The University of Nottingham

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Carbon Management Plan 2010-2020

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Introduction

The University of Nottingham has, over the period 2010-2015 earned a reputation for its sustained commitment to carbon management and reduction. As a result the University has won several awards and featured strongly in national and international rankings. Central to this has been our Carbon Management Plan which sets in place the University's target reductions in carbon dioxide (CO_2) emissions to 2020 and identifies a framework for investment over the next 5 years that will be required to deliver CO_2 savings to meet University targets. The report identifies the main proposed areas of activity, and will evolve over time as new opportunities are identified and brought forward. The Plan has been developed to respond to the UK and HE sector CO_2 emission reduction targets and will deliver both environmental performance improvements and financial savings. It requires a sustained carbon investment programme to meet these targets, with the main areas of investment centred on:

1. improvements in energy efficiency of buildings, including insulation, heating & lighting
2. more efficient use of existing equipment including switching off when not in use
3. generation of energy from medium and large scale low carbon and renewable energy systems
4. provision of information and training to staff and students to engage them with the objectives of the Plan
5. a cultural change in the use of high energy consumption activities within premises and a strategy to replace with lower energy alternatives.

The Plan requires engagement at all levels of the University – from individual behavioural changes to institution led initiatives – in order that the objectives are understood and that contributions are made to maximise delivery of the targets. We want to continue to foster a 'can do' approach and response across the University.

The programme includes a number of specific investment projects in the first two years. It also provides more generic programmes that have identified CO_2 reductions but require further detailed design to ensure maximum value for money and impact is obtained. These focus on the areas of energy saving and energy efficiency for Scope 1 (predominantly gas combustion in boilers) and Scope 2 (electricity use) emissions. CO_2 reductions from travel, procurement and waste (Scope 3) remain a key part of the University's wider sustainability strategy and therefore will now be included in the annual reports from 2015/16

The focus to ensure we achieve our aims by 2020 include 'Move towards carbon-neutral energy performance through a major new carbon investment programme' and 'Raise awareness of environmental sustainability among staff and students'. Our performance targets are summarised as:

	Baseline 2008/09	Objective 2014/15	Actual 2014/15
Total energy consumption p.a.	198 GWh	168 GWh	203 GWh
Total energy emissions p.a.	68,000 tonnes	54,000 tonnes	57,596 tonnes

At the onset the targets required an average annual reductions in energy consumption of 6GWh and CO_2 emissions of 2,800 tonnes; these are fundamental departures from historic rises seen in energy usage. Furthermore this Plan will be used to develop carbon baselines for our overseas campuses, a requirement of the University Plan, and subsequent carbon reduction strategies for all campuses for the period 2015-20.

The University will continue to publish the annual report to monitor and report on our progress and performance achievements against this plan and to provide an update on the CO_2 reduction projects that will ensure that the remaining targets and objectives are met.

UK Carbon Policy

The higher education sector as a whole has embraced the environmental agenda with an increasing commitment towards true sustainability. Indeed as early as 2005 HEFCE set out a vision that: '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.'

Carbon management is becoming of increasing importance at global and local levels. The UK has set legally binding CO_2 reduction targets and, in turn, funding bodies including HEFCE are reflecting these in their strategies, investment criteria and reporting requirements. Key aspects in HEFCE's strategy include:

- Establishing a more demanding approach to delivering carbon reductions via institutions' carbon plans. Targets for the sector are to reduce direct emissions and those caused by electricity purchases by 43% by 2020 and 83% by 2050 (both against a 2005 baseline).
- Adapting the Capital Investment Framework to establish a link between performance against carbon plans – in effect, carbon reduction – and future capital allocations.
- Measure and report progress against the sector-level targets.

The Carbon Reduction Commitment Energy Efficiency Scheme registration commenced in April 2010, with some 5000 organisations participating in this. Each year from 2012 the University has been be taxed on its carbon emissions, this will cost c. £750k, based on a rate set at £12/tonne CO_2. This phase of the scheme is due to close 2019 and the estimated total cost over this 3 year period is expected to be £2.2m

The development and publication of the University's Environmental Strategy in March 2010, coupled with the University Plan, explicitly set the scene and agenda for delivering carbon reductions across the University. Now, in 2016 The University has developed a new sustainability strategy which recognises greenhouse gas reduction as a key priority and measure.

University Carbon Baseline

Consultants SQW were commissioned by the Higher Education Funding Council for England (HEFCE) to calculate estimated carbon dioxide emissions baselines for each higher education institution (HEI) for two years:

1. 1990/91 as the year against which most national and sectoral targets are set

2. 2005/06 as a more recent year for which high quality data are available.

The individual HEI baselines calculated cover Scope 1 and Scope 2 emissions as defined in the 2004 Greenhouse Gas Protocol and adopted by the Department for Environment, Food and Rural Affairs (DEFRA). More specifically, the following emissions have been included:

1. Scope 1 – direct emissions from the combustion of fossil fuels within the HEI estate, such as natural gas, heating oil, coal and other fuels, as well as in assets owned by the institution such as motor vehicles (petrol, diesel and other transport fuels).
2. Scope 2 – indirect emissions associated with the consumption of purchased electricity within the institution's estate

The carbon conversion factors used for the 2005/06 baseline are:

Natural gas	0.18523 kg CO_2 per kWh
Petrol	2.3220 kg CO_2 per litre
Diesel	2.6720 kg CO_2 per litre
Grid electricity	0.53909 kg CO_2 per kWh

Summary of SQW baseline results for the University of Nottingham (see Appendix 1 for detailed breakdown):

1990/91	**Total carbon emissions**	**42,643 t CO_2**
2005/06	**Total carbon emissions**	**57,163 t CO_2 ***

*omitted fossil fuel consumption of 26,312 MWh for Medical School equating to 4,874 t CO_2 emissions.

