Energy Management System Manual

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1 Purpose

This document sets out the system to manage energy at the Cranfield campus and COTEC site in line with the International Standard for Energy Management Systems ISO 50001:2018.

This document is applicable to employees, students, visitors and contractors at the University's Cranfield campus and at COTEC.

2 Common Acronyms

ACRONYM	MEANING
ACI	Air Conditioning Inspection
BEE	Board for Energy and Environment
CHP	Combined Heat and Power System
CoP	Code of Practice
CO_{2e}	Carbon Dioxide equivalence
DEC	Display Energy Certificate
DH	District Heating System
E&E / EET	Energy & Environment Team
EMS	Environmental Management System
EnB	Energy Baseline
EnMS	Energy Management System
EnPI	Energy Performance Indicator
EPC	Energy Performance Certificate
PSU	Professional Service Units
SATM	School of Aerospace, Transport and Manufacturing
SHEE	Safety, Health, Environment & Energy
SOM	School of Management
SWEE	School of Water, Energy and Environment
ToR	Terms of Reference

3 Common Terms and their Definitions

TERM	DEFINITION
AMR – Automatic Meter Reporting	Automatic Half Hourly, or Daily, collection of meter data.
Biomass Boiler	960kW wood chip fed boiler used to support the District Heating system during the main heating season.
Boundaries	Physical or site limits and/or organisational limits as defined by Cranfield University
Continual Improvement	A recurring process which results in the enhancement of energy performance and the **Energy Management System**
CHP – Combined Heat and Power System	The University's 1.4MW gas powered system delivering 60% or more of the annual electricity demand and feeding the District Heating system on the Technical Site of the main campus.
Correction	An action to eliminate a detected **Non-conformity**
Corrective Action	An action to eliminate the *cause* of a detected **Non-conformity**
DH – District Heating System	The University's District Heating system on the Technical Site of the main campus including over 6km of pipework.
Energy	Electricity, Fuels, Steam, Heat, Compressed Air and other similar media
Energy Baseline	Quantitative references providing a basis for the comparison of **Energy Performance**
Energy Consumption	Quantity of energy applied
Energy Efficiency	Ratio or other quantitative relationship between an *output* of performance, service, goods or energy and an *input* of energy
Energy Management System EnMS	Set of interrelated or interacting elements to establish an **Energy Policy** and **Energy Objectives**, and processes and procedures to achieve those objectives
Energy Management Team	Person(s) responsible for the effective implementation of the Energy Management System activities and for delivering energy performance improvements
Energy Objective	A specified outcome or achievement set to meet Cranfield University's **Energy Policy** related to improved **Energy Performance**
Energy Performance	Measurable results related to **Energy Efficiency, Energy Use** and **Energy Consumption**
Energy Performance Indicator EnPI	A quantitative value or measure of **Energy Performance**, as defined by Cranfield University
Energy Policy	A statement by Cranfield University of its overall intentions and direction of the University related to its **Energy Performance**, as formally expressed by **Top Management**
Energy Review	A determination of Cranfield University's **Energy Performance** based on data and other information, leading to identification of opportunities for improvement

TERM	DEFINITION
Energy Services	Activities and their results related to the provision and/or use of energy
Energy Target	A detailed and quantifiable energy performance requirement, applicable to Cranfield University, that arises from the **Energy Objective** and that needs to be set and met in order to achieve this objective
Energy Use	Manner or kind of application of energy
Interested Party	A person or group concerned with, or affected by, the **Energy Performance** of Cranfield University
Internal Audit	A systematic, independent and documented process for obtaining evidence and evaluating it objectively in order to determine the extent to which requirements are fulfilled
Non-conformity	Non-fulfilment of a requirement
Preventive Action	Action to eliminate the *cause* of a potential **Non-conformity**
Procedure	A specified way to carry out an activity or a process
Record	A document stating results achieved or providing evidence of activities performed
Salix	Salix Finance Ltd. provides interest-free Government funding to the public sector to improve their energy efficiency, reduce carbon emissions and lower energy bills. Salix is funded by the Department for Business, Energy and Industrial Strategy, the Department for Education, the Welsh Government and the Scottish Government and was established in 2004 as an independent, publicly funded company, dedicated to providing the public sector with loans for energy efficiency projects.
Scope	The extent of activities, facilities and decisions that Cranfield University addresses through its **EnMS**, which can include several **Boundaries**
SHEE Committees	Quarterly Safety, Health, Environment and Energy Committee Meetings for each School to review performance in each of these sectors.
Significant Energy Use	Energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement
Top Management	The person or group of people who direct and control Cranfield University at the highest level

ISO 50001 Energy Management System Requirements

4 Context of the Organisation

4.1 Understanding the Organisation and its Context

Cranfield University is a wholly postgraduate institution, world-renowned for its transformational teaching and research conducted at its Cranfield campus at Wharley End, Bedfordshire and at the Shrivenham Defence Academy site in Oxfordshire. In addition to classroom-based learning, the University operates industrial-scale research facilities and has superior links with industry and commerce. Part of its Shrivenham activities include Cranfield Ordnance Test and Evaluation Centre (COTEC) on the edge of Salisbury Plain, at Gore Cross near West Lavington, Wiltshire. Energy use at Shrivenham is controlled by the Ministry of Defence, but the COTEC site is responsible for its own energy use. The University's education and research activities can be split into the following themes: Water; Agrifood; Energy and Power; Aerospace; Manufacturing; Transport Systems; Defence and Security; and Management. The education and research activities at Cranfield are supported by a number of Professional Service Units which provide operational support to the Schools.

External Issues

Issue	Comment
Electricity Export	This is banned by the local DNO. Cranfield University generates its own electricity from a CHP system, a large PV Farm, and several roof top PV installations. There are times, e.g. summer weekends, when on-site production can exceed on-site demand. In those situations, the CHP output is automatically modulated down, but that can only be taken as low as 50% before risk damaging the CHP engine, after which it has to be turned off. Although it does not help with energy efficiency, to further reduce carbon emissions it is planned to increase the amount of onsite production. Care will continue to have to be taken to ensure appropriate controls and operating procedures are in place to avoid any export to the grid. Failure to do so will result in significant costs.
Carbon Savings vs Cost Savings	The National Grid has now become so clean that it creates less CO_2 emissions than the University's gas-powered CHP engine. From a carbon perspective, when the CHP heat output is not needed, it would be better to turn off the CHP. However, from a cost point of view it remains better to continue maximising the use of the CHP electrical output. This has no impact on total kWh or energy efficiency but has a potentially negative impact on emissions and the ambition to be "net zero" carbon by 2030.
Degree Days	Colder than average winters will create extra demand for heating and thus increase energy demand in order to provide suitably comfortable working conditions. As the effects of Climate Change continue to increase it is also possible that hotter than average summers will cause increased energy demand for cooling.

Issue	Comment
Student, Partner and Government Expectations	Both students and business/research partners increasingly want to attend or work with organisations which can clearly demonstrate that energy efficiency and the minimisation of greenhouse gas emissions are taken seriously. Similarly, the UK Government has set CO_{2e} emissions targets and expects organisations it funds to support those targets. Failure to make further progress on this risks losing business and a reduction in student numbers.
Global Pandemics	Global pandemics, such as Covid-19 in 2020, may result in a much-reduced income affecting the University's ability to support new energy efficiency projects. The negative effect of that is likely to be much greater than any temporary reduction in energy bills due to much lower usage. Controlling virus spread within the University buildings is now a key issue and may result in changes to the way that HVAC plant has to be run. In particular it is possible for Air Conditioning systems to become a method by which air borne infections are spread and may mean they should not be used if possible, or that they should be run all the time to avoid concentrations of the virus building up. At the time of writing further guidance is necessary.

Internal Issues

Issue	Comment
Old Buildings	The history of Cranfield University, developing from a WW2 RAF base, means many of its buildings are now very old, were not built with energy efficiency in mind, and are used for purposes which were never originally intended. In some cases, the only way to make such buildings really energy efficient would be to knock them down and rebuild but that is not always possible. In such cases maximising insulation and upgrading old plant is the best that can be done.
New Buildings	Cranfield University has a Master Plan which includes the construction of new buildings and test facilities. Whilst new buildings are specified to much higher energy efficiency standards than old buildings, and some older buildings are demolished this will tend to increase absolute overall energy demand. Every new building is an opportunity to make it as energy efficient as possible with the most up to date control functionality. However, there are also issues that when a building is planned the detail of exactly how it will be used has not been finalised and may change after the contract is let. Budgetary constraints will also limit which technologies can be deployed.
New Research Contracts and Experiments	The University works closely with industry and some of the contracts require energy intensive equipment to be used either intermittently or 24/7, sometimes for many weeks, months or even years at a time. Inevitably this will increase both absolute energy demand and the kWh/m^2 for those locations when this occurs. Examples of such facilities include three large wind tunnels, aircraft engine test cells and large-scale compressors. These are all detailed in the High Energy Use Equipment Register.

Issue	Comment
Finance – Loans and Credit Ratings.	The University is able to take advantage of interest free loans from Salix but all such projects have to meet Salix's strict requirements on payback times and the cost per tonne of CO_2 saved. These loans include the annual Revolving Green Fund and one-off SEELS loans. Whilst the former can now have 8-year paybacks the University itself prefers to achieve a 5-year payback to help maintain a good credit rating. Similarly, whilst 5-year SEELS loans can be for multi-million £ projects the University may be reluctant to take on such loans depending on the prevailing financial situation.
Failure of key plant	The CHP engine, PV farm, biomass boiler and steam boiler are all single points of failure with no like for like replacement on site. If the PV farm or CHP fails the lost electricity supply will be made up by importing more electricity from the National Grid, whilst gas boilers will make up the missing CHP heat supply (although overall gas imports may reduce as the CHP is no longer demanding gas.) If the biomass boiler fails gas boilers will make up the missing biomass sourced heat supply. If the steam boiler fails the only alternative at present is to provide extensive electric heating. The steam infrastructure is also a maintenance liability due to the corrosive nature of a steam supply.
Maximum Demand on Site	If all of the SEU equipment at the Cranfield Campus were turned on simultaneously there is a risk that the resulting load would be greater than the private wire network on site could support resulting in a site wide black out. At present the risk of that is very, very small but a process needs to be agreed with Engineering and the Technical Support Services team to ensure it cannot happen. This will become a greater risk if more SEU equipment is added to the Campus facilities.

