UNIVERSITY OF CAMBRIDGE

UNIVERSITY OF CAMBRIDGE
ENERGY AND CARBON REDUCTION PROJECT

ANNUAL REPORT 2013

EXECUTIVE SUMMARY

The University of Cambridge is committed to achieving the highest international levels of excellence in education, learning and research[1]. In pursuit of this mission, the University is committed to continuing research-related growth, both in terms of the level and breadth of the research that it undertakes, and with regards to the extent and quality of the educational and research facilities that it provides. This has significant implications for the size, complexity and energy-intensity of the University estate, as much of the research undertaken at Cambridge is scientific or technical, involving the use of power-hungry electrical equipment.

In 2010, the University adopted its Carbon Management Plan 2010–2020, which sets an ambitious target for the University to reduce its energy-related carbon emissions[2] by 34% against 2005/06 levels by 2020. This target was set in line with best practice guidance provided by the Higher Education Funding Council for England (HEFCE)[3] and represents a significant commitment to carbon reduction.

The Energy and Carbon Reduction Project (ECRP) was set up in 2011, with an annual budget of £2m, to explore how and to what extent the University can achieve reductions in its energy-related carbon emissions without adversely impacting on research activity. To date, the focus of the ECRP has been on five energy-intensive pilot buildings, where a series of carbon reduction measures have been tested.

This report represents the third annual review of the ECRP, covering the period January-December 2013. It shows that, over the past three years, the ECRP has made noticeable progress in reducing electricity consumption and energy-related carbon emissions in the pilot buildings. However, despite this progress in the pilots, the University's total energy-related carbon emissions have continued to increase year by year (by 17% between 2005/06 and 2012/13), predominantly as a consequence of growth of the estate and an increase in the volume of research carried out by the University.

Expenditure and allocations from the ECRP budget were relatively slow in the first two years of the project but have increased as the project has gained momentum. In 2013, the ECRP spent over £425,000 on a range of carbon reductions projects, and allocated around £1.6m to a series of further measures, including the roll-out of an initiative that had been tested and found to be successful in one of the pilot buildings. The implementation of carbon reduction measures across the University estate remains difficult, however. For many projects a lack of engagement and/or capacity within departments presents a considerable hindrance.

Nevertheless, there remains significant scope to achieve substantial reductions in energy-related carbon emissions across the University estate. Achieving this in parallel with a continuing increase in research activity presents a significant challenge and will require long-term commitment. There is much to be learned from the experience and achievements of the ECRP to date and, with a new Environment and Energy (E&E) Section in place, the University is now in a strong position to capitalise on this learning. E&E are leading on a programme of work that will, building on what the ECRP has taught us so far, inform the development of a strategic and targeted approach to carbon reduction across the wider University estate.

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[1] See the University' mission.

[2] In other words, carbon emissions arising from the University's use of electricity, gas, oil, heat and steam (also known as Scope 1 and 2 emissions).

[3] Carbon Management Strategies and Plans, A guide to good practice, HEFCE, January 2010/2.

1. INTRODUCTION AND CONTEXT

In 2010, the University of Cambridge adopted its Carbon Management Plan[4], which sets out a series of challenging carbon reduction targets, to be achieved by 2020:

- An absolute reduction in its total scope 1, 2 and 3 emissions against 2005 levels;
- An absolute reduction in scope 1 and 2 emissions (energy-related emissions) arising from activities that are not associated with scientific and technical research by 34% against 2005 levels;
- A reduction in scope 1 and 2 emissions arising from activities associated with scientific and technical research, as defined by tonnes CO_2 per £ of research income, of 34% against 2005 levels, adjusted for changes in the Retail Price Index (RPI);
- The University is required to consider the development of large new University developments on a case-by-case basis, taking account of the overall targets for scope 1, 2 and 3 emissions.

There are four main factors that have a discernible impact on the University's energy-related carbon emissions and its ability to achieve the carbon reduction targets specified above:

- The volume and type of research undertaken by the University;
- The size (floor area) of the University built estate;
- The weather, which has a particularly marked impact on gas consumption;
- The long-term variation in the carbon intensity of the UK electricity grid.

Clearly, the last two of these factors are beyond the University's control and for this reason they are not considered any further in detail. However, it is useful at this point to reflect briefly on the influence of the other two factors listed above, as this provides a context for the role and purpose of the ECRP.

Figure 1 provides an overview of total energy use across the main University estate[5] between 2005/06 (the base year specified in the Carbon Management Plan) and 2012/13. This shows an increase in total energy (electricity, gas and oil) consumption of 21% over this time period.

Energy-related carbon emissions from the University main estate have increased by 17% over the same time period, reaching 71,739 tCO_2e in 2012/13; see Figure 2.

[4] University of Cambridge Carbon Management Plan 2010-2020.

[5] The 'main University estate' excludes some buildings on the Addenbrookes site, which are shared with other parties, and where the University is not directly responsible for managing building energy use.

Figure 1: Total Energy Consumption across Main University Estate, 2005/06 – 2012/13

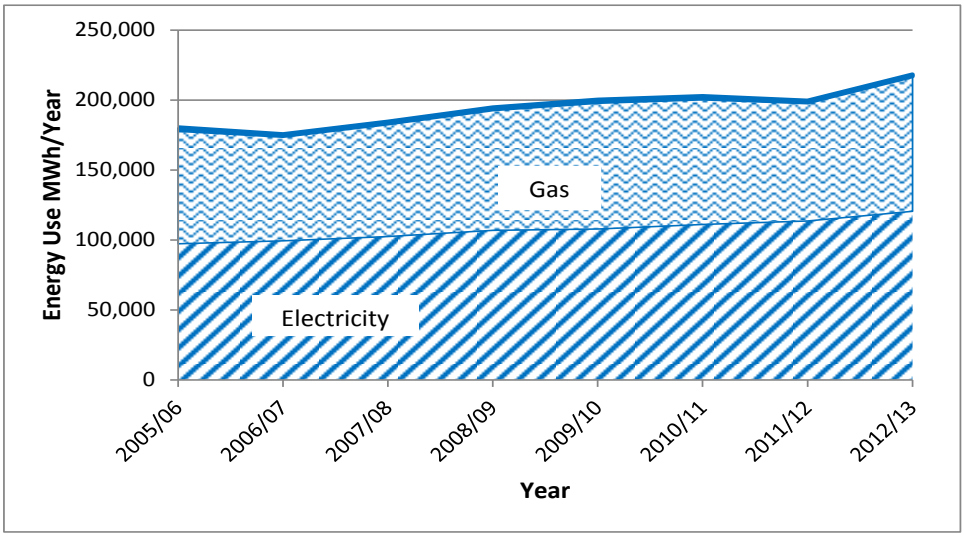
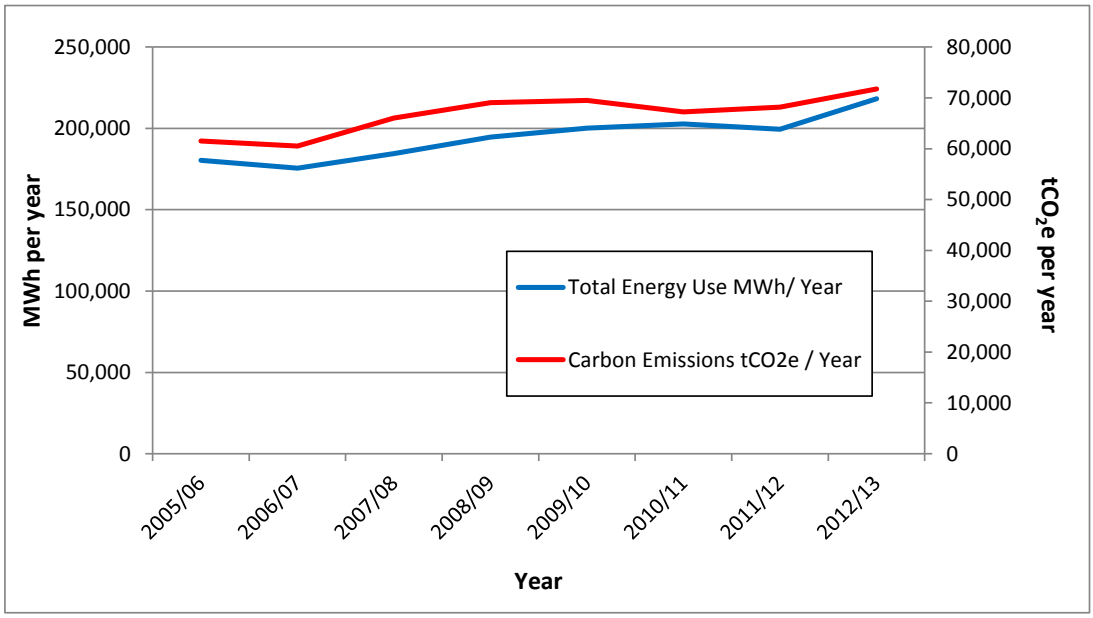


Figure 2: Energy-Related Carbon Emissions from Main University Estate, 2005/06 – 2012/13[6]



The observed increase in total energy use and energy-related emissions has been predominantly driven by a steady increase in electricity use, which rose by 24% between 2005/06 and 2012/13. Gas use also increased over this period, by 19%, but this can be largely attributed to the relatively severe and prolonged winter of 2012/13[7] (oil consumption, meanwhile, decreased during the same period, by 38%).