Revised 2005/06	**Total carbon emissions**	**62,036 t CO_2**

Recent Performance Trends and KPIs

Over the 5 year period between 2009/10 and 2014/15, CO_2 emissions have decreased by 11,030 tonnes with the following trend changes in consumption and emissions:

1. Total energy consumption -0.5%
2. Total CO_2 emissions -16%

Table 1 summarises the annual energy consumption and CO_2 emissions arising from use of electricity and gas at The University's UK campuses.

	2009/10		2012/13[1]		2014/15[1]	
	MWh	t CO_2	MWh	t CO_2	MWh	t CO_2
University Park	115,790	39,194	113.056	32,814	105,667	30,490
Sutton Bonington	29,428	9,854	33,415	10,103	32,294	9,637
Jubilee Campus	12,874	4.949	17,315	4,892	16,917	4,572
Others	10,544	4,568	14,201	3,994	12,834	3,612
Medical School	33,037	10,061	36,329	9,519	35,259	9,285
TOTAL	**204,028**	**68,626**	**214,315**	**61,322**	**203,001**	**57,596**

Table 1: Total consumption and CO_2 emissions

Table 2 takes into account growth and compares CO_2 emissions on a like for like basis.

	2009/10		2012/13		2014/15	
	MWh	t CO_2	MWh	t CO_2	MWh	t CO_2
Emissions Associated with Additional Buildings	0	0	4,873	1,688	5,901	3,753
AMENDED TOTAL[2]	**204,208**	**68,626**	**209,442**	**59,634**	**197,100**	**53,843**

Table 2: CO_2 emissions on a like for like basis

[1] Data calculated using HEFCE EMS CO_2 emission factors
[2] Amended total reflects performance on like for like basis from 2009/10 to 2014/15

'Like for like' performance trends from 2009/10 assets to 2014/15 with no additional buildings

- **Total energy consumption -3.3%**
- **Total CO_2 emissions -21%**

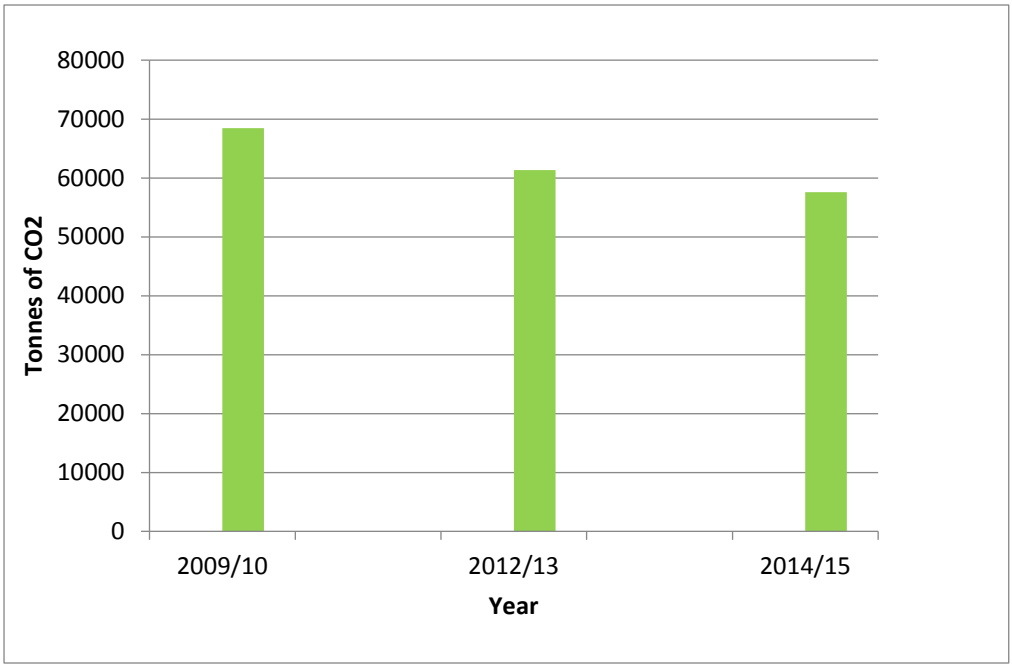

Figure 1: Total absolute CO_2 emissions

Figure 2 summarises absolute CO_2 emissions by energy source (Scope 1 and 2).

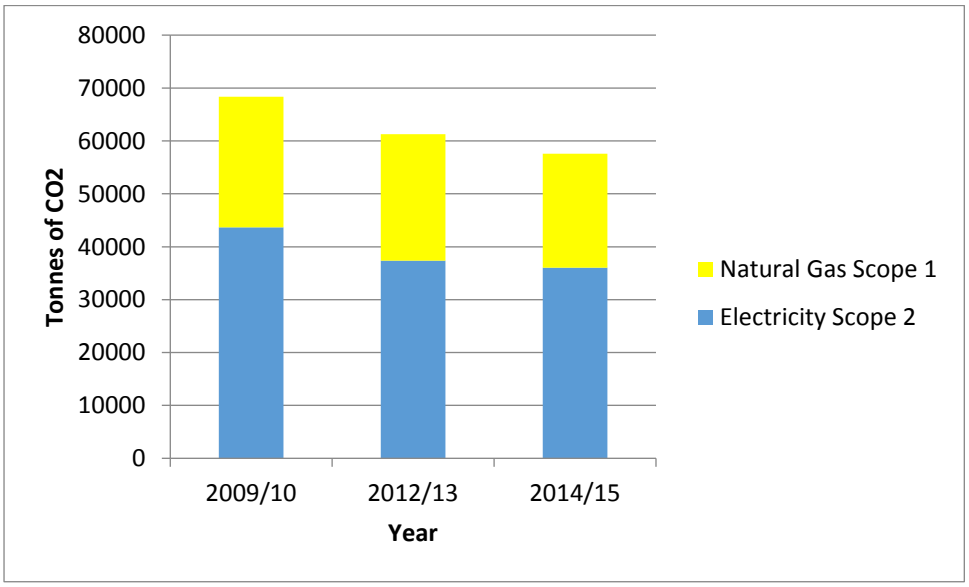

Figure 2: absolute CO_2 emissions by energy source

For relative carbon baselining, the SQW report commissioned by HEFCE has identified total FTE of staff and students combined, and the total income of HEIs as reporting Key Performance Indicators (KPI). It is also

considered appropriate to report against the changes in size of the physical assets and include HEI gross internal area (GIA). Table 3 summarises the reporting trends since 2009/10.