4.2 Understanding the Needs and Expectations of Interested Parties

Interested Party	Requirements	Addressed through the EnMS
UK Government and Local Authorities	To meet all legal obligations and support emission reduction targets.	Fully met and recorded via the Obligations Register which details all relevant legislation and summarises how the University complies with those obligations.
Cranfield University Council, the Executive Committee and the Board for Energy and Environment.	To ensure all legal requirements are met and that internal targets for energy efficiency are being met.	The Obligations Register includes all these requirements. In addition, annual and quarterly reports are provided to the Senate, Executive and BEE as required.
Staff and Students	To provide a comfortable work environment whilst also meeting good environmental and energy practice.	Operational controls and systems achieve the comfort requirements whilst the University's EnMS and EMS seek to achieve good practice.
Partners and Customers	To meet good environmental and energy practice.	The University's EnMS and EMS seek to achieve and demonstrate good practice, certified to ISO 50001 and ISO 14001 respectively.
Tenants at Cranfield Campus	To provide a comfortable work environment whilst also meeting good environmental and energy practice. Timely and accurate billing.	Operational controls and systems achieve the comfort requirements whilst the University's EnMS and EMS seek to achieve good practice. Monthly and quarterly billing processes.
Non-Tenants supplied with electricity from the University Private Wire Network	Continuity of electricity supply. Timely and accurate billing.	Processes to ensure site demand does not exceed the infrastructure capacity or the maximum capacity agreed with the DNO. Monthly and quarterly billing processes.
Local DNO (UK Power Networks)	No export of electricity from the site.	Control systems are in place on the CHP such that if the combined PV and CHP output could exceed site demand the CHP modulates back up to 50% and then turns off. Any new production on site needs similar controls.
On Site HVAC Contractor (BAM)	To be aware of how Cranfield University wants the HVAC used tp be as energy efficient as practical.	Fully discussed in Section 8. Weekly RAG reports and monthly Review meetings
Neighbours	That Cranfield University will not cause unnecessary or avoidable annoyance.	Energy use is largely invisible to the University's neighbours. However, consultation takes place as required on significant projects which may cause a visual annoyance, such as the PV Farm.

4.2.1 Identification of Relevant Legislation

New legislation pertinent to the University will be ascertained via the Energy Legislation Hub, Environmental Association of Universities and Colleges (EAUC), and by subscription to monthly legal update services from Cedrec. The National Archives will also be consulted for full versions of legislation.

The Compliance Obligations Register MS Access Database includes all Energy Legislation and other requirements applicable to Cranfield University. It is maintained and updated as required, and at least annually, by the University's Energy Advisor. The Register is shared with the EMS.

Compliance with specific EPC, DEC and ACI requirements is monitored and recorded in a separate MS Access database "DEC_EPC_ACI.accdb".

4.2.2 Responsibilities

The Energy and Environment Team will amend as necessary any relevant University documentation and provide information regarding changes to energy regulations and other requirements to the relevant people.

It is the responsibility of various departments to ensure that the requirements of relevant legislation and other requirements are implemented by appropriate staff and/or students within their own Professional Services Unit. E.g. Campus Services are responsible for domestic EPCs; Facilities are responsible for commercial EPCs, DECs and Air Conditioning Inspections; the Development Team are responsible for new build EPCs.

Progress of implementation of new or revised legislation will be included in Management Reviews of the EnMS.

4.2.3 Ensuring Compliance

Compliance with legislation and other requirements is ensured via several processes operating across the University as well as via a formal review. These include:

- An annual review of compliance against all applicable legislation and other requirements included within the Compliance Obligations Register Database;
- The DEC_EPC_ACI.accdb database is regularly checked by the Energy Advisor. In particular it is always updated when the new annual DECs are produced each year.
- Weekly RAG reports and monthly meetings ensure that BAM are performing the necessary checks and following the correct operational procedures.
- Monthly and quarterly billing runs to a strict internal deadline set by finance and they will chase up if any bills are missing or look incorrect.
- Internal auditors taking account of applicable legislation and other requirements when undertaking internal audits;
- Planned preventive maintenance of equipment to ensure continued normal operation;
- Training of employees to ensure work is undertaken in line with appropriate procedures and codes of practice;

It is the responsibility of all staff and students to notify the Energy and Environment Team of any energy waste through the appropriate reporting mechanisms.

It is the responsibility of the Energy and Environment Team to bring to the attention of relevant managers/academics/senior management (as appropriate) any instances of legislation being breached and vice versa.

4.2.4 Related Documents and Websites

Document	Location
CU-ENV-REG-05_Compliance_Obligations_Register_Database.accdb	Y:\SHEE Management\Environment\REGISTERS
DEC_EPC_ACI.accdb	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements
Energy Legislation Hub	http://www.energylegislation.co.uk/
Environmental Association of Universities and Colleges (EAUC)	http://www.eauc.org.uk/
Cedrec Environmental	https://cedrec.com/energy/index.htm
National Archives	www.legislation.gov.uk

4.3 Determining the Scope of the Energy Management System

The scope of the EnMS includes all the activities, operations and services associated with employees, students and visitors at the Cranfield campus and COTEC site that are covered by the Carbon Management Plan. That plan covers electricity, heating, process fuels and on-site vehicle fuels for the whole University estate but excluding Shrivenham Campus (where the MOD control energy efficiency, use and consumption).

Cranfield University has approximately 3,200 students and 1,300 staff at any one time, on the Cranfield campus. In addition, approximately 14,500 people attend short-courses each year.

The layout of the Cranfield campus is shown on the centrally published Cranfield University maps. Energy use at COTEC is less than 1% of the total energy use.

4.4 Energy Management System

This manual describes Cranfield University's EnMS.

4.5 Related Documents

Document	Location
ISO50001 Manual CU-SHE-PROC3.48 Energy Management System Manual.doc	Y:\SHEE Management\Energy\4.4) Energy Management System (CoP and Manual)\ISO50001 Manual
Cranfield Campus maps (Intranet)	https://intranet.cranfield.ac.uk/about/Pages/CampusMaps.aspx
Cranfield Campus maps (Extranet)	https://www.cranfield.ac.uk/about/how-to-find-cranfield

5 Leadership

5.1 Leadership and Commitment

The Board for Energy & Environment (BEE) is a formal sub-committee of the University's Executive. It reports to the University Executive on energy and environmental issues, including the following areas:

- Energy and Environmental standards, including ISO 50001 and ISO 14001
- Energy and Environmental legislation
- Water management, including drainage
- Sustainable buildings and infrastructure
- Biodiversity including Grounds Management
- Sustainable procurement, including Fairtrade
- Energy management
- Carbon management
- Sustainable travel
- Waste minimisation and recycling
- Pollution minimisation
- Community Involvement

Authority

The BEE has delegated authority from the University Executive to:

i. drive continual improvement in environmental performance in line with the University's strategic aims;

ii. ensure compliance with existing energy and environmental legislation;

iii. realise recurrent cost savings and reduce financial risk related to utilities;

iv. progress links between Cranfield's academic business in energy and environment and the performance of its Estate regarding corporate sustainability; and

v. enhance Cranfield's reputation by demonstrating a leading capability in environmental performance.

The BEE may establish sub- or working groups as required to fulfil its duties.

BEE Responsibilities

The Board's responsibilities are to:

- formulate and recommend to the University Executive energy and environmental policies, procedures and programmes for implementation, to achieve compliance with legislation, permits, consents and good practice;
- ensure the full implementation of the energy and environment policies, procedures and programmes by means of monitoring and audit, and reporting to the University Executive;
- take appropriate action where policies, standards or targets are not being met;
- recommend to the University Executive the level of resources required to facilitate effective energy and environmental management at the University;
- integrate energy and environmental management system requirements into University business processes;
- receive progress reports from the Energy and Environment Team, and relevant Cranfield bodies and working groups on compliance with policies and progress of programmes;
- support the development and sharing of good practice;
- develop and deliver an action plan, identifying priorities from within the terms of reference;
- review progress against the plan at each Board meeting; and

- develop, implement and monitor a University Carbon Management Plan and report to University Executive and Council.

Specifically, for ISO 50001 the Board:-

a) identified the scope and boundaries addressed by the EnMS

b) approves the Energy Policy before it is sent to the Vice Chancellor for sign off and ensures that the energy objectives and targets are established and remain compatible with the strategic direction of the University and appropriate to its purpose

c) ensures the EnMS requirements are integrated into Cranfield University's business processes

d) ensures that action plans are approved and implemented

e) ensures the necessary resources for the EnMS are made available

f) communicates to those in the University the importance of effective energy management and of conforming to the EnMS

g) ensures that the EnMS achieves its intended outcomes

h) promotes continual improvement of energy performance and the EnMS

i) ensured the formation of the energy management team, as part of the EE Team

j) directs and supports people to contribute to the effectiveness of the EnMS and to energy performance improvement

k) supports other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility

l) ensures the EnPIs appropriately represent the energy performance of the University

m) ensures processes are established and implemented to identify and address changes affecting the EnMS and energy performance within the scope and boundary of the EnMS.

Frequency of BEE meetings

The Board meets at least quarterly on a timescale that allows onward reporting to the Cranfield Executive and to Council, as necessary.

Papers presented to BEE are retained and decisions agreed in the meetings minuted. Minutes are published on the Intranet under Environmental Reporting.

https://intranet.cranfield.ac.uk/EnergyEnvironment/Pages/EnvironmentalReports.aspx

Membership

The membership of the BEE will usually comprise:

- Chair (appointed by Executive, normally from Senior Academic Staff)
- Executive Lead for Energy and Environment;
- University Finance Director;
- Director of Facilities;
- Director of Finance and Operations (CDS)
- Energy and Environment Manager;
- Environment Advisor;
- Energy Advisor
- an additional member of the Professional Services Executive;
- a member of academic staff (normally early career academic);
- a member of Campus Services; and
- a member nominated by the Cranfield Student's Association.

