Carbon Management Plan
Annual Report 2015/16

University of Nottingham

Carbon Management Plan Annual Report 2015/16

Contents

Executive Summary

This annual report provides an update on our investments and performance in reducing emissions of carbon dioxide (CO_2) against the University's targets over the past 12 months[1].

The University's CMP[2] was refreshed in 2015/16 and includes targets for reductions in emissions of CO_2 from energy consumption. It identifies the principal areas of energy use and our investment programmes to improve energy efficiency, reduce consumption and generate energy from lower carbon and renewable energy sources.

In 2015/16 our Scope 1 and 2[3] carbon dioxide emissions have shown an absolute reduction of 9% 5,312t from 2014/15 and down 15,714 t from 2009/10 baseline of 67,998 t CO2.

In the programme's sixth year The University made it's biggest annual investment to date with £4.4m in projects across all areas of the CMP. This included our single biggest project (Sutton Bonington CHP scheme) with predicted annual savings totalling £400k and 1,616 tonnes of CO_2. Since 2010 our CMP has invested in excess of £15.2m, with estimated annual savings in the region of 12,673 tonnes of CO_2.

Over the past year investments have continued to focus on energy and carbon intensive buildings and processes across our campuses. These have covered a range of areas, including boilers and chillers upgrades and replacement, lighting upgrades and the continuation of insulation and double glazing projects along with energy saving fume cupboard upgrades. Targeted action at the Medical School continues with projects to replace the large centralised chilled water production which achieved carbon reductions this summer of 460t CO_2. Through 2015 The University installed a new 800kW combined heat and power (CHP) for our Sutton Bonington Campus that has now been operating for 9 months and is on target to deliver annual savings 1,150t CO2 savings.

Since the publication of the CMP in 2010 the University has continued to grow and the carbon associated with the University's development exceeded its projected additional carbon of 3,000 tonnes by the end of 2012. This trend has continued though to 2016 and can be explained by the impact of increased activity especially in areas of energy intensive research.

The University will continue to deliver its capital program to 2020 along with continued expansion in energy intensive research activity. The CMP will therefore continue to invest in the existing estate and new build projects continue to meet the very highest sustainability standards. For example, The GlaxoSmithKline Carbon Neutral Laboratory of Sustainable Chemistry has achieved a BREEAM[4] rating of Outstanding and a LEED[5] rating of Platinum. As a result, future projects will seek to achieve significant carbon reduction targets, realise financial benefits and improve resilience aligned with the University's Global Strategy 2020.

[1] The scope of our plan includes all of the University's UK assets, with the exception of the University of Nottingham Innovation Park and East Midlands Conference Centre ltd assets along with any temporary energy supplies which are excluded from the reported figures.

[2] www.nottingham.ac.uk/about/values/environment/carbonmanagement.aspx

[3] Scope 1 combustion of Natural Gas. Scope 2 'Grid' supplied Electricity consumption

[4] http://www.breeam.com/

[5] http://www.usgbc.org/leed

1 Introduction

This is the sixth annual report on our Carbon Management Plan (CMP) and covers the financial year 2015/16. It provides details on progress achieved and performance improvements made against targets.

The CMP was originally approved in December 2010 and was updated in 2016. Over the sixth year of the plan The University has invested £4.4 m in projects across all areas of the CMP, with predicted annual savings totalling £400k and 1616 tonnes of CO_2. So far the CMP has resulted in investments in excess of £15.2m, with estimated annual savings of 12,673 tonnes of CO_2.The report provides an update on energy and carbon dioxide (CO_2) emissions arising from Scope 1 and 2 sources, CO_2 reduction projects approved and installed, CO_2 savings, financial performance and the programmes of work planned for the next 12 months.

2 Carbon Management Plan – objectives and targets

The CMP was approved by the University in December 2010 and updated in July 2016 with the main areas of investment to be centred on:

1. Improvements in energy efficiency of buildings, including insulation, heating & lighting
2. More efficient use of existing equipment
3. Generation of energy from small/medium scale renewable energy systems
4. Major infrastructure upgrades to replace existing plant to reduce energy cost, carbon emissions while at the same time improving system resilience.

The programme includes a number of specific investment projects and more generic programmes to deliver CO_2 reductions. 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) are not included within the scope of this report.

The CMP provided a baseline of CO_2 emissions; sets emission reduction targets; and mapped out a 5 year investment programme implemented to deliver environmental performance improvements and carbon & financial savings[6]. The CMP targets and objectives set in the are:

	Baseline 2009/10	Target 2014/15	Target 2020
Total energy consumption	198 GWh	168 GWh	154 GWh
Total CO_2 emissions p.a.	68,000 tonnes	54,000 tonnes	41,000 tonnes

These represented reductions from the 2009/10 usage of 15% on energy and 20% on CO_2 emissions by 2014/15.