	Emissions ($t CO_2$)	Staff & Students (FTE)	Emissions per FTE ($kg CO_2$/FTE)	Income (£M)	Emissions per unit of income ($kg CO_2$/£)	GIA (m^2)	Emissions per area ($kg CO_2/m^2$)
2009/10	68,626	34,878	1,967	454	0.15	577,872	118
2014/15	57,596	39,623	1,453	593	0.97	602,640	95
Change	**-16%**		**-26%**		**-35%**		**-20%**

Table 3: CO_2 emissions and KPI trends summary

The data illustrates how effectively the University has been able to continue to grow both in terms of student numbers, gross internal area and income whilst sustaining relative reduction in emissions per unit.

(Excludes area associated with East Midlands Conference Centre Ltd and University of Nottingham Innovation Park)

University Targets

The targets set within the HEFCE carbon reduction strategy align with UK targets and are seeking an absolute reduction across the sector, against a 2005/6 emissions baseline. It is important to note that HEFCE did set individual institution reduction targets, but sought an overall reduction across the whole sector. However we continue to demonstrate how we are contributing to the overall sector target through future HEFCE capital allocations.

The University Carbon Management Plan commitment was for a 20% absolute reduction in CO_2 emissions from a 2009/10 level to be achieved by 2015. **This equated to a 13% absolute reduction from our 2005/06 baseline.**

The University Plan included for an expansive capital program over the 5 years. Even though the University ensures that its developments are BREEAM excellent as a minimum, development within a research led university inevitably resulted in an underlying growth in energy use from these new buildings. The estimated new build increase to 2015 of circa 30,000m^2 was exceeded (actual increase 55,435m2) along with corresponding estimated annual increase in CO_2 of circa 3000 tonnes.

On a like for like basis taking into account expansion of the estate, the planned reduction in CO_2 emissions by 2015 equates to a reduction of 21% from the 2009/10 level.

For the period 2015 to 2020, our target is to reduce our absolute carbon emissions to 41,000 t CO_2 per annum. This will equate to a total reduction of 40% from our 2009/10 level and 34% reduction from our 2005/06 baseline. This is clearly a challenging target and will require sustained and significant investment in the carbon management plan. The estimated new build increase to 2020 of circa 40,000m^2 and a corresponding estimated annual increase in CO_2 of circa 4000 tonnes.

This strategy equates to a 34% absolute reduction in carbon emissions by 2020 from our 2005/06 baseline.

Strategic Themes

The University's committed to:

> "*improve the environmental performance of our buildings and the University's physical infrastructure by moving towards carbon neutral energy performance, adopting environmentally conscious procurement practice, promoting renewable energy systems, reducing water consumption and waste output*".

The objectives in delivering this are centred on: reducing energy usage, costs and waste; generating energy from renewable energy sources, and specifying carbon neutral or low carbon energy products via procurement and energy contracts.

Whilst projects to reduce energy use have been carried out for a number of years: in our new building designs, high efficiency boilers, monitoring and control of buildings' heating usage and installation of low energy lighting we continue to see upward trends in energy use – this is due to a combination of developing and growing our estate, installation of energy intensive equipment and also the way usage has changed. Therefore, we will identify projects with significant (1000t + CO2 savings) impact to ensure the University can meet its challenging 2020 targets.

The Carbon Management Plan is the principal investment programme for delivering CO_2 emission reductions. It prioritises initiatives and provides investment levels, energy savings and financial and carbon reduction. It also recognises the inherent benefits of greater resilience and efficiency more generally. With this being an evolving programme it is not possible to identify all of the projects that will be undertaken with the 5 year timeframe. A number of feasibility studies are ongoing and several enabling projects are underway that are assisting in the delivery of this Plan. Below are the key themes that have been identified through a number of workshops as key strategic areas of work over the next five years to deliver carbon and financial savings in the short and medium term.

Improvements to building fabric and insulation

The complexity, age and construction of our buildings result in differing thermal properties, with some being very poor at retaining heat and maintaining appropriate internal temperatures. As such a major element of the Plan will continue to improve their thermal performance, thereby reducing the heat and carbon demands. The extent of the works required will vary from building to building and will include elements such as glazing upgrades, installation of roof and cavity insulation and possible external cladding where no cavities exist.

Laboratories

Our research-led agenda results in significant amounts of energy intensive research laboratory equipment being used across the estate. The Plan will complement such activities, enabling them to continue but with a reduced carbon demand. One of the most significant energy users within the laboratory environment are fume cupboards, with some 650 installed across the estate. 400 of these are linked to our Building Management System and data from this shows that in the region of 40% of fume cupboards are left running 24/7 at a cost of £1,250 per fume cupboard per year, each creating 12 tonnes of CO_2. There will be a number of situations that necessitate some fume cupboards requiring to be left on including where dedicated storage for chemicals is necessary. Significant financial and carbon savings have been achieved through retrofitting Variable Air Velocity devices to the existing systems, and operating fume cupboards only when required. Awareness raising, training and education of laboratory staff will be provided to deliver maximum savings in line with more efficient operational use. Recent

investments in the School of Chemistry will assist in reducing carbon emissions from laboratory activity but further investment will be needed.