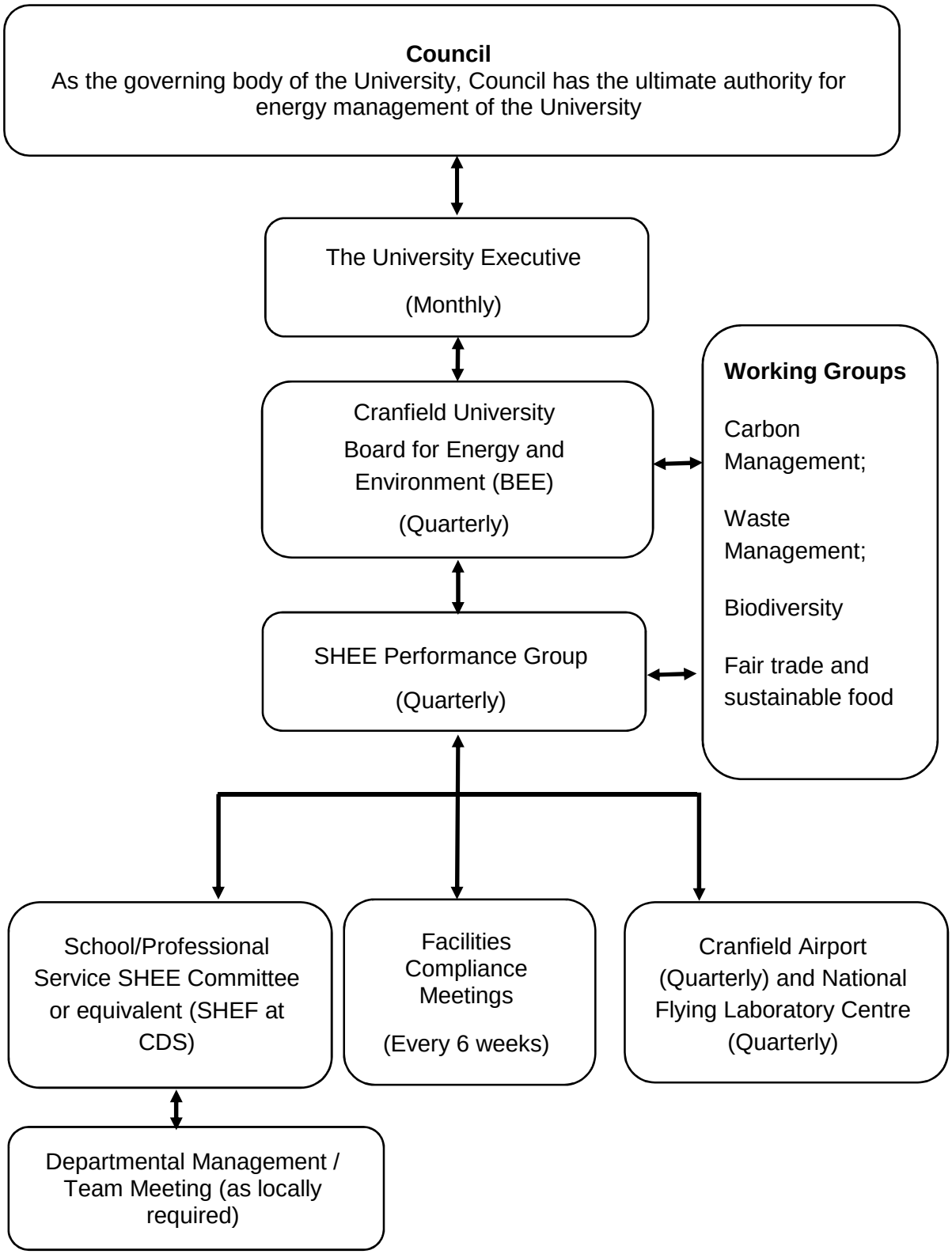
The BEE may, as required, co-opt additional members and invite attendees. The Chair is normally a three-year term.

BEE members represent a cross section of Cranfield University's activities and functions at a senior level. Membership of the Board changes over time, especially the student representative and Chair. The current make up is recorded in the Excel spreadsheet "ISO50001 People.xlsx".

5.1.1 Related Documents

Document	Location
BEE Papers and Minutes	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Board for Energy + Environment\BEE Meetings
ISO50001 People.xlsx	Y:\SHEE Management\Energy\5) Leadership

Figure 1 Governance structure for Energy Management at Cranfield University.



5.2 Energy Policy

The Energy Policy is reviewed and updated annually at BEE meetings, where it is signed off by the Chair of BEE. It is then sent to the Vice-Chancellor for approval and signature. The Energy Policy is a written statement of the approach of the University regarding the management of energy and its compliance with the requirements of ISO 50001. The University's Energy Policy Statement is made available to all members of staff and students, and may be viewed on University notice boards and on the University's intranet or external website.

The Energy Policy Statement documents the University's commitment to continual improvement in energy performance, and the aim to reduce absolute carbon emissions to 50% of 2005 levels by July 2021.

5.2.1 Related Documents

Document	Location
CU-ENV-POL-02 Energy Policy Statement	Y:\SHEE Management\Energy\5.2) Energy Policy Intranet: https://intranet.cranfield.ac.uk/EnergyEnvironment/Pages/Carbon-home.aspx and click on "University Energy Policy" in the "Further Links" box External website: https://www.cranfield.ac.uk/about/environmental-credentials/carbon-and-energy-management and clicking "Download our Energy Policy Statement".

5.3 Organisational Roles, Responsibilities and Authorities

The key roles within the Energy and Environment Team are:

- Energy and Environment Manager
- Energy Advisor
- Environment Co-ordinator

The relationship of these roles to management is shown in Figure 1 above. The Energy Advisor and Environment Co-ordinator report to the Energy and Environment Manager, who in turn is line managed by the Director of Facilities. All four sit on BEE. The responsibilities of these positions are described below.

Energy & Environment Manager

- Acting as the main link between the Energy Advisor and Board for Energy and Environment.
- Formulating and recommending to the Board, energy and environmental policies, procedures and programmes for implementation, to achieve compliance with legislation and good practice.
- Ensuring the full implementation of the energy and environment policies, procedures and programmes by means of monitoring and audit, and reporting to the BEE.
- Taking appropriate action where standards or targets are not being met.
- Receiving progress reports from the Energy and Environment Team, and relevant Cranfield bodies and Working Groups on compliance with policies and progress of objective programmes.
- Supporting the development and sharing of good practice.
- Allocating budgets for training and EnMS maintenance.

Energy Advisor

The Energy Advisor ensures the efficient running, management and continual improvement of the EnMS and compliance with relevant legislation and ISO50001 at all times. Key specific responsibilities include:

- Overall responsibility for facilitating the implementation of and promoting continual improvement of the EnMS at the Cranfield campus.
- Advising and assisting senior management on the development and implementation of the Energy Policy, Objectives and Targets.
- Preparing and delivering reports covering the status of the EnMS including energy compliance, progress against Objectives and Targets, system audits and corrective action status for consideration during the management review process.
- Developing and implementing procedures and/or work instructions to ensure that all necessary data are collected, recorded and reported to ensure statutory compliance.
- Ensuring EnMS documentation is established and maintained.
- Developing and maintaining a register of energy intensive equipment
- Promoting energy efficiency.
- Managing EnMS surveillance audit visits by the external certifying body and arranging for internal audits to take place.
- Ensuring energy awareness of all staff and students is kept up-to-date including, where appropriate, delivery and making records of general and specific energy training.
- Management of non-conformity issues from audit reports and other sources in collaboration with relevant staff.
- Maintaining an up-to-date knowledge of UK and European energy legislation and informing/advising management on compliance.

Environment Co-ordinator

The Environment Co-ordinator supports behaviour change programmes, communications, information system management and re-charging. Key specific responsibilities include:

- Delivering a behaviour change programme covering carbon reduction, recycling, sustainable transport and other environmental improvements.
- Communicating progress on energy and environmental improvements to University staff and students and also externally.
- Maintaining an information system covering the data required to comply with statutory requirements and University targets for Carbon, Energy and Environment.
- Supporting the recharging of electricity and water on Cranfield Campus

6 Energy Planning

6.1 Actions to Address Risks and Opportunities

This EnMS Manual defines the energy planning process which is designed to lead to continually improved energy performance, taking account of the external and internal issues detailed in Section 4.1, and the expectations of interested parties detailed in Section 4.2.

The key points to note are:

1) All energy use is recorded in the Energy Manager Database from SystemsLink. The underlying data is sourced from a number of different routes:-

   a. Automatic Meter Readings (AMR)
   b. Manual Meter Reads
   c. Oil Dips
   d. Invoice Data

The AMR is provided by a number of different systems:

Utility Type	AMR System	Comment
Electricity; Gas; Heat; PV; Solar Water;	Name: MeterRingMM Supplier: Elcomponent Name: IQ or 963 BMS Supplier: Trend Name: Johnson BMS Supplier: Johnson Controls	An automatic data collection module runs in SystemsLink Energy Manager to pick up the half hourly data provided by MeterRingMM and the Trend 963 BMS system. There are also meters connected to the Johnson Controls BMS from which half hourly data can be downloaded. In future more data will come from the Trend IQ BMS which will replace Trend 963 and send a daily file by FTP to SystemsLink for downloading into Energy Manager. Where practical, meters communicating via battery driven radio transmitters are being replaced with either LAN connections or MODBUS radio solutions. Battery radio transmitters only have a life 6-7 years and are replaced as they show signs of expiring. New meters use LAN unless it is prohibitively expensive to do so, when MODBUS Radio is used instead.
Electricity;	Name: MeterRingMM Supplier: Elcomponent	Meters monitoring the main incomers to buildings (i.e. NOT building sub-meters except where PV has to be considered) also have their data FTP'ed daily to SystemsLink. This enables Smart Spaces warnings to be set up to send alerts of any unusual usage.