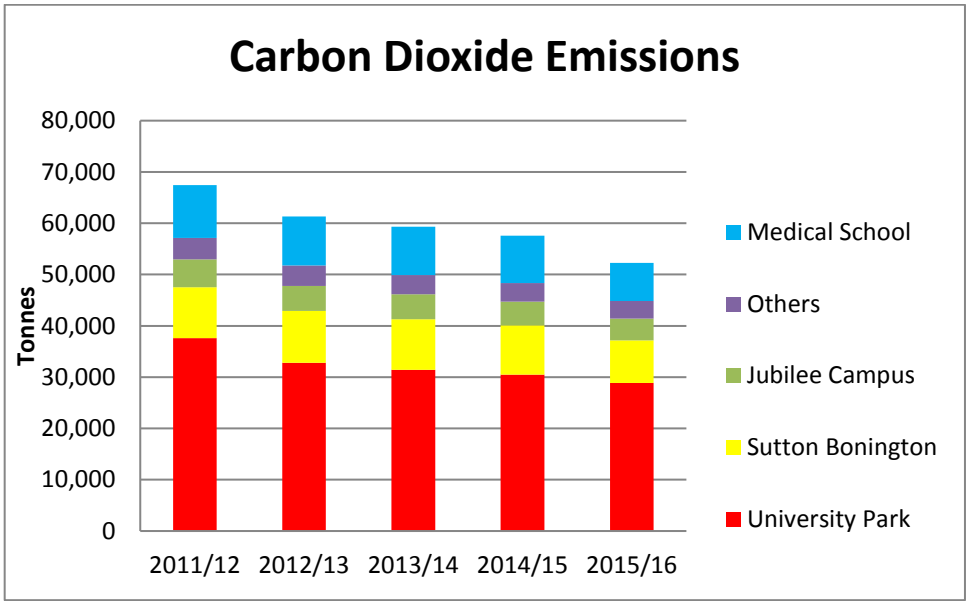
We will continue to prioritise the most energy and carbon intensive buildings such as the Medical School, science and engineering while developing energy strategies for each campus with the overall aim of reducing carbon emissions, improving financial sustainability, system resilience and student experience and where possible, deliver income generation via government feed in tariffs.
Assets of commercial subsidiary companies of the University at Innovation Park and East Midlands Conference Centre ltd are excluded from reported figures consistent with previous annual reports.

[6] www.nottingham.ac.uk/about/documents/carbonmanagementplan2011.pdf

3 Performance achieved

3.1 Carbon dioxide emissions (Scope 1 and 2)

In 2015/16 carbon dioxide emissions fell by 5,312 tonnes following continued investment in projects as detailed in section 4. The National Grid has reduced its CO_2 emissions associated with power generation through the increasing proportion of renewable energy and gas fired power stations supplying the grid with a corresponding reduction in the use of coal fired plant. However the percentage site reductions shown below at Sutton Bonington (14%)and Medical School (19%) clearly show the impact of significant investment at these sites when compared with others.



CO2 Emission factor [4]	2010/11	2011/12	2012/13	2013/14	2014/15	2015/2016
Electricity Kg/kWh	0.541	0.541	0.484	0.494	0.462	0.412
Natural Gas Kg/kWh	0.204	0.204	0.184	0.185	0.184	0.184

CO2 Emissions (t)							Change
	2010/11	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2014/15to2015/16**
University Park	38,007	37,578	32,814	31,424	30,490	28,898	-5.2
Sutton Bonington	9,804	9,964	10,103	9,876	9,637	8,244	-14.5
Jubilee Campus	5,192	5,430	4,892	4,855	4,572	4,247	-7.1
Others	4,587	4,161	3,994	3,731	3,612	3,425	-5.2
Medical School	9,865	10,289	9,519	9,446	9,285	7,470	-19.5
Total	**67,455**	**67,422**	**61,322**	**59,332**	**57,596**	**52,284**	**-9.2**

[4] Our emission factor for grid consumed electricity includes Scope 1 and 2 emissions associated with power generation but does not include scope 3, i.e. those associated with transmission and distribution losses and are obtained from DEFRA.

3.2 Electricity

Overall electricity consumption reduced 3.4% over the last 12 months compared to 2014/15 due to the installation of the CHP plant at Sutton Bonington (24% reduction for this site) versus a small increase in electrical use on all other sites. This is a significant reduction in electrical use for this site noting that there has been only 7 months CHP operation out the 12 month period of the reporting year.

