UKERC

ENERGY USE AND CARBON EMISSIONS FROM THE HIGHER EDUCATION SECTOR

Working Paper, November 2005

Dr Tina Fawcett

Environmental Change Institute, University of Oxford
UKERC Demand Reduction theme

UK Energy Research Centre

UKERC/WP/DR/2005/005

Contents

Summary

In order to contribute to the UK's target of 60% carbon dioxide emissions reduction by 2050, the higher education (HE) sector should be reducing its emissions by a minimum of 2% per year. However, there are no statutory targets for carbon emissions reduction within HE, and most institutions have not set their own targets. Due to the sector's very limited data collection and publication, it has not been possible to estimate its total carbon emissions. The best information has been available for emissions from energy use in buildings and for the effects of increasing recruitment of international students.

Within buildings, energy use is increasing and is likely to continue to do so. It is highly probable that this increase in energy use has been accompanied by increasing carbon emissions. Both increasing amounts of built space and more intensive use of buildings have more than offset improvements in energy efficiency. There are still thought to be many cost-effective opportunities for energy and carbon savings in HE. However, many institutions do not even have good data on how much energy their building stock is using, let alone what the resultant carbon emissions are, and are therefore not well placed to make effective energy or carbon savings.

Preliminary research shows that carbon equivalent emissions from international students' air flights to and from the UK are similar to or greater than carbon emissions from the whole HE sector's building stock. They are also rising extremely quickly, by more than a factor of five within the past fourteen years. The implications of this for universities, if they are aiming to reduce carbon emissions or become more environmentally sustainable, are very challenging. However, there is little evidence that the sector has begun to acknowledge the additional damage to the climate involved in recruitment of international students.

It has not been possible to estimate the carbon effects of HE business travel, staff and student commuting, or embodied carbon / suppliers' emissions from the products and services that HE procures. This is because of the lack of available data. Given the on-going expansion of HE, it is most likely that carbon emissions from all of these activities are increasing and will continue to do so. Although it has been argued that the most important effect of the sector on carbon emissions will be via the influence of its teaching and research, making a true assessment of these effects is likely to be extremely difficult, if not impossible. At present, the priority should be to increase the understanding of carbon emissions from the operational aspects of higher education.

Finally, reducing carbon emissions is clearly not a priority at present for the HE sector. While there are examples of good practice, the sector as a whole is neither planning for nor contributing to a lower carbon future in a substantial way.

Introduction and context

This working paper pulls together and summarises the key information available about energy use and carbon emissions within the UK higher education (HE) sector. In addition it undertakes new analysis based on existing data (some of it unpublished) to provide a better understanding of the sector's carbon emissions.

There are a number of reasons for focussing on carbon emissions from the higher education (HE) sector. Firstly, HE is an important sector which is currently experiencing strong growth. The sector comprises primarily of universities and their associated institutes, along with a smaller number of higher education colleges. There were 171 higher education institutions (HEIs) in 2004 (Universities UK 2004), with total staff numbers estimated at 300,000 and 2.25 million students (HEFCE 2005a). It is government policy to further increase the participation rate in HE to 50% of the eligible UK population. Meanwhile, the number of international students is also increasing. Thus further expansion is planned and, all other things being equal, expansion will require greater use of energy and lead to increased emissions of carbon dioxide. Not only is HE significant in its own right, researching the HE sector should give wider insights into whether and how a sector can combine effective responses to climate change with a growth in activities.

Debate has recently intensified on sustainability within HE with the publication of a policy statement from the English funding council (HEFCE). Their vision statement is

> *"Within the next 10 years, the higher education sector in this country will be recognised as a major contributor to society's efforts to achieve sustainability – through the skills and knowledge that its graduates learn and put into practice, and through its own strategies and operations."* (HEFCE 2005b).

This research should help inform HEFCE's and the sector's thinking on how their performance on the key aspect of environmental sustainability, carbon dioxide emissions reduction, can be improved.

Higher education is not currently subject to sector wide targets for reduction of either energy use or carbon emissions. The national carbon dioxide reductions required to meet Kyoto targets have not been formally devolved downwards to individual sectors, and neither have savings required under the UK government's 2050 target. If all sectors of the economy were to contribute equally to achieving the goal of 60% reduction by 2050, a 2% reduction in carbon emissions each year from now onwards would be required.

In some cases individual institutions have adopted their own targets. For example, Oxford University[1] has a target to reduce total carbon emissions by 20% from 1990 levels by 2010 (Oxford University undated). This is a precise and ambitious target with a date for achievement, which is far from typical of university environment policies, where they exist. As the National Audit Office Wales (2005) recently reported on Welsh HEI's energy and water management policies: "*Most … policies included broad statements of intention to follow good practice but lacked any obvious reference to an operational plan with clear and measurable targets*."