This continuous increase in electricity consumption can, in turn, be largely attributed to a significant increase in the volume of research activity undertaken by the University, in particular in research of a scientific and technical nature, which often involves the use of

[6] Carbon emissions for all years have been recalculated using latest guidance from DEFRA, at http://www.ukconversionfactorscarbonsmart.co.uk/. For this reason, the figures shown here will differ slightly from those reported previously elsewhere.

[7] The total degree days for 2012/13 amounted to 2,671 making it 18% colder than 2011/12 (2,255 degree days) and the coldest year in the last 2 decades (Annual Utilities Report, 2012/13).

power-hungry electrical equipment and facilities. To illustrate this, between 2005/06 and 2012/13:

- the number of contract research staff on the University payroll, which can be taken as a crude measure of the volume of research carried out by the University, increased by 25%;
- total income generated by the University (inflation adjusted), which again provides an indication of the level of research activity, increased by 30%;
- the University invested in a number of new, substantial facilities to support increasing levels of scientific and technical research, most notably the Plant Growth Facility (2005), the Centre for the Physics of Medicine (2008), and the Sainsbury Laboratory (2011). Due to the nature of the research carried out in these facilities, they are all large electricity consumers (and within the top 30 most energy-intensive buildings in the University estate).

As the volume of research undertaken by the University has increased – and brought with it the need for new research facilities – the total floor area of the University estate has increased (by 10% between 2005/06 and 2012/13). An increase in the physical size of the estate will have undoubtedly played a part in driving up the University's total emissions, as a larger estate consumes more energy.

However, Figure 3 shows that even when this growth is taken in to account, by dividing total energy-related emissions by the floor area of the estate, there has been an upward trend in emissions since 2005/06. The 'carbon intensity' of the estate – that is, the amount of carbon produced per m^2 of floor area ($kgCO_2e/ m^2$) – increased by 6% between 2005/06 and 2012/13. This trend is undoubtedly related to the increase in research activity, but the exact nature of this relationship is not yet fully understood. There could be a number of reasons why the estate is becoming more carbon intensive, including the use of more energy-hungry research equipment; an increasing reliance on ICT equipment; or more demanding ventilation and climate control requirements in new research facilities.

Figure 3: Energy-Related Carbon Emissions ($kgCO_2e$) Divided by Floor Area of University Estate (m^2), 2005/06 – 2012/13

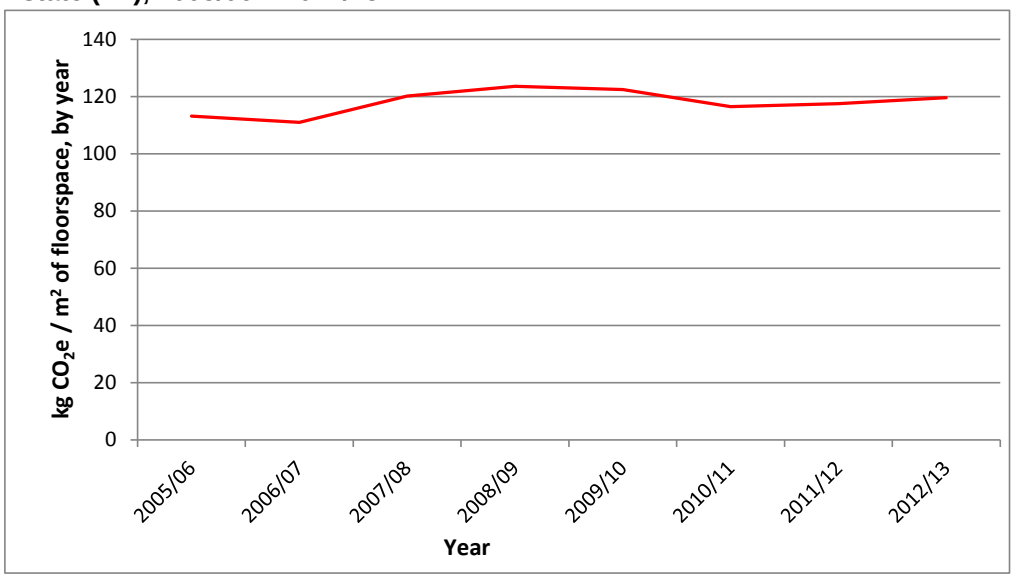
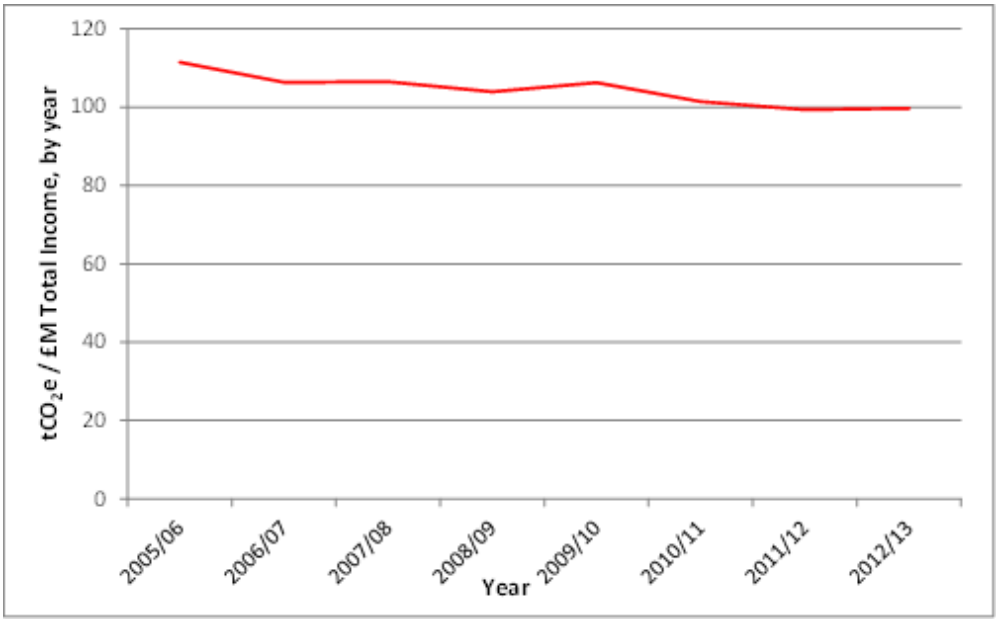


Figure 4, meanwhile, provides a different perspective. This shows the University's energy-related emissions against total income (inflation adjusted) generated per year, between 2005/06 and 2012/13. This is one of the key parameters that the University is required to report to HEFCE on an annual basis. The downward trend in Figure 4 shows that, in recent years, the University's income levels have been increasing at a faster rate than its carbon emissions.

Figure 4: Energy-Related Carbon Emissions Divided by Total Income (Inflation Adjusted), 2005/06 – 2012/13



By way of a conclusion, what can be drawn from this section, and in particular Figures 3 and 4, is the following:

- The University's total energy use and energy-related emissions have increased in recent years, due to the impact of a number of factors;
- Of these factors, those under the direct influence of the University are the physical size of its estate and the volume and type of research that it undertakes;
- Not only is the University estate getting bigger, in terms of its physical size (measured as floor area, m^2), but it is also becoming more carbon intensive (measured in terms of $kgCO_2e/ m^2$);
- This increase in the carbon intensity of the estate is most likely being driven by an increase in the volume of scientific and technical research carried out by the University – although further work is needed to explore this relationship in more detail (see Section 5);
- At the same time, the University is becoming more 'carbon-efficient' for every £M of income that it generates in support of excellence in education, learning and research.

Finally, and what cannot be overlooked is that, the University is a long way from achieving an absolute reduction in its energy-related carbon emissions; it will be exceptionally challenging to meet the targets set out in the current Carbon Management Plan.

However, the University remains committed to reducing it carbon emissions. As following sections of this report show, ECRP has begun to make progress in the pilot sites and is developing a comprehensive programme of work to ensure it builds on this success.