3.3 Natural Gas

Consumption of natural gas reduced by 0.6%, over the last 12 months due mainly to the large reduction in steam use at the Medical School (28%) following significant investment in high efficiency chillers and other system improvements. Other sites saw a small increase in natural gas consumption with the exception of Sutton Bonington which had a 16% increase in consumption due to the installation of the gas fired CHP plant.

Further details and a full breakdown of electricity and fossil fuel usage campus by campus and major buildings can be found in the University's 2015/16 Energy Report.

3.4 Targets

Our 2015 Carbon Management Plan target was 51,000 tonnes, a reduction of 17,000 tonnes plus an additional 3000 tonnes to offset impact of new buildings. Our total programme savings at the end of 2015/16 now stand at 12,673 t CO2 per annum from 2009/10.
Since the publication of the CMP in 2010 the University has exceeded its estimated growth plan, however carbon emissions have reduced by 15,714 t CO_2. Once again the success or failure of the National grid to reduce it CO_2 emissions associated with power generation will have a significant influence on our carbon performance. The challenge over the period to 2020 will be to continue to identify and implement carbon reduction initiatives to achieve absolute reductions in emissions offsetting continued growth in new buildings and increased intensive energy consumption from research. It is clear that to achieve our targets we need to continue to invest in large scale carbon reduction projects to decarbonise our power and heating needs.

4 Carbon projects

4.1 Carbon Management Plan projects

A summary of carbon saving projects installed in 2015/16 together with totals for investment in previous years is given below. Projects are grouped into the main CMP themes together with their financial and carbon performance.

Project theme	Project description	Investment cost £	Estimated annual savings	
			Financial £	CO_2 tonnes
Improvements to building fabric, glazing and insulation	Double glazing and insulation to Medical school, Chemistry, Physics, North Lab and Lecture Block	2,260,000	22,639	163
Laboratories: Continuation of Fume Cupboard works	Upgrade of fume cupboard controls, inverters and upgrade of fume cupboards with VAV in Chemistry.	98,000	23,467	143
Medical school Chilled water	Replacement of Steam Absorption units With 'Turbocor' Electric chillers	1,234,000	222,231	933
Boiler Replacements and controls	Replacement of old inefficient boilers for more efficient models in halls of residence, along with improved controls and BMS sensors	234,125	19,245	156
Controls, heating upgrades, insulation pump motor drives	Segregation of heating circuits, pipework insulation, controls to Medical School and installation of new inverter drives to pumps etc.	461,400	105,634	175
Lighting upgrades	LED replacement lighting in Medical School and halls of residence.	100,680	6,571	47
Total for 2015/16		4,388,205	399,792	1616
Total for 2014/15		2,863,391	433,325	2,021
Total for 2013/14		2,136,070	339,793	1,390
Total for 2012/13		2,806,613	219,481	1,522
Total for 2011/12		1,489,937	350,467	2,028
Total for 2010/11		1,509,361	666,424	4,096
Total for 6 years		**15,193,577**	**1,975,957**	**12,673**

4.2 Project overview and updates

Our strategy to invest in areas of the University that are energy and carbon intensive has continued through 2015/16 and a full schedule of projects is included in Appendix 1 and provides details of type, location and capital spend with calculated annual energy, financial and carbon savings.

Improving the thermal performance of our buildings has continued with a number of significant insulation projects carried out. Several large buildings including the Medical School and Chemistry have seen single glazing replaced with double glazing improving the thermal performance of the building and improving the comfort for occupants.

We have continued to deliver investment in the laboratory fume cupboard efficiency programme with further works to reduce fan speeds with full variable speed extracts to deliver reduced electricity use and, as a consequence, reduced gas from space heating.

The replacement of old plant, both chillers and boilers, has resulted in improved efficiency across the estate and this rolling programme will continue over coming years. This year's installations included replacement water heaters to Rutland, Sherwood and Lenton & Wortley halls of residence along with boiler replacements in Chicken Met and the Centre for Biomolecular Sciences.

Our largest investment project was completed in December 2015 with the installation of a combined heat and power plant in the main boiler house at Sutton Bonington. Over the last 8 month this equipment has provided a low carbon heat and power supply for the site delivering 3,137,025kWh of electrical energy and 4,067,440kWh of heat which represents 35% of sites energy use. To date, this has produced fuel cost savings of £172,400 along with 807 t CO_2 which means the scheme is on target to meet the predicted annual savings of £250,000 and 1,150 t CO_2.