Major equipment upgrades

Significant savings have been achieved through upgrades to chillers, fridges, pumps, drives, motors and their controls. There will continue to be a number of inefficient pieces of equipment that are coming to the end of their useful lives; these will be replaced over the next few years with more efficient equipment. This will enable greater efficiencies in use of energy and allow for greater control so that the use of energy and associated carbon is done in the most effective way.

Behaviour change and awareness

Whilst there are significant savings that can be realised through technical solutions it is essential to seek a change in culture through engagement with staff and students. Awareness and training can result in significant savings, however for such activity to be effective it needs to be sustained and on-going. Work is under preparation for a pilot project with NUS Services limited, the Students' Union and the Environment Team looking into the effectiveness of different marketing and awareness raising methods. Engagement with the student body is essential from day one and this project will enable us to kick start this.

Boiler replacement programme

Upgrading our boiler assets with the most efficient options available will increase the system efficiency and decrease associated carbon emissions generated from combustion. At the same time low carbon technologies will be considered including biomass, using either chip or pellet fuel. The replacement programme will be led by our boiler asset register that will identify the least efficient boilers and those coming to the end of their lives.

Heating energy strategy

The district heating system at University Park provides opportunities to consider options for a medium term energy strategy. These include continuation of the existing heating systems and also consider new generation technologies such as combined heat and power (CHP) and biomass which would utilise the existing the heat network and allow for low carbon energy supplies. Work has recently been completed to fully assess and identify preferred options, with investment likely in the next 1 to 2 years to deliver energy and CO_2 savings. The latest feasibility study for CHP on University Park has identified CO_2 savings c 2,302 tonnes and £412K per year.

Lighting upgrades

There is an ongoing programme of lighting upgrades moving towards a low carbon standard across all of our refurbishment projects. These will include LED systems and controls based on need, daylight and proximity to ensure efficient use.

Renewable energy projects

More effectively utilising renewable energy technologies is an important part of this Plan, both from its carbon and investment paybacks, but perhaps more importantly the message that it gives. These projects can be highly visible and start the transition to a low carbon economy. Although recent reductions in the Government's Feed-in-Tariffs have increased payback periods, the falling installed cost of these systems has gone some way to redress the balance. The University has submitted a planning application for a wind turbine at Sutton Bonington and feasibility studies on large ground based PV Arrays are underway which offer a significant carbon saving and the possibility of significant reductions in electricity costs for the site.

Relevant schemes include the use of wind projects, photovoltaics (PV), biomass and solar water heating schemes. Technologies such as lake source and ground source heat pumps provide low carbon solutions and further work will be done on assessing the viability of retrofitting to existing systems in a number of locations.

Sustainable IT

ICT in UK higher education has a large carbon footprint. It is estimated that in the sector there are one and a half million computers, 250,000 printers and 240,000 servers which collectively produce 500,000 tonnes of CO_2 a year. Work has been undertaken to date in conjunction with Information Services, reducing the energy demand of computers through the procurement process, power management and shutdown, server virtualisation and moving away from printers and photocopiers to MFDs. It is important that the widespread roll-out of any new technologies is supported with a comprehensive marketing and awareness campaign to ensure maximum buy in and carbon savings.

Lower energy strategies for activities within buildings

Our intensive research and teaching activities in many of the Science, Engineering and Medicine faculty buildings result in significantly increased building energy consumption and CO_2 emissions, compared to typical BREEAM benchmark figures of 90-130 kg CO_2/m^2 (see Appendix 2) even in new energy efficient building designs. Analysis of these situations suggests that there is scope with appropriate investment for substituting current operational practice and large scale high energy consumption equipment with alternative strategies for delivering the necessary research and teaching outputs with much reduced carbon emissions.

This will be a medium to longer term objective and is expected to contribute significantly to our CO_2 target reductions over he next 10 years

Carbon Saving Projects

Since the late 1990s, the University has been committed to sustainability and low energy/carbon developments demonstrating new technologies and achieving significant performance improvements to the requirements of building regulations. A number of projects have been recognised with national and international awards.

Particularly noteworthy are:

- Jubilee Campus – phased development expanded to 65 acres since 1999. An exemplar of brownfield regeneration and low carbon building design and environmental excellence.

- Sustainable Research Building – low carbon design achieving less than 50 kg CO_2/m^2.

- Creative Dwellings – a cluster of 7 experimental houses each demonstrating a different combination of new materials and technologies to produce low carbon housing.

- Centre for Sustainable Chemistry, Jubilee Campus – a carbon neutral Chemistry building.

- Energy Technologies Building, Jubilee Campus – to be one of the first BREEAM outstanding buildings in the HE sector.

Our investments programme in existing buildings and infrastructure has maintained a focus on energy/carbon reduction; where opportunities have arisen, these have included the following:

- 800kW CHP Scheme at Sutton Bonington Campus
- High Efficiency Chilled water plant for the Medical school
- Voids ventilation control for the Medical School
- 1000m^2 solar PV array on the Vet School at Sutton Bonington
- Low energy light fittings
- High efficiency boilers and water heaters.

To further support our carbon investment in 2014/15 we secured funding from Salix/HEFCE's Revolving Green Fund (Round 4) of £1,674k to support these investments and, to date, approximately £260k worth of carbon saving projects have been realised with financial savings being re-circulated to fund new projects.

2016 – 2017 Projects

Below is an overview of the indicative scope of projects planned for 2016/2017 including an indication of the scale of investment required, the potential carbon saving and the payback in years. It is assumed that 60% would be realised within this timeframe.

Building fabric and insulation projects

Investment – £2.5m Carbon Savings – 400 tonnes/yr Payback Period 5 to 40 years

Continuation of roofing, cavity wall and glazing upgrades. More than 30 buildings – equating to 30,000 m^2 of roof space - have been identified requiring roofs being insulated to a thickness of 300mm insulation, including ten Halls of Residence. To maximise the short term benefit it would be necessary to progress installation before the start of the main heating seasons. Medium term there is the potential for external cladding of some buildings without wall cavities to both improve their thermal performance and appearance. The ongoing program of replacement of single glazing systems will continue and be carried out in conjunction with the cavity insulation where appropriate.