Utility Type	AMR System	Comment
Electricity	Name: MainsTalk Supplier: Energy Controls	This is now only used for Housing Meters in the three Closes. Other houses were transferred to the Elcomponent system as the LV infrastructure was upgraded. MainsTalk is an increasingly temperamental system to maintain with the meter transmitters beginning to fail after over 10 years' use. Spare meters have been retained from earlier upgrades and from building demolitions.
Electricity	Name: Focus PAYG Supplier: Energy Controls	Only used for Housing Meters where the MainsTalk system has failed before Elcomponent took over.
Electricity	Name: SavenergyOnline Supplier: Stark	Used to download the half-hourly profile data for the 2 Main Incomers on Cranfield Campus (MIE1 and MIE2) and the Martell House incomer (MH001). This data is FTP'ed direct to SystemsLink for downloading to the Energy Manager database.
Gas	Name: Total Gas and Power Supplier: Total Gas and Power	All 21 of the main gas meters on site are now supplied with half hourly data from TGP which is FTP'ed to SystemsLink. 126 of the 128 domestic houses where Cranfield University owns the gas account now also have Smart meters installed and half hourly data for those is now also being received via an FTP to SystemsLink. The other 2 pre-existing meter types currently have no industry solution to provide AMR and those will not provide half hourly data until the industry identifies a solution. 7 domestic properties have assured/protected tenants who maintain their own gas accounts.

2) The Main meters and other records which sum together to give the total energy use on site are detailed in the SystemsLink Energy Manager database, split by type into: Electricity, Gas, Biomass, Aviation Fuels (AVTUR and AVGAS), Solar Water, LPG, Oil, Petrol and Diesel. New meters are added as required to ensure adequate coverage in sufficient detail for all buildings. Meters are closed when buildings cease to be used but the data is retained to ensure a full history is maintained.

3) DEC results and total energy use guide the University's planning to identify the most inefficient buildings, taking into account any process loads which inherently warp the DEC results due to the energy intensity of the processes involved. The top ten heaviest energy usage areas are identified in "Energy & Carbon Plan 2018-19.doc". DEC results are summarised in the MS Access database "DEC_EPC_ACI.accdb" (which also includes all EPC and Air Conditioning Inspection reports).

4) There is an annual Salix planning cycle to identify potential projects across the University which can use the Revolving Green Fund to pay, or partly pay, for new energy efficiency work. This fund has £397,900 in total, the amount available per

annum is dependent upon previous projects and the repayments made against them. An MS Access database of potential projects is maintained in "SalixProjects.accdb" with new possibilities added and researched throughout the year and then prioritised for funding.

5) Salix also makes available occasional larger scale SEELS funding for specific projects which the University bids for as and when the opportunity arises. This can be used for large infrastructure projects that reduce the risk of single point of failures and enhance the robustness and security of the energy supplies e.g. expanding PV or biomass facilities and removing steam from the District Heating system.

6) Degree Day data is used when reviewing heating energy performance to ensure as much of a like-for-like assessment as possible is done when comparing performance across several years.

7) A record of intensive "Process" energy loads, as distinct from "General Office" energy use, has been created in the "High Energy Use Equipment Register.xlsx".

Issues	Risks and Opportunities
Electricity Export not permitted	Care will continue to have to be taken to ensure appropriate controls and operating procedures are in place to avoid any export to the grid. Failure to do so will result in significant costs.
Carbon Savings vs Cost Savings for the CHP	Running the CHP full time minimises the cost of electricity to the University but the National Grid is now cleaner the CHP electricity production creating a tension between minimising costs and minimising CO_2 emissions when the heat from the CHP is not needed.
Degree Days	Colder winters and hotter summers will increase demand for heat and cooling respectively, thereby increasing energy demand. It is most likely that Climate Change will drive hotter summers so maximising the efficiency of cooling methods will give long term benefits.
Student, Partner and Government Expectations	Continuing to improve the University's EnMS and maintaining ISO 50001 certification will help to meet all these expectations which should help secure future funding and maintain or boost student numbers.
Global Pandemics	These may affect University income and can severely disrupt the usual methods of working. Closed buildings do not use zero energy unless everything is shut down completely. New ways of working may also be needed. Buildings may have greatly reduced occupancy but still require full heating or cooling. Air Conditioning equipment, unless it can be turned off entirely to stop virus spread throughout a building, may need to run constantly to stop the virus building up inside it.
Old Buildings	Maximising insulation and upgrading old plant will help to make these old buildings as energy efficient as practical.

Issues	Risks and Opportunities
New Buildings	Every new building is an opportunity to make it as energy efficient as possible with the most up to date control functionality. However, there are also issues that when a building is planned the detail of exactly how it will be used has not been finalised and may change after the contract is let. Budgetary constraints will also limit which technologies can be deployed.
New Research Contracts and Experiments	Some of the University's contracts and research requires energy intensive equipment to be used either intermittently or 24/7, sometimes for many weeks, months or even years at a time. Inevitably this will increase both absolute energy demand and the kWh/m^2 for those locations when this occurs.
Finance – Loans and Credit Ratings.	The University is able to take advantage of interest free loans from Salix but also needs to protect its Credit Rating by not having too much debt.
Failure of key plant	The CHP engine, PV farm, biomass boiler and steam boiler are all single points of failure with no like for like replacement on site. If the PV farm or CHP fails the lost electricity supply will be made up by importing more electricity from the National Grid, whilst gas boilers will make up the missing CHP heat supply. If the biomass boiler fails gas boilers will make up the missing biomass sourced heat supply. If the steam boiler fails electric heating has to be used. The steam infrastructure is also a maintenance liability due to the corrosive nature of a steam supply.
Maximum Demand on Site	If all of the SEU equipment at the Cranfield Campus were turned on simultaneously there is a risk that the resulting load would be greater than the private wire network on site could support resulting in a site wide black out. At present the risk of that is very, very small but a process needs to be agreed with Engineering and the Technical Support Services team to ensure it cannot happen. This will become a greater risk if more SEU equipment is added to the Campus facilities.

6.1.1 Related Documents

Document	Location
Energy & Carbon Plan	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\Energy and Carbon Plan
SalixProjects.accdb	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\7 SALIX EVERYTHING BUT FINANCE\AA Database
High Energy Use Equipment Register.xlsx	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\High Energy Use Equipment and Photos
DEC_EPC_ACI.accdb	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements

6.2 Objectives, Energy Targets and Planning to Achieve Them

An annual Energy and Carbon Plan is produced to identify the key objectives, targets and action plans supporting achievement of the EnPIs detailed below.

This plan identifies the top 10 areas of electricity and gas use with focus on the largest loads.

39 buildings require annual DECs to be completed by the end of October and these results are compared with previous years and the information fed back to the main users of those buildings via regular quarterly SHEE meetings.

In some areas there are extremely energy intensive processes which are used on a highly variable basis depending upon the nature of the current research or requirements of companies hiring those facilities (8 x 6 wind tunnel, 8 x 4 wind tunnel, icing wind tunnel, the Test Area's 1MW compressors and AIRC Test Cell). Usage of that equipment is specifically monitored to assess its contribution to the overall energy performance of the organisation. See the register of High Energy Use Equipment detailed below.

Whilst specific action plans will vary from year to year, certain common themes continue from one year to the next:

- Use of SALIX and other capital funds to replace equipment with more energy efficient versions – in particular there is still great scope for replacing fluorescent lights with LEDs and to upgrade the lighting control systems. A database of potential SALIX opportunities is maintained to ensure the annual Revolving Green Fund is spent within the SALIX year (April to March).
- Improvements to motor controls used in air handling and heating systems
- Ensuring building heating patterns continue to match the occupancy hours
- The site HVAC contractor, BAM, has a contractual obligation to identify opportunities for achieving 5% annual energy savings as part of their normal duties
- Ensure use of the CHP heat and biomass heat is optimised to minimise the gas used to supplement the District Heating system.

Primary responsibility for delivering the overall Annual Action Plan rests with the Energy and Environment Manager and the Energy & Environment Team, supported by the Engineering Team.

The improvement in energy performance will be measured and verified using the meters and sub-meters relevant to the area and utilities concerned, as recorded in the SystemsLink Energy Manager database.

6.2.1 Related Documents

Document	Location
Energy & Carbon Plan	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\Energy and Carbon Plan
SalixProjects.accdb	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\7 SALIX EVERYTHING BUT FINANCE\AA Database
High Energy Use Equipment Register.xlsx	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\High Energy Use Equipment and Photos

6.3 Energy Review

Every month a report is prepared to identify total annual carbon emissions to date and a revised forecast of savings to the end of the University's financial year (end July). These monthly reports are reviewed every quarter at the BEE meetings to assess progress against the overall carbon emissions target for July 2021.

The report uses the official Government figures for Scope 1 and Scope 2 carbon emissions per kWh or per litre for each fuel type used by the University. It should be noted that for electricity, the Transmission and Distribution emissions are also included. The total kWh for each fuel type is recorded in the SystemsLink database.

In addition, there are quarterly Safety, Health, Environment and Energy (SHEE) meetings held with the University schools at which the energy use in those departments' key buildings and/or processes (as appropriate) is reported. These reports cover electricity, gas and district heating use.

Previously District Heating kWh assigned to each building was solely based on a percentage share of the total District Heating input based on the Gross Internal Floor area of each building. Great progress has been made getting regular data form the heat meters installed in nearly all the buildings on the DH system. These continue to be actively investigated and monitored to identify gaps and to add them to the AMR system where they are missing. Progress is monitored at monthly District Heating meetings with Engineering and BAM. Where heat meter data is available that is now used to assign heat demand. Remaining buildings still use the "percentage based on GIA sq. m approach" allowing 5% for network losses.