Not only will HE have an impact on climate change through its carbon emissions, climate change will start to impact on HEIs as well. Early impacts might include increased energy requirements in summer as temperatures rise and more air conditioning is required, limited water availability in the south east in summer, and increased flooding risks for those HEIs situated near to the shore or watercourses. This working paper does not consider further the risks for HEIs as the climate changes.

Methodology for counting carbon emissions

How should the climate change impacts of HE be estimated? Both the Carbon Trust and DEFRA have produced guidance about the types of emissions which organisations could include when auditing their own performance. Their advice is summarised below, and its relevance to HEIs is then discussed.

Existing methodologies

The Carbon Trust (2005) has published a general classification of emissions types from organisations:

- **Direct:** on-site combustion of fuels e.g. boilers, business travel, company-owned vehicles.
- **Indirect:** off-site combustion of fuels (for use on-site) e.g. procured resources: electricity, materials and employee commute.
- **Process:** on-site emission caused by processes.
- **Energy Export:** on-site combustion of fuels for use off site.
- **Upstream:** emissions caused by suppliers.
- **Downstream:** emissions created by an organisation's products/activities during their lifecycle.

[1] Examples from Oxford University are used throughout this document because it is the author's home institution and she has access to information about its energy use.

Some of these categories of emissions, particularly process and energy export will be very minor or non-existent for HEIs. Since the main output of HEIs is knowledge rather than physical products, the downstream emissions due to their activities will be extremely difficult, if not impossible, to estimate. This leaves the most relevant and measurable emissions from HEIs as direct, indirect and upstream emissions.

DEFRA (2001) offer advice to organisations about how they should report their greenhouse gas emissions. They suggest that for an organisation which purchases electricity from the national grid a report can cover:

- Direct emissions (those generated from energy use on site) plus indirect emissions from energy generated elsewhere.
- Direct emissions plus indirect emissions from energy and from transport, including freight and/or distribution and/or business travel by employees.

For travel they suggest it is likely that the following travel emissions should be included:

- Freight movements by road, rail, air and sea by the company and by any contractors to be included in the organisation's reporting.
- Business travel by road, rail, air and sea, including international travel undertaken by UK based employees.

Normally the following would be excluded:

- Short distance business travel where it may be disproportionately expensive to collect data
- Private mileage / travel to and from work by employees, although this could be covered in a separate green travel plan.

Interestingly, DEFRA suggest that emissions from employees commuting should not be included in 'indirect' emissions, whereas the Carbon Trust suggests they should. DEFRA do not suggest including suppliers' emissions within the audit, i.e. those identified as 'upstream' by the Carbon Trust.

Application of the methodologies to HE

Based on these classifications the most relevant categories of emissions from HEIs are: direct emissions from energy use on site; indirect emissions from energy use elsewhere; business travel by employees; and upstream emissions caused by suppliers.

These categories need to be adapted in some cases to reflect HE operations. For example, HEIs are different from most other service/ tertiary sector organisations because part of their core activity involves teaching large numbers of students. Thus emissions from students' travel as part of their courses should ideally also be included in the 'business travel' category.

Two further types of energy using activity will also be of interest, although the first is not included in the DEFRA methodology and the second is included in neither. The first activity which should be added is commuting travel by staff and students. This is relevant for two key reasons. Firstly, energy use and carbon emissions are rising more quickly from the transport sector than any other in the UK (DEFRA 2005a). Secondly, through provision of transport facilities, such as car parks/ bike racks / dedicated bus services, and other measures HEIs influence the travel choices that staff and students make. The subsequent carbon emissions are in part a consequence of the infrastructure and incentive systems set up by individual institutions.

The second category which should be added to the standard list is the energy used by international students in their travel to and from their home country. Increasing numbers of students are recruited from abroad as a deliberate strategy by the sector as a whole and by many individual institutions. However, given the high environmental impact of air travel, the emissions from this activity should be investigated. HEFCE (2005b:27c) has acknowledged that the number of international students studying in the UK has a global environmental impact.

To summarise, the activities which contribute HE sector emissions to be investigated in this working paper are:

1. Energy use in buildings (i.e. direct and indirect emissions)
2. HE business travel by employees and course-related travel by students
3. Commuting travel by staff and students
4. Air travel by international students
5. Upstream emissions caused by suppliers

Carbon impacts not being counted

All of the energy uses identified in the previous section could be characterised as operational impacts of universities. However, a recent report about the carbon impacts of HE in Yorkshire and Humberside Hopkinson and James (2005) argue that teaching and research and knowledge transfer would also have important carbon impacts. Teaching could affect the attitudes and behaviour of students. Research could affect the management practices of organisations and individuals, by the creation of knowledge, consultancy and expert advice.