Awareness

Investment – £30,000 Carbon Savings – 323 tonnes/yr Payback Period 2 – 3 years

Awareness raising has been proven to result in savings, indeed our own energy campaign in November 2008 resulted in £30,000 savings in a single month. To maximise the energy and carbon saving a dedicated resource - an intern, placement or new staff member - will be required including a budget for events, materials and training. Savings have been assessed using a 1.25% reduction in gas usage due to staff and student behaviour change.

Fume cupboards

Investment – £200,000 Carbon Savings – 278 tonnes/yr Payback Period 4 – 6 years

Continued work for significant savings through improvements to the management and technical operation of fume cupboards. Work with Chemistry, the Estate Office and the Safety Office assessed the reduction of face air velocities, awareness raising and improving fume cupboard controls. Moving from current 24/7 operation to working day operation results in the region of 75% cost savings, with associated carbon savings of 226 tonnes for the first phase of this project.

Lighting upgrades

Investment – £75,000 Carbon Savings – 170 tonnes/yr Payback Period 2 – 10 years

Improvements to and upgrades of lighting will continue to be carried out across the University, particularly in spaces that are currently not controlled and in many instances left switched on. LED technologies are being evaluated in corridors, lavatories and outside lighting areas of University buildings. A number of projects will be installed to demonstrate the technology and more will be installed as further cost effective advances are made.

Building energy/carbon management

Investment –£125,000 Carbon Savings – 746 tonnes/yr Payback Period 3 – 5 years

Improvements to the control capabilities of pumps, drives and motors will enable better management of energy and carbon production. Improvements to Building Management Systems controls will enable incremental savings to be made. These will often be carried out in conjunction with associated remedial building fabric work to deliver required temperature controls. Improving the thermal performance of buildings will enable us to consider reducing our heating temperature initially by 1 degree Celsius which would result in a c. 5% reduction in gas usage. This would result in significant CO_2 savings of c. 606 tonnes.

Renewable energy projects

Investment – University £200,000 Carbon Savings – 25 tonnes/yr Payback Period 8 – 12 years

The significant reduction of the Feed-in tariffs (FIT) has resulted in extended financial paybacks of small/medium scale renewable electricity projects. It is important that clear messages about the overall contribution are communicated for these very visible initiatives, as the investments in on-site renewable technologies only give modest carbon savings. Energy utilities have confirmed their interest in partnering with the University to install photovoltaic (PV) systems at scale. These could be internally and/or externally financed. High visibility systems of this type also have the additional benefit of improving staff and student buy-in to the Plan.

Summary of Projects 2016 – 2017

Over the next 2 years we are planning an £8.2m investment which will achieve 4,211 tonnes CO2 saved / year made up of a range of investments outlined below.

Project areas	Investment	Carbon savings – tonnes
Building fabric and insulation	£2.5m	400
Awareness and engagement	£30k	323
Fume cupboards	£200k	278
Boiler and LED Lighting replacements plus small scale renewables	£400K	150
Main Campus CHP Scheme	£3.3m	2310
Sutton Bonington Wind Turbine	£1.8m	750
Total	£8.2m	4,211

Carbon Management Plan summary 2016-2020

Below is a summary table of the Action plan to 2020 highlighting investment and Carbon savings – a list of identified pipeline projects for 2016 – 2020 is given in Appendix 3.

Area	Indicative investment	Carbon savings - tonnes /yr
2016 – 2017 as above	£8.2m	4,211
Building Fabric and Insulation	£4m	600
Fume Cupboards	£200K	278
Boiler replacements and LED lighting	£ 800K	150
Large scale ground PV Array or Wind Turbine	£5m	3000
Building activities – lower energy strategies	tbc	1500
'Grid' Electricity to decarbonise from 0.464 to 0.417Kg CO2/kWh by 2020	**nil**	**3,808**
Total	**£18.2m**	**13,547**

Table 4: Summary of five year Action Plan to 2020

Appendix 1

University Carbon Baselines - detailed breakdown of components

Year	Oil		Gas		Electricity		Coal		Transport	TOTAL
	m³	t CO_2	MWh	t CO_2	MWh	t CO_2	MWh	t CO_2	t CO_2	t CO_2
1990/91	4,117	10,466	9,139	1,693	26,798	20,674	4,072	9,514	296	**42,643**
2005/06	0	0	91,488*	76,946	74,105	39,949	0	0	267	**57,163**
Revised 2005/06	0	0	117,800	21,820	74,105	39,949	0	0	267	**62,036**

* Omitted fossil fuel consumption of 26,312 MWh for Medical School.