Building reports compare present usage with the previous 3 years' worth of data (where available) to help identify any issues and to review the results of energy efficiency projects. Where building performance is heavily affected by the intermittent use of energy intensive equipment within it, that effect is noted.

Facilities Managers for each building are encouraged to identify areas where their buildings will benefit from energy efficiency projects. All such opportunities are recorded in the Salix database which also keeps a record of completed projects which can be reviewed by Year, Building and Technology Type. These opportunities are then investigated to see if they can be implemented within the payback time and cost per tonne of CO_2 saved required under the prevailing Salix rules.

6.4 Energy Performance Indicators

Cranfield University has two Energy Performance Indicators.

The long standing indicator is for total carbon emissions where the target is by end July 2021 to have achieved a 50% reduction compared with the 2005 Baseline. This translates into a 6% year on year reduction target since 2010. It is reviewed on an annual basis at the end of each financial year to ensure progress is on track and that plans for the coming year will continue maintain the necessary progress.

The total energy use recorded in the SystemsLink database is used to calculate the total kWh or litres of fuel used and this is then converted into tonnes of CO_2 emissions using the official Government conversion factors for that year. See also 6.5 Energy Baseline below.

This indicator does not allow for any change resulting from activity growth or adverse weather conditions.

To meet the requirements of ISO50001:2018 a second performance indicator was agreed in 2020. This second indicator is the Energy Intensity in kWh/m^2 of Floor Area relating to buildings, adjusted for Degree Days.

6.5 Energy Baseline

The University's energy baseline for its carbon emission target is defined in the Carbon Management Plan, beginning in 2005 and adjusted to take account of the sale or acquisition of any assets in the interim.

The key modifications to that baseline since 2005 are:

Date	Location	Comment
30/08/2012	Silsoe	Demolished; stays in original baseline
31/07/2013	Best Western Sudbury House Hotel	Sold; removed from baseline

The present carbon Baseline is dynamically calculated from data held in the SystemsLink Database and exported into the "Custom_Group_Report_Carbon&Budget.xlsx".

The Annual kWh, Annual tonnes of CO_2, Annual Conversion Factors used, and a chart tracking progress against the key Energy Performance Indicator are all extracted from the template and saved in "Energy Baseline Summary.xlsx".

The energy baseline for kWh/m^2 indicator is the University's performance in 2015/2016, and the Degree Days for that year.

6.5.1 Related Documents

Document	Location
Custom_Group_Report_Carbon &Budget.xlsx	Y:\EstatesShared\SystemsLink Energy Manager
Energy Baseline Summary.xlsx	Y:\SHEE Management\Energy\6.5) Energy Baseline

6.6 Planning for Collection of Energy Data

Key characteristics of the University's operations which determine energy performance are monitored, measured and analysed at planned intervals.

The fundamental tool for this work is the SystemsLink Energy Manager database into which all automatic (AMR/Profile), manual (Direct) and invoice data gathered is entered for all meters, oil tanks and other energy purchases. (In some cases, the Invoice data includes data generated to create internal invoices to send out to tenants so an Invoice entry does not necessarily mean it is an external charge to the University.)

The SystemsLink database contains data going back more than 10 years and is capable of producing numerous graphs and comparisons with earlier years for each data point.

In parallel with SystemsLink a second MS Access database "Meter History" has been created to make it easier to track any ongoing issues with meters or automatic data collection and to note the source of the data for every meter. This is used to drive Engineering work to improve the quality of the data available. With over a thousand meters on site it is inevitable that some will always have a problem and as the original infrastructure ages an increased amount of work is needed to keep the automatic data systems working (e.g. replacing time expired battery driven radio transmitter systems).

Calibration of all incoming utility meters is the responsibility of the utility companies themselves. The vast majority of meters on site are sub-meters used to give greater granularity of data and to enable month-on-month and year-on-year comparisons to be made. The Meter Design Guide requires that all new meters installed meet the required legal requirements to allow billing to be done from them and that they are provided with working AMR functionality at the time of handover. Sanity checks are done on new meter installations to check:

a) that the AMR data received agrees with manual readings

b) that the consumption figures indicated are realistic for the equipment the meter is covering

c) that the sum of any building sub-meters matches, within meter tolerance and parasitic loss factors, the total recorded on the master meter feeding those sub-meters

For the CHP it is a requirement that the gas feed meter is calibrated by the University and this work is undertaken by Edina.

The key characteristics monitored are explained below:

a) significant energy uses and other outputs of the energy review	These are closely monitored via a number of different routine routes including: 1) Quarterly reviews of key buildings' meter information and comparison with past performance, taking into account weather conditions and changes to building usage. This data is used in preparing for SHEE meetings with the various schools. 2) Monthly or quarterly reviews of electricity and gas bills created internally for domestic tenants, non-domestic tenants and university departments who can re-charge for energy use. A comparison with previous bills is done both to ensure each bill makes sense but also to spot any usage anomalies that may indicate operational problems. 3) Monthly reviews of overall energy usage to provide a monthly report of progress against the Carbon Management Plan target. 4) Monthly/Quarterly reviews of external bills received by the University from Laser (for nPower and Total Gas and Power) covering the utility imports to the sites for all electricity and gas supplies. This also includes reviewing the half hourly data where available. 5) Annual DECs for buildings over 250 Sqm regularly visited by the public (including students) to compare with previous years' DEC results. 6) Annual SECR reports where the reasons for any significant changes in emissions are required to have a high-level explanation. 7) Reviews of energy usage in locations where Salix projects have been implemented after sufficient time has passed to make it feasible to assess the difference (assuming there is appropriate metering/sub-metering to distinguish the impact).
b) the relevant variables related to significant energy uses	Degree data is used to assess the impact of cold weather. Any knowledge of changes to operations on site, including the addition of new buildings, the removal of old buildings, the sale of any assets, installation of more efficient plant, changes to opening hours, or significant changes to the test equipment used on site is also considered.
c) Energy Performance Indicators	A monthly report is produced and published on the intranet showing annual progress against the main Energy Performance Indicator. This is then backed up by an annual report summarising progress against the 15-year target (July 2021 vs July 2005 carbon emissions).
d) the effectiveness of the action plans in achieving objectives and targets	Progress against specific annual plans to achieve objectives and targets is reported to the Carbon Management Working Group and the Board for Energy and Environment on a quarterly basis.

e) evaluation of actual versus expected energy consumption	At the highest level this is already covered by the key Energy Performance Indicator which looks at the combined effect of all energy efficiency projects across the whole University. Where Salix projects have been implemented and the level of sub-metering gives sufficient granularity comparisons of before and after usage are made and reported.

An annual energy management plan is agreed and documented each year,

Where any significant deviations in energy performance are observed they are investigated to understand the root cause and to correct any problems identified. Engineering and BAM will record any issues with the HVAC equipment and the actions taken to resolve them.

Any other issues highlighted to the Energy and Environment Team will have the results of any investigations recorded against the relevant buildings folder.

Any issues with metering equipment, and the solutions, are recorded in the Meter History Database.

6.6.1 Related Documents

Document	Location
SystemsLink Energy Manager Database	Y:\EstatesShared\SystemsLink Energy Manager
Meter History Database	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\2 Meters\2 Meter Database Use Performance
Annual Action Plan	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\Energy and Carbon Plan
CRC Reports	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\CRC & SECR
DECs	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements\Display Energy Certificates
Building Folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Buildings + Infrastructure\Buildings
High Energy Use Equipment Register.xlsx	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\High Energy Use Equipment and Photos

7 Support

7.1 Resources

Section 5.3 defines the key members of the Energy and Environment Team who have primary responsibility for the establishment, implementation, maintenance and continual improvement of the University's energy performance and the EnMS.

The Leadership Team, to whom the Energy and Environment Team Report and who also have primary responsibility for ensuring sufficient resources are allocated, are detailed in Section 5.1.

In addition, a number of key people have been identified who have a significant role in supporting the EnMS due to the nature of their jobs in either looking after buildings, operating equipment with Significant Energy Use and/or having primary opportunities to identify inefficient practices. These are listed in the Excel sheet "ISO50001 People.xlsx".

In addition, there are a large number of other people who take care of the day to day running of the University and who are trained on the correct Operating Procedures for specific items of equipment, for site maintenance and providing services ranging from building surveys to meter readings.

The operation of the main Cranfield Campus' Heating, Ventilation and Air Conditioning (HVAC) systems is contracted out to BAM, who are also contracted to identify cost effective opportunities to reduce energy use by 5% each year.

7.2 Competence

All people working for or on the University's behalf, related to significant energy uses, are competent on the basis of appropriate education, training, skills or experience. Training is provided when necessary to meet the needs of the Energy Management System.

The primary significant energy uses on site relate to the Heating, Ventilation and Air Conditioning (HVAC) systems but there are also a number of very high energy demand pieces of test equipment.

HVAC systems are the responsibility of the Engineering team for overall control with day to day operations and maintenance carried out by the University wide sub-contractor BAM.

Test equipment falls under the University's own Technical Support Services. These technicians follow Standard Operating Procedures for the equipment they are responsible for and are aware of the need to use the kit as efficiently as possible and to avoid the 4-7pm period as much as possible to keep costs down.

Cranfield University training records are maintained within the Agresso system. Key people also maintain their own Continuous Professional Development records and history of training prior to working for Cranfield University.

BAM maintain their own Training Records.

All staff and students also go through an induction process which includes compulsory Environmental and Energy Awareness training. That training is repeated every three years.