HEFCE's document on sustainability makes a similar point:

> *"Our view is that the greatest contribution higher education has to make to sustainable development is through the values, skills and knowledge that its graduates learn and put into practice."* (HEFCE 2005b)

While these arguments may suggest that measures should be developed for investigating the carbon impacts of teaching and research activities, it is very difficult to know whether this could result in meaningful information. It might be possible to monitor the number of courses or modules a university teaches which incorporate consideration of carbon emissions reduction (or sustainability more broadly) – but could courses which tend to lead to increasing carbon emissions equally be counted?

While universities should strive to improve the carbon emissions awareness / sustainability of their students, such a measure has the potential to be highly selective allowing HEIs to tell very flattering stories about themselves. The sustainability / carbon effects of research work are likely to be equally if not more difficult to estimate. If the UK economy is becoming less not more sustainable then HEIs would have to take part of the blame rather than highlighting positive aspects of their research and teaching output.

In summary, estimating the carbon effects of teaching and research may well be impossible. Even if it can be done, it is unlikely to be the most effective way of influencing HEI research and teaching for the better. No attempt will be made in this paper to consider the carbon impacts of research and teaching.

Energy use in buildings

Energy use UK-wide

HEIs have a wide variety of buildings used for teaching, research, support and residential purposes. All of these buildings require heating and hot water and electricity, and an increasing proportion requires cooling. The size of the HE estate is increasing year on year, with an increase of 3% in available space between 2000/01 and 2002/03 (HEFCE 2004).

Unfortunately, there is a lack of publicly available data about energy use in HE buildings. Each year UK HEIs are asked to complete an ‘estates management statistics’ questionnaire from which selected summary results are published by HEFCE (e.g. (HEFCE 2003)). This summary does not include an estimate of total energy use or carbon emissions by HE sector buildings. Neither is energy use by individual organisations published[2].

However, it has been possible to get restricted access to the full database of HE estates management statistics (referred to as ‘HEFCE database’), which is not publicly available (Table 1).

[2] For the future, there are plans to expand the remit of the estates management statistics exercise (HEFCE 2005b).

Table 1: Estimated building energy use in the UK HE sector, 2000/01 – 2002/03

	2000/01	2001/02	2002/03
Total energy use for HEIs providing data (TWh)	6.0	5.9	6.4
Institutions providing energy data (%)	76	72	80
† Estimated total energy use (TWh)	7.1	7.0	7.4
Change compared with previous year (%)		-0.2	+5.6

Source: HEFCE database

†A significant proportion of institutions do not provide energy data – as indicated in Table 1. By using data on their floor area, and the floor area of institutions providing energy data, an estimate of energy use within the whole sector can be made. The assumption is that institutions not providing data have the same energy use per square metre as those which have provided energy data.

Estimated total energy use from all HEIs in 2002/03 was 7.4TWh, which equates to 1.6% of industrial, commercial and public sector energy used in the UK. From 2000/01 to 2002/03 estimated building energy use in the sector rose by a little over 5%.

There are considerable limitations with these energy data. Firstly, not all institutions supply HEFCE with energy use information, as shown in Table 1. Secondly, it is not clear how accurate the data supplied is likely to be, given the lack of energy monitoring in HEIs highlighted during the recent audit of Welsh institutions:

"..only five of the twelve institutions reported that they regularly monitor and target energy and water consumption.... " (National Audit Office Wales 2005:24)

Finally, the data provided may not relate to the whole HE estate. For example, Oxford University energy figures do not include energy use within the colleges (largely residential spaces) (George 2005). It is likely that other institutions will also have parts of their estate for which energy data is not returned to HEFCE. In summary, the final figure is of uncertain accuracy and is highly likely to be an under- rather than over-estimate of actual energy use.

The general rise in energy use within the sector has also been experienced by individual institutions. For example, Oxford University experienced a 5.7% rise in energy consumption between 2002/03 and 2003/04, largely due to a 10% rise in electricity use in newly opened buildings. However, this rise was smaller than the growth in the estate area of 7.9% over the same period, meaning that energy use per square metre fell (Oxford University 2004).

Energy use and carbon emissions - Wales

The most comprehensive data available on both energy use and carbon emissions comes from a recent study carried out in Wales (National Audit Office Wales 2005). Unlike the HEFCE data, the energy data is provided by fuel type, allowing calculations of carbon emissions to be undertaken.

