Report

Review of the Newman University Carbon Management Plan.

Prepared for

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1.0 INTRODUCTION

ICDM Energy **(ICDM)**, a division of International Construction Design and Management Limited, has been requested by Newman University **(The University)** to review the University's Carbon Management Plan (CMP).

This progress report on the University CMP outlines the savings to date and also adjusts the targets to accommodate the new accommodation block, known as the Cofton Hall. The emissions being accounted for are those from the burning of fossil fuels (natural gas and vehicle fuels) on site or from University vehicles, which are Scope 1 emissions, and emissions from the generation of electricity, which are Scope 2 emissions.

ICDM have also carried out a high level site survey which has helped to identify further opportunities to minimise the University carbon emissions (and thus costly energy consumption) although it has to be noted that the progress that the Estates Department have made to date is very credible with most of the JDI (Just Do It) opportunities already completed.

2.0 SUMMARY

The Carbon Management Plan set earlier this decade needs to be modified to accommodate the new Cofton Hall which is scheduled to open in Quarter 1 of 2018. Although there are a few uncertainties surrounding the calculation of the target (for example it is not known which emissions factors were first used to calculate the emissions) we believe that the University is on track and should achieve its target by 2020, so long as further action is taken to further minimise energy consumption and therefore the Carbon Dioxide (CO_2) emissions.

Within this report we review the performance to date and future opportunities as well as a recommendation to adjust the target to take Cofton Hall into account. We also offer opportunities to reduce the energy consumption thus reducing costs and CO_2 emissions which should be adopted in order to achieve the target. On-going work has not been included within this report which will further reduce the University CO_2 emissions below the target.

3.0 CARBON MANAGEMENT PLAN OBJECTIVES AND ACHIEVEMENTS

Although the CMP targets were set some time ago there is a need to adjust them to accommodate the latest building projects. To this end the new Cofton Hall building will be fully commissioned during Quarter 1 of 2018 and we believe that additional carbon will be required in the CMP budget for the energy use with this expanded activity.

3.1 Classification of emissions

Emissions attributed to the University are categorised in three scopes, outlined below:

- Scope 1
  Scope 1 emissions are direct emissions from sources owned or controlled by the organisation. These include gas combusted on site (boilers, water heaters, air heaters etc.), process emissions (emissions released from production processes), fugitive emissions (refrigerant leaks from air conditioning systems or natural gas distribution systems) and mobile combustion of fossil fuels (petrol/diesel etc. from vehicular and other sorts of transport).
- Scope 2
  Scope 2 emissions are indirect emissions from the consumption of purchased electricity[1], steam, hot or chilled water generated by and supplied to the organisation by others (for example grid electricity generated at the power station and used at an organisation's site).
- Scope 3
  Scope 3 emissions are other indirect emissions, emissions that are released into the atmosphere as a result of the organisation's activities from sources that are not directly owned or controlled by the organisation and these can include employee/staff and student commuting and business travel, third party logistics, production of purchased goods, emissions from products. Also included in Scope 3 emissions are the carbon dioxide emitted as a result of the electricity transmission and distribution losses, treatment of water and waste (refuse) sent to landfill.

The University provided sufficient data to calculate most of Scope 1 and Scope 2 emissions. However the vehicle fuel was estimated at 250 litres for University owned transport, grounds maintenance (gardeners) vehicles and powered equipment[2]. Gas and electricity consumption and cost data was obtained in spreadsheet format from the University's energy broker, TEC (The Energy Consortium). Refrigerant losses, which are a Scope 1 or fugitive emission, were not recorded.

3.2 Carbon Emissions/Conversion Factors

The Carbon Management Plan (version 14 dated 30th March 2011) does not indicate which carbon emissions factors have been used in calculating the emissions for that report. Emissions factors

[1] Note that we have not included the emissions attributed to electricity Transmission and Distribution losses which are regarded as Scope 3 emissions whereas emissions attributed to the generation of electricity are reported within Scope 2. The transmission and distribution loss emissions equate to 42.5 tCO_{2e} at the University.

[2] Note that the petrol declared is based on an estimate as the figures are not readily available. It is strongly recommended that the University improve their data collection to ensure that all the petrol and any diesel (for Scope 1) is accounted for accurately.

used in this report were published in the UK Government Green House Gas Conversion Factors for Company Reporting 2017/18. The Gross CV has been used in each case for Scope 1. These emissions factors can be downloaded from "www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017". The emissions factors for this decade are presented in Appendix 1.

There are seven main GHGs that contribute to climate change, as covered by the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen tri-fluoride (NF_3).

All emissions factors presented in this report are expressed in units of 'kilograms of carbon dioxide equivalent of gas emitted per kWh' (kgCO_{2e}). In order to calculate the carbon dioxide equivalent emissions the Global Warming Potential (GWP) of each of the greenhouse gasses emitted is multiplied by its volume and then added together. This is accommodated within the calculation of the emissions factors provided in the Government documentation. CO_{2e} is the universal unit of measurement used to indicate the GWP of GHGs, expressed in terms of the GWP of one unit of CO_2. Examples of the GWP of some gasses are given in Appendix 2.

The Government GWPs used in the calculation of CO_{2e} emissions are based on the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) over a 100-year period (this is a requirement for inventory/national reporting purposes).

As a minimum, for each activity there is a factor that can be used to calculate emissions of all relevant GHGs combined (kg CO_{2e} per unit activity).

The emissions factors used in this report, CO_{2e}, are built up of the sum of the separate factors for each gas (that is, kg $CO_{2e} = CO_2 + CH_4 + N_2O$) as explained above.

It must be noted that the introduction of wind and solar PV energy across the United Kingdom has seen a reduction in the electricity generation emissions factor of 11% between 2015 and 2016 with a further 15% between 2016 and 2017. However, there was an increase in the CH_4 (methane) emissions of 59% between 2016 and 2017 which has been attributed to the increased use of municipal solid waste and wood to generate electricity (for example the Drax power station at Selby in Yorkshire which now burns wood (biomass[3]) and the forecast rate for 2017 was up to 7.5 million tonnes of biomass which has displaced coal). Continued replacement of coal, oil and gas fired generating plant with cleaner processes (which may include CCS, carbon capture and storage where the CO_2 from combustion is pumped into old gas and oil fields, not released into the atmosphere) will continue to help the University to reduce its emissions from consumption of electricity.

3.3 Carbon Map

The carbon map, shown in Figure 1, shows the sources of the carbon being emitted. The consumption of electricity (44.5%) and natural gas (55.4%) are responsible for most of the emissions, electricity where the carbon emissions are released at a power station, natural gas with emissions at the University and the smallest portion from the combustion of petrol (0.05%) where the emissions are from the vehicle/equipment exhaust pipe. Note that the electricity generated

[3] Biomass is regarded as having a zero emissions factor as the carbon generated during combustion is being recycled having recently been taken out of the atmosphere when the vegetation grew whereas coal, oil and gas release carbon that has been stored underground for millions of years into the atmosphere.

by the Solar PV arrays, which is carbon free, saved 32 tonnes of CO_{2e} from being emitted into the atmosphere during the 2016/17 academic year.

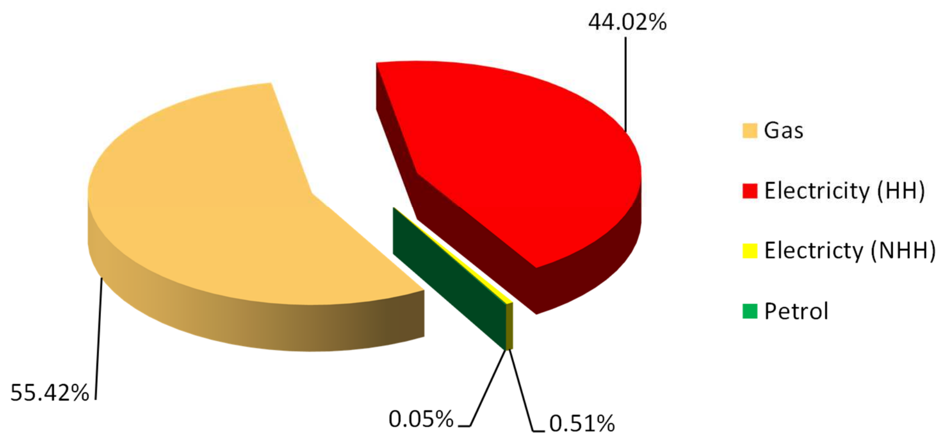

Figure 1: The Site Carbon Map

The total of the University Scope 1 and Scope 2 emissions are in Table 1, below.

Table 1: Carbon emissions and sources

Scope:	Source	CO_{2e} Emissions
Scope 1	Natural Gas Petrol (estimated)	576.68 tonnes 0.56 tonnes
Scope 2	Electricity	458.07 tonnes
Scope 3	Incomplete information available and not included in the target.	
Total[4]		**1,040.66 tonnes**

3.4 Targets

"Newman University had set an aspirational target of reducing CO_2 emissions by 30% by 2015, based on the baseline year of 2009/10 covering Scope 1 and 2 emissions from buildings and transport. Newman University's target for 2020 is for a 43% reduction relative to emissions in 2005/6"[5].

The actual performances are highlighted in Table 2. This shows that the University achieved its target of 1,136 tonnes in the 2015/16 financial year when it had reduced emissions to 1,011 tCO_{2e} and again in 2016/17 with emissions of 1,041 $tCO2_e$ compared to a target of 1,088 $tCO2_e$. The 2020 target is 944[6] tonnes and there is still some way to go to achieve this. The target was, however, also achieved in 2010/11 and 2012/13 in this decade.

[4] Period: The financial year August 2016 to July 2017.
[5] Newman University Carbon Management Programme Version 14 dated 30th March 2011, Page17 'Targets and Objectives' in the second green cell.
[6] Note that this is the original target and does not take into consideration the future energy consumption and emissions from the new Cofton Hall.

Table 2: Carbon Emissions Targets and known performance (Scope 1 & 2 only)

Year	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
Target (tCO_{2e})	1,568[7]	1,591[7]	1,614[7]	1,637[7]	1,660[7]	1,425	1,377	1,329
Actual (tCO_{2e})	1,568[7]	1,311	1,185	1,296	1,533	1,425	n/a	n/a
Year	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Target (tCO_{2e})	1,281	1,233	1,185	1,136	1,088	1,040	992	944
Actual (tCO_{2e})	1,155	1,247	1,209	1,011	1,041	-	-	-

Whilst we have not included the Scope 3 emissions it would be appropriate for the University to publish figures for emissions associated with electricity transmission and distribution losses (42.5 tCO_{2e}), waste to landfill, water consumption, business travel and staff commuting. The simplest emissions to report are those where there should be records. Waste to landfill (21.8kgCO_2/tonne) and water consumption (0.344kgCO_2/m^3) for example. It is to be remembered that the target set by the University only encompasses Scope 1 and Scope 2 emissions and therefore these Scope 3 emissions should not be used to offset the performance against target.

It is recommended that the University put in place a system to record such data as is required to calculate some of the Phase 3 emissions in order to demonstrate their commitment to reducing all carbon emissions associated with the site. This may help the University to gain higher rankings in some of the published University environmental league tables.

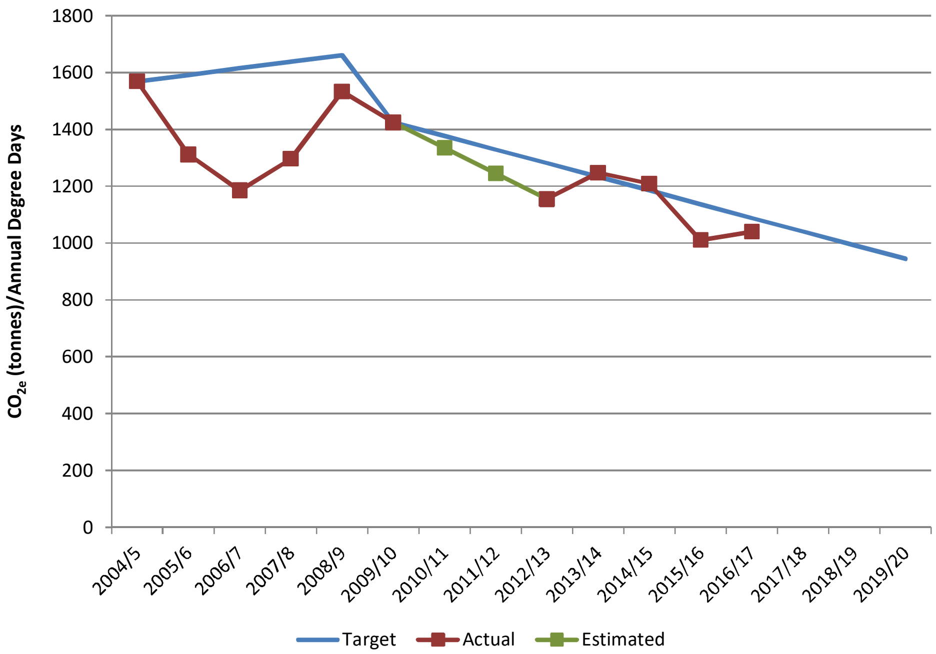

Figure 2: Annual (Scope 1 & 2) CO_2 Emissions Target and Performance

[7] We believe that these figures may include about 250 tCO_{2e} per year which are Scope 3 emission from transport (business travel and staff commuting). Within the CMP it states that only Scope 1 and Scope 2 emissions are include within the target and thus these Scope 3 emissions should be excluded from the CO_{2e} emissions targets (CMP Version 14 dated 30th March 2011, Page 17).

It would appear that when the carbon emissions target was calculated Scope 3 emissions had been included even though the CMP specifically states that only Scope 1 & 2 emissions are to be included. This may also be the case with some of the annual performances stated, specifically between 2004/5 and 2008/9 financial years. Note that, in Figure 2, it has been necessary to estimate the emissions for 2010/11 and for 2011/12 as neither the energy consumption nor emissions data was available.

For 2016/17 the emission increased marginally. This will be, in part, due to the construction of the new Cofton Hall whose electricity, during the construction phase, has been taken from the site. Cofton Building is to be commissioned during Quarter 1, 2018 and this is discussed further in Section 5.0.

Table 3: Energy Consumption Changes 2015/16 compared to 2016/17

Energy Stream	Source	kWh 2015/16	kWh 2016/7	Difference	Performance
Electricity (HH)	Invoices	1,275,520	1,300,537	25,017	2%
Electricity (AWP)	Invoices	16,981	15,203	-1,778	-10%
St Chad's Gas	Invoices	525,237	491,154	-34,082	-6%
IT & Early Years Gas	Invoices	111,758	99,656	-12,102	-11%
Campus Main Gas Meter	Invoices/ meter readings	2,380,067	2,540,556	165,496	7%

There was a reduction in energy consumption from 2015/16 to 2016/17, as outlined in Table 3, for the non-half hourly (All Weather Pitch) electricity and the gas supplies to St Chads and to the IT & Early Years supplies but the Half Hourly electricity, which supplies the main site, and Campus Main Gas Meter have both increased. We believe that the electricity consumption increase is due to the construction of Cofton Hall, where all electricity has been drawn from the main supply, whilst we are unable to explain the increase in gas consumption over the last two financial years.

4.0 PERFORMANCE - ENERGY CONSUMPITON AND CARBON EMISSIONS

4.1 Energy Map

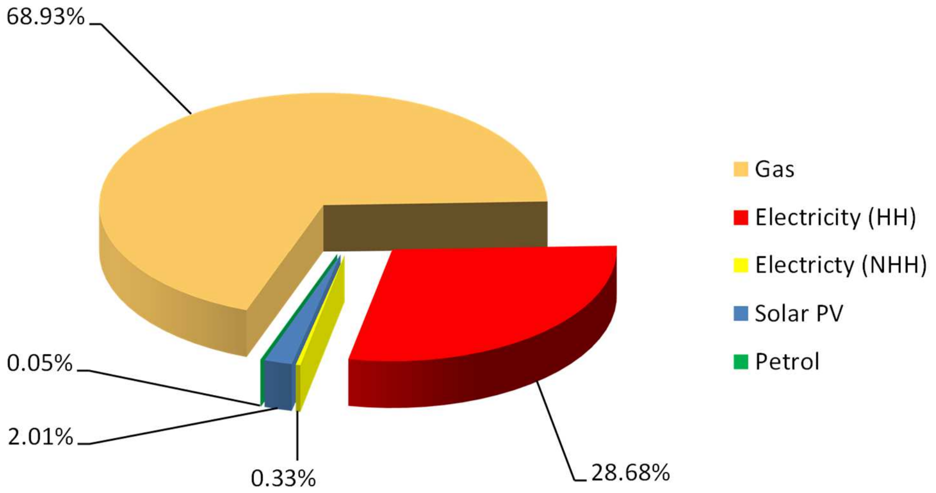

Figure 3: The Site Energy Map (kWh)

The site energy map, shown in Figure 3, demonstrates what energy is being used at a very high level, and where it comes from. The greatest proportion of energy being consumed is natural gas (68.93%) followed by the main electricity supply (28.68%), self-generated solar photovoltaic (2.01%, which is carbon free), the non-half hourly electricity supply (0.33% and this is the floodlighting on the All Weather Pitch) and petrol for University vehicles and estate maintenance equipment (0.05%).

4.2 Electricity Consumption Profile

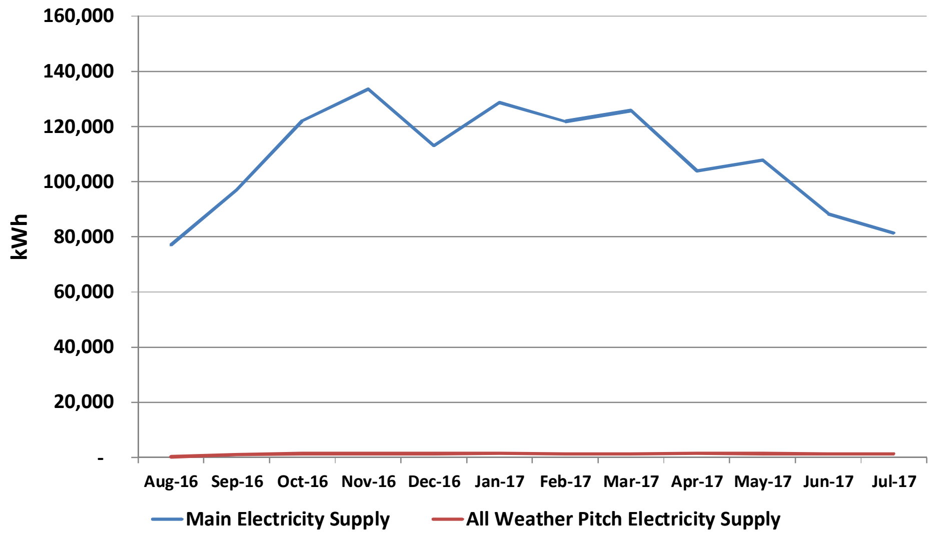

Figure 4: Monthly Electricity Consumption Profile

The Site currently has two electricity supplies, the supply that serves the main site is a half hourly supply (HH), the electricity consumption being measured every half hour of the day and night (giving 17,520 half hour periods during a year), and a separate supply for the All Weather Pitch (AWP) on the sports field the opposite side of Genners Lane to the main campus, which a non-half hour (NHH) supply that is not remotely metered and the consumption is measured monthly (the supplier's meter reader having to go physically visit the meter to take a reading). Other electricity that is consumed is generated by the University's solar PV panels. Because this is carbon free we are not considering it in this report but can advise that its generation saved emissions of 32 tonnes of CO_{2e} emissions.

The electricity consumption profile is typical of an educational establishment although it is normal for the fall in consumption during vacations to be more defined. It is noted that many of the students do remain in residence during the Christmas and Easter vacations and this means that services have to be provided (heating/hot water/lighting, etc.) which could otherwise be reduced or turned off.

4.3 Electricity Consumption Map

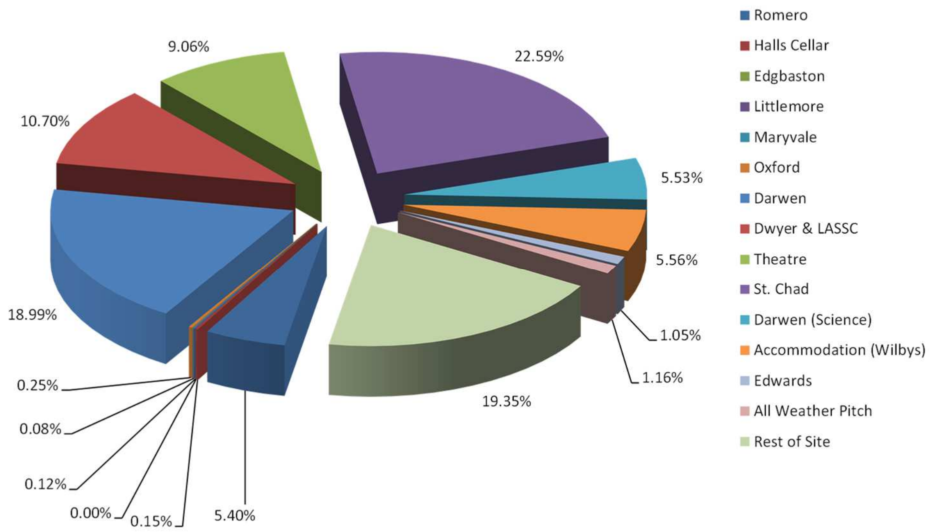

Figure 5: The University Electricity Map

Site electricity metering, most of which is read weekly on a Friday, has allowed the site electricity map to be generated. This is included in Figure 5 and it shows where the site electricity is being used as well as the percentage of the electricity used in each named area.[8]

4.3.1 Triad Charges

The Triads are, being simplistic, the three half hour periods between the beginning of November and the end of February when the GB National Grid experiences its highest demand. The user's average demand during these three periods determines the TNUoS[9] charges.

During the winter of 2016/17 the Triads were the half hour period starting 17:30hrs on 5th December 2016, 17:30hrs on 5th January 2017 and again on 23rd January 2017. At these times the University demand was 244.4kW, 224.4kW and 231.2kW giving an average of 233.3kW which

[8] Please note that some of these consumption figures are derived from suspect metering that was changed during the year, in particular that serving Edgbaston, Maryvale, Littlemore and Oxford buildings. The accuracy of the new meters will be determined during the 2017/18 financial year.

[9] TNUoS charges – Transmission Network Use of System charges.

equates to Triad charges of £12,800, much of this collected in the March invoice, at the National Grid tariff of £45.738925/kW (+ VAT = £54.89).

Without reviewing the University supply contract we cannot comment further on the charge but would like to identify the Triads as an opportunity to manage demand and make financial savings. The electricity supplier or broker will, if requested, send out triad warnings and the University can manage their demand. There are generally somewhere around 20 Triad warnings over the winter as the actual Triad periods can only be determined in March, after the event.

To manage the Triads the University should switch off unnecessary plant and equipment for the duration of the warning period, for example ensuring that the housekeeping staff and students do not start washing machines, use vacuum cleaners or other energy consuming plant during the periods. This may also involve using the BMS to switch off the heating and ventilation plant for half an hour or an hour or so. This will reduce the demand on that day as well as potentially reducing the Triad charges. The action results in energy savings and a consequential reduction in CO_{2e} emissions savings. Note that some plant, having been switched off, may not be switched on again at the end of the period generating further energy and CO_{2e} savings.

4.4 Heating Energy Consumption (Natural Gas)

The gas consumption profiles, through the three fiscal gas meters, are shown in Figure 6. These are compared to the local degree days[10] and the number occupied term days in each month[11]. During the winter months with the highest number of Degree Days the heating will be working it's hardest to maintain the temperatures within both the University facilities and the Halls of Residence and that should result in the highest gas consumption, although this does not appear to be the case as the consumption is highest during March, which is not the coldest month. Similarly outside term time the numbers of students in residence will fall and the heating gas consumption should reduce accordingly. This, again, does not appear to be the case with St Chad's gas consumption remaining static during the Christmas period. The Campus main meter also consumed more gas than expected during March although some of these meter readings may be estimated.

We would recommend that the gas supplier be advised of the correct reading where estimates have been used for billing purposes. These are available as the University reads the meters weekly. As an example, if at the end of a month the reading for a meter was estimated by the supplier and at the end of the following month a University reading was used the result would be that during the first month gas consumption would have been overestimated and therefore the second month's would be less than it should have been. The University would have paid for gas that it had not used at the end of the first month which would have been used during the second month, in effect the University would be banking with the gas supplier, which will have an adverse effect on cash flow.

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[10] Degree-Days are a measure of the severity of the weather and are available for all regions of the UK. Degree-days are calculated from a standard base of 15.5 °C outside temperature. Above this outside temperature and depending on the insulation quality of the building, most buildings in the UK do not require additional space heating as internal heat gains from lights, people and equipment provide sufficient heat to maintain comfort temperature. Therefore, the colder the weather the higher will be the degree-days recorded and more energy will be required for space heating. The Degree Days have been obtained from www.Degreedays.Net for their IBIRMING106 weather station in Cyprus Close, Birmingham, B29 4EG, approximately 1 mile from the University which will give an excellent representation of the ambient conditions on the campus.

[11] Note that in order to compare all the data on one graph the number of term days has been multiplied by 10.

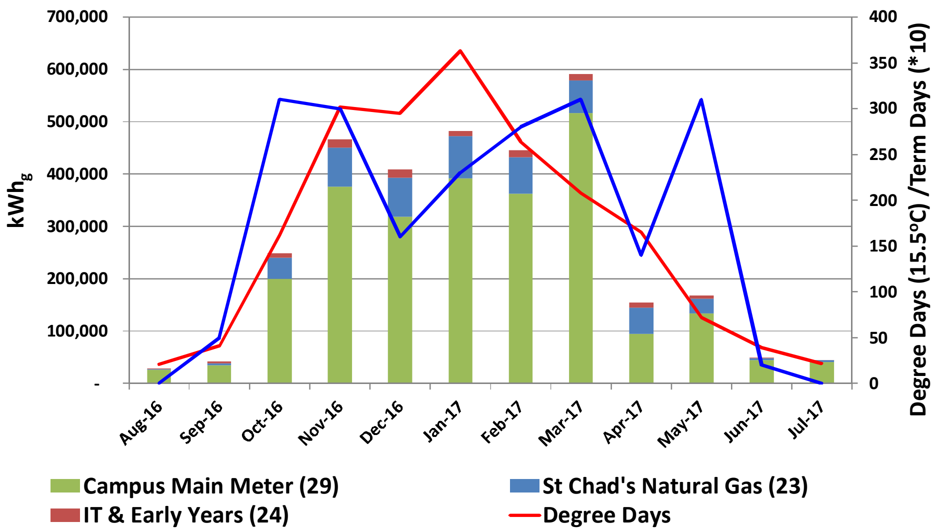


Figure 6: Monthly Gas Consumption[12]

In an endeavour to further understand the University gas consumption through the three fiscal gas meters we have used regression analysis to compare the consumption with the ambient temperatures. This has shown that there could be improvements to the controls and a study of the BMS performance may be appropriate. The consumptions have been calculated from the University meter readings.

Better use of the BMS may improve the consumption profile particularly during periods of low occupancy, for example over Christmas.

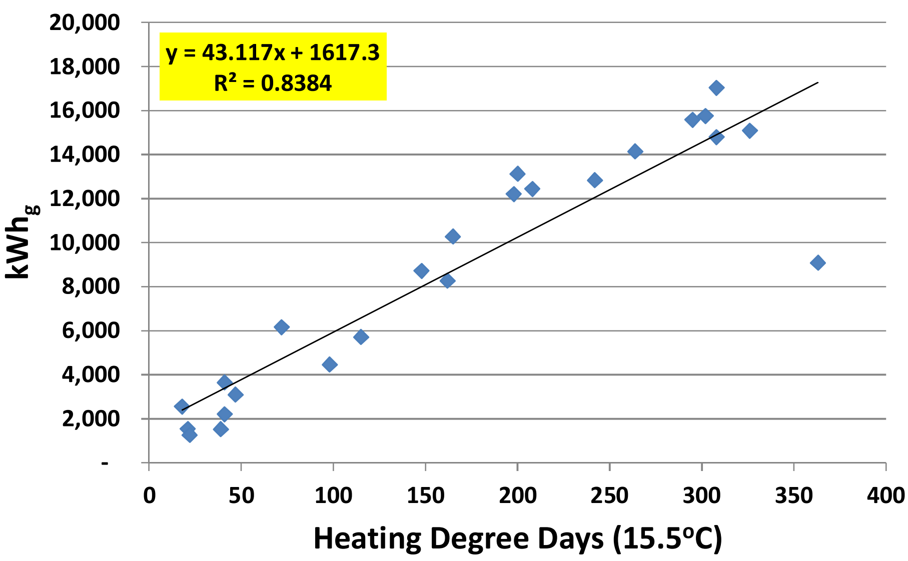


Figure 7: Regression Analysis comparing gas consumption with Degree Days, IT and Early Years Meter (24).

Figure 7 illustrates the relationship between the gas consumption and degree-days (temperature) during the 2016/17 Financial Year on a weekly basis for the gas supply to IT & Early Years, meter

[12] Note that the University meter numbers, as used by the Security Staff when they read the meters, are given against the meter names.

(No.24). When comparing the gas consumption with degree days we are comparing the consumption to the ambient temperatures – the colder it is the greater the number of degree days and the more gas that is consumed to maintain temperatures. If the gas consumption is well controlled then the points on the graph would all be in a straight line. If the points are scattered then there is little evidence of control.

For the IT & Early Years meter there is a little scatter about the regression line which leads to a coefficient of correlation (R^2) of 0.838, indicating that the control of the heating plant is better than typical. A typical site will have a correlation coefficient about 0.75 and for a well-controlled site it will be higher than 0.9. This supply is just a little better than typical with scope to improve control and thus reduce gas consumption. It is not known why the January 2017 point, with 363 degree days this was the coldest month, has such a low gas consumption but we would speculate that the gas meter readings at the end of December were probably estimated (this consumption data was provided by TEC in spreadsheet form and apparently represents the volumes invoiced).

The regression line would cross the 'y' axis at 1,617 kWh and this identifies the monthly base load when the ambient temperature is 15.5°C, the ambient outside air base temperature for the degree-days used above which buildings should not require heating and therefore this monthly consumption theoretically represents the gas used to heat domestic hot water.

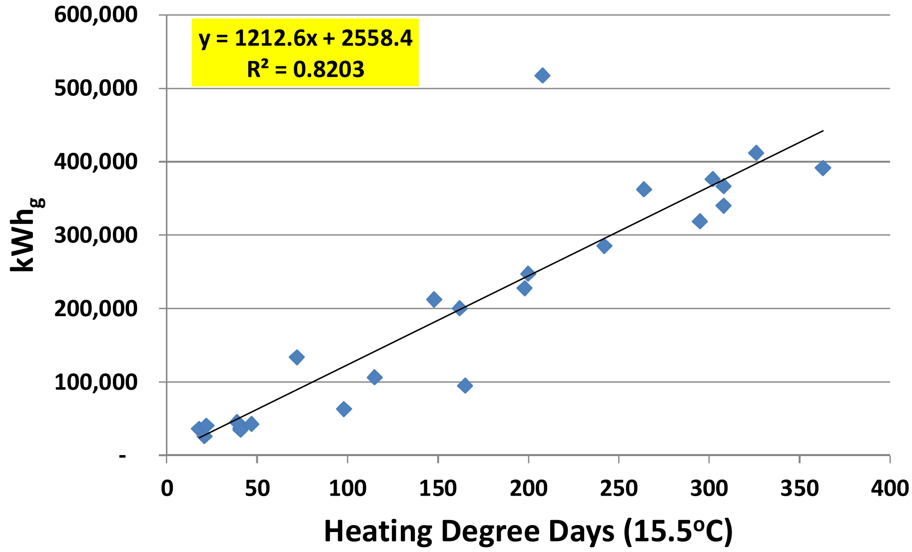


Figure 8: Regression Analysis comparing gas consumption with Degree Days, Rotary Gas Supply Meter (29) to the rear of the Sanctuary.

Similarly Figure 8 illustrates the relationship between the gas consumption and degree-days for the gas supply through the Rotary Meter (No.29) to the Main Campus, the meter being located at the rear of the Sanctuary.

For this supply there is some scatter about the regression line which leads to a correlation coefficient (R^2) of 0.8203, indicating that the control of the heating plant is a little better than for meter 24 but could still be improved. Again improving the controls to achieve a higher value of R^2 would reduce gas consumption. We are unsure about the very high consumption in March 2017 with 208 degree days and over 500,000 kWh. As this consumption was calculated from the University's own metre readings it is likely that some activity on site caused the high demand.

The regression line would cross the ‘y’ axis at 2,558 kWh and this suggests the monthly base load gas used to heat domestic hot water.

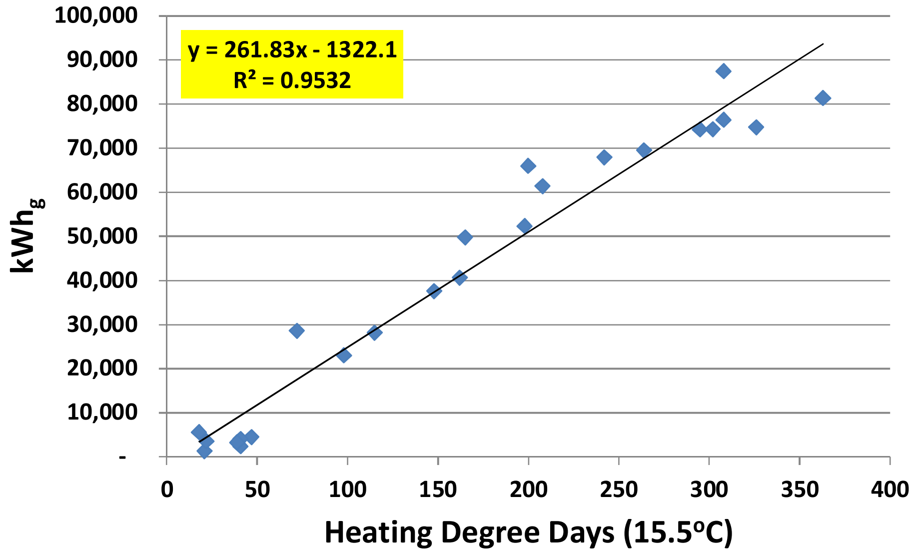


Figure 9: Regression Analysis comparing gas consumption with Degree Days, St Chads Gas Supply Meter (23).

Figure 9 illustrates the relationship between the gas consumption and degree-days for the St. Chads (reception) gas supply (No.23) with the meter located adjacent to the Visitors Car Park.

For this supply there is little scatter about the regression line which leads to a correlation coefficient (R^2) of 0.9532, indicating that the control of the heating plant is a better than for meters 24 and 29, and regarded as excellent. This is possibly because the facility is relatively new.

The regression line would cross the ‘y’ axis at 1,322 kWh and we would expect that this monthly base load gas would be used to heat domestic hot water. If this supply does not feed any hot water heating the consumption could dry-cycling the boiler plant (keeping the boilers hot even though the building is not requesting heat). If this is the case it should be possible to overcome the issue utilising the programming capabilities of the BMS.

5.0 IMPACT OF COFTON HALL FORECAST ENERGY CONSUMPTION

The University is to commission Cofton Hall, a new accommodation block with five floors (ground and four upper floors) in Quarter 1, 2018 when the first residents will occupy the building. The energy consumption in this facility will have a substantial effect on the University energy consumption and emissions.

The building services include a small CHP set which will generate electricity to contribute to a reduction in the University electricity demand as well as providing thermal energy for environmental heating and domestic hot water. This will be supplemented by the gas fired boiler plant. The overall effect of the CHP installation is to reduce the CO_2 emissions from the building as well as the cost of heating and lighting it.

The forecast information we have is taken from two Government sources, the EPC (Energy Performance Certificate) and the UKBRL Output Document (which is required for Building Regulations Compliance)[13]. The total CO_2 forecast emissions calculated from these two documents are given in Table 4. For the purpose of this report we have used the UKBRL figure as it is based on the actual building, rather than a notional calculation. We have used the BER in this report.

Table 4: Forecast CO_2 Emissions

	EPC	UKBRL
Notional Emissions	164.4 tCO_2/annum	165.9 tCO_2/annum
Building CO_2 Emissions Rate (BER)		138.2 tCO_2/annum

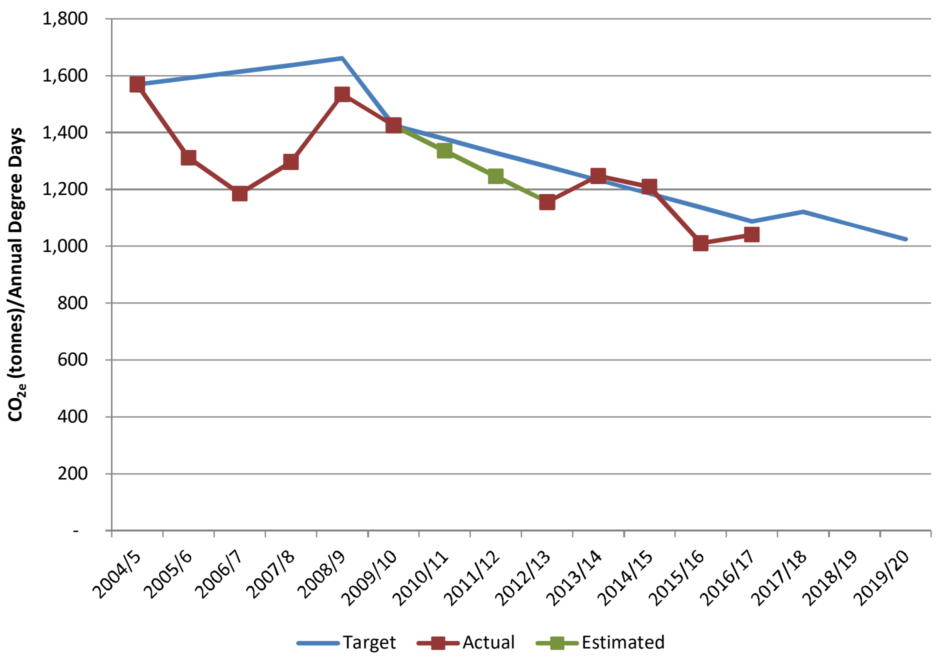


Figure 10: Suggested revised target including Cofton Hall

[13] Note that both the EPC and UKBRL calculations may use emissions factors that differ from the

In Section 3.0 we discussed the Carbon Management Plan target and mentioned that the impact of Cofton Hall was not included. In Figure 10 the suggested revised target for the University, including Cofton Hall, from the 2017/18 academic year, is shown and presented numerically in Table 5.

Table 5: Revised Carbon Emissions Targets, Including Cofton Hall, and known performance (Scope 1 & 2 only)

Year	2004/5	2005/6	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
Target (tCO_{2e})	1,568[14]	1,591[7]	1,614[7]	1,637[7]	1,660[7]	1,425	1,377	1,329
Actual (tCO_{2e})	1,568[7]	1,311	1,185	1,296	1,533	1,425	n/a	n/a
Year	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Target (tCO_{2e})	1,281	1,233	1,185	1,136	1,088	1,121	1,073	1,025
Actual (tCO_{2e})	1,155	1,247	1,209	1,053	1,162	-	-	-

The emissions figures used for revising the target, the BER from the UKBRL Output document, will not include the energy used by the occupants (mobile telephone chargers, computers and printers and any other appliances that they might have) thus presenting a reduction target for the building once fully commissioned.

It should also be noted that, during construction, Morgan Sindle has had portable office and amenity accommodation on site consuming electricity from the University network. When removed this electricity consumption will cease which will help to reduce emissions towards the target. It is possible that some of the recent rise in consumption can be attributed to these facilities.

Once commissioned it is important to ensure that the energy consumption of Cofton Hall is controlled in such a way that the needs of the building occupants are satisfied but the energy consumption is minimised. For example the BMS should modulate the CHP set to ensure that the heat demand of the building is satisfied by the CHP's thermal output before the boilers are brought on line to provide environmental heating or DHW. The environmental heating should only be provided when required and should certainly be turned off during the summer months, when it might be necessary to shut down the CHP set is the thermal load generating DHW is not high enough to allow the CHP to generate at 50% of its thermal output, because of a greater loss in CHP efficiency making it more expensive to generate electricity than purchase from the grid.

The EPC recommendation document only includes one recommendation and that is to install solar PV collectors on the roof. The estimated costs and savings are outlined in Opportunity 4 on page 23.

[14] We believe that these figures include about 250 tCO_{2e} per year which are Scope 3 emission from transport (business travel and staff commuting). These Scope 3 emissions are stated as being excluded from the CO_{2e} emissions targets (CMP Version 14 dated 30th March 2011, Page 17) and should therefore not have been included.

6.0 CARBON REDUCTION OPPORTUNITIES

6.1 No Cost and JDI Opportunities

The University are continuing with simple and low cost opportunities, for example the upgrading of lighting to LED. This will slowly reduce the electricity consumption and therefore costs and carbon emissions. Further opportunities are highlighted below with estimated energy, cost and CO_2 savings.

Opportunity 1	**Fit restrictors to taps and replace shower heads**						
Water & Sewerage Savings	**Energy Saving**	**Total Cost Savings** (Gas & Water)	**Capital Cost**	**CO_2 Saving**	**% of CO_2 savings required**	**Simple Payback**	**ROI**
Cu M	**kWh**	**£**	**£**	**Tonnes**	**(%)**	**(Years)**	**(%)**
2,250	**129,462**	**£3,340**	**840**	**23.8**	**25%**	**0.25**	**398%**

Existing Situation	Showers and wash basins are provided in the student living accommodation. In the older accommodation viewed there was no restriction on the water flow rates from the taps and we would estimate that one tap was possibly exceeding 20 litres/minute. Other taps seen on the campus had lower flow rates.
Recommendation	 **Figure 11: Flow from taps**  **Figure 12: In line and tap flow restrictors** Figure 11 shows the flow from two taps. The tap on the right is discharging at 12 litres/minute whereas the tap on the left has been fitted with a simple flow

restrictor which has reduced the flow to 6 litres/minute. For hand washing this will halve the hot water used and thus reduce by half the heating fuel used to replenish the hot water storage tank. We have not included the cost of the University plumber or mechanical fitter installing the restrictors in our calculations.

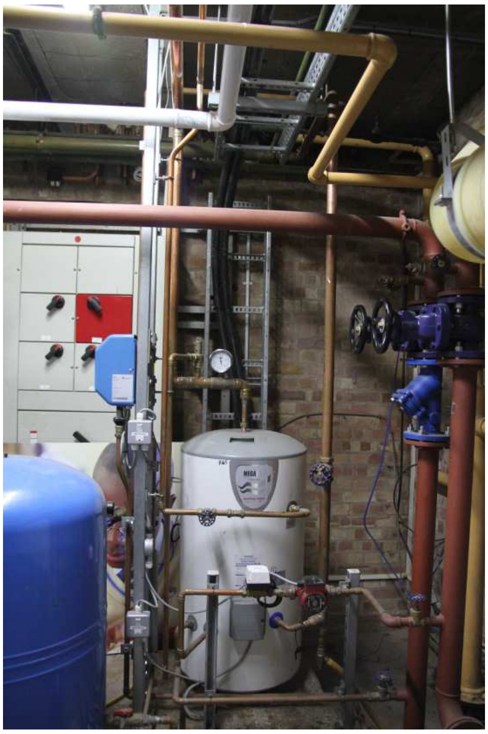
Fitting flow restrictors to the pipework supplying the tap is simple enough for a plumber and the cost of the restrictors, shown on the left in Figure 12, is in the region of £3 each whereas a restrictor fitted to the discharge of a tap, shown on the right, will be in the region of £8.

Figure 13: A shower head which delivers between 5lit/m and 10lit/m

Changing the shower heads with more efficient aerated heads will reduce the water consumption used for showering. This can be achieved during the normal maintenance of showers (for example during Legionella management when we would expect the shower heads to be changed for sterilised units). Water savings can be as much as 50% (typically a shower head may pass more than 15 litres/minute but reducing to a 6 litres/minute aerated unit will give almost the same experience to the person in the shower whilst halving the water consumption). The only capital on-cost will be the purchase of new shower heads. Such a shower head can be obtained for as little as £20 (including VAT). The cost of sterilisation and fitting will already be borne because of the legionella prevention regime that should be carried out regularly in the accommodation.

We have calculated the savings based on the University reducing its hot water consumption by 33% by reducing the flow through showers and taps.

Note that by fitting restrictors to cold taps further savings will be made but not carbon savings (unless Scope 3 emissions are to be reported).

Opportunity 2	Install thermal insulation on hot water pipework					
Energy Saving kWh	Cost Savings £	Cost £	CO_2 Saving Tonnes	% of CO_2 savings required	Simple Payback Years	ROI (%)
134,667	£4,069	£5,490	17.4	18%	1.35	74%
Existing Situation	 **Figure 15: Unlagged pipework in accommodation**  **Figure 14: Unlagged pipework in Boiler house 5** Within the current accommodation blocks there is hot heating pipework at high level, shown in Figure 15 in the student's rooms. This is allowing uncontrolled heat into the building, if it is needed or not and could cause overheating of the rooms which are also fitted with radiators and thermostatic radiator valves (TRVs) to control the temperature. Within the boiler houses there are also many hot water pipes without thermal insulation. The photograph in Figure 14 shows Boiler house 5 where there are both copper and steel pipes without thermal insulation.					

Recommendation	Applying thermal insulation to the pipework will retain the expensive heat within the system. The thermal insulation for pipework can be readily obtained from plumbers merchants and installed by the site maintenance staff. In replacing the missing thermal insulation it is important to ensure that the pipeline fittings (valves, etc.) are also insulated. Typically a pipeline valve can radiate almost as much energy as 1m of pipe of the same diameter. The thermal insulation on all DHW pipework across the site should be checked to ensure that it is in place and in good order. Any missing or damaged insulation should be replaced. The costs and savings above are based on fitting or replacing thermal insulation to the accommodation blocks and to Boiler House 5.pipework. Other pipework found to be without thermal insulation will further increase the savings when the insulation is fitted..

6.2 Projects requiring investment

Opportunity 3	Install Combined Heat and Power into Boiler Room 3					
Energy Saving kWh	Cost Savings £	Cost £	CO_2 Saving Tonnes	% of CO_2 savings required	Simple Payback Years	ROI (%)
-101,268	£17,985	£58,206	10.74	11%	3.24	31%

Existing Situation

CHP is the generation of electricity using (usually) a gas engine to drive a generator. About 35% of the energy in the gas input is converted into electricity with over 45% converted into useable thermal energy. At the fossil fuel power stations the waste heat given off during electricity generation is discarded via the large cooling towers associated with such plants.

Figure 16: Didcot Power Station Cooling Towers discarding waste heat

By utilising this waste heat energy and cost savings can be made, as well as reducing costs and carbon emissions.

Recommendation

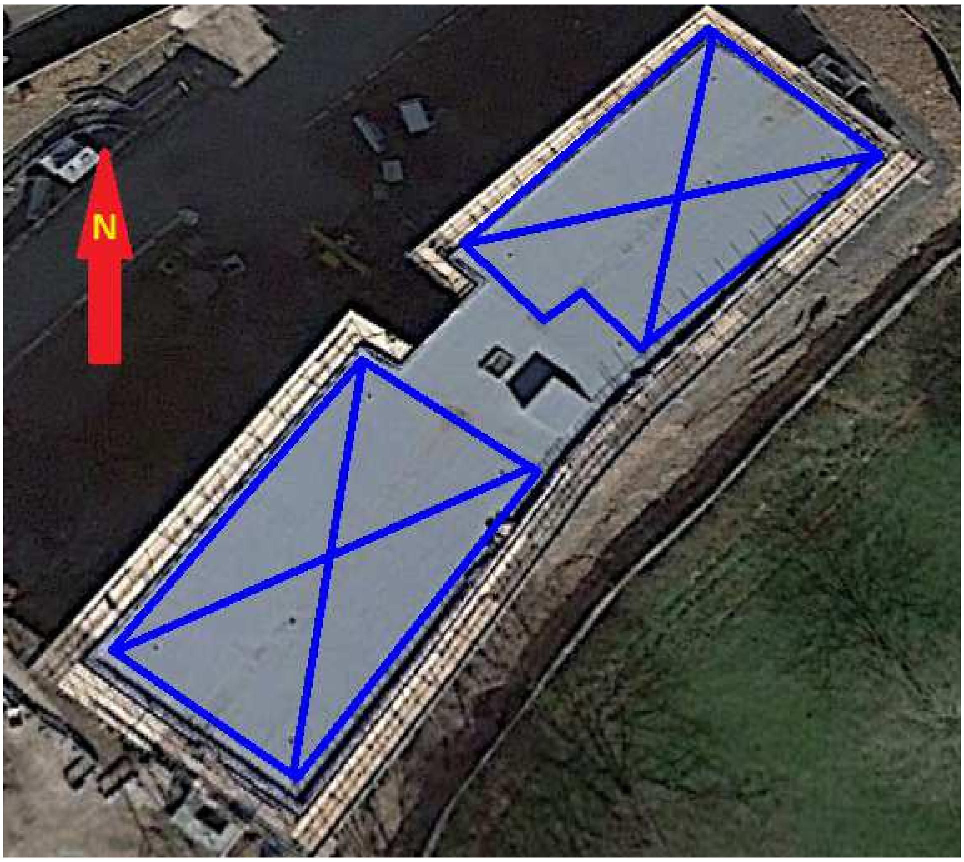
CHP is not suitable for every application and must be correctly sized to optimise the savings and this payback. There may be an opportunity to install a $15kW_e$ CHP set in Boiler Room 3 which serves the Edgbaston, Littlemore, Maryvale and Julian of Norwich halls, providing heat from boilers in the winter and domestic hot water throughout the year. A CHP set could be integrated into both the DHW and the heating systems to optimise carbon savings.

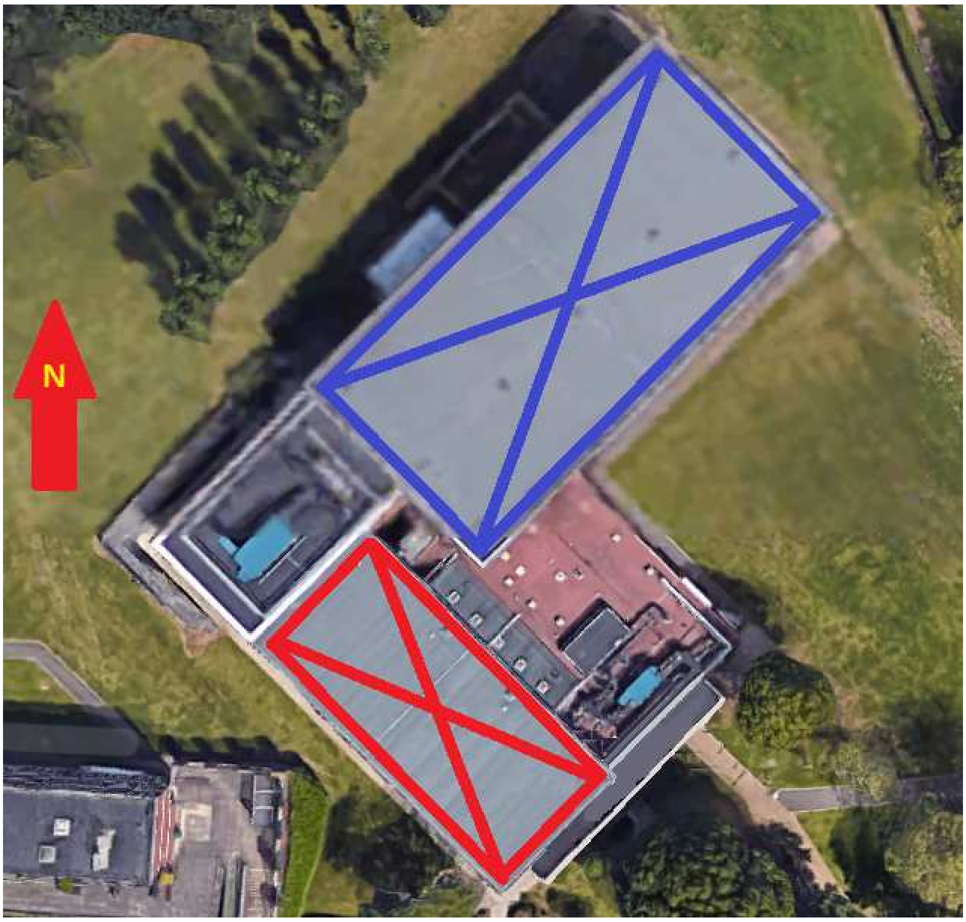
Savings stated above are a very conservative estimate and we recommend that a detailed study be carried out to generate more accurate figures. It is important to understand that running a CHP set and discarding the heat results in fewer savings or even losses being incurred which in turn will increase the payback time and increase carbon emissions. A detailed survey would investigate the load profile of the Andrews DHW heaters and, whilst we have an accurate cost for the purchase of the CHP and ancillaries a firm cost for the installation would be sought. It will also be necessary to establish exactly where the unit could be installed. If there is no room to install the CHP set in Boiler House 3 alternative arrangements may increase the capital costs.

If running at full load during the Triad periods further savings of about £800 may be realised.

The University should be able to use SALIX funding for this project.

Note that bringing hot water consumption under control as suggested in Opportunity 1 may reduce the savings available to a CHP set and so the water savings should be made first.

Opportunity 4	Install Solar PV collectors on Cofton Hall roof					
Energy Saving kWh	Cost Savings £	Cost £	CO_2 Saving Tonnes	% of CO_2 savings required	Simple Payback Years	ROI (%)
50,160	£6,511	£52,800	17.6	18%	8.1	12.3%
Existing Situation	As mentioned in the EPC Recommendations report there is an opportunity to install Solar PV panels onto the building roof. There is currently nothing on the roof.					
Recommendation	The University has already installed Solar PV onto some building roofs, for example Chad, and is considering the Edwards building roof space. Solar PV generates carbon free electricity. The building, which has yet to be commissioned, does have a CHP set which will generate electricity and the addition of solar PV panels will contribute to this. In the unlikely event that the CHP and solar PV panels generate more electricity together than the building is using the electricity will flow backwards into the rest of the site and be consumed in other buildings, depending upon the volume of electricity generated by the other solar PV panels at the University. It may be appropriate to carry out a survey to establish if electricity (battery) storage would be appropriate to store surplus electricity if generation exceeds demand. We have calculated the savings assuming that the area of the panels is 50% of the area of the roof of the two 'wings' of Cofton Hall. The potential area for the installation of a solar PV array on the sports hall roof is highlighted in blue in Figure 17.  **Figure 17: Area of Cofton Hall Roof that could be used for solar PV collectors**					

Opportunity 5	Install Solar PV collectors on Edwards Building roof					
Energy Saving kWh	Cost Savings £	Cost £	CO_2 Saving Tonnes	% of CO_2 savings required	Simple Payback Years	ROI (%)
63,270	£8,213	£66,600	22.2	23%	8.11	12%
Existing Situation	The roof of the Edwards Sports Centre is ideally located for installation of solar collectors, for generating electricity or hot water (see also Opportunity 6).					
Recommendation	The University are already considering installing solar PV collectors onto the Edwards Building roof. The calculations to achieve the numbers given assume that the area of the panels is 50% of the area of the main sports hall roof. It will be necessary to assess the structure of the roof before committing to install the panels (even if only as a safety issue to prevent installers falling through the roof fabric). The potential area for the installation of a solar PV array on the sports hall roof is highlighted in blue in Figure 18.  **Figure 18: Area of Edwards Building Roof that could be used for solar collectors**					

Opportunity 6	Install Solar Thermal collectors on Edwards Building roof					
Energy Saving kWh	Cost Savings £	Cost £	CO_2 Saving Tonnes	% of CO_2 savings required	Simple Payback Years	ROI (%)
34,580	£4,641	£26,000	6.4	7%	5.6	17.9%
Existing Situation	The roof of the Edwards Sports Centre is ideally located for installation of solar collectors, for generating electricity or hot water. The need for hot water, for the changing facilities and some environmental heating, is served by an Andrews 80kW water heater and a Worcester Bosch 80kW boiler, both being fired by natural gas. The building consumes 43,000kWh of natural gas a year.					
Recommendation	By installing solar thermal collectors on part of the squash court/fitness centre roof there is an opportunity to reduce the quantity of gas required to provide domestic hot water for the changing facilities and possibly the limited internal heating (all provided from the gas fired boiler). This will reduce the carbon emissions by up to 6.4 tonnes. The potential area for the installation of a solar thermal array on the squash court, fitness centre and administration office roof is highlighted in red in Figure 18.					

7.0 FURTHER OPPORTUNITIES

There are further opportunities that the University are aware of and we understand will be pursuing. These include the refurbishment of the restaurant kitchens and re-roofing which includes updating the thermal insulation under the roof decking.

Completion of these and other planned projects will help to reduce the carbon emissions below the target whilst reducing costs.

Greater interaction between the University and the students, in relation to energy consumption and the environment, will create other opportunities to minimise emissions. The interaction must be two way and on-going, rather than a one off project.

Appendix 1 Emissions Factors

The emission factors used in this report (where we have had to calculate the emissions from the energy input rather than having been given the total emissions) have been provided by DEFRA/DECC for use in Company Emissions Reporting and are shown in Table 6. The electricity Transmission and Distribution emissions factors are given here but have not been used in this report as they are Scope 3 emissions, the University is specifically reporting only Scope 1 and 2 emissions.

Table 6: Fuel and Electricity CO_2 Emissions Factors

Year	Gas (Scope 1)	Petrol (Scope 1)	Electricity (Scope 2)	T&D (Scope 3)
2010	0.18523	0.24176	0.48219	0.03908
2011	0.1836	0.2361	0.45205	0.03863
2012	0.18521	0.24063	0.46002	0.03634
2013	0.18404	0.23394	0.44548	0.03809
2014	0.183973	0.23277	0.49426	0.04322
2015	0.18445	0.23299	0.46219	0.03816
2016	0.184	0.23324	0.41205	0.03727
2017	0.18416	0.23341	0.34885	0.03287

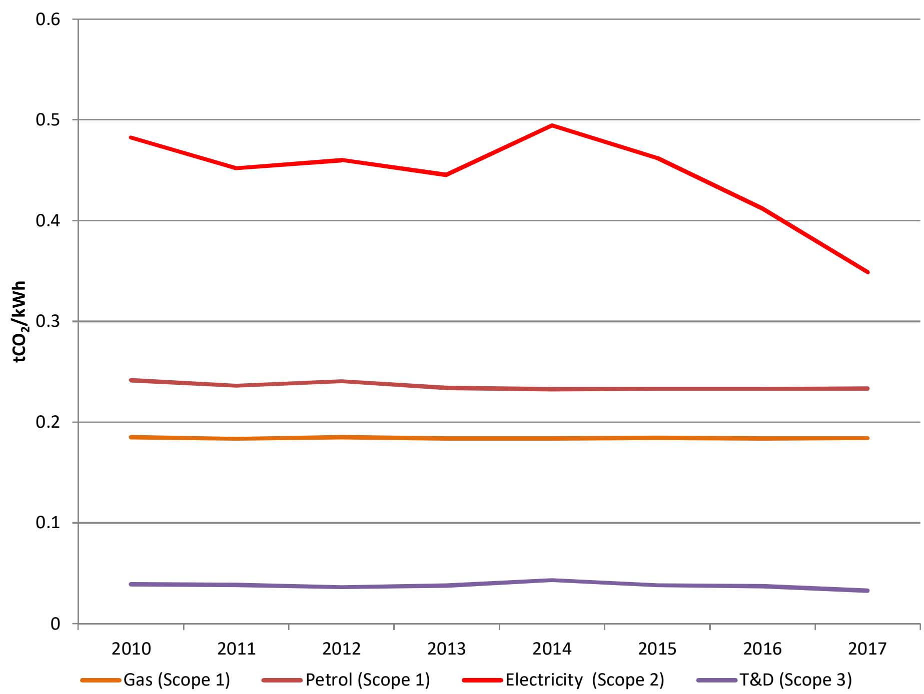


Figure 19: Emissions factors this decade

Figure 19 represents the emissions factors graphically and it can be seen that as a greater proportion of the electricity consumed in the UK is 'Green' and generated by wind, solar or biomass, which are carbon neutral, the emissions factor has been reducing. In fact the emissions from electricity have reduced by 28% so far this decade.

Emissions factors for the other streams have been fairly constant with fluctuations in natural gas and petrol emissions varying according to the sources of the fuel.

Table 7 identifies the GWP (Global Warming Potential) for refrigerants. Thus, for example, if 5kg or R134a refrigerant is lost to atmosphere the equivalent of 6.5tCO_{2e} (5kg * 1,300kg CO_{2e}) would have been emitted.

Table 7: Refrigerant Global Warming Potentials

Activity	Emission	Unit	kg CO_{2e}
Kyoto protocol - standard	Carbon dioxide	kg	1.0
	Methane	kg	21.0
	Nitrous oxide	kg	310.0
	HFC-23	kg	11,700.0
	HFC-32	kg	650.0
	HFC-41	kg	150.0
	HFC-125	kg	2,800.0
	HFC-134	kg	1,000.0
	HFC-134a	kg	1,300.0
	HFC-143	kg	300.0
	HFC-143a	kg	3,800.0
	HFC-152a	kg	140.0
	HFC-227ea	kg	2,900.0
	HFC-236fa	kg	6,300.0
	HFC-245fa	kg	560.0
	HFC-43-I0mee	kg	1,300.0
	Perfluoromethane (PFC-14)	kg	6,500.0
	Perfluoroethane (PFC-116)	kg	9,200.0
	Perfluoropropane (PFC-218)	kg	7,000.0
	Perfluorocyclobutane (PFC-318)	kg	8,700.0
	Perfluorobutane (PFC-3-1-10)	kg	7,000.0
	Perfluoropentane (PFC-4-1-12)	kg	7,500.0
	Perfluorohexane (PFC-5-1-14)	kg	7,400.0
	Sulphur hexafluoride	kg	2,3900.0

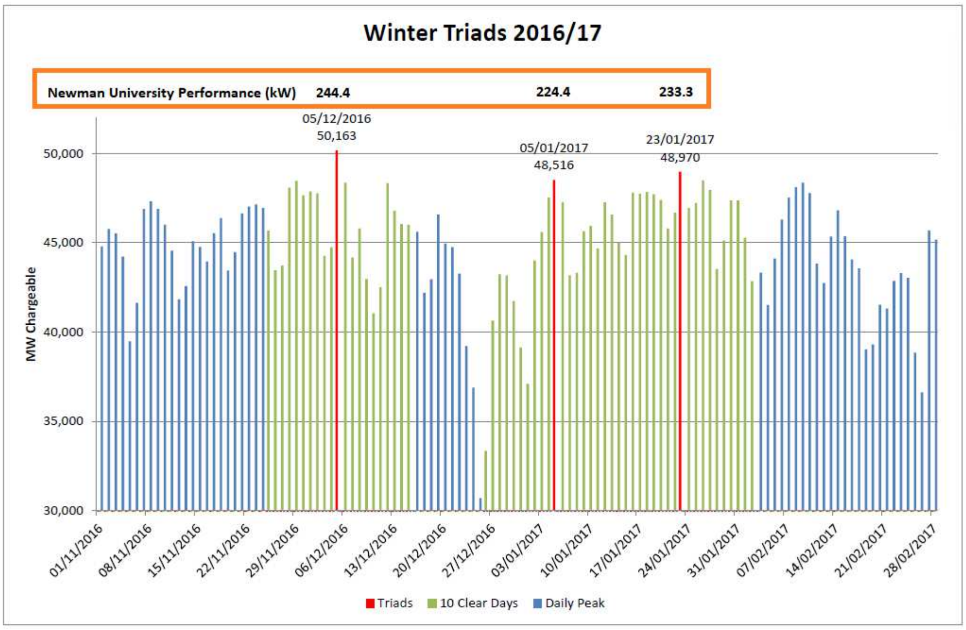
Appendix 2 Example Global Warming Potentials (GWP) of the six Green House Gasses

GWP values and lifetimes[15]	Lifetime (years)	GWP	
		20 years	100 years
Carbon Dioxide (CO_2)[16]	1	1	1
Methane (CH_4)[16]	12.4	86	34
HFC-134a (hydrofluorocarbon)[16]	13.4	3,790	1,550
CFC-11 (chlorofluorocarbon)[16]	45.0	7,020	5,350
Nitrous oxide (N_2O)[16]	121.0	268	298
Carbon tetrafluoride (CF_4)[16]	50,000	4,950	7,350

[15] from 2013 IPCC AR5 p714 (with climate-carbon feedbacks)

[16] These are the basket of six Kyoto GHGs (Carbon-dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6)).

Appendix 3 2016/17 Triad Information from National Grid



The Triads are the three half hour settlement periods of highest GB demand between 1st November and the end of February. Triads can occur in any settlement period but are separated from each other by a minimum of ten full days. (See Section 14 of the Connection and Use of System Code.)

Triads are decided using the latest available settlement data when they are calculated in March. The run types are Settlement Final (SF), 1st Reconcilation (R1) and 2nd Reconcilation (R2). Subsequent settlement data may change demand but the triads are not re-calculated.

Date	Half Hour Ending	Settlement Period	Demand (MW)	Settlement Run
Tuesday 1-Nov-16	17:30	SP35	44,795.620	R2
Wednesday 2-Nov-16	17:30	SP35	45,762.432	R2
Thursday 3-Nov-16	17:30	SP35	45,521.046	R2
Friday 4-Nov-16	17:30	SP35	44,212.932	R2
Saturday 5-Nov-16	17:30	SP35	39,479.550	R2
Sunday 6-Nov-16	17:30	SP35	41,622.334	R2
Monday 7-Nov-16	17:30	SP35	46,883.374	R2
Tuesday 8-Nov-16	17:30	SP35	47,303.832	R2
Wednesday 9-Nov-16	17:30	SP35	46,892.572	R2
Thursday 10-Nov-16	17:30	SP35	45,999.790	R2
Friday 11-Nov-16	17:30	SP35	44,553.156	R2
Saturday 12-Nov-16	17:30	SP35	41,837.696	R2
Sunday 13-Nov-16	17:30	SP35	42,565.670	R2
Monday 14-Nov-16	17:30	SP35	45,074.478	R2
Tuesday 15-Nov-16	17:30	SP35	44,756.434	R2
Wednesday 16-Nov-16	17:30	SP35	43,940.864	R2
Thursday 17-Nov-16	17:30	SP35	45,528.594	R2
Friday 18-Nov-16	17:30	SP35	46,375.020	R2
Saturday 19-Nov-16	17:30	SP35	43,437.666	R2
Sunday 20-Nov-16	17:30	SP35	44,472.352	R2
Monday 21-Nov-16	17:30	SP35	46,632.272	R2
Tuesday 22-Nov-16	17:30	SP35	47,026.060	R2
Wednesday 23-Nov-16	17:30	SP35	47,144.304	R2
Thursday 24-Nov-16	17:30	SP35	46,942.302	R2
Friday 25-Nov-16	17:30	SP35	45,676.286	R2
Saturday 26-Nov-16	18:00	SP36	43,453.604	R2
Sunday 27-Nov-16	17:30	SP35	43,715.654	R2
Monday 28-Nov-16	17:30	SP35	48,067.030	R2
Tuesday 29-Nov-16	17:30	SP35	48,456.986	R1
Wednesday 30-Nov-16	17:30	SP35	47,631.858	R1
Thursday 1-Dec-16	17:30	SP35	47,863.510	R1
Friday 2-Dec-16	17:30	SP35	47,760.038	R1
Saturday 3-Dec-16	17:30	SP35	44,250.732	R1
Sunday 4-Dec-16	17:30	SP35	44,749.442	R1
Monday 5-Dec-16	17:30	SP35	50,163.102	R1
Tuesday 6-Dec-16	17:30	SP35	48,359.530	R1
Wednesday 7-Dec-16	17:30	SP35	44,164.558	R1
Thursday 8-Dec-16	17:30	SP35	45,793.668	R1
Friday 9-Dec-16	17:30	SP35	42,966.328	R1
Saturday 10-Dec-16	17:30	SP35	41,047.372	R1
Sunday 11-Dec-16	17:30	SP35	42,492.674	R1
Monday 12-Dec-16	17:30	SP35	48,329.942	R1
Tuesday 13-Dec-16	17:30	SP35	46,781.998	R1
Wednesday 14-Dec-16	17:30	SP35	46,046.360	R1
Thursday 15-Dec-16	17:30	SP35	46,003.782	R1
Friday 16-Dec-16	17:30	SP35	45,606.420	R1
Saturday 17-Dec-16	18:00	SP36	42,198.082	R1
Sunday 18-Dec-16	17:30	SP35	42,950.166	R1
Monday 19-Dec-16	17:00	SP34	46,568.160	R1
Tuesday 20-Dec-16	17:30	SP35	44,942.314	R1
Wednesday 21-Dec-16	17:30	SP35	44,749.274	R1
Thursday 22-Dec-16	17:30	SP35	43,263.674	R1
Friday 23-Dec-16	17:30	SP35	39,208.814	R1
Saturday 24-Dec-16	17:30	SP35	36,886.754	R1
Sunday 25-Dec-16	13:00	SP26	30,709.654	R1
Monday 26-Dec-16	17:30	SP35	33,340.024	R1
Tuesday 27-Dec-16	17:30	SP35	40,639.748	R1
Wednesday 28-Dec-16	17:30	SP35	43,233.346	R1
Thursday 29-Dec-16	17:30	SP35	43,156.522	R1
Friday 30-Dec-16	17:30	SP35	41,734.122	R1
Saturday 31-Dec-16	17:30	SP35	39,137.324	R1

Date	Half Hour Ending	Settlement Period	Demand (MW)	Settlement Run
Sunday 1-Jan-17	17:30	SP35	37,100.362	R1
Monday 2-Jan-17	18:00	SP36	43,990.522	R1
Tuesday 3-Jan-17	17:30	SP35	45,595.644	R1
Wednesday 4-Jan-17	17:30	SP35	47,522.648	R1
Thursday 5-Jan-17	17:30	SP35	48,515.608	R1
Friday 6-Jan-17	17:30	SP35	47,273.496	R1
Saturday 7-Jan-17	18:00	SP36	43,178.476	R1
Sunday 8-Jan-17	17:30	SP35	43,303.240	R1
Monday 9-Jan-17	17:30	SP35	45,629.922	R1
Tuesday 10-Jan-17	17:30	SP35	45,944.942	R1
Wednesday 11-Jan-17	17:30	SP35	44,672.514	R1
Thursday 12-Jan-17	17:30	SP35	47,253.488	R1
Friday 13-Jan-17	17:30	SP35	46,567.374	R1
Saturday 14-Jan-17	18:00	SP36	45,003.764	R1
Sunday 15-Jan-17	17:30	SP35	44,314.252	R1
Monday 16-Jan-17	17:30	SP35	47,798.916	R1
Tuesday 17-Jan-17	17:30	SP35	47,732.590	R1
Wednesday 18-Jan-17	17:30	SP35	47,840.888	R1
Thursday 19-Jan-17	17:30	SP35	47,713.544	R1
Friday 20-Jan-17	18:00	SP36	47,388.048	R1
Saturday 21-Jan-17	18:00	SP36	45,780.072	R1
Sunday 22-Jan-17	18:00	SP36	46,679.150	R1
Monday 23-Jan-17	17:30	SP35	48,970.458	R1
Tuesday 24-Jan-17	18:00	SP36	46,944.826	R1
Wednesday 25-Jan-17	17:30	SP35	47,216.978	R1
Thursday 26-Jan-17	18:00	SP36	48,484.500	R1
Friday 27-Jan-17	17:30	SP35	47,946.856	R1
Saturday 28-Jan-17	18:00	SP36	43,522.044	R1
Sunday 29-Jan-17	18:00	SP36	45,126.186	R1
Monday 30-Jan-17	17:30	SP35	47,358.862	R1
Tuesday 31-Jan-17	18:00	SP36	47,353.372	R1
Wednesday 1-Feb-17	18:00	SP36	45,279.700	R1
Thursday 2-Feb-17	18:00	SP36	42,848.960	R1
Friday 3-Feb-17	18:00	SP36	43,324.652	SF
Saturday 4-Feb-17	18:00	SP36	41,509.248	SF
Sunday 5-Feb-17	18:00	SP36	44,105.738	SF
Monday 6-Feb-17	18:00	SP36	46,296.730	SF
Tuesday 7-Feb-17	18:00	SP36	47,524.052	SF
Wednesday 8-Feb-17	18:00	SP36	48,101.084	SF
Thursday 9-Feb-17	18:00	SP36	48,353.714	SF
Friday 10-Feb-17	18:00	SP36	47,769.574	SF
Saturday 11-Feb-17	18:00	SP36	43,818.160	SF
Sunday 12-Feb-17	18:00	SP36	42,736.294	SF
Monday 13-Feb-17	18:30	SP37	45,343.724	SF
Tuesday 14-Feb-17	18:00	SP36	46,811.176	SF
Wednesday 15-Feb-17	18:30	SP37	45,345.406	SF
Thursday 16-Feb-17	18:30	SP37	44,053.700	SF
Friday 17-Feb-17	18:30	SP37	43,563.520	SF
Saturday 18-Feb-17	18:30	SP37	39,020.804	SF
Sunday 19-Feb-17	18:30	SP37	39,312.008	SF
Monday 20-Feb-17	18:30	SP37	41,524.218	SF
Tuesday 21-Feb-17	18:30	SP37	41,316.684	SF
Wednesday 22-Feb-17	18:30	SP37	42,858.426	SF
Thursday 23-Feb-17	18:30	SP37	43,297.016	SF
Friday 24-Feb-17	18:30	SP37	43,021.708	SF
Saturday 25-Feb-17	18:30	SP37	38,841.380	SF
Sunday 26-Feb-17	18:30	SP37	36,621.688	SF
Monday 27-Feb-17	18:30	SP37	45,693.290	SF
Tuesday 28-Feb-17	18:30	SP37	45,163.462	SF

Published: 27/03/2017

Appendix 4 Accommodation

Hall	Rooms/Students
Edgbaston (formerly Block A)	95 (93 std + 2 flats)
Littlemore (formerly Block B)	9 (7 std + 2 en suite)
Maryvale (Formerly Block C)	84 (67 std + 15 en suite + 2 flats)
Oxford (formerly Block D)	5 (4 std + 1 flat)
Cofton (not yet occupied)	100

It is noted that Cofton Hall is not yet occupied and this has not been accounted for in the savings calculations relating to the halls. However it is assumed that all the accommodation is occupied on the basis of 1 student per room. The current assumption is that there are, at the time of writing, 193 students in the halls of residence.

Appendix 5 Rejected Opportunities

Opportunity 7	Centralise heat generation and install Biomass Boiler Plant				
Energy Saving kWh	Cost Savings £	Cost £	CO_2 Saving Tonnes	Simple Payback Years	ROI (%)
None	None	£700,000	272	None	None
Existing Situation	The site is heated by local gas fired boilers across the site. These boilers are responsible for the generation of most of the carbon dioxide from the use of natural gas on the site, the exception being the kitchens that currently use natural gas for catering. The new Cofton building will use natural gas for heating and domestic hot water production but incorporates CHP technology to generate heat and electricity in the building (supported by boiler plant when the thermal demand exceeds the CHP capabilities).				
Recommendation	Creating a central Energy Centre to provide heat to a site wide district heating system would enable to University to be heated centrally by biomass boiler (or CHP) plant. In reporting Biomass combustion the CO_2 emissions are regarded as zero[17]. It is estimated that the University could reduce its CO_2 emissions by approximately of 272 tonnes. There are, however, disadvantages of handling a solid fuel like biomass in that it is delivered by road, has to be stored in a dry bunker and the ash needs to be disposed of (similar to the logistics of a coal fired boiler plant). There will also be an increase in manpower for handling the fuel and disposing of the ash. Combustion of biomass can be in boiler or CHP set and with modern technology the equipment can be controlled to satisfy the needs of the university efficiently. Indications are, however, that biomass (wood pellets) would be more expensive than Natural Gas and whilst this project would reduce carbon emissions there would not be a payback.				

[17] "Within the Scope 1 conversion factors for biofuels, the CO_2 emissions value is set as net '0' to account for the CO_2 absorbed by fast-growing bioenergy sources during their growth". This is quoted from the UK Government GHG Conversion Factors for Company Reporting 2017/18 available to download from www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017. Scope 1 conversion factors are presented containing the values for N_2O and CH_4 emissions (which are not absorbed during growth) to give the emissions factors for CO_{2e}.