2. SUMMARY OF THE PURPOSE AND ACHIEVEMENTS OF ECRP TO DATE

The University established the Energy and Carbon Reduction Project (ECRP) in 2011 as a means of exploring how and to what extent carbon emissions can be reduced without impacting on the the level and type of scientific and technical research carried out at Cambridge. In other words, how can the 'carbon intensity' of the estate be reduced, without affecting the ability of Cambridge to continue to excel in these areas of research? The primary focus of ECRP to date has been on exploring opportunities for reducing research-related electricity consumption because, as shown above, an increase in electricity use has been key in driving up the University's total energy-related emissions.

The ECRP was established as a ten year programme, with an annual budget of £2m. The intention was that this funding would be used to implement carbon reduction measures, including innovative and previously untested solutions, in a handful of pilot buildings, and that the outcomes from these projects would be captured and used to inform future investments in energy efficiency across the wider University estate.

To date, the ECRP has focussed on five pilot buildings within the departments of:

- Chemistry;
- Engineering;
- Plant Sciences;
- the Gurdon Institute;
- The University Library.

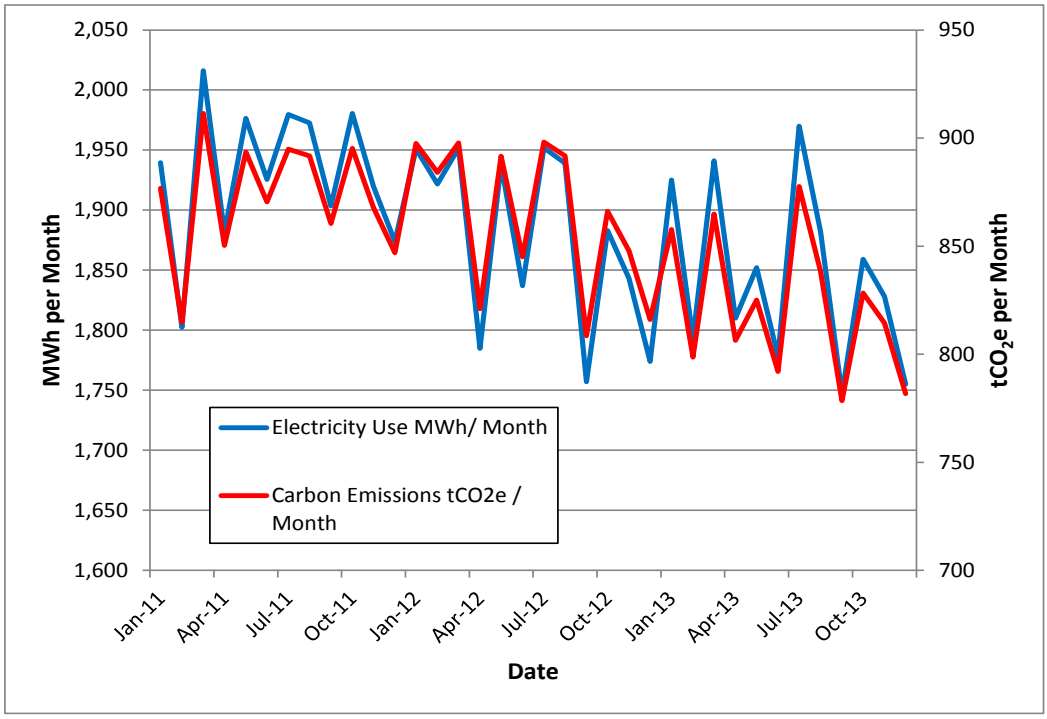
These particular buildings were chosen as examples of the different types of energy-intensive buildings and research facilities that are represented in the University estate.

Later sections of this report provide details of ECRP activity and achievements in each of the pilot buildings during 2013[8]. However, by way of an overview of what has been achieved through the ECRP to date, Figure 5 shows electricity consumption and electricity-related emissions in the pilot buildings between January 2011 and December 2013. Electricity usage in the pilots during 2013 was 4.5% lower than in 2011; and emissions in 2013 were 5.8% lower than in 2011. These reductions have been achieved through the implementation of a range of energy efficiency measures and staff engagement initiatives, and with no detrimental impact on the level or type of research being undertaken in the pilot buildings.

Whilst a number of ECRP projects have been implemented only relatively recently, these preliminary figures do suggest that it is possible to reduce energy-related emissions without adversely impacting on research activity.

[8] Information and case studies of what has been achieved by the ECRP in previous years, including the 2012 Annual report, can be found on the ECRP webpage, at http://www.environment.admin.cam.ac.uk/what-are-we-doing/carbon/energy-and-carbon-reduction-project-ecrp

Figure 5: Electricity Consumption and Emissions in Pilot Buildings, January 2011 – December 2013[9]



3. OVERVIEW OF CARBON REDUCTION ACTIVITY

The ECRP is one of a number of streams of work that are being taken forward in pursuit of the aims and target set out in the Carbon Management Plan.

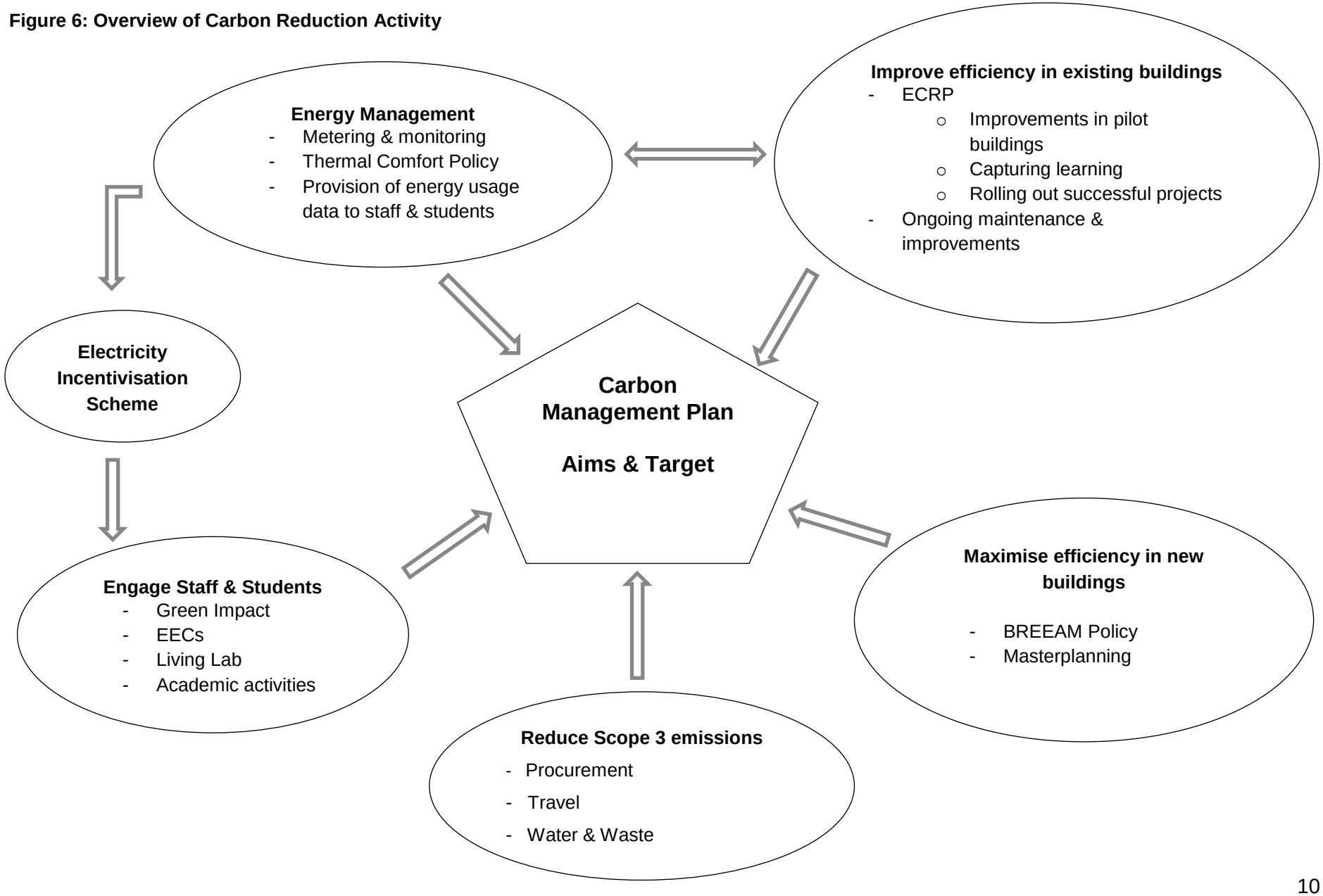
Many of these areas of work are now being coordinated and implemented by the University's new Environment and Energy Section (E&E), which was established in May 2013 and reached full strength in September 2013. This Section is responsible for developing and implementing policies and practices throughout the University to protect and enhance the local and global environment[10]. The establishment of this new Section represents a significant investment and commitment by the University to delivering meaningful improvements to its operational environmental performance. As part of its work to achieve this, E&E strives to link in with and learn from sustainability-related research underway across the University's academic community[11]; and to learn from its achievements to bring benefits to the rest of the University estate, and beyond.