Appendix 2

Existing Data: Building/Energy Consumption and Carbon Emissions 2009/10

Building	Building no.	Floor Area (m^2)	Electricity (kWh)	kWh/m^2	$kgCO_2/m^2$	Fossil Fuel (kWh)	kWh/m^2	$kgCO_2$ /m^2	Total kWh/m^2	Total $kgCO_2/m^2$
Cripps Computing (South)	1242	1,514	2,651,907	1,752	952	383,549	253	47	2005	999
Plant Sciences	5711	4,934	2,900,000	588	320	2,354,293	477	88	1065	408
Swimming Pool	1571	1,428	507,445	355	193	1,574,296	1102	203	1458	396
Magnetic Resonance Centre	1491	1,867	731,397	392	213	472,976	253	47	645	260
Bio-Molecular Sciences	1353	9,476	3,180,615	336	183	3,586,781	379	70	714	252
Chemistry	1261	13,737	5,023,626	366	199	3,129,520	228	42	594	241
Wolfson Building	1421	3,358	1,031,940	307	167	553,822	165	30	472	198
Boots Science Building	1581	3,951	1,036,600	262	143	1,043,892	264	49	527	191
L3 Chemical Engineering	1311	2,930	739,938	253	137	667,503	228	42	480	179
Clin Sciences (City Hosp) ph1&2	3325	5,430	1,072,677	198	107	1,787,485	329	61	527	168
Maths & Physics	1251	11,284	2,334,394	207	113	2,570,686	228	42	435	154
Biology	1341	6,734	1,247,042	185	101	1,534,119	228	42	413	143
Portland Bldg	1111	15,182	2,543,786	168	91	3,810,866	251	46	419	137
Hallward Library	1171	10,153	1,599,654	158	86	2,313,025	228	42	385	128
Computer Sciences (DCS) & The Atrium	7040	6,254	1,155,000	185	100	887,144	142	26	327	127
The Amenities Building	7330	2,365	546,184	231	126	0	0	0	231	126
Medical School	3101	75,384	9,571,000	127	69	20,651,614	274	50	401	119
L4 Mechanical Engineering	1321	6,011	844,021	140	76	1,369,407	228	42	368	118
L2 Civil Engineering	1301	5,328	710,254	133	73	1,213,808	228	42	361	114
Psychology	1332	6,727	869,420	129	70	1,532,524	228	42	357	112
Tower	1271	7,683	987,230	128	70	1,750,317	228	42	356	112
Pharmacy	1333	4,659	591,598	127	69	1,061,399	228	42	355	111
D H Lawrence Lakeside Pavilion	1631	1,791	239,440	134	73	365,375	204	38	338	110
King's Meadow Campus	6901	22,211	3,310,488	149	81	3,201,744	144	27	293	108
George Green Library	1281	3,726	420,765	113	61	848,846	228	42	341	103
Business School South (new)	7080	5,338	851,472	160	87	446,454	84	15	243	102
Lenton & Wortley Hall	2141	5,783	491,332	85	46	1,731,895	299	55	384	101
Main Building (SB)	5011	4,505	805,748	179	97	85,684	19	3	198	101
Derby Medical School	3561	6,924	855,641	124	67	1,203,031	174	32	297	99
Law & Social Sciences Building	1151	8,084	840,331	104	57	1,841,672	228	42	332	98
Arts Centre & School of Music	1501	3,420	431,582	126	69	531,689	155	29	282	97
Sports Centre, Main Campus	1221	5,073	678,116	134	73	653,719	129	24	263	96
Hugh Stewart Hall	2181	9,255	622,232	67	37	2,867,795	310	57	377	94
Sir Clive Granger Bldg	1201	6,585	598,822	91	49	1,500,174	228	42	319	91
Veterinary School	5721	7,520	650,000	86	47	1,770,501	235	43	322	90
Willoughby Hall	2211	6,603	558,119	85	46	1,554,629	235	43	320	89
Coates Building (T2)	1292	8,943	767,644	86	47	2,037,366	228	42	314	89
International House	7320	3,400	542,339	160	87	0	0	0	160	87
Sir Colin Campbell Building	7340	4,534	714,263	158	86	0	0	0	158	86
Pope Building (T2)	1291	4,944	385,252	78	42	1,126,327	228	42	306	84
Cavendish Hall	2111	5,025	353,021	70	38	1,117,667	222	41	293	79
Jesse Boot Conference Centre	1481	3,946	233,270	59	32	986,720	250	46	309	78
Lincoln Hall	2151	6,502	359,723	55	30	1,552,050	239	44	294	74
Trent Building	1101	13,326	584,193	44	24	3,580,327	269	49	313	73
Business School North (SMF)	7020	3,936	403,088	102	56	373,084	95	17	197	73
Archaeology & Classics (OEB)	1141	4,826	265,113	55	30	1,099,444	228	42	283	72
Jubilee Sports Centre	7301	2,467	205,894	83	45	331,380	134	25	218	70
Sherwood Hall	2200	8,243	433,286	53	29	1,770,641	215	40	267	68
North Laboratory	5091	3,626	451,035	124	68	728	0	0	125	68
Cripps Hall	2171	11,449	499,016	44	24	2,605,179	228	42	271	66
Nottingham Geospatial Building	7350	2,994	290,000	97	53	202,913	68	12	165	65
Dearing Building (FOE)	7050	5,977	547,569	92	50	495,297	83	15	174	65
Newark Hall	7130	8,082	537,651	67	36	1,230,853	152	28	219	64
Rutland Hall	2191	7,157	309,429	43	24	1,537,363	215	40	258	63
Nightingale Hall	2161	6,456	202,027	31	17	1,537,905	238	44	270	61
The Exchange (CTF)	7030	3,984	288,645	72	39	453,988	114	21	186	60
Southwell Hall	7120	4,035	232,800	58	31	626,018	155	29	213	60
Derby Hall	2121	9,821	371,044	38	21	2,098,898	214	39	251	60
Florence Boot Hall	2131	7,931	421,683	53	29	1,326,365	167	31	220	60
Sustainable Research Building	1436	1,693	102,746	61	33	85,889	51	9	111	42
Lenton Grove (History)	1211	1,481	46,447	31	17	164,156	111	20	142	37

