Carbon Management Plan
Annual Report 2017/18

University of Nottingham

Carbon Management Plan Annual Report 2017/18

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 2017/18 our Scope 1 and 2[3] carbon dioxide emissions have shown an absolute reduction of 2.9% or 1,423 t from 2016/17 and down 21,051 t from 2009/10 baseline of 67,998 t CO2.

In the programme's eighth year the University continued investment of £0.6m in projects across all areas of the CMP. Since 2010 our CMP has now invested in excess of £18.8m, with estimated annual savings in the region of 14,034 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 BMS controls investments along with energy saving fume cupboard upgrades. Continued action at the Medical School with further work on the steam distribution system sees further reductions in steam energy losses and Carbon emissions with investment over the last three years delivering total accumulative carbon savings of 8,695 t CO2

The National Grid has continued to reduce 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. While this helps with our overall CO_2 emissions it makes the case for certain technologies such as gas fired combined heat and power (CHP) difficult to justify in terms of carbon emissions reduction. While CHP schemes still offers significant overall fuel cost savings we have to balance this with the effect on our environmental credentials.

The University will continue to deliver its capital program to 2020 and beyond 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 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.

As Jubilee Campus continues expansion, carbon emissions will continue to increase and in 2017/18 this equated to a 9% rise. This has been amplified over the last year as the research energy intensive engineering buildings such as the Advanced Manufacturing Building and the Research Acceleration Demonstration Building (even with their BREEAM and PAssivhaus designs) have begun operating. This trend will continue when the Power Electronics building is commissioned.

[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 eighth annual report on our Carbon Management Plan (CMP) and covers the financial year 2017/18. 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 and again this autumn. Over the eighth year of the plan the University has invested £570k in projects across all areas of the CMP, with predicted annual savings totalling £115k and 433 tonnes of CO_2. So far the CMP has resulted in investments in excess of £18.8m, with estimated annual savings of 14,034 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.

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 2010 CMP are:

	Baseline 2009/10	Target 2014/15	Target 2020
Total CO_2 emissions p.a.	68,000 tonnes	54,000 tonnes	41,000 tonnes

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

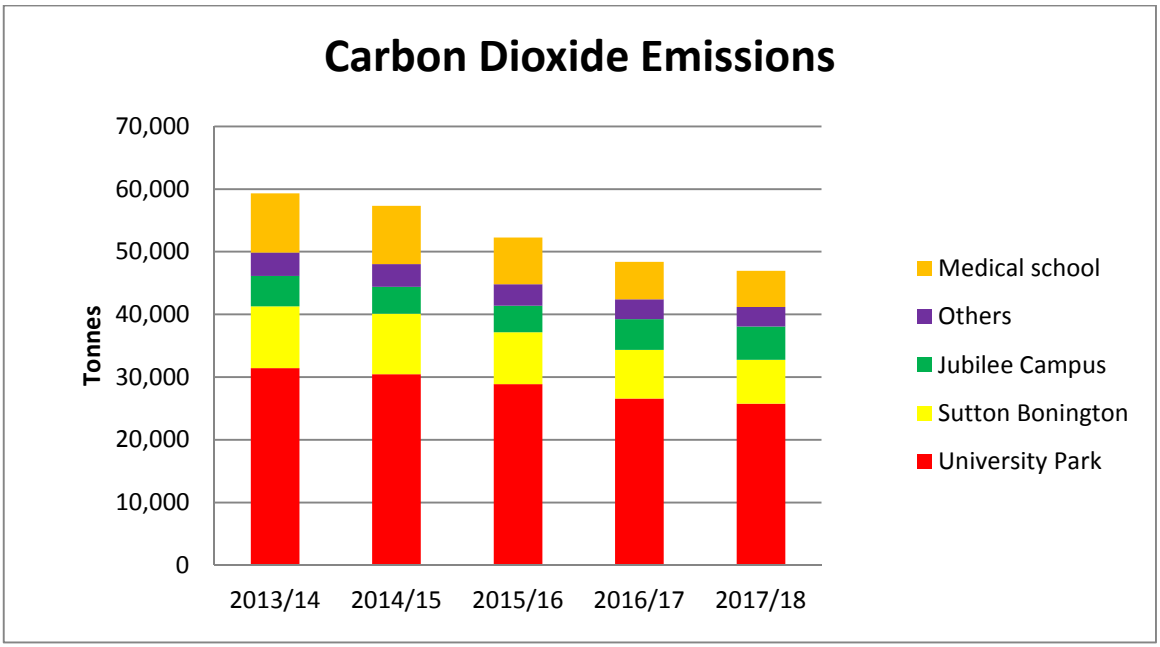
We will continue to prioritise the most energy and carbon intensive buildings and achieve a better understanding of what contributes to our significant 'out of hours' baseload. Continued development of energy strategies for each campus with the overall aim of reducing carbon emissions, improving financial 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 2017/18 carbon dioxide emissions fell by **1,423** tonnes following continued investment in projects as detailed in section 4. The National Grid has continued to reduce 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.