A key piece of work currently being coordinated by the E&E Section, and supported by a University-wide committee, is a review of the University's Environmental Policy. The outcome will be an environmental sustainability policy and strategy covering teaching, research and administrative functions of the University. Amongst other things, the findings of the review will inform the University's future approach to carbon management, including a full review of the current Carbon Management Plan, scheduled to commence in late 2014.

[9] The energy consumption data used to produce this graph has not been weather-corrected, meaning it is subject to seasonal variations.
[10] See http://www.environment.admin.cam.ac.uk/who-are-we
[11] See http://www.environment.admin.cam.ac.uk/what-are-we-doing/academic-activity

Figure 6 provides a schematic overview of the various strands of carbon reduction activity carried out by the University, and their relationship to the ECRP. Further details of these areas of work are provided as Appendix A.

Figure 6: Overview of Carbon Reduction Activity



4. KEY ECRP ACTIVITIES AND ACHIEVEMENTS DURING 2013

Table 1 below provides an overview of all income to and expenditure from the ECRP budget for each financial year between 2010/11 and 2012/13.

Table 1: ECRP Budget, 2010/11 – 2012/13

	2010/11	2011/12	2012/13
Brought Forward		£781,713	£2,442,135
Allocations	£800,000	£2,000,000	£2,000,000
Expenditure & Commitments	£18,287	£339,578	£1,040,252
Carry Forward	£781,713	£2,442,135	£3,401,883

Table 1 shows that expenditure and allocations from the ECRP budget were slow during the initial phases of the project, as it took time to build up momentum and gain support in the pilot departments. Allocations from the budget have markedly increased as the E&E section and the initiative have become more established and the pilots have become more engaged. There are now a number of large projects at the feasibility stage and it is expected that the rate of expenditure will increase significantly from 2014 onwards, as these projects are taken forward to implementation.

The rest of this section provides an overview of ECRP-funded projects that were completed in the pilot buildings during 2013; an overview of additional funding allocations made from the ECRP budget throughout 2013; and ECRP activity beyond the pilot sites over the past year. Whereas Table 1 provides income and expenditure figures per financial year, the rest of this section considers the achievements of ECRP during the 2013 calendar year.

Further information on ECRP activity and achievements in each of the individual pilot buildings during 2013 is provided in Appendix B.

4.1 Projects completed[12]

Several energy efficiency measures were implemented in the pilot buildings during 2013, including lighting upgrades and controls; modification and optimisation of ventilation and air conditioning systems; and improvements to research-related equipment. Two specific examples are provided below. In total, ECRP provided approximately £106,000 in support of these efficiency measures. Collectively, the measures are estimated to achieve carbon savings of around 213 tCO_2 per year, and energy cost savings of around £38,000, giving an overall financial payback period of around 2.8 years.

A further £297,000 of ECRP funding was contributed to the energy roof (Phase 1) at the Department of Engineering, which became operational in June 2013. The solar PV array is expected to deliver carbon savings of around 35 tCO_2 per year and achieve a financial payback period of 12 years.

Throughout 2013, ECRP funded a series of feasibility studies of potential future projects, for example the installation of a weather-responsive fume exhaust system in the Department of Chemistry, and the replacement of water chiller units in the Department of Engineering with

[12] The annual cost savings and payback periods specified in this section have been calculated on the basis of current unit energy prices. The actual savings and payback period achieved by individual projects will be influenced by future changes in unit energy prices.

a high efficiency unit. Both of these projects are being taken forward for implementation during 2014.

In addition, ECRP continued to fund a series of staff and student engagement initiatives throughout 2013, including further development and implementation of energy dashboards showing real-time energy consumption data in the pilot sites; and the purchasing of specialist software, which has enabled students in Engineering to explore the business case for additional solar PV systems on specific buildings within the University estate.

Case Study 1: Lighting Controls in the Gurdon Institute

In March 2013, lighting sensors and controls were installed in several low-occupancy areas of the Gurdon Institute, including equipment rooms, stores, cold rooms and toilets. The sensors detect motion/ occupancy, and switch off the lights in areas not being used. The sensors and controls communicate at radio frequencies and as a consequence are wireless, which allows then to be retrofitted to existing lighting infrastructure at low cost and minimal disruption.

ECRP provided £24,000 in support of this project, and it is estimated to achieve savings of 54 tCO2e and £10,000 per year. The new lighting controls have been received well by users. Following the success of this project, work is now underway to install the same technology in several other buildings across the University estate. ECRP has provided £500,000 to fund the roll-out.

Case Study 2: Department of Chemistry: NMR UPS Replacement

The Department of Chemistry runs a Nuclear Magnetic Resonance (NMR) laboratory, for the purposes of analytical chemistry. In 2013, a strong business case was identified for replacing the existing uninterruptible power supply (UPS) to the NMR equipment with a more efficient UPS technology. The existing UPS was ten years old and highly energy-intensive, representing the third largest single electrical load in the Department.

The new UPS technology includes an ‘ECOmode’ setting, a mode whereby the UPS switches on the battery supply only when a power supply irregularity occurs. This takes out the energy losses associated with charging the batteries continuously through an inverter.

The ECRP provided £19,500 to this project. Running in ECOMode, the new UPS technology is expected to deliver carbon savings of 23 tCO_2e/ year and around £4,000 / year.

Further work is now required to assess the scope to replicate this project for other UPS systems in use across the University estate.

4.2 Approved funding allocations

To date, applications for the ECRP funding have been assessed against a series of criteria, the most significant being:

- Annual carbon savings (tCO_2e/ year);
- Annual cost savings (£/year);
- Project cost and financial payback period. As a general rule, projects with a payback of up to ten years have been given priority, although longer pay back periods have also been accepted for projects with a sufficiently long lifetime or for particularly innovative projects;
- Potential for new learning as a result of the project (how innovative is the project?);
- Scope to replicate the project, if proven to be successful, more widely across the estate.

These criteria will be reviewed as part of the forthcoming review of the Carbon Management Plan.

Throughout 2013, ECRP allocated over £1.6m to a series of proposed carbon reduction measures, including:

- A second energy roof at the Department of Engineering, which received £50,000 from ECRP and is expected to achieve carbon savings of 11 tCO_2/ year and a financial payback period of 13 years;
- Retrofitting of LED lighting in shaker units, which typically rely on fluorescent lighting, used for research purposes within the Department of Plant Sciences. ECRP awarded £75,900 in support of this innovative project, which is estimated to deliver carbon savings of around 37 tCO_2/ year and annual energy cost savings of around £6,500;
- A feasibility study at the University Library, exploring options for achieving carbon reduction in a Grade II listed building with very specific climate control requirements. The study has identified a series of feasible improvements to the Library's building management system (BMS), building fabric, lighting and heating, ventilation and air conditioning (HVAC) systems, which would in total cost in the region of £1.5m (plus VAT) to implement. The University is now working towards implementing the most cost-effective of these measures, starting with improvements to the Library's BMS.

If all of the projects that were awarded ECRP funding in 2013 are successfully implemented (including the roll-out of wireless occupancy sensors beyond the pilot buildings, see the next Section), they will deliver estimated carbon savings of around 2,500 tCO_2/ year and annual energy cost savings of around £490,000, providing an overall financial payback period of less than four years.

4.3 ECRP activity beyond the pilot sites

As well as the work undertaken in the pilot buildings, the ECRP has supported the following additional areas of work during 2013:

- Options for low-cost energy monitoring: ECRP facilitated in the award of £40,000 to researchers at the University's Computer Laboratory, to investigate the possibility of adapting and utilising the Raspberry Pi computer, a credit-card size, low cost programmable computer developed by the Computer Laboratory[13], to provide a cost-

[13] See http://www.cl.cam.ac.uk/projects/raspberrypi/

effective sub-metering solution for the University estate. The Department of Pathology is currently being used as a case study for this work.

- Reducing emissions from IT use: ECRP awarded £10,000 to a newly-formed IT Use Strategy Group, to explore options for reducing electricity consumption by desktop PCs used in the Department, including those used for research purposes, and with specific operating requirements. The preliminary findings of this work are now available and are being developed into IT power management guidelines for dissemination to other departments.