7.2.1 Related Documents

Document	Location
ISO50001 People	Y:\SHEE Management\Energy\5) Leadership
BAM Terms and Conditions as per HVAC Contract Invitation to Tender	Y:\SHEE Management\Energy\8.1) Operational Planning and Control

7.3 Awareness

The following key points are addressed as described below to ensure that any people working for or on the University's behalf are aware of:

a) the energy policy	The Energy Policy, signed by the Vice Chancellor, is displayed on Building Noticeboards and copies are on both the Intranet and Extranet. It is normally updated annually.
b) their contribution to the effectiveness of the EnMS, including achievement of objectives and energy targets and the benefits of improved energy performance	Under the Energy Policy everyone has a responsibility to help reduce energy wastage and identify opportunities for improvement, but the key people for supporting ISO50001 are identified in "ISO50001 People.xlsx" along with their roles. Due to their roles and experience these people already have a general knowledge of the requirements to support the EnMS and to be energy efficient but further training was provided in June 2018 to the people then in post to highlight several key aspects for them and their teams, especially the cost of electricity in the 4-7pm period and the associated Triad charges. BAM personnel are employed on the basis of their competence and training to operate and maintain the HVAC facilities on site. The Energy Advisor and Energy and Environment Manager have received specific technical training on a range of Energy Efficiency topics and maintain their own Continuous Professional Development records to satisfy the requirements of the professional bodies and/or accreditation organisations to which they are affiliated. The University Intranet contains many pages relating to Energy Performance and makes clear the financial and environmental benefits of minimising energy use as much as possible, including shifting the time of operations to try to avoid the expensive periods of electricity use and during winter to minimise the University's exposure to Triad charges.

c) the impact of their activities or behaviour with respect to energy performance	The Energy Code of Practice makes particular reference to comfort heating/cooling. Notices about Triad periods are displayed on the intranet when Triad warnings are received; SHEE committees are briefed about the impact of 4-7pm electricity charges, the Triad results and the energy use in the buildings they use. There are regular shutdown campaigns over Christmas and Easter periods and other ad hoc campaigns, such as Energy Champions training to remind people of their responsibilities and how their individual actions will affect energy use.
d) the implications of not conforming with the EnMS requirements	The induction training, repeated every 3 years, and contractor training, repeated every year, covers the impact of not being energy efficient in terms of the monetary costs, climate change and potential loss of ISO 50001 certification.

7.3.1 Related Documents

Document	Location
Energy Policy	Y:\SHEE Management\Energy\5.2) Energy Policy
Energy Code of Practice	Y:\SHEE Management\Energy\4.4) Energy Management System (CoP and Manual)\Code of Practice
ISO50001 People	Y:\SHEE Management\Energy\5) Leadership

7.4 Communication

Communication of the University's energy performance and EnMS is achieved via a number of different routes:-

Subject	Frequency	Audience	Method	Responsibility
The most important information about the EnMS and its supporting data and actions that is to be shared with Internal people.	As the relevant information is updated and deemed appropriate for the intranet.	All staff and students	The Energy and Environment web pages on the intranet	Energy and Environment Manager; Energy Advisor; Environment Co-ordinator
The most important information about the EnMS and its supporting data and actions that is to be shared with External people.	As the relevant information is updated and deemed appropriate for the extranet.	Everyone who looks at Cranfield University's web site – especially prospective new students	Cranfield University's website on the internet for external communications	Energy and Environment Manager; Energy Advisor; Environment Co-ordinator
Switch off campaigns	Ad hoc; Christmas; Easter	All Staff and Students	Intranet Announcements; E-mails; Meetings	Energy and Environment Manager; Energy Advisor; Environment Co-ordinator
Actual Energy performance year to date and forecast of the future performance for the rest of the Financial Year.	Monthly	All Staff and Students	Published on the Intranet	Energy and Environment Manager; Environment Co-ordinator
Review of energy and environment progress.	Monthly	Facilities Managers; Engineering; Development Team	Meeting with reports, presentations and discussion.	Energy and Environment Manager;

Subject	Frequency	Audience	Method	Responsibility
Review of the performance of the CHP system.	Monthly	Engineering; BAM; Edina; Engineering Consultant	Meeting with reports, presentations and discussion.	Energy and Environment Manager; Energy Advisor;
Review of the performance of the District Heating system.	Monthly	Engineering; BAM; Engineering Consultant; Project Development	Meeting with reports, presentations and discussion.	Energy and Environment Manager; Energy Advisor;
Triad warnings and results	1st November to 28/29th February for warning. Late march/early April for results	All University Staff and Students, especially the key people who can take action to reduce energy use from 4pm to 7pm	Announcements on the Intranet when a warning is received; E-mail to key people asking them to take action when a warning is received; E-mail the resulting Triad charge details to key people and finance when they are known after the Triad season has completed.	Energy Advisor
The latest news on changes or plans to the overall University Environment and Energy use. Requests for assistance if needed.	Quarterly	Staff Green Team Members	Team Meeting	Energy and Environment Manager; Energy Advisor; Environment Co-ordinator

Subject	Frequency	Audience	Method	Responsibility
The latest news on changes or plans to the overall University Environment and Energy use. Requests for assistance if needed.	Quarterly	Student Green Team Members	Team Meeting	Energy and Environment Manager; Energy Advisor; Environment Co-ordinator Student Green Team Leader
Progress against targets and action plans, results of actions. Updates on Actions from previous BEE meetings	Quarterly	BEE Members; University Executive; University Council	Meeting with reports, presentations and discussion.	Energy and Environment Manager; Energy Advisor;
Progress against targets and action plans, results of actions. Updates on Actions from previous Executive meetings	Quarterly	University Executive;	Meeting with reports, presentations and discussion.	Energy and Environment Manager; Chair of BEE
Energy Use in key buildings; Updates to Energy and Environmental Action Plans; Updates on Actions from previous SHEE meetings	Quarterly	Safety, Health, Environment and Energy (SHEE) meeting members of the Schools and Professional Units	Meeting with reports, presentations and discussion.	Energy and Environment Manager; Energy Advisor; (Due to the number of SHEE meetings, some of which are simultaneous, the Environment Advisor will also attend them and report on behalf of the Energy Team to spread the load.)
Energy consumption of major buildings	Quarterly	All Staff and Students	pdfs on the intranet	Energy Advisor;
Reminders of the EnPI(s)	Quarterly	Domestic tenants who pay for their electricity use	Electricity bills	Energy Advisor;

Subject	Frequency	Audience	Method	Responsibility
Progress against targets and action plans, results of actions. Updates on Actions from previous Council meetings	Annually	University Council	Meeting with reports, presentations and discussion.	Energy and Environment Manager; Chair of BEE
Progress made over the last year	Annually	University Executive	Formal Report and Presentation; The Energy and Environment web pages on the intranet	Energy and Environment Manager;

The Board for Energy and Environment decided that the University will communicate externally about its energy policy, EnMS and energy performance. This is achieved by publishing relevant documents, including the Annual Report and the Carbon Management Plan on the internet.

The Environment Co-ordinator has principle responsibility for issuing regular information on the EnMS and for updating the Intranet pages of the E&E Team. The Co-ordinator also liaises with the External website team and the University' Communications Team as required. The Co-ordinator also maintains an annual Calendar of events, reviewed regularly, which has additional planned communications listed for both energy and environment, often tying in with "National Days" or "International Days". All energy related communications are agreed with either the Energy Advisor or the Energy and Environment Manager to ensure the content is accurate and consistent with the EnMS, in particular data from the SystemsLink Energy Manager database and information relating to EnPIs.

Comments or suggested improvement to the EnMS can be made by emailing green@cranfield.ac.uk and this e-mail address is highlighted on the intranet. All such suggestions are recorded in a Suggestions Database shared with ISO 14001. The database contains a history of the actions taken in response to each suggestion. Progress responding to those suggestions are reviewed at regular Energy and Environment Team Meetings.

7.4.1 Related Documents

Document	Location
Events Calendar YYYY- YYYY+1	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Engagement + behaviour change\Calendar of Events

7.5 Documented Information

7.5.1 General

This Manual and the documents (electronic or paper) and databases it refers to describe the core elements of the University's EnMS and how they interact. This Manual and all the listed Related Documents within it ensure that the EnMS includes the:

a) documented information required by the ISO 50001:2018 Standard

b) documented information determined by Cranfield University as being necessary for the effectiveness of the EnMS and to demonstrate energy performance improvement.

The University's Energy Advisor is responsible for reviewing, amending, issuing and controlling EnMS related documents. Where these are shared with the EMS and/or the Health and Safety Management System this is done in collaboration with the relevant people.

7.5.2 Creating and Updating

The requirements for document identification, description, format, review and approval is documented in the following process:

CU-SHE-PROC-01 Control of Management System Documentation Procedure (V1.5) April 2018(PB)

7.5.3 Control of Documented Information

Documented information required by ISO 50001 and the EnMS is controlled to ensure:

it is available and suitable for use, when and where it is needed	All documents are saved in the SHEE Management folder Y:\SHEE Management with the vast majority in the Energy sub-folder but some shared documents in the Environment or Health and Safety sub-folders.
it is adequately protected	The vast majority of documentation is held electronically on the University's mirror server system. Only manual meter readings or older utility bills are sometimes recorded on paper. Those records are retained in files but the data from them is transferred to the SystemsLink Energy Manager database at the earliest opportunity. Access to the documents requires a User Name and Password, along with either physical access to the University LAN or advanced knowledge of the University's computer system to enable remote access over the internet.
it is appropriately retained and disposed of	All old documents are moved to an Archive or History folder where it is useful or required that old versions are retained. Printed versions of controlled documents are automatically uncontrolled.
changes are controlled	All controlled documents reviewed as per their own documented review timetable and also in response to any agreed suggestions to improve them. Controlled documents contain a header on each page and a document control panel at the end to record the version status of each document. These are also recorded in the Excel sheet Control of Management System Spreadsheet for Controlled Documents.