The Medical School continues to receive investment with the installation of 2 large high-efficiency chillers to replace the aging steam absorption units. This switch from steam generated cooling to electrical systems has led to a significant reduction in gas (which is used to generate steam). The system was commissioned at the end of April 2016, ready for the warmer summer months when cooling demand increases, and to date has generated 1,553,980 kWh of chilled water and consumed 274,724kWh (COP 5.6) of Electrical units costing £21,978. As a comparison with summer 2015 (Jun-Aug) steam consumption for the Medical school dropped from 3,669,205kWh to 1,256,223 kWh - a saving of £120,649 with additional electrical cost over the same period of £16,884 resulting in a net saving of £103,764.

We have significantly invested in renewable energy generation in 2015/16 too with additional PV array capacity installed on both the new Centre for Sustainable Chemistry and David Ross Sports Village has added an additional 354,115 kWh annual generating capacity an increase of over 100% on existing installation output.

A 153kW Bio-oil CHP unit at the Centre Sustainable Chemistry will produce near carbon zero heat and electricity which together with the PV array and other technologies should enable the building to achieve carbon neutrality over 25 years.

4.3 Renewable energy projects

Small and medium scale renewable energy projects are financially supported by UK legislation through initiatives such as the Feed in Tariffs (FITs) and Renewable Heat Incentive (RHI). These programmes promote widespread uptake and provide income from generation to accredited technologies including photovoltaics (PV), wind, biomass, solar thermal and ground source heat pumps (GSHP). Below is a summary of the University's renewable energy generation in the last 12 months.

Building	Technology	Annual Production (kWh)
Dearing	PV	7,472
Business School North	PV	13,602
Computer Sciences	PV	6,524

Derby Hall	PV	47,204
Lincoln Hall	PV	50,446
Si Yuan Chinese Studies	PV	8,274
Aerospace Technology	PV	10,706
Environmental Education Centre	PV	20,734
Sustainable Research Building	PV	7,001
Riverside Sports	PV	17,600
The Barn	PV	6,000
Veterinary School	PV	123,705
Total		**319,268**
Si Yuan Chinese Studies	Solar thermal	2,117
Geospatial	Biomass	61,030
BioEnergy	Biomass	133,930
Total		**197,077**

These installations have saved 180 tonnes of Carbon and have generated in excess of £62k in revenue through the Feed in Tariff and Renewable Heat Incentive. These tariffs are currently under review and are likely to see significant reduction for all new schemes. However, tariffs for existing arrangements, as above, are fixed.

4.4 Audits and feasibility studies

A significant amount of work has been carried out looking at the long term energy strategies of both University Park and Sutton Bonington campuses due to their energy intensive activities. At Sutton Bonington the mixed blend includes the installation of the CHP scheme, photovoltaic (PV) array and a wind turbine . Further details and update is shown below.

1MWe Ground-based PV Array

Detailed studies are currently under way investigating the viability of a ground based PV array located on land at Sutton Bonington. Initial calculations show potential for a 6300m^2 array that could generate an annual yield of 876,500kWh of electricity or about 7% of the Sutton Bonington demand. This would result in an annual cost saving of £70,000 and a carbon saving of around 361t CO_2. Combined with the existing CHP plant on certain days of the year the campus could be self-sufficient in electrical power.
CHP and solar PV have a good output synergy as PV provides power peak around the middle of the day/ early afternoon when heating demand reduces and the CHP usually reduces output as heating demands are met, hence maintaining a good electrical generation balance for the site. A business case for this investment is being prepared to this effect.

500kW (peak) Wind Turbine

A £1.8m scheme to install 500kW of wind turbine capacity situated near the dairy farm could generate an estimated annual output of 1,633,000kWh with savings of 630 tonnes CO_2 based on a mean wind speed of 6.1m/s. Since the initial planning submission the fall in purchased electricity and the reduction of Feed in Tariff along with the fall in CO_2 emissions associated with 'grid' supplied electricity has made the business case less attractive. However, the annual fuel cost savings are significant (£211k), comprising £130K in displaced electrical costs and £73K from Feed in tariff (4.5p/kWh). The scheme is currently being evaluated by the local planning authority.

University Park Low Carbon Energy Centre

Development of a low carbon energy centre to be located in the former CHP building behind the boiler house (adjacent to the Life Sciences building) could achieve significant fuel cost savings and reduction in CO_2. A business case has been prepared for consideration and it is proposed that this £3m scheme will utilise gas-fired CHP plant along with high efficiency gas-fired boiler plant with aim of reducing energy costs, carbon emissions while at the same time improving overall system resilience of the district heating system that serves around 20 buildings across University Park. The system will be designed to fully integrate with future low carbon heat/ energy sources as and when they become available.
A 2.3MW CHP installed capacity along with some new high efficiency back up boilers has been identified has the best 'fit' solution. The fully costed Business case Identified overall annual fuel cost of around £582,421 along with annual carbon savings of 2,042 t CO_2.