- Implementation of wireless occupancy lighting sensors: ECRP awarded £0.5m to fund the roll-out of wireless occupancy lighting sensors in some of the most energy-intensive buildings in the University estate, following the successful trial of this technology in the Gurdon Institute (See Case Study 1 above). A series of buildings have been identified for implementation during 2014. There is scope for this project to deliver significant carbon and cost savings, in the region of 1,200 tCO_2e and £270,000 per year.

5. THE STORY SO FAR: KEY CONCLUSIONS

There are some key conclusions that can be drawn from the achievements and experience of the ECRP to date; it is important that these are recognised and used to inform the University's approach to carbon reduction moving forward.

5.1 ECRP has shown that carbon reduction and research are not mutually exclusive…

Figure 5 has shown that, over the past three years, the ECRP has achieved noticeable reductions in electricity consumption and carbon emissions in the pilot sites without any adverse impacts on research activity. A concentrated effort in the pilot buildings has helped to uncover a series of inefficiencies in the management and operation of some of the pilot buildings and/or certain equipment within them. Ensuring that energy-intensive equipment is operating efficiently can deliver sizeable savings, at relatively low cost, as exemplified by the fan exhaust servicing undertaken in the Department of Chemistry (see Appendix B). It is highly probable that similar inefficiencies exist in other buildings across the University estate and that there is scope to address many of these and achieve substantial savings, without in interfering with research activity.

5.2 …but we need to explore and understand this further

Whilst there has been progress in reducing carbon emissions in the pilot buildings, there is a considerable gap between what has been achieved through the ECRP to date and the level of carbon reduction that the University needs to make, if it is to make any serious progress towards achieving its carbon reduction target. More work is needed to assess how much scope there is to replicate what has been achieved in the pilot buildings across the wider University estate, and how far this will take the University towards its target. This will involve reviewing the success of those projects implemented in the pilot buildings to date and their replicability/ applicability to other University buildings. It will also be important to gain a better understand of the interrelationship between research volume, estate size and carbon emissions, and understand why the estate is becoming more carbon intensive. This will inform us further on how and to what extent we can expect to achieve significant carbon reduction without adversely impacting on research activity.

5.3 Capacity remains a barrier

A shortage of staff and/or relevant expertise in the pilot departments and the central University has caused delays to the implementation of a number of projects. The recent establishment of new E&E Section is helping to address this and there are plans to add further to the University's central expertise on energy and carbon management, which will help even more. However, a shortage of relevant expertise and capacity within individual departments remains a hindrance and is a priority issue for ECRP to address in 2014. It will also be important for the E&E Section to develop and maintain effective communication channels and working relationships with departments where ECRP projects are proposed, including those beyond the original pilot sites.

5.4 Incentivising and supporting departments

Alongside the capacity issue, the ECRP also needs to address how it can provide effective incentives and support to individual departments, and ultimately individual members of staff and students, to give priority to carbon management. This will require a multi-faceted approach, involving:

- Strong leadership from senior management, including the ECRP Board[14];
- Clarity over individual roles and responsibilities in relation to carbon reduction;
- Guidance and support to help individual departments identify what actions they can take, and how; and
- The provision of accurate and targeted energy consumption data for individual buildings.

It will also be vital to support departments in making clearer linkages between their research activity and carbon emissions – for example, by ensuring that the carbon implications of their research proposals are considered and recognised at an early stage.

The E&E Section is seeking to recruit to a new energy management post, which will play a key role in providing energy consumption data to departments. The E&E Section will also be leading on a review of the University's Electricity Incentivisation Scheme (EIS) during 2014 and, as part of this, will examine how the EIS can be used more effectively as an incentive for departments to prioritise carbon reduction and support the ECRP.

5.5 There is still more work to do in the pilot buildings

The work of the ECRP over the past 3 years has helped to ensure that energy-related carbon emissions from the pilot buildings have not increased in line with those from the estate as whole. Nevertheless, it is clear that more work needs to be done in the pilots, both in terms of implementing those projects that have already been approved, which will require the issues of staff capacity and engagement to be effectively addressed; and in terms of identifying additional carbon reduction projects that might be suitable for implementation within the pilots, in particular those targeted at reducing gas consumption.

5.6 Progress will require serious commitment

Finally, a certainty highlighted by this report is that, for as long as the University remains committed to research-related growth, it faces an uphill struggle to reduce its carbon emissions. Whilst this may not be insurmountable, it will require the University to become more seriously committed to carbon reduction for the long-term and to be open to new and potentially innovative solutions and approaches. There will be major implications here for

[14] The ECRP Board is a predominantly academic group, providing strategic direction to the ECRP. See http://www.environment.admin.cam.ac.uk/what-are-we-doing/carbon/ecrp-project-board

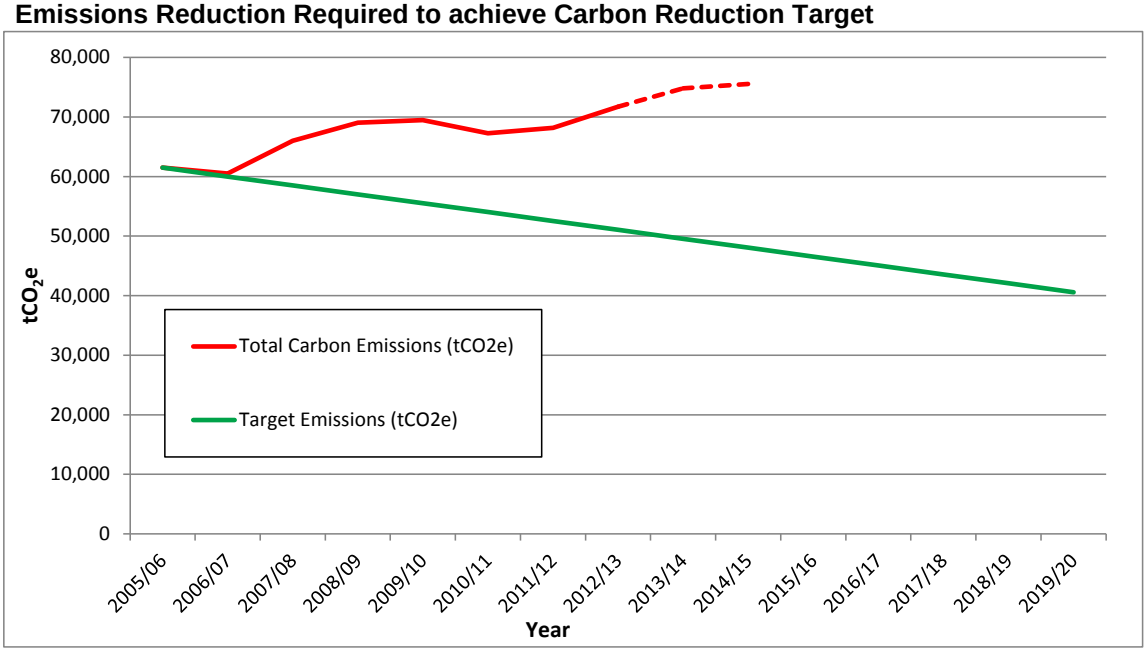
how we plan, assess and manage building and energy-reduction projects, and for how we engage the academic and administrative community.

6 FUTURE PLANS AND PRIORITIES FOR THE ECRP

Taking into account current and planned growth and projects on the University estate, Figure 7 projects how the University's energy-related emissions are likely to increase over the next couple of years. This diagram also shows how this increase is moving the University's energy-related emissions even further away from the direction of travel that would be required to achieve a 34% reduction against 2005/06 levels by 2020.

It is unquestionably beyond the reach of the ECRP alone to achieve the University's carbon reduction target by 2020; this would require the University to adopt urgently a strategic, multi-faceted and very stringent approach to reducing emissions from across its estate. Nevertheless, the ECRP does have a key role to play and is now in a good position to extend its reach beyond the initial pilot sites, building on what it has achieved and taught us so far. In October 2013, the ECRP Board agreed that, whilst ECRP will continue to support initiatives within the five pilot buildings, moving forward there will be an increasing focus on identifying and funding effective carbon reduction measures for delivery in other energy-intensive buildings across the University estate. This represents a significant change in the focus of the ECRP. Clearly, delivering carbon reduction measures across the whole University estate presents a huge challenge and needs to be done in an informed way. The guiding principles that will shape how this work is taken forward are outlined below.

Figure 7: Projected Increase in University Total Emissions 2013/14 – 2014/15, against Emissions Reduction Required to achieve Carbon Reduction Target



6.1 Learn from experience

It is clear that the University needs to continue to target its carbon reduction activities on the most energy-intensive buildings in its estate which, in most cases, are those used for scientific and technical research. The ECRP has begun to reduce energy-related emissions

in the pilot buildings without compromising research activity; the University now needs to utilise the lessons learned through the ECRP to inform its carbon reduction activity in other energy-intensive buildings.

6.2 Build on existing resources

Extending the reach of the ECRP beyond the pilots will include building stronger links between ECRP and the University's Long Term Maintenance Plan and other relevant work streams, and using ECRP to supplement other existing budgets in order to deliver carbon reduction 'on the back of' maintenance and refurbishment work that is already scheduled. This will help to ensure that ECRP funds are used in the most cost effective way for achieving carbon reduction, and streamlining efforts in this way may also help to reduce conflicting demands on teams that are experiencing capacity difficulties.

6.3 Adopt a targeted approach

With an estate comprising over 300 buildings, the University needs to have a clear understanding of the priority areas for carbon reduction, and apply its efforts and resources accordingly.

With these guiding principles in mind, the E&E Section is commissioning third party support during 2014, to help develop a quantified and prioritised programme of carbon reduction measures for implementation across the wider estate. The purpose of this work is to identify the priority areas for investment in improvements to the efficiency of some of the University's most energy-intensive buildings, as well as that of mechanical and electrical equipment that is used in these buildings. This work will give consideration to successful projects already delivered through ECRP and how and where these might be replicated; options for delivering carbon reduction measures across the estate, including as an extension to existing, relevant work programmes; and what level of investment (financial and personnel) the University would need to commit to in order to achieve meaningful reductions in emissions from its estate.

The outcome from this work will inform the allocation of ECRP funds for 2015 onwards, as part of the University's financial planning process during autumn 2014. It will also inform the forthcoming review of the University's current Carbon Management Plan.

Alongside this work, the E&E Section is continuing to further develop the other strands of carbon reduction activity shown in Figure 6, which will help to support the ECRP moving forward, in particular around the issues of staff and student communications and engagement; guidance and support for departments; and the provision of accurate energy consumption data for individual buildings.

APPENDIX A: OVERVIEW OF KEY AREAS OF CARBON REDUCTION ACTIVITY AT THE UNIVERSITY OF CAMBRIDGE

1. Energy management

The University has a long-standing commitment to the responsible management of utilities for both environmental and financial reasons. In 2012/13, the University spent around £14m on energy.

Electricity Incentivisation Scheme (EIS):

The EIS is an award-winning initiative launched by the University in 2008/09 to encourage individual departments to take responsibility for their electricity use. The EIS was launched to address the fact that, because the University's energy costs are paid for centrally, departments do not have a direct financial incentive to manage and reduce their usage. Under the Scheme, each department has been allocated a baseline for their annual electricity usage and costs, based on their historical usage. If the department uses less than this baseline over the year, then the difference is returned to them as a financial reward. If the department exceeds their baseline electricity usage, they are issued a bill for the additional cost.

In 2014, the E&E Section will be leading on a review of the EIS, which will address how the baselines for individual departments should be set in future and how the EIS might be more strongly linked to the work going ahead under the ECRP.

Thermal Comfort Policy:

In January 2014, the University adopted a new Thermal Comfort Policy, the aims of which are to:

- Identify parameters between which the internal environmental conditions are considered acceptable;
- Outline a transparent decision making process to determine a course of action where occupants are unsatisfied with the internal environment;
- Comply with relevant legislation;
- Support the University's aspirations in respect of reducing carbon emissions;
- To clarify the University's position on thermal comfort and so facilitate improved communication with building users on the subject of energy saving.

The University now aims to heat buildings to be within the range of 19 to 21°C during their core operational hours. At the other end of the scale, current national design guidelines (*CIBSE Guide A: Environmental Desig*n) suggest 25°C as an acceptable summer indoor design operative temperature for non-air-conditioned office buildings providing the expected occurrence of operative temperatures above 28 ºC is limited to 1% of the annual occupied period.

Energy Monitoring:

Access to information about the amount of energy being used in specific buildings is vital to allow the University to launch targeted carbon reduction activities, as well as for building users to see the impact that their actions are having on energy use.

2. Estate Development

The University is committed to sustainable construction and uses multiple approaches to support this goal, as detailed below. A forthcoming review of our approach to sustainable construction will seek to both align and strengthen our policy approach.

Environmental Design Guidelines:

These guidelines, adopted in 2008,[15] set out the University's ambitions, policies and overall approach in relation to the sustainable design and construction of new buildings. They will be revised as part of the forthcoming review of the University's approach to sustainable construction.

Energy Efficiency Standards for New Build:

As part of Estate Management's *Design and standards brief for University services and construction works*, Part E Energy Conservation details a range of strategies and specifications which the University targets to improve the energy efficiency of its new buildings. These guidelines are provided to all design teams at the outset of new projects.

BREEAM:

The University's new buildings are certified through BREEAM (Building Research Establishment Environmental Assessment Method). This is a comprehensive environmental assessment method and rating system for new buildings, which includes aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes. The University's current BREEAM target is to achieve an *Excellent* rating; in cases where BREEAM *Excellent* is not achieved, the project is expected to achieve an *Excellent*-equivalent rating in the Energy and Carbon category AND the savings made from reducing the overall target from *Excellent* to *Very Good* must be spent on additional energy saving/carbon reduction features (in addition to those required to achieve *Excellent* in the Energy and Carbon category).

ARUP Building Sustainability Framework:

The Arup Building was built in the 1970s and is currently undergoing refurbishment. Due to the lack of environmental assessment methods which deal adequately with existing building of this nature, coupled with the ambition of the University to create a truly sustainable refurbishment, a team of consultants were engaged to create a bespoke sustainability framework. The framework, which covers energy and carbon, water and waste, as well as wider issues such as biodiversity and ecology, is being implemented as part of the current refurbishment. The wider applicability of this approach to other refurbishments across the University's Estate is also under consideration.

Masterplanning:

The University of Cambridge uses masterplanning as a tool to underpin our approach to sustainable construction, ensuring that a defined Sustainability Plan sets out the parameters for future development. Sustainability Plans include the fundamental principles, objectives and targets that future construction projects must adhere to, and are agreed with key stakeholders including University governing bodies and the Local Planning Authorities.

[15] http://www.environment.admin.cam.ac.uk/resource-bank/guidance-documents/design-and-construction-environmentally-sustainable-new-buildings

Sustainability Plans are referred to as construction projects are brought forward, to ensure that sustainability remains central to the aims and objectives for the site.

A key concern addressed via masterplanning is to ensure that land is used most effectively, to provide the right amount of space for current and future users. In addition there is focus on the creation of a high quality, permeable public realm, to ensure sites are embraced by occupants and the wider public and help ensure they remain viable into the future. Carbon reduction and energy efficiency, the provision of renewable energy and sustainable travel options are also central to our approach, alongside moving towards a culture of shared facilities and flexible spaces. Currently there is ongoing masterplanning work occurring on the New Museums Site, West Cambridge Site, and the Old Press/Mill Lane Site

3. Engagement and Behavioural Change Initiatives

The E&E Section has adopted the Cambridge Green Challenge as the umbrella branding for the University's work on staff and student engagement.

Green Impact[16]:

The University is now into its second year of Green Impact, an environmental accreditation scheme which supports and encourages teams across the collegiate University in reducing their environmental impacts. Supported by the Environment and Energy Section, teams sign up to an online workbook and progress through simple, clear and easy criteria towards recognised awards and targets. There are now a series of issues and criteria specific to research laboratories and colleges.

There are currently 35 teams taking part in Green Impact 2013-2014 which is over double the number from last year. Workbooks will be submitted in April, audited in May and the award ceremony is due to take place in June.

There are opportunities for students to get involved with Green Impact, either as Project Assistants who are assigned to a team to assist them in gaining an award, or as an Auditor who will audit teams to ensure that they have met the requirements of the workbook. The students gain practical work experience that they can add to their CV and the programme begins to bridge the gap between staff and students.

Environment and Energy Coordinators (EECs)[17]:

An EEC network was launched on 10 September 2013 and is now fully established with over 90 members. Each EEC acts as champion for environmental issues within their department and as a point of contact between the Environment and Energy Section and department staff, students and senior management. EECs are connected via an email distribution list and receive a bi-weekly digest from the Environment and Energy Section keeping them up to date with news and information. There are regular networking events, such as the "6 month review" which was held in March 2014.

[16] http://www.environment.admin.cam.ac.uk/getting-involved/green-impact-staff-and-student-engagement-programme

[17] http://www.environment.admin.cam.ac.uk/getting-involved/environment-and-energy-coordinators

NetPositive[18]:
The Environment and Energy Section is supporting Cambridge in being one of nine universities piloting the NETpositive student engagement tool this academic year. Students sign up online and select generic sustainability-related statements that they identify with, such as 'I probably waste energy in my Department' or 'I'm concerned about where the things I buy come from'. These then combine with demographic data to create a personalised action plan for students to record and improve their sustainable actions and level of understanding. The Environment and Energy Section will receive data relating to the student population about what they think are the main areas of concern which can inform future campaigns.