Table 2: Estimated energy consumption and carbon emissions across the HE estate in Wales, 2003-04

	Consumption (GWh)	Conversion factors (kgC/kWh)	C emissions (tC)
Electricity†	120	0.147	14,610
Gas	231	0.052	11,970
Oil	4.4	0.068	300
Total			26,880

Sources: energy consumption data – National Audit Office Wales 2005; conversion factor for electricity for 2003 from Table 3, other figures from Table 2, DEFRA 2005b

†20.8 GWh was provided from green, zero carbon sources (or electricity was produced from CHP schemes and emissions are already counted under gas / oil) and carbon emissions have been adjusted downwards to take account of this fact

Carbon emission estimates – UK

Because the UK HE energy data provided in the HEFCE database is not by fuel, it is not possible to accurately calculate carbon dioxide emissions from the sector. However, if fuel use in the whole UK were the same as Wales, the total fuel use would be in the following proportions: electricity (excluding zero carbon electricity) 29.7 %, gas 65%, oil 1.2%. Using this assumption for each year, and government figures for the carbon intensity of electricity over the period, total carbon emissions from the UK HE building stock can be estimated (Table 3). These calculations suggest that emissions from HE buildings are around half a million tonnes of carbon per year, and on a rising trend.

Table 3: Estimate of total carbon emissions from UK HE building stock, 2000/01 – 2002/03

	2000/01	2001/02	2002/03
Total energy use (TWh)	7.1	7.0	7.4
Carbon intensity of electricity (kgC/kWh)	0.139	0.145	0.142
Total carbon emissions (MtC)	0.51	0.52	0.54

Source: carbon intensity of electricity data - DEFRA 2005b

Given the number of assumptions used to generate this estimate, the degree of confidence in the precise numbers must be limited. Nevertheless, with rising energy use in buildings, unless universities are turning en masse to lower carbon fuel sources, carbon emissions would clearly also be rising.

The emissions total of 0.54 MtC can be put in context by comparing them with emissions from the service sector (which includes light industrial and commercial activities, as well as public sector, government and farming) which were 24.6MtC in 2003 (DEFRA 2005). This makes emissions from HE buildings about two per cent of service sector emissions and one third of one percent of total UK emissions from all sources.

Business travel by staff and course-related travel by students

There are two key reasons for suspecting that business and course-related travel is increasing in the HE sector. As the sector internationalises, it is likely that staff and student are travelling more often and further on university business, e.g. for research meetings and conferences, with associated environmental impacts.

Secondly, whether or not travel per staff member or student is increasing, overall travel is likely to be increasing with the steady increase in staff and student numbers. However, there is no national data collection of staff or student travel, and it is doubtful whether much information exists at an institutional level. Thus there are no data available to examine this hypothesis.

Nevertheless, there is evidence that some HEIs or specific departments within them are beginning to recognise the carbon impacts of university business travel. Examples of responses include:

- Carbon offsetting for university business travel (e.g. Environmental Change Institute, University of Oxford);
- Purchasing low carbon emissions vehicles for university car pools (e.g. Prius hybrid car acquired by University of Derby (HEEPI 2004)).

Neither of these actions on its own challenges the (hypothesised) underlying increase in travel.

Staff and student commuting

Individual universities undertake occasional travel surveys of their staff and students which focus on their commuting travel. A number of university travel surveys have been assessed in outline, and three keys points have emerged. Firstly, car use by staff and students varies considerably between universities. This is in part a reflection of the location of the university. Secondly, there is a big difference between the transport modes used by staff and students, with staff being much more car-dependent. Thirdly, increasing student and staff numbers, combined with the general increase in car ownership and usage, are leading to problems with traffic and parking around sites. Beyond analysis of survey results, the commentary within these travel surveys is often limited. For example, there is no reflection on the relationship between city transport policy context and university modal split or comparison between university staff travel patterns with those of other organisations. In addition, none of the travel surveys examined calculated the total energy or carbon emissions impacts of commuting to the university.

According to Hopkinson and James (2005), the University of Bradford has undertaken a carbon survey of its operations which found that emissions from commuting traffic to the university were very similar to total emissions from its building stock. Other Yorkshire universities are planning to map their carbon emissions during 2005, which will begin to give a basis for estimating the carbon emissions from staff and student commuting.

The Higher Education Environmental Performance Improvement organisation (HEEPI) runs an annual ‘Green Gown’ competition which aims to ‘recognise progress towards more sustainable further and higher education in the UK’(HEEPI 2004). Transport is among the award categories. All of the awards recognised the efforts of universities in reducing car travel to their sites, chiefly by providing dedicated bus services, limiting parking availability and increasing parking charges, but also through providing incentives and information to enable car sharing, cycling and walking.