The internal documents used by the EnMS include:

Record Type	Format	Location
Energy Management System	Specific electronic folders	Y:\SHEE Management\Energy
CRC and SECR	Specific electronic folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\CRC & SECR
Compliance and Obligations Register	MS Access Database (CU-ENV-REG-05_Compliance_Obligations_Register_Database.accdb)	Y:\SHEE Management\Environment\REGISTERS
Energy Savings Opportunity Scheme	Specific electronic folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\ESOS
Display Energy Certificates	Specific electronic folders and Landmark Register	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements\Display Energy Certificates
Energy Performance Certificates	Specific electronic folders and Landmark Register	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements\Energy Performance Certificates
Air Conditioning Inspections	Specific electronic folders and Landmark Register	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements\Air Conditioning Inspections TM44
Meter Readings and Invoices	SystemsLink Energy Manager database	Y:\EstatesShared\SystemsLink Energy Manager
Manual Meter Readings	Reported electronically in Excel and then uploaded into SystemsLink	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Budget + Finance\Energy Invoicing\7 Meter Reading Templates
Manual Meter Readings	Paper copies (all details entered into SystemsLink)	Folders stored in B44 by the Energy and Environment Team
Manual Meter Readings	Photos (all details entered into SystemsLink)	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\2 Meters\1 Photos
Any Issues with Meters	MS Access Database and specific electronic folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\2 Meters\2 Meter Database Use Performance
Salix History and Plans	MS Access Database and specific electronic folders plus Salix's own Website	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\7 SALIX EVERYTHING BUT FINANCE\AA Database

Record Type	Format	Location
Actions from Management Reviews	Specific electronic folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Board for Energy + Environment\BEE Meetings
Training Records	Agresso Database and Personal/Line Management Records	University Agresso System and own records for training prior to joining Cranfield University or held by Contractor's company.
Corrective Actions	Excel Sheet CU-ENV-REG-07_CAPA_Register_LIVE.xlsx	Y:\SHEE Management\Environment\REGISTERS
"Switch Off" Campaigns	Specific electronic folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\5 Switch Off Campaigns
Communications to Schools and Professional Service Units	Specific electronic folders especially regular Safety, Health, Environment and Energy meetings (SHEEs)	Y:\SHEE Management\Energy\7.4) Communications

Table: Energy Management System Internal Records and Locations

The external documents used by the EnMS are:

Record Type	Location
the Government's officially published CO_{2e} factors for different energy sources	https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019 This includes links to earlier years and future years have the same URL format, so only the year reference has to be edited
calorific value of gas	http://marketinformation.natgrid.co.uk/gas/DataItemExplorer.aspx
DEC CIP files (official Government data provided to members via Elmhurst)	https://members.elmhurstenergy.co.uk/WebFormLogin.aspx under My Documents/DECs after the user has logged in.

Table: Energy Management System External Records and Locations

7.5.3.1 Related Documents

Document	Location
CU-EHS-PROC-01 Control of Management System Documentation Procedure	Y:\SHEE Management\Health and Safety\3) PROCEDURE DEVELOPMENT\Procedures\Control of Management System Doc\Current
Control of Management System Spreadsheet for Controlled Documents v#.#.xlsx	Y:\SHEE Management\Health and Safety\3) PROCEDURE DEVELOPMENT\Procedures\Control of Management System Spreadsheet for Documents\Current

8 Operation

8.1 Operational Planning and Control

The most significant energy uses at the University relate to:

- Heating, Ventilation and Air Conditioning (HVAC) of all buildings – non-domestic and domestic.
- The 1.4 MW Combined Heat and Power (CHP) unit meeting over 60% of campus electricity demand.
- The District Heating (DH) system using the waste heat from the CHP, supplemented by three stream boiler heat exchangers, a 960kW biomass (woodchip) boiler, and two gas boilers.
- The 1 MW PV farm.
- Individual items of energy intensive test equipment used for testing and research

The University plans, implements and controls the processes, related to its SEUs defined in 6.3 above, needed to meet requirements and to implement the actions determined in 6.2 above by:-

establishing criteria for these processes, including the effective operation and maintenance of facilities, equipment, systems and energy-using processes, where their absence can lead to a significant deviation from intended energy performance;	The Engineering Team and the site contractor BAM are responsible for the correct operation and maintenance of all HVAC equipment on site. The equipment is operated to reflect the individual usage patterns and thermal characteristics of each building based on information supplied by the Facility Managers responsible for each building, many years' experience of running the site and any additional relevant criteria. Regular meetings are held between Engineering and BAM to ensure satisfactory operation of the equipment and that planned preventative maintenance is occurring as required. A large proportion of the site is controlled via the Johnson Building Management System with some buildings on a newer Trend Building Management System. Some individual buildings work from timers or have individual Air Conditioning controls within certain rooms. All BMS and timer systems are the responsibility of BAM. Where local Air Conditioning controls exist limits on the temperature settings have been set where possible but individuals are responsible for using them in line with the Energy Code of Practice to minimise any waste. Monthly meetings are held with Edina, the supplier and maintainer of the CHP system to review its performance, review any issues arising and plan for future maintenance and meter calibration issues. These are attended by the Engineering Team, BAM and the Energy and Environment Team Separate monthly meetings are also held to discuss the performance of the District Heating system attended by

	the Engineering Team, Facility Managers, BAM and the Energy and Environment Team. Test and laboratory equipment are operated by Technicians in the Technical Support Services team following Standard Operating Procedures for each item. They are aware of the need to avoid 4-7pm all year round whenever possible but especially when a Triad warning has been received. Usage is driven by contractual obligations and research demands and thus follows no particular pattern.
communicating the criteria to relevant people doing work under the control of the University;	The start of the HVAC contract included a long familiarisation process to ensure BAM understand the systems they are responsible for operating and maintaining. Domestic tenants are provided with information on their heating systems by Campus Service when they first arrive. Edina are the experts on the CHP system they provide and have remote control and monitoring facilities via a broadband link.
implementing control of the processes in accordance with the criteria, including operating and maintaining facilities, equipment, systems and energy-using processes in accordance with established criteria;	The comments above also address this aspect but it should be noted that, in addition to the regular meetings, any deviation from the accepted normal practice is monitored in a number of ways as detailed in Section 9.1 below.
keeping documented information to the extent necessary to have confidence that the processes have been carried out as planned	Engineering maintain a very close working relationship with BAM having daily, monthly and quarterly meetings. Daily operations meetings take place to identify any issues or to review SEU controls. Any ongoing issues are fed into a weekly RAG (Red, Amber, Green) report, which is then reviewed at the monthly meetings. The quarterly meetings are more focussed on contract performance. Appropriate records are kept from all these meetings to ensure the required processes have been carried out as planned.

8.1.1 Related Documents

Document	Location
Energy Code of Practice	Y:\SHEE Management\Energy\4.4) Energy Management System (CoP and Manual)\Code of Practice
Monthly reports	https://intranet.cranfield.ac.uk/EnergyEnvironment/Pages/EnvironmentalReports.aspx
Internal Energy Bills	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Budget + Finance\Energy Invoicing
External Energy Bills (in relevant CRC/SECR folder for all electricity and significant gas supplies – details are added to SystemsLink when received)	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\CRC & SECR
Edina Meeting Information	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\CHP Performance, Heat & Steam Minutes
BAM Terms and Conditions as per HVAC Contract Invitation to Tender	Y:\SHEE Management\Energy\8.1) Operational Planning and Control
BAM Contract Information	Y:\EstatesShared\4. ENGINEERING\Contracts\BAM
BAM Meeting Information	Y:\EstatesShared\4. ENGINEERING\MINUTES\BAM
Display Energy Certificates	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements\Display Energy Certificates

8.2 Design

Engineering are responsible for the Design Guide used on all new projects. Input to this guide comes from the Engineering Team, the E&E Team, the Development Team and external consultants employed to look at particular aspects. There is a formal process to request any changes to the Design Guide and it is kept under regular review.

The Design Guide contains specific criteria on energy performance, including the overall aim of the University to be as energy efficient as practical and the fact that it has an EnMS which must be followed.

The University's Development Team are responsible for the projects requiring the design of new, modified and renovated facilities, equipment and systems that will have a significant impact on energy performance. They will use the agreed Design Guide as their starting point and it will be issued with any Invitations to Tender. Any deviations required by a project due to its particular constraints will be agreed between the teams.

Specific design criteria vary in detail from one project to another and are documented within the Development Team's own filing structure.

8.2.1 Related Documents

Document	Location
Facilities Design Standards	Y:\FacilitiesDesignStandards
Specific Project Design Documentation	Y:\EstatesShared\5. DEVELOPMENT\Development Team\Project Team standard forms\Tender Document file

8.3 Procurement

Any Project related procurement of energy services, products and equipment that have, or can have, an impact on significant energy use, will follow the Design Standards used by the Development Team as described in Section 8.2 above.

The BAM contract for operating and maintaining the University HVAC equipment contains key criteria to help improve energy efficiency by 5% per annum across the site and that was a requirement of the Invitation to Tender.

Other purchases relating to significant energy use are most likely to result from a Salix funded project. In that case the items purchased must be on the approved list of Salix technologies proven to be energy efficient and must pay back their capital costs from the savings achieved within either 5 or 8 years whilst not costing more than £120 per tonne of CO_2 saved (5 year projects are preferred, 8 year projects need specific prior agreement from Salix before proceeding). Cranfield has used both Salix SEELS and Salix Revolving Green Funding since 2010. The history of those projects including capital expenditure, estimated – and where possible to measure actual – kWh savings, and estimated CO2 savings are all detailed in the Salix projects MS Access database.

The Procurement Team uses public sector framework agreements, where possible, which include suppliers already vetted for sustainable practices. IT equipment (including pcs and servers) has historically been purchased to meet energy efficiency standards. Some equipment required for research is highly bespoke with very limited supplier choice and thus the application of energy efficiency as a key criterion is inappropriate, however such equipment rarely constitute a significant energy use.

All Invitation to Tender documentation makes clear that energy performance is one of the evaluation criteria for procurement.

All of Cranfield University's gas and electricity is procured using Kent County Council's Laser Public Sector Buying Group and its OJEU compliant frameworks. This is a managed service which includes detailed supplier bill checking, with any disputed bills not being paid until the dispute is resolved.

8.3.1 Related Documents

Document	Location
Salix Database of Historic and Potential Future Projects	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\7 SALIX EVERYTHING BUT FINANCE\AA Database

9 Performance Evaluation

9.1 Monitoring, Measurement, Analysis and Evaluation of Energy Performance and the EnMS

9.1.1 General

Key characteristics of the University's operations which determine energy performance are monitored, measured and analysed at planned intervals.