The Living Laboratory[19]:
The 'Living Lab' provides opportunities for students to propose and carry out projects across the University to improve Cambridge's sustainability. These projects are carried out directly on and with the buildings, grounds and operations of the University. The Living Lab is sponsored by Santander.

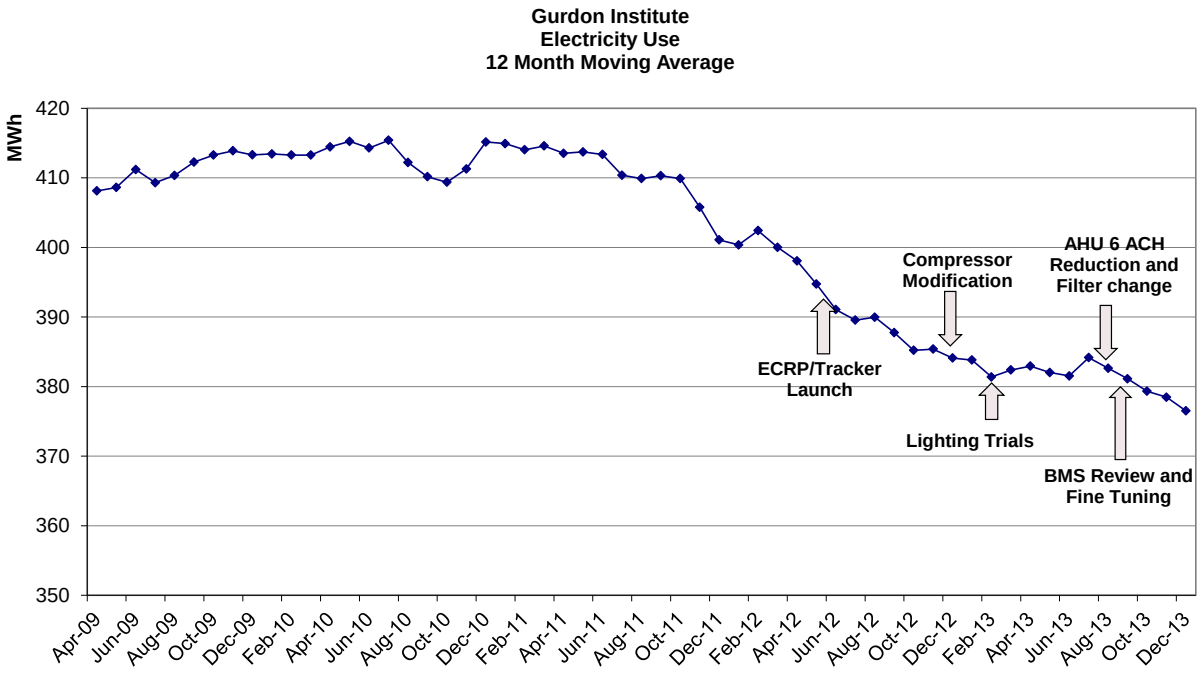
4. Scope 3 Emissions

The University has recently commissioned some work to create a 2012/13 baseline of its scope 3 carbon emissions. This report[20] highlights the indirect, more hidden carbon costs associated with the University's activities. Just over two-thirds of our overall annual carbon emissions were discovered to be the result of scope 3 sources, with procurement of goods and services accounting for over half of the total scope 1, 2 and 3 CO_2e footprint. The University will carry out further work around scope 3 emission reduction following the 2014 Environmental Policy Review and forthcoming review of the Carbon Management Plan.

[18] http://www.environment.admin.cam.ac.uk/getting-involved/netpositive-student-information-tool
[19] http://www.environment.admin.cam.ac.uk/getting-involved/living-laboratory-sustainability
[20] http://www.environment.admin.cam.ac.uk/files/university_of_cambridge_scope_3_element_1_final.pdf

Appendix B: ECRP Pilots 2013

Gurdon Institute



ECRP Funding Awarded to Projects Completed in 2013	£35,825

Total Estimated Savings from Projects Completed in 2013:

- £17,000 per year
- 97 tCO_2e per year

Key Projects/ Successes:

- Replaced traditional terminal HEPA filters in biomedical air handling unit with an ePTFE filter (MEGAcel) that optimises energy efficiency; and reduced the air change rates to the Home Office minimum standard of 15 air changes per hour. This has resulted in a saving of 27,000 kWh electricity over the last five months of 2013.
- Energy awareness has become part of the culture of the Institute, following a series of successful staff engagement campaigns.

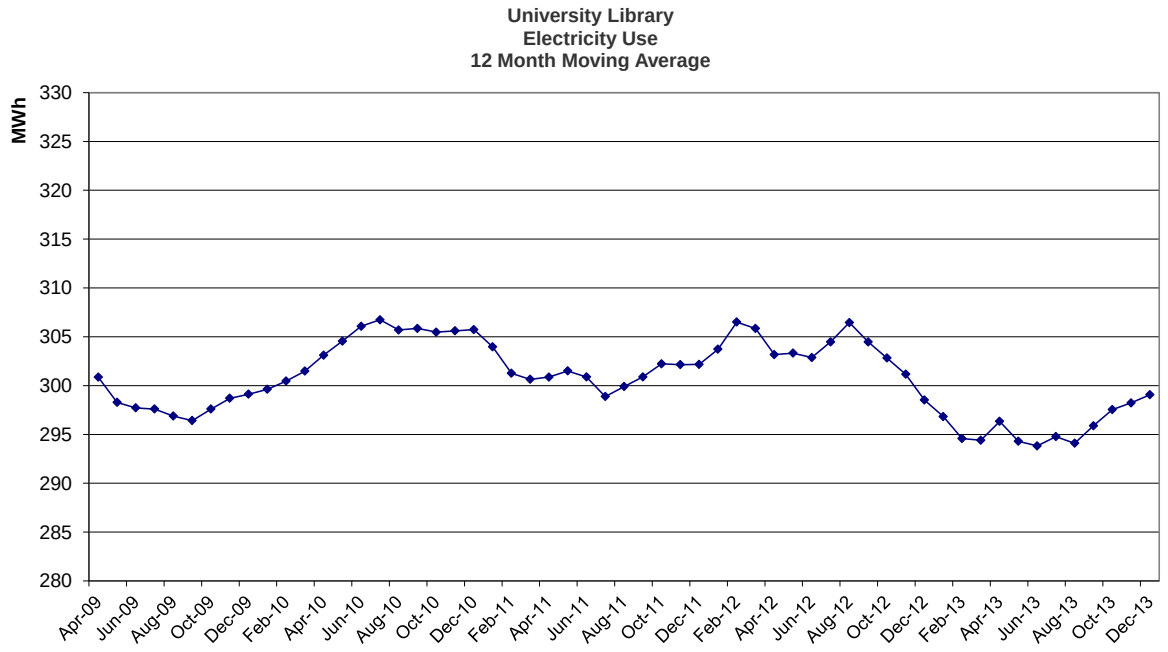
Key Lessons Learned:

- Savings achieved by the installation of wireless occupancy sensors have not been as high as expected in some areas; the users' interaction with the space and its lighting has had an influence on the predicted savings and, in certain areas, the use of occupancy sensing may not have been as preferable as vacancy sensing.

Key Projects & Objectives for 2014:

- The Gurdon plans to hold a 'One-million kWh saved' celebration party, attracting local and national coverage.
- Implement gas humidifier project (awarded £64,000 by ECRP in 2013).
- Optimisation of ventilation systems (ECRP awarded £171,000 in 2013).

University Library



ECRP Funding Awarded to Projects Completed in 2013	£17,000

Total Estimated Savings from Projects Completed in 2013:

- £5,500 per year
- 32 tCO_2e per year

Key Projects/ Successes:

- Re-launch and rebranding of the local staff green group as the Green Futures Group, and extending activities of the Group into other University Library's bodies/ committees, to ensure green principles are instilled in everything we do and plan to do.
- Extensive feasibility study, which has identified a series of feasible improvements to the Library's building BMS, building fabric, lighting and heating and HVAC systems, which if fully implemented will deliver savings in the region of £121,000 and 650 tCO_2e per year.