Staff and student travel to HEIs was the only transport issue recognised by the awards (with the very minor exception of noting a low carbon vehicle purchased for one institution's car pool). There was no focus on reducing travel or carbon emissions from staff and students on university business.

Overseas students travelling to and from the UK

International student numbers have been rising rapidly in the UK, and in 2003/04 stood at more than 300,000 (Table 4). By 2003/04 international students made up 13.4% of all HE students (HESA 2005). International student numbers were more than five times higher in 2003/04 than in 1990/91 (Table 4). Since 2000/01 EU-15 student numbers have declined slightly, while non-EU student numbers have increased by 54%. Because these students inevitably travel long distance by air, this increases their carbon dioxide emissions considerably compared with home students.

Table 4: International students in higher education UK, 1990/91 – 2003/04

Student origin	1990/91	2000/01	2001/02	2002/03	2003/04
EU-15 (exc. UK)	14,212	94,575	90,135	90,580	89,545
Non-EU	42,197	136,295	152,620	184,690	210,510
All international	56,409	230,870	242,755	275,270	300,055
Non-EU as % of total	75	59	63	67	70
increase on previous year – all students (%)			5.1	13.4	9.0

Source: HESA (2005) and earlier editions of the same series

The HESA statistics contain data on the country of origin of students, with only a minority coming from unidentified countries (Table 5). These data can be used to estimate how far international students travel to and from the UK each year, and then to calculate the carbon dioxide equivalent emissions which result from their air travel. To do this, a number of assumptions have to be made:

- Each student travels by air to and from the UK twice per year.
- All journeys are between the capital city of the student's country of origin and London.
- The distance between other capital cities and London is calculated based on the 'great circle' path, which is the shortest path on the surface of a sphere between two points on sphere.

- Distances between cities were calculated by a web site, www.indo.com, which bases its calculation method on a system developed by the US Geological Survey. Errors are estimated at less than 0.2%.
- Conversion factors to turn air travel distances into carbon equivalent emissions are 0.52 $kgCO_2e/km$ within Europe and 0.31 $kgCO_2e/km$ beyond Europe (Hillman and Fawcett 2004). These figures take into account the fact that air emissions are estimated to have three times the global warming effect of the carbon component alone (RCEP 2002).

By using all these assumptions in combination with the HESA statistics, carbon equivalent emissions have been calculated for the air travel of the majority of international students (Table 5). The distances and emissions from international travel have been calculated for all students whose country of origin is known, with minor exceptions. The result is that carbon equivalent emissions from international student air travel were around 652,000 tCe in 2003/04. Over 80% of these emissions were from non-EU15 international students, who made up 70% of international student numbers.

Table 5: Carbon equivalent emissions for air travel to and from the UK by international students, 1990/91 – 2003/04

	1990/91	2000/01	2001/02	2002/03	2003/04
Origin of student unknown (%)	10.3	9.5	9.2	1.4	1.4
Students for whom international travel calculated (%)	88.7	90.5	90.8	97.5	97.4
Total carbon equivalent emissions (tCe)	115,300	453,800	483,300	597,400	652,100
Non-EU15 students carbon equivalent emissions (tCe)	97,500	309,700	348,200	465,600	527,900
Non-EU15 emissions as % of total	85	68	72	78	81

Sources: HESA (2005) and earlier editions of the same series, plus author's own calculations using sources of data referenced in the text.

The strong growth in international student numbers is reflected in the growth of carbon equivalent emissions. Emissions from air travel have increased by a factor of 5.7 between 1990/91 and 2003/04 and by 44% between 2000/01 and 2003/04. This is a much faster growth rate than seen in global or UK-origin air travel only. For example, energy consumption for air travel originating in the UK grew by almost 80% between 1990 and 2004 (DTI 2005). Although this represents rapid growth in comparison with other energy uses, it is an order of magnitude lower than the growth seen in international student travel to the UK.

There are a number of sources of uncertainty which mean the emissions (and distance travelled) figures should be treated with caution. The assumption which is most speculative is that each international student travels to and from their home country twice a year on average. Obviously if students only travel home once a year on average, the estimate of their air travel emissions should be halved.

Another assumption, that all students fly from their home capital to London, is clearly a simplification. They may fly from regional cities at home to regional cities within the UK. Given that there are limited direct flights from some of the countries sending large numbers of students to the UK (e.g. China, Malaysia) this assumption may lead to an under- rather than over-estimate of distance travelled. This is because the student will first have to travel from their home to the capital city, before coming to the UK. Other than for that reason, in principal assuming capital city origin and destination should not systematically distort the calculations.

Some students from nearby European locations may travel by sea or the channel tunnel to get to Britain. These modes of transport would be responsible for considerably less emissions per trip than a flight – meaning the emissions calculated for these students would be an overestimate.