5 Future carbon management and investment programmes

At this mid-term position, over the past year we have refreshed and updated the CMP in order to continue to deliver the depth and range of carbon projects needed to deliver our institutional targets. This includes continuing with plant replacement, glazing and insulation projects and at the same time continue on site with major investments such as continuation of the Sutton Bonington low carbon energy strategy. We will continue to take an evidence-based and targeted approach and further investments in energy and carbon intensive buildings. There will be further investment in the Medical School and a focus on heat delivery to buildings served by the district heat network on the University Park campus. An options appraisal for an energy strategy to cover the expansion of Jubilee Campus is being developed to look at options for low carbon energy sources to serve a number of buildings at the north end of the campus from a common plant room. Whilst there is likely to be significant further development on acquired sites the appraisal assumed the development of the 'bonded warehouse' site whilst the future plans of that site are considered.
Investment over the next 5 years on various carbon reduction programmes is expected to reach £14m and is likely to include large scale building fabric upgrades.

The programme continues the focus on investment in the CMP's main areas based

- Large and small scale Plant/ infrastructure replacements
- Laboratory efficiency program
- Campus wide low carbon generation strategies
- Staff and student engagement
- Continued improvements to existing building fabric to reduce heat losses
- Review renewable energy strategies following recent reduction in Government feed in tariffs.

6 Financial requirements

CMP projects continue to be assessed for financial and carbon performance and submitted for approval, having initially gone through a carbon reduction working group. Funding for CMP projects is provided from CMP capital, revenue expenditure, Salix finance and grant contributions and loans.

6.1 Salix Finance

The University continues to utilise its Salix Finance revolving green fund and has used it to invest more than £764K in carbon saving projects to date and will continue to invest these ring fenced savings into further carbon saving projects.

Appendix 1 – Carbon Management Plan projects 2015/16

Project	Location	Technology description	Investment cost (incl VAT)	Estimated Annual Savings			Payback period	Cost per Tonne of CO2
				Financial	CO_2	Energy		
			£	£	tonnes	kWh	(years)	£
Double Glazing	Medical School SE Elevation		800,000	10,565	56	222,000	75.7	14286
	Chemistry SW Elevation		950,000	3,215	25	132,375	295.5	38000
	Physics SE elevation		200,000	1,172	12	61,875	170.6	17391
	North Lab SW Elevation		250,000	7,190	66	359,769	34.8	3788
	Lecture block		60,000	497	5	24,840	120.7	13043
Lighting upgrades	Medical School F Floor	LED Lighting	39,345	1,738	19	46,116	22.6	2104
	Chemistry	LED Lighting plus PIR	7,835	967	6	14,563	8.1	1399
	Florence boot Hall corridors	LED Lighting plus PIR	36,000	3339	19.4	46567	10.8	1856
	Lincoln Hall Bedrooms	LED Lighting	17500	527	3	7287	33.2	5833
Chiller replacement	Medical School	Turbocor Chillers	1,234,000	222,231	933	n/a	5.6	1323
Boiler Replacement	Sherwood & Rutland Hall	water heaters	78,000	1,535	9	43,850	50.8	9176
	Lenton & Wortley	water heaters	83,000	1,013	6	28,939	81.9	14821
	Main Boiler House burner controls	controls/ inverter	34,125	16,100	136	670,000	2.1	251
	Chicken MET	condensing Boilers	20,000	247	2.3	12,346	81.0	8696
	CBS	water heaters	19,000	350	3.2	17,530	54.3	5938
BMS, controls & metering	Medical Sch CT pressurisation, controls		171000	20,800	83	367,970	8.2	2060
Plant Room/roof/void space serv's	Medical Sch CT heating segregation etc		239,000	16,800	69	301,758	14.2	3464
Thermal insulation								
Fume Cupbords	Chemistry North Wing B45/46 Fume Cupboards	Full VAV system/ auto sash	98,000	23,467	143	558,654	4.2	685
Pump inverter drives	CBS Chilled water pumps	Inverter variable speed	11,400	1,739	11	26,699	6.6	1065
Water leak/ mains repairs/ replace			40,000	66,300	12	n/a	0.6	3333
	Summary		**4,388,205**	**399,792**	**1,616**			**2715**

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA