Energy & Carbon Plan 2019/20

Executive Summary

This energy plan reviews the current performance against the University target to reduce carbon emissions and sets out a plan for energy management and carbon reduction for the current year and up to 2020/21. This plan is a fundamental part of the University's ISO 50001:2011 certified Energy Management System. The University has reduced its carbon footprint by 38% since 2005 and is on target to meet a 50% reduction by 2020 provided the level of investment in energy and carbon saving is maintained. The Salix Revolving Fund has been increased and extra funding from Salix for larger projects continues to be sought.

There are still significant opportunities for further energy efficiency improvements and also for renewable energy investments. A greater emphasis on energy cost saving is required as prices have already risen sharply and are forecast continue to do so over the next 5 to 10 years. This will involve energy saving but also the investigation of alternative energy sources and systems with more predictable costs.

Recommended actions are as follows

1. Seek to continually improve energy management through ISO 50001.
2. Continue to seek energy saving opportunities and funding for same.
3. Improve tenant billing to make it more transparent and cost effective.
4. Continue to develop and improve the District Heating system.
5. Explore the feasibility of more on site generation including renewable energy options.
6. Develop a business case for energy storage both for the District Heating and for the campus HV electricity network.

Energy Planning

Significant Energy Uses

The majority of energy use on site is associated with buildings in the form of heating, lighting, small and large power use. There are also centralised IT servers (with a mirror on site for backup), a sewage works, an airport, and a street lighting network.

The building energy uses split out into offices, teaching and meeting spaces, research spaces and equipment, workshops, hotels, halls of residence, flats, family houses, aircraft hangars, bus depot, kitchens, restaurants and other eating outlets.

The energy to heat and power the buildings is delivered in a number of ways. Over 50% of the electricity for the campus is generated on site by a 1.4 MW combined heat and power unit and 1 MW solar PV farm. The CHP also provides the base load heat for a district heating system which supplies most of the buildings on the technical site part of the campus. A biomass boiler also provides heat to this district heating system with gas boilers providing back up. Other buildings including all residential buildings are heated with gas boilers. Only two buildings on the technical site are still heated with oil, opportunities are being taken to convert these to district heating when possible.

The new buildings being delivered as part of the Masterplan are beginning to have an impact on energy consumption. This includes the AIRC building, AIRC Test Cells, IMEC building, new Glasshouse and the FAAM buildings. Agri Tech, UKCRIC 1 and 2 buildings have just become operational and the DARTeC building is under construction.

There are 814 electricity meters monitoring demand. When grouping these into major loads and building loads, the top 40 users of electricity account for 76% of consumption, with the top 10 accounting for 39%.

The table below shows the top 10 electricity users with the year-on-year change.

Electricity use	18/19 kWh	Annual change
C052A	1,412,827	-4%
C052	1,022,109	-19%
IT Servers	847,630	-20%
C083	804,547	0%
C057	712,556	-1%
C085	651,761	10%
C239	627,190	-10%
C055	609,996	-4%
C300 Martell	574,647	3%
C070	483,001	-14%

The above top 10 electricity sites will be reviewed week on week using data from the University's Half Hourly Automatic Metering System. Graphs showing monthly consumption and annual totals are maintained on an ongoing basis.

There are 186 gas meters monitoring demand. Most (61.4%) of the gas imported is used to fuel the CHP which produced 54% of the electricity consumed in 17/18. Excluding the CHP, the top 10 users of gas account for 35% of natural gas consumption.

The tables below show the top 10 gas users with the year-on-year change (negative means usage has increased).

Gas use	18/19 kWh	Annual change
Gas for District Heating	5,926,484	23%
Gas for houses	4,221,377	7%
Lanchester	2,523,759	9%
Mitchell Hall	2,373,988	15%
CMDC	1,479,653	31%
Stringfellow	1,135,995	-4%
C300 Martell House	788,505	-23%
Conference Hotel	761,344	-24%
Test Area	685,275	-2%
Fedden	574,063	-6%

The "Beast from the East" snow in March 2018 had an adverse effect on 2017/18's results, as did a failure of the Biomass Boiler in the same month.

The top 10 gas sites will also be reviewed week on week using the gas supplier's Half Hourly data. Graphs showing monthly consumption and annual totals are maintained on an ongoing basis.

Energy Costs

Gas prices have increased by 6% this year compared with last, demonstrating the volatility of the energy markets. Electricity prices have also risen by 11%.

Energy Infrastructure

The District Heating network on site has allowed the use of low carbon heat, utilising the free heat from the CHP unit and also the output of the biomass boiler. Further expansion of the network as part of the Masterplan will allow more biomass to be used, preventing an increased reliance on gas. Expanding the network onto the residential side of the campus would facilitate a significant reduction in gas use.

The high voltage (HV) electricity network covers the entire campus (including residential as well as technical areas). There are 30 HV transformers on the network which are of varying age and condition. There are opportunities to replace some of these with more efficient versions, review their sizes and improve the way they are controlled to minimise losses.

Energy storage on both the heat and electricity networks would help maximise the use of renewable energy, smooth and reduce maximum demand and help optimise costs. The existing District Heating has a small buffer to deal with morning heating demand peaks. However, this is not sufficient for the expanding network and changes to the boiler house will provide the opportunity to review a more appropriate size of buffer.

There is currently no energy storage on the electricity network, however changes to time of day charges, an increasing power demand from new facilities and a requirement for greater resilience (backup) for key research and operations is making the case for a large scale battery system to be considered. This would also allow the expansion of onsite renewable energy generation whilst respecting the local district network operator's (DNO) requirement that there is no export of electricity from the site.

Energy Management

The Energy Management System has been updated to ensure compliance with ISO50001:2011. There is now a manual documenting how the system works, setting out responsibilities, the policy, the various procedures, tracking legislative changes to maintain compliance and setting a system for monitoring and targeting energy savings.

There are 39 statutory annual DECs (Display Energy Certificates) and 31 ten year DECs (excluding new builds). The annual DECs are updated each September.

The Carbon Reduction Commitment (CRC) reporting has now ceased but is being replaced by SECR (Streamlined Energy & Carbon Reporting). This includes business travel by car.

The internal recharging of costs and charging of tenants has been much improved recently but more work is needed to streamline the processes involved. The charges need to be reviewed on more regular basis. A model needs to be developed to account for all the costs involved.

The Energy Advisor and Energy & Environment Manager need to maintain training and CPD requirements to be qualified to undertake DEC and ESOS (Energy Saving Opportunities Scheme). Training is also provided to all staff and students (awareness training and online training).Training needs for FMs and Green Team members needs to be reviewed.

Monitoring and Targeting is being deployed on the operation of the District Heating and CHP with monthly reviews of performance. The maximum demand of the site is also being closely monitored and targeted during winter to minimise Triad charges. As described above the top 10 electricity and gas users are already monitored monthly and will now be monitored weekly too.

KPIs

The overarching KPI is the absolute target to reduce carbon emissions by 50% by 2020/21 from a 2005/6 baseline. This is equivalent to a 6% year on year reduction target since 2010. Energy costs as a proportion of turnover is another indicator which is under consideration. Over the last 5 years energy costs have reduced from 1.8% of turnover to 1.3%.

In 2010 HEFCE made certain capital funding conditional on Universities having a Carbon Management Plan and target for 2020 against a baseline of 2005. Cranfield University set a target of 50%.

The University has also signed up to the BEIS voluntary target to reduce CO_2 emissions by 30% from 2009 levels by 2020.

Energy and Carbon Saving Opportunities

Energy efficiency

Lighting is the main electrical load in some buildings. Replacing fluorescent lights with LED lighting and improved control can reduce this consumption by more than 50%. Opportunities to upgrade lighting to LED will continue to be sought. The current list of opportunities for LED upgrades includes Buildings 3, 30, 32, 70, 111, 122, 192, Conway House, Conference Hotel, Conference Centre Car Park and the Library**.**

Modern motors with improved control can significantly reduce the electrical loads associated with air handling and heating systems. BAM have been asked to identify opportunities as part of their operation and maintenance of the heating and ventilation on site.

The existing Johnsons BMS system for controlling temperatures is difficult to manage and optimise. Where possible it is being upgraded to a Trend system. In the meantime, the control of the District Heating is being more closely monitored and adjusted to reduce heat consumption and optimise the use of CHP heat and Biomass heat.

A new system for draught proofing windows has been trialled and will continue to be rolled out to other buildings (B044 and B042/042A).

As part of the IT strategy, the project to upgrade the University server estate has identified improvements in on-site technology and energy usage. The server replacement is estimated to save £50k pa in electricity costs. Additionally power saving measures have been introduced for the two High Performance research computers (Delta and Crescent) to put unused individual nodes into idle mode when not required.

Renewable energy

The new Solar PV array on the far side of the airfield has performed extremely well since becoming operational in April 2018. Output has been 20% higher than expected due to an exceptionally sunny summer.

The Biomass boiler operated well until Christmas but then broke down. Recent focus on the operation of the District Heating had helped to ensure that it is used more consistently to support the heating coming from the gas CHP unit. The option to replace or supplement the gas CHP needs to be investigated in the next few years. The gas CHP unit was fully renovated in August 2018.

The potential of Ground Source Heating to also supply the District Heating has been explored as part of a student project. If new buildings can be specified to operate with heating systems with low return temperatures then it may be possible to have the District Heating network supported by heat pumps. As heat pump technology develops and the grid becomes decarbonised then this becomes a more attractive low carbon option. This needs further investigation.

Solar Thermal systems have been added to new buildings to provide hot water and there is some scope to extend this to some existing buildings particularly where there is a significant demand for hot water and where electricity is currently used.

Large scale wind power is still the most cost-effective form of renewable energy for electricity generation. The options for siting a large wind turbine at Cranfield are limited. The main issue is the airport and the potential impact on instrumentation and radar systems. However, this should continue to be reviewed as technology develops which may overcome these issues.

Behaviour change

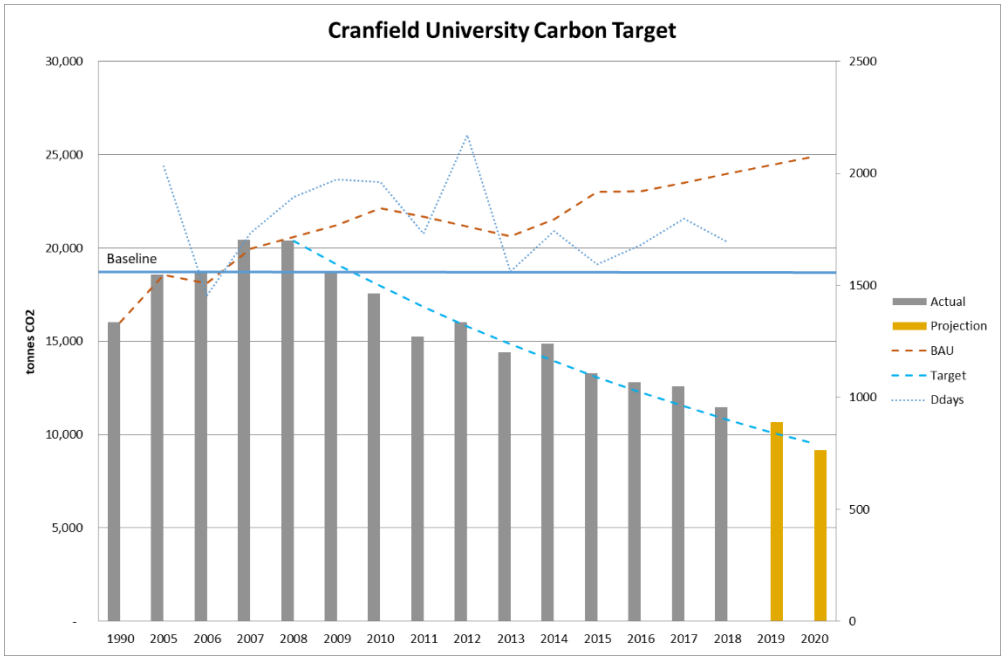
Alongside the University of Energy Policy there is an Energy Code of Practice which provides more detail for the interpretation of the energy policy. This helps manage expectations and ensure operations are efficient. This code is reviewed annually.

All staff and students are given awareness raising training either through presentation (students) or via online training (staff). Staff and students who are keen to volunteer to help improve the environment at Cranfield are organised in staff and student “Green Teams” and are supported to help with campaigns to save energy.

Meeting the 2020 Carbon Target

Review of Carbon Management Plan Progress

At the end of 2018-19 Carbon emissions are 38% lower than the baseline figure for 2005.



Note the years are University years. 2005 runs from August 2005 to July 2006. The 2020 target will not be delivered until July 2021.

The target is an absolute target which does not allow for the growth of the University or for weather and climatic variations. The Business As Usual (BAU) line on the graph illustrates what would happen if no energy saving measures had been undertaken and energy use allowed to grow in line with turnover. The degree days line also shows when we had colder years (2012 in particular) and the effect on progress can be seen.

There has been consistent investment in energy efficiency since 2010 using a Salix Revolving Fund to install more efficient lighting, pipe insulation, new compressors and better controls. This has been supplemented by larger projects to install a CHP (in 2011), improve the district heating network and install a Biomass boiler (2012 to 2014). In 2018 a 1MW Solar PV array was installed, combined with a large project to install LED lighting.

Completed Salix Projects

Energy efficiency projects committed this Salix Year 2019/20 (Apr-Mar) using Salix loans are summarised below:

Committed Date	Title	Carbon Saving / tCO_2e	kWh Savings	Project Costs	Annual Savings	Payback Time
31-May-19	B039 Microscopy Lab led lights	2.51	8,158	£12,082	£1,655	7.30
27-Jun-19	B056 Hyperbaric Lab Lighting	0.88	2,873	£1,860	£583	3.19
15-Jul-19	B111 District Heating Connection	114.75	609,103	£75,000	£19,546	3.84
19-Nov-19	B044 B042/42A Draughtproofing	4.3	20,207	£3,464	£1,552	2.23
28-Nov-19	B030 B122 and B316 led Lights	21.66	78,121	£73,591	£15,210	4.84
Totals		**144.1**	**718,462**	**£165,997**	**£38,547**	**4.31**

The annual summary of the Salix Revolving Green Fund Salix is shown below:

Commissioned (Salix Year)	No of Projects	Carbon Savings tCO_2e	Annual kWh Savings	Project Costs	Annual Savings	Payback / Years
2019/2020	5	17	60,385	£51,138	£9,378	5.5
2018/2019	5	149	310,380	£164,124	£32,114	5.1
2017/2018	4	91	210,942	£187,378	£37,029	5.1
2016/2017	4	49	154,979	£62,861	£12,3667	5.0
2015/2016	6	157	308,408	£173,588	£36,631	4.7
2014/2015	12	119	383,479	£124,265	£40,633	3.1
2013/2014	11	131	377,587	£136,290	£45,918	3.0
2012/2013	11	162	470,628	£194,209	£48,897	4.0
2011/2012	8	262	767,842	£208,862	£67,459	3.1
2010/2011	2	10	17,712	£6,487	£3,069	2.1
2009/2010	11	567	1,684,911	£217,901	£118,959	1.8
Totals	**79**	**1,713**	**4,747,253**	**£1,527,104**	**£452,754**	**3.4**

In addition to the above, the following one-off loan funded projects have been completed.

Completed	Loan	Project	Carbon Savings tCO_2e	Annual kWh Savings	Project Costs	Annual Savings	Payback / Years
Apr 2018	SEELS 2017	1 MW PV farm in field	439	1,037,660	£1,262,609	£211,683	6.0
Jan 2018	SEELS 2017	B052 LED Lighting Upgrade	56	128,262	£27,680	£26,165	1.1
Dec 2017	SEELS 2017	B114 LED Lighting Upgrade	29	64,989	£43,255	£13,258	3.3
Dec 2017	SEELS 2017	B083 LED Lighting Upgrade	25	57,976	£14,077	£11,827	1.2
Dec 2017	SEELS 2017	B070 LED Lighting Upgrade	4	9,903	£3,187	£2,020	1.6
Nov 2017	SEELS 2017	Lanchester LED Lighting	151	345,468	£208,881	£70,476	3.0
Sep 2017	SEELS 2017	B052 LED Lighting Upgrade	4	7,981	£4,896	£1,628	3.0
Jul 2017	SEELS 2017	B045 LED Lighting Upgrade	16	39,009	£36,892	£7,958	4.6
Mar 2015	HEFCE RGF	Biomass Boiler	527	20,767			6.5
Oct 2014	SEELS 6	District Heating Control	289	1,560,000	£242,520	£66,898	3.6
Mar 2013	SEELS 5	Pipe insulation	59	322,348	£27,075	£9,348	2.9
Mar 2013	SEELS 5	Cavity Wall Insulation	19	104,714	£16,158	£3,560	4.5
Mar 2013	SEELS 5	Martell BMS improvements	107	375,337	£43,354	£20,977	2.1
Mar 2013	SEELS 5	Adiabatic coolers	74	141,988	£127,443	£29,817	3.3
Nov 2012	SEELS 4	DH Pipework improvements	616	3,353,755	£638,772	£128,449	5.0
Jul 2010	SEELS 3	UPS Upgrade (IT Servers)	72	133,200	£71,362	£20,797	3.4
		Totals	**2,488**	**7,703,357**	**£3,768,160**	**£779,499**	**4.8**

Projection 2018 to 2020

Breakdown of projected carbon savings 2019-20 to 2020-21

Year	Project(s)	Details	tCO2 pa
2019-20	Salix Revolving Fund	various	150
	Grid factor	effect of cleaner grid	110
	Behaviour Change		50
2020-21	SEELS	Renewable energy	1500
	Salix Revolving Fund	various	150
	Grid factor	effect of cleaner grid	85
	Reduced CHP hours	Reduced running of CHP weekends	200
	Behaviour change		100
Total			**2,445**

Note this will result in just over a 50% overall reduction in CO2. A large SEELs proposal is factored in which will see improvements to the district heating, an additional biomass boiler, an extension to the solar farm and further LED lighting installed. The additional solar will necessitate reduced running hours of the CHP in summer resulting in further savings and the continued decarbonisation of the UK National Grid will also help. However, working against that will be any increased activity or expansion of the University. Weather influences will also be a big factor which could go either way.

Action Plan

The following actions were completed in 18/19.

Task	Description	Who	When
Maintain DECs	Update DECs annually	AM	Annual
Revise Tenant Billing	Monthly billing & review rates	AM/GE	Annual
Identify funding for de-steaming/DH	Funding identified with Salix, business case to be developed	GE/SS	Apr-19
Identify funding for BMS	Ongoing	GE/AM	
Investigate low temperature DH	Ongoing	GE/SE	
Identify funding for DH extension to Residences	Changes to residential estate have delayed this	GE/SS	Jul-19
Investigate Biomass CHP	No suitable system identified	GE/SE	Jul-19
Investigate solar & wind with storage	Costings for solar identified	GE	Jul-19

The immediate plan for the current year is set out below:

Task	Description	Who	By When
Maintain DECs	Update DECs annually	AM	Annual
Revise Tenant Billing	Monthly billing & review rates	AM/GE	Annual
Identify funding for solar farm extension along with LED projects	Develop business case for SEELs funding	GE	Dec-19
Identify funding for de-steaming/DH/Biomass boiler	Develop business case for SEELS/RHI funding	GE/SS	Apr-20
Identify funding for BMS for DH	Develop business case	GE/SE	Apr-20
Investigate energy storage (heat & electricity)	Produce feasibility study	GE/SE	Jul-20

Conclusions and Recommendations

Good progress is being made towards the University carbon reduction target. There are still significant opportunities for further energy efficiency improvements and also for renewable energy investments. Continued investment in these measures will result in the target being achieved.

Recommended actions are as follows

1. Seek to continually improve energy management through ISO 50001.
2. Continue to seek energy saving opportunities and funding for same.
3. Improve tenant billing to make it more transparent and cost effective.
4. Continue to develop and improve the District Heating system.
5. Explore the feasibility of more on site generation including renewable energy options.
6. Develop a business case for energy storage both for the District Heating and for the campus HV electricity network.