In terms of distance between cities, the real routes that aeroplanes take aren't always the great circle ones, for various reasons. There are sometimes problems with flying over other countries' airspaces. Wind speed and direction make a difference as well: it can be quicker to deviate from the great circle route in order to pick up a beneficial tailwind. Thus the great circle distance is unlikely to be the actual distance travelled by particular planes. Nevertheless, it seems the best assumption that can be made, without going into hugely detailed calculations – which in any case may not be feasible, if routes vary with weather systems.

In summary, the factor leading to most uncertainty in the carbon emissions estimate presented is the number of flights to and from the UK undertaken by the average international student per year.

Even if the true emissions from air travel were half those estimated above, air travel by international students would still have a significant environmental impact. The implications for universities, if they are aiming to reduce carbon emissions or become more environmentally sustainable, are very challenging. However, there is little evidence that the sector has begun to acknowledge the damage to the climate involved in recruitment of international students.

Upstream emissions caused by suppliers

HEIs also have an impact through 'embodied' energy, that is, the energy which was involved in creating the products and services they use. The total non-pay spend in the English HE sector is £4bn per annum (HEFCE 2005a). Within the sector there is interest in this aspect of environmental performance: it was added into HEFCE's sustainability document as a result of feedback received during the consultation process (HEFCE 200b, 2005c).

However, as for the carbon implications of HE-related travel, there is little data available about the carbon impacts of universities' procurement and waste management policies. While embodied energy and carbon emissions are important factors in choosing less environmentally damaging products and services, it is not always necessary to have detailed data in order to make more responsible choices.
HEFCE are planning to help to develop sustainable procurement policies and guidance. This seems a good first step, before trying to look in more detail at the carbon emissions implications of current HE practice.

Future trends

It is government policy both to increase the number of UK students participating in higher education, and to increase recruitment of international students. In addition to government policy, there are also strong financial incentives for HEIs to favour the recruitment of international, especially non-EU, students. Thus, two of the strongest drivers for growth in carbon emissions are expected to continue to be influential in the future. This section briefly considers the range of drivers specifically influencing energy use / carbon emissions in buildings, staff and student travel and international air travel.

In addition to the drivers listed below, HEIs may start to feel pressure from stakeholders to demonstrate lower carbon emissions. As mentioned earlier, HEFCE has indicated its interest in improving the sustainability of the sector – although it is as yet unclear whether financial incentives for more sustainable operation will be introduced. Student groups, staff and other stakeholders may also become more influential. For example, student groups campaigned strongly to persuade Oxford University to keep its green electricity supply. Whether stakeholder pressure could be a powerful positive influence in the context of existing HE financial and organisational structures is an interesting question which requires additional research.

Building energy use

There are many drivers affecting energy use in buildings and thus carbon emissions. Firstly the pressures to decrease energy / carbon are outlined, followed by summary of the driving forces leading to increasing carbon emissions.

There are a range of pressures on HEIs (and many other organisations) to reduce their building energy use / carbon emissions or improve the energy efficiency of their building stock. Taxation and regulatory policies include: the Climate Change Levy, a form of energy taxation for which some HEIs are liable; the EU Emissions Trading Scheme which controls carbon emissions from larger energy using plant (e.g. boiler houses); UK Building Regulations, which set increasingly rigorous efficiency standards for new buildings; the EU Performance of Buildings Directive which will shortly be introduced and includes new obligations on energy standards, monitoring and reporting for buildings. There are also several voluntary UK and international initiatives which encourage HEIs to take up lower carbon options such as 'combined heat and power' or to pay more attention to energy efficiency, e.g. Higher Education Partnership for Sustainability, HEEPI (HEFCE 2005b).

Despite the pressures to reduce building energy use, studies show there is still considerable potential for efficiency improvements within HE. Significant carbon and energy savings from the adoption of zero and low cost measures were identified in Welsh HEIs (National Audit Office Wales 2005). However, the difficulties in accessing efficiency savings have often been identified and still persist. Sorrell (2000) identified the key barriers to uptake of efficiency as being lack of capital, lack of staff time and departments being unaccountable for energy costs. Another study on HE reported that "..*energy efficiency investment tends to be discretionary, non-core and low priority*." (ESD 2004). These barriers are largely within the control of HEIs, and yet it seems they have generally chosen not to overcome them.

For a number of years, the price of energy has been falling rather than rising, so decreasing the likelihood that HEIs will invest in energy saving measures. However, this has recently changed, and many institutions have been facing dramatic price rises. Hopkinson and James (2005) state that many institutions found that renewals of their electricity contracts were 40-50% more expensive in 2004. If prices continue to rise, as many expect, the increased cost of energy could become an important driver to lower energy use and carbon emissions.