CO2 Emission factor [4]	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Electricity Kg/kWh	0.541	0.484	0.494	0.462	0.412	0.352	0.311
Natural Gas Kg/kWh	0.204	0.184	0.185	0.184	0.184	0.184	0.184

CO2 Emissions (tonnes)								% Change
		2012/13	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2016/17 to 2017/18**
University Park		32,814	31,424	30,490	28,898	26,573	25,780	-3.0
Sutton Bonington		10,103	9,876	9,637	8,244	7,791	6,999	-10.2
Jubilee Campus		4,892	4,855	4,295	4,247	4,877	5,294	8.6
Others		3,994	3,731	3,612	3,425	3,199	3,114	-2.7
Medical School		9,519	9,446	9,285	7,470	5,930	5,760	-2.9
Total		**61,322**	**59,332**	**57,319**	**52,284**	**48,370**	**46,947**	-2.9

[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 / BEI

3.2 Electricity

Overall 'Grid' imported electricity consumption increased 4.9% over the last 12 months compared to 2016/17 due to substantial new buildings that were added to the University's Estate (Advanced Manufacturing, RAD building and full year of operation of Jubilee Conference centre). Sutton Bonington Campus increased the use of imported electricity as operational issues with the CHP plant meant that generation was reduced earlier in the year although we did see an overall reduction in CO_2 emissions. It was again pleasing to see continued reductions in electrical use at the Medical School (down 5%) following continued replacement and upgrade of plant and equipment.

3.3 Natural Gas

Overall consumption of natural gas increased by 2.4% (despite significant reduction in gas consumption at Sutton Bonington due to reduced run hours of the CHP Plant). Consumption was generally up across all sites due to two factors: the extended cold winter period we experienced earlier in the year and the increase in total University Estate by 2.6%.
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 2017/18 Energy Report.

3.4 Targets for scope 1 and 2 emissions

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 2017/18 now stand at 14,034 t CO2 per annum from 2009/10.Since the publication of the CMP in 2010 the University has exceeded its planned growth plan, however carbon emissions have reduced by 21,051 t CO_2 with the help from the National Grid de-carbonising power generation. This will continue to have a significant influence on our performance and ability to meet carbon targets. The challenge over the period to 2020 and beyond will be to continue to identify and implement cost effective 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 long term targets we need to continue to invest in large and small scale carbon reduction projects to decarbonise our power and heating needs. As the National power grid continues to de-carbonise our challenge will be to de-carbonise the heat supply to our buildings which is currently predominately from combustion of natural gas.

4 Carbon projects

4.1 Carbon Management Plan projects

A summary of carbon saving projects installed in 2017/18 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
Laboratories: Continuation of Fume Cupboard works	Upgrade of fume cupboard controls, with full VAV with PIR auto sash closure in North wing Chemistry.	96,650	25,656	171
Boiler Replacements, steam controls and water leaks	Replacement of old inefficient boilers for more efficient models in halls of residence, along with improved controls and BMS sensors	338,644	57,174	148
Controls, heating upgrades, insulation pump motor drives.	Controls to Medical School and Wolfson building ventilation systems and installation of new inverter drives to fans etc.	68662	22050	83
Lighting upgrades	LED and T5 replacement lighting in Medical School and Pope Building	26,120	2557	9
Ultra-low temperature Freezers and replacement cooling units	High efficiency replacement -80C freezers and replacement of DX split cooling units with A++ rated units	42,164	7245	22
Total for 2017/18		**572,240**	**114,682**	**433**
Total for 2016/17		3,042,923	179,623	928
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 8years		**18,808,740**	**2,270,262**	**14,034**

4.2 Project overview and updates

Our strategy to invest in areas of the University that are energy and carbon intensive has continued through 2017/18 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.

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. These systems included PIR occupancy sensors that automatically lower the fume cupboard sash window and reduces fan speed if no one is in front of the cupboard. The means savings are achieved as soon as possible with the added safety benefit a lowered sash provides for other lab users.

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 installations included replacement water heaters to Cavendish, Derby, Newark and Southwell halls of residence along with heating boiler replacements in the Business School South, School of Architecture and Built Environment Studio Block, Lenton Hurst and Riverside.

The Medical School has had additional projects involving replacement lighting on F Floor, new controls to existing central extract systems and work on the steam main to reduce significant losses. Along with the chiller replacement investment in the Medical School over the last three years has now delivered the total accumulative carbon savings of 8,695 t CO_2.

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	6,795
Business School North	PV	14,284
Computer Sciences	PV	6,955
Derby Hall	PV	49,403
Lincoln Hall	PV	38,537
Si Yuan Chinese Studies	PV	4,678
Aerospace Technology	PV	11,453
Energy Technologies Building	PV	11,307
Environmental Education Centre	PV	14,342
Sustainable Research Building	PV	5,124
Ingenuity Centre (TEC)	PV	4,553
Riverside Sports Pavilion A	PV	10,017
The Barn	PV	3,376
Sustainable Chemistry	PV	214,388
George Green Library	PV	3,084
Orchard Hotel	PV	7,849
Advanced Manufacturing Building	PV	3,597

Veterinary School	PV	124,295
Total		**564,047**
Si Yuan Chinese Studies	Solar thermal	1,724
Rutland and Sherwood	Solar thermal	10,627
Geospatial	Biomass	41,686
Bio Energy	Biomass	26,891
Total		**80,928**

These installations have saved 191 tonnes of Carbon by displacing electricity and Gas that would have been provided by the 'Grid. A number of sizeable low carbon energy generation schemes have been installed on both the David Ross Sports Village (solar PV and combined heat and power) and the Teaching and Learning Building (solar PV) that are awaiting permission from Western Power for connection to the local grid. These should come on line in 2019 following works to enhance local grid resilience.

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. Further details and update is shown below.

Ground-based PV Array

A detailed business case for a 1MWe PV array located on land at Sutton Bonington was submitted with calculations showing potential for a 6500m^2 array that would generate an annual yield of 870,000kWh of electricity or about 8% of the Sutton Bonington demand. This has an estimated potential to achieve annual fuel cost savings of £92,000 and a carbon saving of around 309t CO_2. Over the 25 year life of the panels the system is expected to save in excess of £3m in electricity cost and over 5000 t 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. Consideration of using land known as the 'Paddocks' situated just south of Melton Lane along with other locations is underway including land close to the Dairy farm and land adjacent to the River Trent which could be used for significant PV generation (around the 5MW output). The business case for investment will be made in 18/19.

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 was submitted for consideration Jan 2018 and was updated (March 2018) to reflect the latest cost and CHP engine availability to suit our high temperature heat network. It was proposed that this £3.5m scheme will utilise gas-fired CHP 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 scheme has just been updated (October 2018) to reflect the latest utility costs and carbon intensities of 'Grid' supplied electricity. Due to lack of suitable high temperature engines and 'Grid' decarbonisation this CHP scheme is under review to establish its financial and carbon benefits. The project is currently on hold with a reappraisal of all other options including full decentralisation with installation of gas fired boiler plant to individual buildings.

University Park Electrical loads

We have continued with ongoing monitoring to understand where the significant overnight baseloads are located and how these may be reduced. The loads are quite diverse across the campus with no particular high density energy use located with the exception of specialist research equipment. As would be expected this is located in the Science and Engineering faculties which account for almost 40% of total electrical use mainly due to equipment/ processes that operate year round. Further understanding is still required and schools and departments have been asked to submit equipment schedules detailing power rating and likely operating profiles. Demand reduction will continue to be an area of focus in 18/19.

5 Future carbon management and investment programmes

At this mid-term position, with a refreshed and updated the CMP 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. As mentioned above, work will continue with options appraisal/ investment proposals for heat delivery to buildings served by the district heat network on the University Park campus. 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.

As the University develops its wider strategy and an estate masterplan we will identify where investment is needed over the next 5 years to reduce carbon emissions. These are likely to include large scale building fabric upgrades as part of major general refurbishment works to our halls of residence as well as investment in the underpinning heat and power infrastructure.

The programme continues the focus on investment in the CMP's core activities:

- Large and small scale Plant/ infrastructure replacements
- Laboratory fume cupboard efficiency upgrades
- 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 imminent removal of 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 energy/carbon 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 £983K in carbon saving projects to date and will continue to invest these ring fenced savings into further carbon saving projects.

Carbon Management Plan 2017/18 projects								
Date printed	**09/10/2018**							
			Investment cost	Estimated Annual Savings			Payback period	Cost per Tonne of CO2
			(incl VAT)	Financial	CO_2	Energy		
Project	Location	Technology description	£	£	tonnes	kWh	(years)	£
Lighting upgrades	Medical School	T5 lighting	12,250	1,647	5	15,685	7.4	2511
	Pope Building	LED lighting	13,870	1,210	4	11520	11.5	3871
Cooling units	Various locations	Inverter driven A++	23,764	3,118	9	29692		
Boiler Replacement	Cavendish hall	water heaters	54,324	639	6	31,674	85.0	9207
	Derby Hall	water heaters	59,439	671	6	33,549	88.6	9587
	Derby Medical School	water heaters	6,600	150	1.4	7,500	44.0	4714
	Business sch South	condensing Boilers	27450	631	5.5	31,574	43.5	4991
	Newark Hall	water heaters	36,350	751	7.0	37,563	48.4	5193
	Southwell Hall	water heaters	52,800	1,049	9.7	52,467	50.3	5443
	Riverside	condensing Boilers	9,550	175	1.6	8,750	54.6	5969
	East Park Unit 4	condensing Boilers	5,790	128	1.2	6,440	45.2	4825
	CBS	water heaters	6,870	91	0.8	4,550	75.5	8179
	Cavendish hall Hardwick hall	water heaters	23,950	196	2	9,785	122.2	13306
	Lenton Hurst		3,250	391	4	19,550	8.3	903
	Built Environ't Studio Block	condensing Boilers	5,780	173	2	8,647	33.4	3613
minus 80 Freezer replacements	Medical School and CBS	Vacumm chamber	7,600	2,253	7	21,460	3.4	1139
	SB north	Vacumm chamber	10,800	1,874	6	17,847	5.8	1946
BMS, controls & metering	Wolfson Building	Ventilation controls	7,697	3,984	14	89,467	1.9	550
	Ancaster hall Controls	BMS upgrade	17,829	329	3	16,490	54.2	5943
	Cavendish hall Controls	BMS upgrade	13,091	385	4	19,269	34.0	3740
	Medical Ventilation conrols	BMS	10,140	13,521	38	135,212	0.7	267
	Jubilee Conference centre	Electrical metering	9,126	2,061	6	20,610	4.4	1573
	KMC AHU Plant	Inverter drives	10,779	4,725	12.7	45,000	2.3	849
Fume Cupbords	Chemistry B12, B13, B29 and B31 Fume Cupboards	Full VAV system/ auto sash	96,650	25,656	171	788,456	3.8	565
Water leak/ mains repairs/ replace			41,250	27,450	7	n/a	1.5	5893
Misc	Medical school	Stream traps	5,241	21,425	102	394,425	0.2	51
	Summary	**YTD £**	**572,240**	**114,682**	**433**		103.1	**1321**

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