Appendix 3

Investment to date showing details of energy and carbon

2014/2015

Project	Location	Technology description	Investment cost (incl VAT) £	Estimated Annual Savings Financial £	CO_2 tonnes	Energy kWh	Payback period (years)	Cost per Tonne of CO2 £
Improvements to building fabric and insulation								
Double Glazing	Pope Building Courtyard	Glazing	95,000	3,172	26	141,000	29.9	3654
	Melton Hall	Glazing	87,000	1,137	9	50,550	76.5	9667
	Chemistry C floor labs and inner quad	Glazing	276,000	1,872	14	74,875	147.4	19714
	Chemistry SE Elevations	Glazing	325,000	3,597	27	143,875	90.4	12037
Lighting upgrades	Medical School F Floor	LED Lighting	39,645	1,738	19	34,760	22.8	2087
	Sir Clive Granger		13,746	1,085	6	13,564	12.7	2291
Boiler Replacement	Hugh Stewart	water heaters	91,000	1,535	8	43,850	59.3	11375
	Lincoln Hall	water heaters	76,000	1,013	6	28,939	75.0	13571
BMS & metering		BMS temperature sensors	29,000	5,865	36	195,500	4.9	806
Plant Room/ roof space services	Various plant rooms	Thermal covers	20,000	5,136	42	228,260		476
Thermal insulation								
Fume Cupbords	CBS C25	Auto sash closuers	15,000	4,695	29.0	172,130	3.2	517
	Chemistry C25/27	Full VAV system	90,000	23,467	143	558,654	3.8	629
Pump inverter drives	Medical School VT heating Circuit	Inverter variable speed	9,000	879	9	17,594	10.2	1000
	Vets School chilled water	Inverter variable speed	7,000	1,739	11	21,738	4.0	654
Misc	Medical Sch Voids B and C	Controlled Ventilation	328,000	55,390	187	1,132,000	5.9	1754
	Medical Sch BMSU Humidity control	BMS controls	15000	7,500	30	150,000	2.0	500
	Medical Sch passing steam valves	Valves/BMS controls	27,000	42,500	170	850,000	0.6	159
SB low carbon projects		CHP	1,320,000	272,000	1,250.0	n/a	4.9	1056
	Summary	**YTD £**	**2,863,391**	**434,320**	**2,021**		**32.6**	**1417**
		-	-					

2013/2014

Project	Location	Technology description	Investment cost ` £	Estimated Annual Savings Financial £	CO_2 tonnes	Energy kWh	Payback period (years)	Cost per Tonne of CO2 £
Improvements to building fabric and insulation								
Double Glazing	L3 Building	Double Glazing	110,000	1,933	11.6	64,444	56.9	9483
	Coates Building	Double Glazing	180,000	4,000	24.0	133,333	45.0	7500
	Chemistry	Double Glazing	70,000	2,167	13.0	72,220	32.3	5385
Flat roof replacement insulation	L3	Thermal Insulation	110,000	2,880	17.6	96,000	38.2	6250
	Medical school phase 4 and 5	Thermal Insulation	190,000	13,179	48.5	263,585	20.0	3918
	Cripps Health Centre	Thermal Insulation	79,500	1,685	10.7	56,166	47.2	7430
Plant Room/ roof space services	Life Sciences C Floor roof space pipework	Insulation to services pipework	12,000	8,166	49.0	272,220	1.5	245
Thermal insulation	Various Plant rooms	Insulation Jackets	43,800	13,710	83.0	457,140	3.2	528
BMS temperature Sensors	Various Buildings on UP	BMS Controls	79,000	25,300	120.0	598,000	3.1	658
BMS Controls	Medical school	New control system	130,000	11,500	58.0	230,000	11.3	2241
Lighting upgrades								
	Main Campus Street Lighting	LED	120,000	7,886	38.0	78,800	15.2	3158
	L Buildings high Bay workshop lighting	LED	45,000	7,230	35.0	72,300	6.2	1286
Chiller replacement								
	Medical School F Floor AHU Plant A, B, C and D	High Efficiency Turbomiser	190,000	45,598	145.0	1,388,000	4.2	1310
Boiler Replacement	Trent Roof top	Condensing Heating Boiler	14,930	667	4.0	22,256	22.4	3733
	Nightingale Hall	Condensing Heating Boiler	60,000	2,880	17	96,000	20.8	3468
	Ancaster Hall	Condensing heating Boilers	45,000	2,370	14	79,000	19.0	3147
Pump inverter drives	Sutton Bonington Boiler House	Inverters to Main site Pumps	8,550	4,250	21	43,800	2.0	407
	KMC	Inverters to Main CT pumps	5,876	3,624	17.6	36,424	1.6	334
	Plant Sciences	Inverters to AHU circuit pumps	4,414	2,333	11.3	23,328	1.9	391
Misc	Trent Building VT pump replacement	Replacement of main pumps	10000	826	4.0	8264	12.1	2500
	Hallward Library CT pump replacement	Replacement of main pumps	9,000	1,446	7.0	14,462	6.2	1286
	Medical School D and E Voids	Controlled Ventilation	220,000	47,600	186.0	1,139,000	4.6	1183
	Medical School passing steam/ chilled water valves	New Control Valves	46,000	71,000	185.0	1,423,395	0.6	249
	Derby and Rutland Dining rooms	Inverter driven heat pumps	15,000	1,800	10.0	20,666	8.3	1500
Fume Cupboards	Chemistry C13	Variable volume extract	90,000	19,788	134.0	744,000	4.5	672
	CBS phase 1 C22 floor	Auto sash closer	25,000	9,975	56.0	266,000	2.5	446

Solar Technology	Vets School Clinical Sciences wing	1000m2 PV Array	223,000	26,000	69.0	127,115	8.6	3232
			Total	Total	Total	Total	Average	Average
		TOTALS	2,136,070	339,793	1,390	7,825,918	14.3	2569