The most important single pressure for increasing energy use and carbon emissions is the expansion of HE activities in research and especially teaching. This requires an increase in built space. For example, Oxford University expects its estate to expand a further 8% in 2004/05 with additional plans for future expansion (Oxford University 2004).

In addition, building energy use is expected to increase within each building due to energy-intensive equipment for research activities, increasing intensity of building use, with many moving towards 24-hour operation, and the impact of IT (HEFCE 2003). Oxford's experience certainly reflects this general trend. Its experience is that across the estate electricity consumption has risen by 1-2% a year per square metre due to the growth in IT equipment, cooling and longer occupancy hours (Oxford University 2004).

Earlier analysis in this working paper suggests that to date the drivers of growth in energy use and carbon emissions from buildings have outweighed pressures to reduce energy use. Even though UK and EU policy pressure to improve efficiency is increasing and energy prices are rising substantially, it seems unlikely that the sector will actually experience reducing overall energy use unless there are very big changes in investment in and management of buildings.

Projections of future energy use and research into the potential for carbon and energy savings from HE buildings will be undertaken within the 'Building Market Transformation' programme funded by the UK research councils. This should give further insight into possible future developments and suggest how carbon emissions from the sector's buildings can be reduced.

Staff and student travel

The major pressure on HEIs with regard to making travel patterns less energy-intensive appears to be the need to control access to car parking on their sites and in surrounding residential areas, given space limitations and increasing demand. This leads institutions to adopt a variety of methods to promote alternatives to car use, including walking, cycling and public transport. There are few transport policies which affect HEIs as institutions, with one exception being Planning Policy Guidance (PPG) 13 which requires universities and colleges (like all large organisations) to promote and integrate sustainable transport choices.

Given the increasing staff and student numbers, it seems most likely that energy use and emissions from travel will continue to increase in the absence of determined efforts to limit travel growth and switch to less energy-intensive modes.

International air travel

There are currently no significant initiatives to reduce or restrain the growth in international air travel. Indeed it can be argued that current national and international planning and taxation policies are strongly encouraging an expansion of this most environmentally damaging form of travel.

Discussion and conclusions

The research aims of this working paper were to come up with a first estimate of carbon dioxide emissions from the UK's higher education sector, to assess whether the trend was up or down and look at the prospects for the future. The findings about carbon emissions and trends in emissions are summarised below (Table 6). The data in the table are estimates based on incomplete data, which in itself indicates the low priority the HE sector has given to understanding its own carbon impact. Although this table is only partially complete, it is clear that the overall recent trend has been for increasing carbon emissions. The brief analysis of future trends in the previous section indicates this increase continuing into the future.

Table 6: Summary of carbon emissions and trends in HE

Activity	**Carbon emissions**	**Trend**
Building energy use	0.54 MtC (2002/03)	Building energy use increasing year on year by, around 2-3% per annum. Carbon emissions also very likely to be increasing.
Staff and student business travel	n/a	Increasing as staff and student numbers increase. Possible increase per member of staff / student as well.
Staff and student commute	n/a may be similar to building energy emissions	Increasing as staff and student numbers grow. In addition, increasing dependence on car travel – the most carbon intensive surface travel mode.
International student travel to UK	0.65 MtCe (2003/04)	Very rapid increase, by more than a factor of five over the past fourteen years.
Upstream / suppliers' emissions	n/a	Increasing as HEI activities expand.
Total / summary	More than 1.09 MtCe per year	Increasing carbon emissions.

Considerably more data collection and research would be required in order to make better and more complete estimates of carbon emissions from the sector. Key missing data include:

- Publicly available information on energy use in HEIs which can be translated into carbon emissions
- Estimates of travel on university business by staff and students, both at an institutional and sectoral level

- Assessments of the carbon impacts of staff and student commuting
- Estimates of the carbon impacts of key resources procured by HEIs
- Air travel patterns of international students

There is clearly a strong case for more detailed research into HE and carbon emissions. As mentioned previously, building energy use will be further investigated within an existing major research programme. The Carbon Trust is also becoming actively involved in carbon management within the sector. However, there will still be scope for more active and urgent research in this area.

In addition to the requirement for increased data, an agreed methodology for estimating the carbon impacts of the sector and individual institutions should be developed. Existing methodologies for organisations vary in the energy uses they prioritise and do not take account of the special circumstances of HEIs. Boundaries need to be agreed and priorities for improved data collection set. Several important questions need to be answered. For example, is it more important to improve data collection on business travel or on the carbon effects of procurement practices? Is including the additional carbon impact of international students legitimate, and if not, why not?

The paucity of data on carbon emissions and the poor record of institutions in monitoring and managing energy use within their own buildings are just two of the factors which lead to the conclusion that managing and reducing carbon emissions is not a priority for the sector. In addition, few universities have carbon reduction aspirations, and even fewer have targets against which progress is monitored. Travel policies which encourage staff to use low carbon options for university business travel are notable by their absence. There appears to be little recognition of the environmental impacts of recruitment of international students. In summary, there is a wide range of evidence that the sector is not planning for or seriously contributing towards a lower carbon future.

At the beginning of this document, it was suggested that in order to contribute to the UK's target of 60% carbon dioxide emissions reduction by 2050, the higher education (HE) sector should be reducing its emissions by a minimum of 2% per year. The data, incomplete as they are, have shown that, to the contrary, emissions from the sector are rising by more than this rate per annum. The sector has not begun to seriously address its environmental responsibilities nor to take action to reduce its contribution to global climate change. Given the seriousness of the effects of climate change, this is unacceptable in any sector of the economy, and particularly in one which aspires to be a vital contributor to a better future for the UK.

References

Carbon Trust (2005). *Types of emissions.* Published on the web: http://www.thecarbontrust.org.uk/carbontrust/reduce_emissions/rcen1_1_3_1.html The Carbon Trust.

DEFRA (2001). *Environmental reporting: Guidelines for company reporting on greenhouse gas emissions.* Published on the web at: www.defra.gov.uk/environment/envrp/gas/index.htm, Department for the Environment, Food and Rural Affairs.

DEFRA (2005a). *E-Digest statistics about: global atmosphere.* Published on the web at: http://www.defra.gov.uk/environment/statistics/globatmos/gaemunece.htm, Department for the Environment, Food and Rural Affairs.

DEFRA (2005b). *Annexes to guidelines for company reporting on greenhouse gas emissions.* Published on the web: http://www.defra.gov.uk/environment/business/envrp/gas/envrpgas-annexes.pdf, Department for the Environment, Food and Rural Affairs.

DTI (2005). *Digest of UK Energy Statistics 2005.* London, The Stationery Office.

ESD (2004). *University carbon management: scoping and design.* London, The Carbon Trust / Energy for Sustainable Development.

George, C. (2005). *Discussion about Oxford University energy use*. T. Fawcett. Oxford.

HEEPI (2004). *The green gown awards 2004.* Published on the web: www.heepi.org.uk, Higher Education Environmental Performance Improvement.

HEFCE (2003). *Energy management in higher education: a value for money study*. Published on the web: www.hefce.ac.uk/pubs/hefce/2003/03_30.htm, Higher Education Funding Council for England.

HEFCE (2004). *Estate management statistics: annual report 2004.* Published on the web: www.hefce.ac.uk/pubs/hefce/2004/04_45/04_45.pdf, Higher Education Funding Council for England.

HEFCE (2005a). *Higher education in the United Kingdom.* Bristol, Higher Education Funding Council for England.

HEFCE (2005b). *Sustainable development in higher education.* Bristol, Higher Education Funding Council for England.

HEFCE (2005c). *Sustainable development in higher education: Consultation on a support strategy and action plan.* Bristol, Higher Education Funding Council for England.

HESA (2005). *Students in higher education institutions 2003/04.* Cheltenham, Higher Education Statistics Agency.

Hillman, M. and T. Fawcett (2004). *How we can save the planet.* London, Penguin.

Hopkinson, P. and P. James (2005). *How Yorkshire and Humberside higher education can help to minimise the region's carbon dioxide emissions.* Published on the web: http://www.heepi.org.uk/index.htm, HEEPI.

National Audit Office Wales (2005). *Energy and water management in the higher education sector in Wales.* Cardiff, National Audit Office Wales.

Oxford University (2004). *Buildings and Estates Sub-committee: Utilities report 2004.* Oxford, Oxford University [unpublished].

Oxford University (undated). *Statement of environmental policy.* Published on the web: www.admin.ox.ac.uk/estates/environment/statemento.shtml [accessed 16 March 2005], University of Oxford.

RCEP (2002). *The environmental effects of civil aircraft in flight.* London, Royal Commission on Environmental Pollution.

Sorrell, S. (2000). *Barriers to energy efficiency in the UK higher education sector. Reducing barriers to energy efficiency in private and public organisations*. Brighton, SPRU, University of Sussex.

Universities UK (2004). *Higher education in facts and figures.* London, Universities UK,.

Acknowledgements

With thanks to Colin George, Oxford University Estates Department. Additional thanks for their assistance with parts of this paper are due to Dr Jillian Anable, Robert Gordon University and Joss Smith.