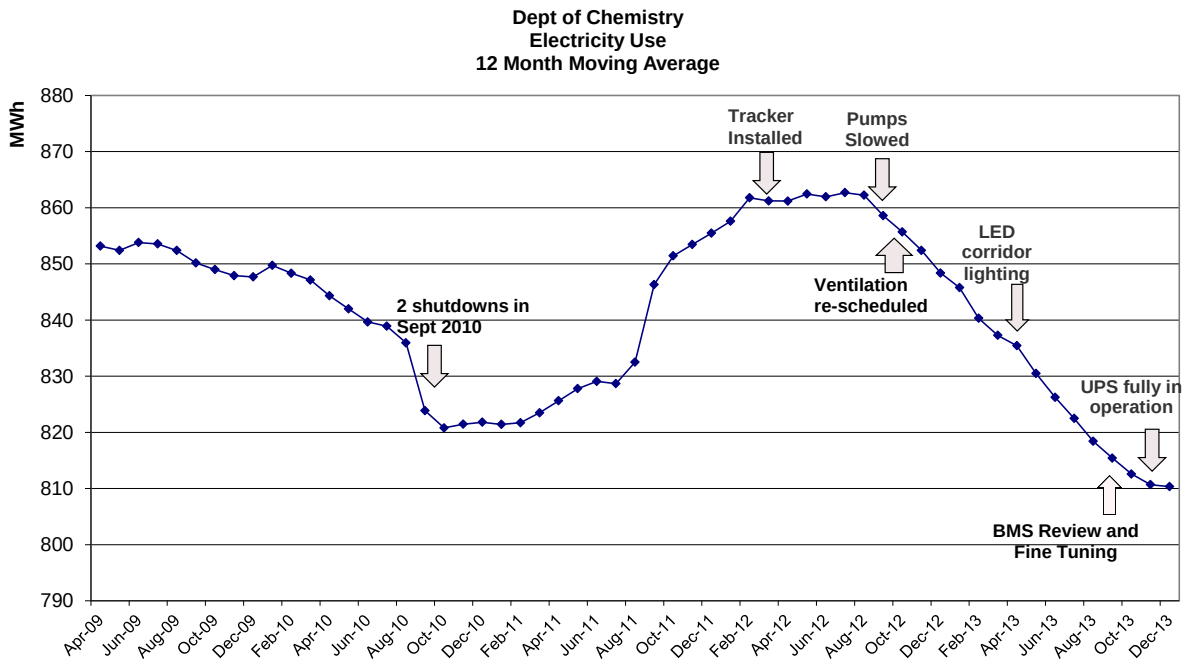
Key Lessons Learned:

- Staff engagement initiatives and groups that have become stale can be reinvigorated and given a new lease of life through rebranding and the involvement of new members and new ideas. Linking these initiatives in with other departmental groups and processes helps to embed good practice into day-to-day activities and ensure this is sustained.

Key Projects & Objectives for 2014:

- Implementation of wireless occupancy lighting sensors.
- Implement carbon reduction measures identified through the Feasibility Study.
- Further develop the Green Futures Group and a behavourial change campaign for staff.
- Link up with international colleagues in other libraries as far afield as Australia to share good sustainability practice and behaviours and lessons learned.

Department of Chemistry



ECRP Funding Awarded to Projects Completed in 2013	£63,600

Total Estimated Savings from Projects Completed in 2013:

- £15,500 / year
- 84 tCO2 per year

Key Projects/ Successes:

- Exhaust fan servicing: ECRP provided £26,500 for repairs, modifications and optimisation of a number of exhaust fans that serve fume cupboards within the Department. This has been highly effective in improving the energy efficiency and performance of the exhaust systems. Estimated savings are in the region of 54 tCO_2e and £10,000 per year.

Key Lessons Learned:

- As exemplified by the exhaust fan servicing, there is scope to achieve significant carbon and cost savings simply by ensuring that equipment/systems are operating at their optimum condition.
- Capacity issues within the Department have been significant and caused delays to the implementation of some projects.

Key Projects & Objectives for 2014:

- ECRP will support Department in resolving local capacity issues.
- Implementation of wireless occupancy lighting sensors.
- Repairs and modifications to heating system.
- Reinvigorate staff engagement activities, under new leadership.
- Improve monitoring of energy use on an individual laboratory basis.

Department of Plant Sciences	
ECRP Funding Awarded to Projects Completed in 2013	£75,900 allocated to support retrofitting of LED to shaker units

Key Projects/ Successes:

- Conversion to LED lighting in plant growth rooms and cabinets at the Plant Growth Facility (PGF), located at the Botanic Gardens. To date, three trials have been performed using typical experimental species including Tobacco, Tomato, Wheat and Arabidopsis.
- Suppliers of shaker units started to build and test algal growth shakers/incubators retrofitted with LED lighting.
- Monitoring energy use within the department on an individual laboratory basis.

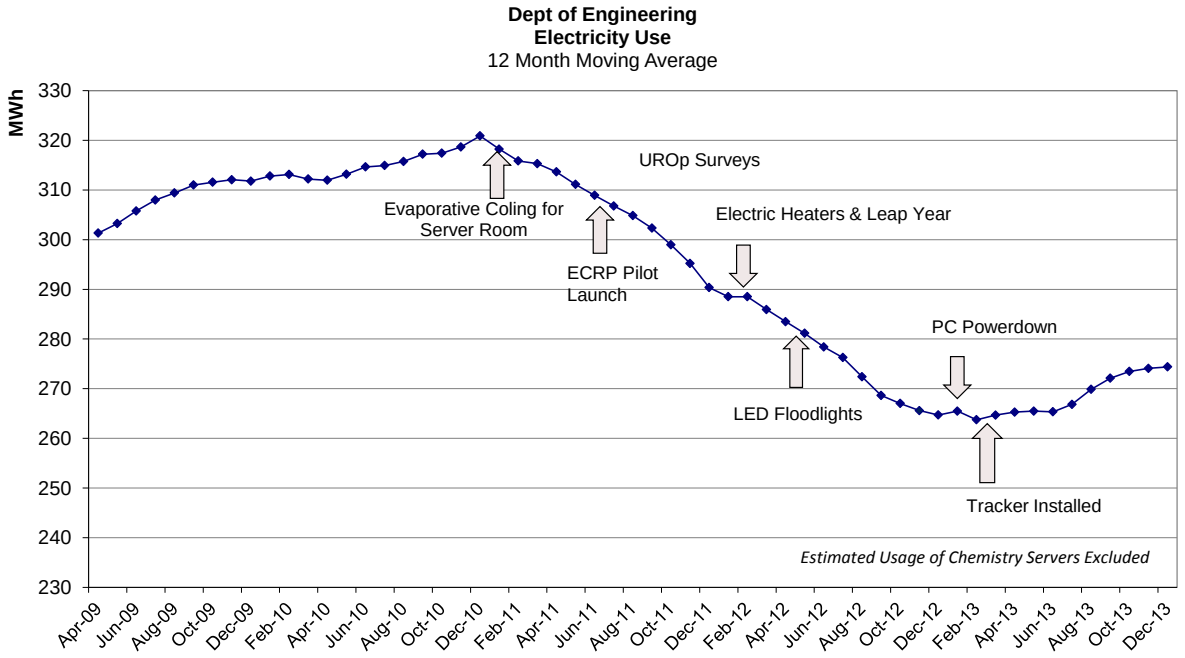
Key Lessons Learned:

- Have found that the LED platform 4 provides the best results in terms of plant growth similarities with those grown under the fluorescent bulbs. Measured a variety of key physiological factors associated with plant growth and photosynthesis in Tomato, Wheat, Setaria, Tobacco, Arabidopsis and Cleome. The majority of the data showed no significant difference between plants grown under LED 4 or Fluorescent bulbs. This suggests that LED 4 is the canopy most suitable to use as a replacement.

Key Projects & Objectives for 2014:

- Still a range of experimental systems to test under the LEDs, these will be more research-group specific, enabling the academics to have confidence that there specific experiments will not be affected by the LED light change over.
- Fit out an entire room with one of the configurations of the LED canopies (most likely LED canopy 4) and record the total power output for that room under normal use compared with that of the fluorescent bulbs. This will take into account the energy consumption for light production as well as the energy required for climate control. Plant Sciences will then be in a position to decide when to convert all the growth rooms in the PGF with LED canopies.
- Monitoring: Monitor the autoclave loads, to give an understanding of load for comparison against replacement machines when due; and improve monitoring in specific areas of the building, and link this to the building's BMS.

Department of Engineering



ECRP Funding Awarded to Projects Completed in 2013	£ 314,136

Total Estimated Savings from Projects Completed in 2013:

- 35 tCO2 per year

Key Projects/ Successes:

- Energy roof (Phase 1) became operational in June 2013 (£297,000 of ECRP funding).

Key Lessons Learned:

- Capacity issues have caused delay to implementation of certain projects.
- Department has experienced significant growth in research staff numbers and research income in recent years. Need to assess impact this is having on overall energy usage.

Key Projects & Objectives for 2014:

- Implementation of wireless occupancy lighting sensors.
- Replacement of chilled water plant (£221,000 of ECRP funding).
- Completion of energy roof Phase 2.
- ECRP will support Department in resolving local capacity issues.