2012/2013

Project	Location	Technology description	Investment cost (incl VAT) £	Estimated Annual Savings Financial £	CO_2 tonnes	Energy kWh	Payback period (years)	Cost per Tonne of CO2 £
Double Glazing	Clive Granger Phase 2 / 3	double glazing	250,000	3,197	21.7	106,573	78.2	11499
	Biology	double glazing	115,000	2,798	19.0	93,256	41.1	6045
	L2 building	Insulated window panels (492m2)	40,000	849	5.8	28,290	47.1	6931
	L3 building	Insulated window panels (175m2)	20,000	302	2.1	10,062	66.3	9744
	L4 Building	Insulated window panels (434m2)	40,000	750	5.1	24,995	53.3	7845
	Sir Clive Granger	double glazing	205,000	2,834	19.3	94,450	72.3	10640
	Psychology remaing facades	double glazing	75,000	1,140	7.8	38,000	65.8	9675
	Pharmacy remaining 1	double glazing	68,000	1,080	7.3	36,000	63.0	9259
	Pharmacy remaining 2	double glazing	71,000	1,110	7.5	37,000	64.0	9406
	Coates C1/3 and 4	double glazing (220m2)	80,500	1,935	13.2	64,500	41.6	6118
Flat roof replacement	Hallward Library	flat roof insulation	300,000	5,610	38.1	187,000	53.5	7864
	Medical school	Part flat roof insulation 3000m2	230,000	15,950	65.1	319,000	14.4	3534
	Portland roof	Part flat roof insulation	68,000	515	3.6	17,157	132.1	19429
Insulation	Biology walls	Insualtion	7,200	474	3.2	15,810	15.2	2232
	Coates C1/3 and 4 walls	Insulation	7,200	483	3.3	16,100	14.9	2192
	Lenton Hurst	Roof Insulation	2,838	598	4.1	19,949	4.7	697
	The orchards	Roof Insulation	946	787	5.4	26,235	1.2	177
	Highfields	Roof Insulation	1,315	1,094	7.4	36,467	1.2	177
	Engineeing Manufacteuring Building	Cavity Wall Insulation	3,360	1,596	10.9	53,196	2.1	310
BMB Temp sensors	Various Buildings	additional sensors	109,660	20,625	140.0	599,999	5.3	783
Lighting upgrades	Newark Hall Pantries	Controls	2,951	904	5.0	9,315	3.3	590
	Derby Hall Corridors	Controls	4,722	1,751	10.0	18,048	2.7	472
	KMC Corridor	Controls	13,326	2,936	16.0	30,261	4.5	833
	Boots Science	Corridor lighting controls	5,281	4,063	6.0	10,952	1.3	880
	Sherwood Hall	Corridor lighting controls	10,970	2,479	14.0	25,548	4.4	784
	Rutland Hall	Corridor lighting controls	10,794	3,977	22.0	40,995	2.7	491
	Jubilee Campuse	Controls	65,000	5,380	30	55,453	12.1	2167
Chiller replacement	Various Buildings	chiller replacement	152,300	2,143	14.0	22,086	71.1	10879
Boiler Replacement	Sherwood Hall	Boiler replacement	45,000	1,667	11.3	55,556	27.0	3971
	Nightingale Hall	Boiler replacement	45,000	1,306	8.9	43,529	34.5	5068
	Florence Boot Hall	Boiler replacement	45,000	1,306	8.9	43,529	34.5	5068
	Willoughby Hall	Boiler replacement	45,000	1,765	12.0	58,824	25.5	3750
Boiler heating	Cripps Hall	Improvements to heating zoning	45,000	710	5.7	27,895	63.4	7908

system upgrades								
	Lenton and Wortley hall	Improvements to heating zoning	30,000	515	4.3	21,052	58.3	6986
Plant Room/ Pipework Insulation	Plant Room Insulation	Insulation	45,645	11,847	82.0	400,000	3.9	557
	Plant Room Insulation phase 2	Insulation	45,000	8,100	57.0	270,000	5.6	789
	Cripps Hall Plant Rooms	Pipework thermal Insulation	15,939	6,500	41.0	173,361	2.5	389
Fume Cupboards	Chemistry C8/10	42 FC's in teaching labs upgrade controls and inverters	26,400	14,600	130.0	407,229	1.7	184
	CBS Labs C22,C25,C28,C30	CBS Reduction of extract rate at low sash position	20,400	14,000	113.0	346,783	1.5	180
	Chemistry B11	Seprate extract fan for FC storage cabinets	12,000	5,500	49.0	150,447	2.2	233
	Chemistry B11	Sash stop to 400mm	3000	650	5.0	20573	6	600
	Chemistry C31 & C33	400mm sash and discharge mods	5,500	2,000	20.0	70122	2.8	275
	CBS Labs C22,C25,C28,C30	Night temp set back to 12 C	Nil	5,200	42.0	143,678		
	Chemistry Surface Science	3 off replacement VAV Fume Cupboards	48,000	4,922	51.0	226,964	9.7	941
	Chemistry B19/B21	3 off replacement Fume Cupboards	35,000	3,300	39.0	172,481	10.6	897
Pumps	Plant Sciences	Install inverters to CW pumps	5820	1351	7.0	13505	4.3	831
	Medical School	Install inverters to CT pumps	14400	2190	24.0	43800	6.5	600
	Hallward Library	New water booster pump	5632	352	1.9	3518	16	2964
	Trent Building	VT pump replacement	13,000	450	2.5	4,500	29.0	5200
	CT pumps HPHW plant rooms	Software modifications	Nil	2,233	12.0	22,328		
	Lenton and Wortley Dining room	Upgrade heat pumps / controls	8,400	1,060	5.0	9,259	8.0	1680
AHU	Plant Sciences	Install inverter on AHU's	22670	3800	22.0	40114	5.8	1030
Ventilation/ Cooling	Plant Sciences	Install DX cooling	20027	3577	20.0	36500	6	1001
	Boots Science	Install PIR co2 sensors to lecture theatre	2,021	418	2.5	9,282	5.0	673
	Sir Clive granger B29/ B29a	Replace cooling to IT lab	21,396	3,794	21.5	39,944	5.8	972
	Pope Building A26	Install PIR to AC units	500	333	2.0	3,700	1.5	250
	Pope Building A25	Install PIR to AC units	500	278	1.5	2,777	1.8	333
	Medical school	Controlled ventilation to D and E voids	220,000	28,400	108.0	541,015	7.7	2037
Carbon Capture	Diamond Wood	Planting of Woodland	Nil		105.0			
			152,300	2,143	14	22,086		
		TOTALS	2,542,169	182,683	1,522	4,805,744		