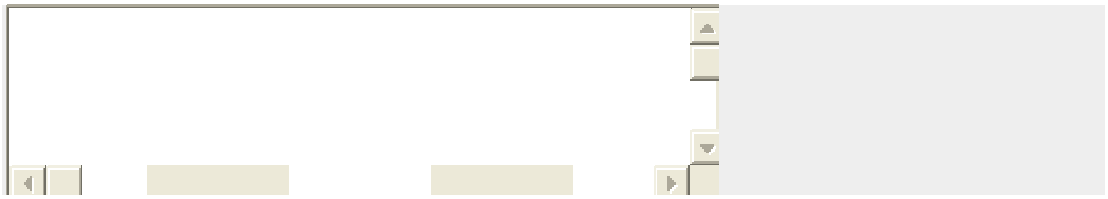
25. Walk
26. Bicycle
27. Jammie Shuttle only
28. Private car only
29. Private car + Shuttle
30. Taxi only
31. Taxi + Shuttle
32. Bus only
33. Bus + Shuttle
34. Train only
35. Train + Shuttle
36. Other

8. If you normally use **other** or multiple transport modes please specify:

9. If you use private car please specify occupancy:

Just myself 2 people 3 people 4 people 5 or more people

10. If you do **not** use the shuttle please specify reason(s):



11. The areas below have been grouped by their relative distance from UCT. Which of the groups includes an area closest to your place of residence?

37. Bellville, Hout bay, Mitchell's Plain, Muizenberg, Parklands, Table view
38. Camps bay, Elsiesrivier, Dieprivier, Montague gardens, Parow, Philippi
39. Canal walk, Cape Town, Epping, Goodwood, Kenilworth, Milnerton, Wynberg
40. Athlone, Claremont, Maitland, Newlands, Pinelands, Woodstock
41. Mowbray, Observatory, Rondebosch
42. UCT campus
43. Much farther than all the above areas

2. Data for other universities

University	Number of Students[2] 2008	Emissions [Tons CO_2-eq]					Total Emissions/capita	Year	Source[3]
		Energy	Transportation	waste	Others	Total emissions	Tons CO_2eq/student		
National University of Lesotho	8 566	573						2007	*1)*
City University London	12 861	10 686	-		1 597	12 283	0.96	2007	*2)*
University of Glasgow	23 590	27 000					0.00	2006	*3)*
University of Cape Town	21 175	69 083	14 855	708	279	84 925	4.01	2007	
University of Texas at Arlington	25 297	88 830				98 700	3.90	2005	*4)*
University of Delaware	19 359	116 614	33 336	2 538	54	152 542	7.88	2007	*5)*
University of Maryland	36 014	224 733	118 466	4 560	3 386	351 145	9.75	2007	*6)*
Rice University	5 061	31 986				69 032	13.64	2007	*7)*
Harvard University	29 900	192 230						2007	*8)*
University of Connecticut	20 229	171 993	24 248	487	1 025	197 753	9.78	2007	*9)*
Purdue University	39 102	378 400				668 800	17.10	2007	*10)*
Hollins University	1 039	16 874	1 000	75	137	18 086	17.41	2007	*11)*
University of Pennsylvania	26 537	317 000	25 548	5 750	0.48	348 298	13.13	2007	*12)*
Yale University	11 851	244 814	34 904		11 236	290 954	24.55	2002	*13)*
Vanderbilt University	11 577	247 877	53 308	1 098	134	302 417	26.12	2007	*14)*
Massachusetts Institute of Technology	5 909	195 861	16 407	2 807	0	215 075	36.40	2003	*15)*

Sources:

1) *Mpholo, M., **Electricity consumption of the National University of Lesotho**, T. Letete, Editor. 2009: Maseru.*

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[2] Obtained from: Top universities. *University Profiles: Statistics*. 2009 [Available from: http://www.topuniversities.com/.]

[3] *Most of the reports are available on the following website: http://www.aashe.org/resources/ghg_inventories.php*

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14) *George, A., S. Gild, and K. Abkowitz,* ***Baseline Inventory of Greenhouse Gas Emissions*** *2005-2007. 2009, Vanderbilt University.*
15) *Groode, T. and J. Heywood,* ***A Methodology for Assessing MIT's Energy Use and Greenhouse Gas Emissions****. 2004: Cambridge.*

Estimating South Africa's 2007 per capita emissions

Information	value	units	Source
2007 country Emissions	498.5	MTons CO_2	Winkler, H., ed. *Long Term Mitigation Scenarios: Technical Report*. 2007, Prepared by the Energy Research Centre for Department of Environment Affairs and Tourism, Pretoria, October 2007.
2007 mid-year population estimate	47.9	Million people	http://www.southafrica.info/about/people/population.htm