The fundamental tool for this work is the SystemsLink Energy Manager database into which all automatic (AMR/Profile), manual (Direct) and invoice data gathered is entered for all meters, oil tanks and other energy purchases. (In some cases, the Invoice data includes data generated to create internal invoices to send out to tenants so an Invoice entry does not necessarily mean it is an external charge to the University.)

The SystemsLink database contains data going back to at least 2008 and is capable of producing numerous graphs and comparisons with earlier years for each data point.

In parallel with SystemsLink the MS Access database "Meter History" has been created to make it easier to track any ongoing issues with meters or automatic data collection and to note the source of the data for every meter. This is used to drive Engineering work to improve the quality of the data available. With over a thousand meters on site it is inevitable that some will always have a problem and as the original infrastructure ages an increased amount of work is needed to keep the automatic data systems working (e.g. replacing time expired battery powered radio transmitter systems).

Calibration of all incoming utility meters is the responsibility of the utility companies themselves. The vast majority of meters on site are sub-meters used to give greater granularity of data and to enable month-on-month and year-on-year comparisons to be made. The Meter Design Guide section of the overall Design Guide requires that all new meters installed meet the required legal requirements to allow billing to be done from them and that they are provided with working AMR functionality at the time of handover. Sanity checks are done on new meter installations to check:

a) that the AMR data received agrees with manual readings

b) that the consumption figures indicated are realistic for the equipment the meter is covering

c) that the sum of any building sub-meters matches, within meter tolerance and parasitic loss factors, the total recorded on the master meter feeding those sub-meters

For the CHP it is a requirement that the gas feed meter is calibrated by the University and this work is undertaken by Edina.

The key characteristics monitored and measured are detailed below:

the effectiveness of the action plans in achieving objectives and energy targets	Progress against specific annual plans to achieve objectives and targets is reported to the Board for Energy and Environment on a quarterly basis and discussed in the BEE meetings. Progress is also reported quarterly to the University Executive and an annual report on progress produced each year.
Energy Performance Indicators	A monthly report is produced and published on the intranet showing annual progress against the main Energy Performance Indicator. This is then backed up by an annual report summarising progress against the 15-year target (July 2021 vs July 2005 carbon emissions).
operation of the SEUs	These are closely monitored via a number of different routine routes including: Quarterly reviews of key buildings' meter information and comparison with past performance, taking into account weather conditions and changes to building usage. This data is used in preparing for SHEE meetings with the various schools. Monthly or quarterly reviews of electricity and gas bills created internally for domestic tenants, non-domestic tenants and university departments who can re-charge for energy use. A comparison with previous bills is done both to ensure each bill makes sense but also to spot any usage anomalies that may indicate operational problems. Monthly reviews of overall energy usage to provide a monthly report of progress against the Carbon Management Plan target. Monthly or Quarterly reviews of external bills (as appropriate) received by the University from Laser (for nPower and Total Gas and Power) covering the utility imports to the site for all electricity and gas supplies. This also includes reviewing the half hourly data where available. Annual DECs for buildings over 250 Sqm regularly visited by the public (including students) to compare with previous years' DEC results. Annual CRC/SECR reports where the reasons for any significant changes in emissions are required to have a high-level explanation. Reviews of energy usage in locations where Salix projects have been implemented after sufficient time has passed to make it feasible to assess the difference (assuming there is appropriate metering/sub-metering to distinguish the impact). Daily operational meetings between BAM and Engineering which results in the weekly RAG report.

actual versus expected energy consumption	At the highest level this is already covered by the key Energy Performance Indicator which looks at the combined effect of all energy efficiency projects across the whole University. Where Salix projects have been implemented and the level of sub-metering gives sufficient granularity comparisons of before and after usage are made and reported. As detailed above, checks against previous usage are also made on a regular basis against key building and billed meters.

Degree data is used to assess the impact of cold weather. Any knowledge of changes to operations on site, including the addition of new buildings, the removal of old buildings, the sale of any assets, installation of more efficient plant, changes to opening hours, or significant changes to the test equipment used on site is also considered.

An annual energy management plan is agreed and documented each year,

Where any significant deviations in energy performance are observed they are investigated to understand the root cause and to correct any problems identified. Engineering and BAM will record any issues with the HVAC equipment and the actions taken to resolve them.

Any other issues highlighted to the Energy and Environment Team will have the results of any investigations recorded against the relevant buildings folder.

Any issues with metering equipment, and the solutions, are recorded in the Meter History Database.

9.1.1.1 Related Documents

Document	Location
SystemsLink Energy Manager Database	Y:\EstatesShared\SystemsLink Energy Manager
Meter History Database	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Energy + Carbon Management\2 Meters\2 Meter Database Use Performance
Annual Action Plan	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\Energy and Carbon Plan
CRC/SECR Reports	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\CRC & SECR
DECs	Y:\SHEE Management\Energy\4.2) 9.1.2) Legal and Other Requirements\Display Energy Certificates
Building Folders	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Buildings + Infrastructure\Buildings
High Energy Use Equipment Register.xlsx	Y:\SHEE Management\Energy\6.2) Objectives, Energy Targets and Planning\High Energy Use Equipment and Photos

9.1.2 Evaluation of Compliance with Legal Requirements and Other Requirements

A register of applicable legislation and other requirements is maintained and checked at least once a year, usually March, to ensure ongoing compliance. New legislation or other requirements are added to the register as it becomes applicable and is identified. The register itself is used to record the results of the evaluation, along with the dates of any reviews.

For each piece of legislation or other requirement the database includes the Stakeholders and their expectations.

9.1.2.1 Related Documents

Document	Location
CU-ENV-REG-05_Compliance_ Obligations_Register.accdb	Y:\SHEE Management\Environment\REGISTERS

9.2 Internal Audit

Cranfield University conducts internal audits of the EnMS at planned intervals to provide information on whether the EnMS:

a) improves energy performance

b) conforms to

- the University's own requirements for its EnMS
- the energy policy, objectives and targets established by the University
- the requirements of the ISO 50001:2018 standard.

c) is effectively implemented and maintained

The agreed audit plan allows for each clause in the standard to be reviewed at least once every 3 years. The plan defines the scope and criteria for each audit and is updated with the actual areas audited as required. Future audit plans are adjusted as necessary to ensure each clause is audited within the thee year cycle. Any Non-Conformities or Opportunities for Improvement identified are added to the CAPA database and progressed as required.

The auditors used are a mixture of internal and external auditors as resources allow and will not be conducted by anyone directly involved with delivering the actions necessary to achieve the ISO 50001 requirements.

Planning for each audit is the responsibility of the Energy Advisor. For each audit, relevant people for the clauses to be checked are invited to attend the audit at specific times, as agreed with the auditor. Each resulting audit report is saved within the EnMS folder structure.

Results from all audits are reported to the Board for Energy and Environment, including any trends identified. The minutes of the BEE meetings record the fact that each audit's results were discussed. The papers provided as inputs to those meetings are also retained.

9.2.1 Related Documents

Document	Location
ISO50001 Internal Audit Schedule.xls	Y:\SHEE Management\Energy\9.2) Internal Audit
BEE Minutes and Papers	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Board for Energy + Environment\BEE Meetings
Audit Reports	Y:\SHEE Management\Energy\9.2) Internal Audit

9.3 Management Review

9.3.1 Planned Intervals

Top Management formally review the EnMS annually at the January BEE meeting when a full Management Review report is discussed to ensure its continuing adequacy, effectiveness and alignment with the strategic direction of the University.

Different aspects of the Management System are also considered at each quarterly meeting, including progress against targets, results from internal audits and progress against the Corrective and Preventative Action lists (CAPA).

The University's Energy and Environment Manager and Energy Advisor are responsible for ensuring that inputs are prepared for these meetings.

Outputs from the Reviews are recorded in the minutes of the meetings.

9.3.2 Items to be Considered

Inputs to the management review include:

a) the status of actions from previous management reviews;

b) changes in external and internal issues and associated risks and opportunities that are relevant to the EnMS;

c) information on the EnMS performance, including trends in:

   1) nonconformities and corrective actions;

   2) monitoring and measurement results;

   3) audit results;

   4) results of the evaluation of compliance with legal requirements and other requirements;

d) opportunities for continual improvement, including those for competence;

e) energy policy.

9.3.3 Further inputs to the Management Review

The energy performance inputs to the annual management reviews include:

- the extent to which objectives and energy targets have been met;
- energy performance and energy performance improvement based on monitoring and measurement results including the EnPI(s);
- status of the action plans.

The elements identified in Sections 9.3.2 and 9.3.3 above are reflected in the papers submitted to the BEE meetings.

9.3.4 Output from Management Review

The minutes from the BEE meetings will include decisions related to continual improvement opportunities and any need for changes to the EnMS, including:

a) opportunities to improve energy performance;

b) the energy policy;

c) the EnPI(s) or EnB(s);

d) objectives, energy targets, action plans or other elements of the EnMS and actions to be taken if they are not achieved;

e) opportunities to improve integration with business processes;

f) the allocation of resources;

g) the improvement of competence, awareness and communication.

In addition, any changes to the energy performance of the organisation are reflected in the Annual Report.

Changes to the energy policy are agreed by BEE before being sent to the Vice Chancellor for approval.

Changes to the EnB(s), EnPI(s), objectives, targets or other elements of the EnMS, or to the allocation of resources will be recommended by the Energy and Environment Manager and reported upwards to BEE for approval.

The agreed output from the review is minuted at the BEE meeting and the formal output document saved within the EnMS folder structure.

9.3.5 Related Documents

Document	Location
BEE Papers and Minutes	Y:\EstatesShared\6. ENERGY+ENVIRONMENT\Board for Energy + Environment
Management Review Inputs and Outputs	Y:\SHEE Management\Energy\9.3) Management Review

10 Improvement

10.1 Nonconformity and Corrective Action

The University regularly reviews its EnMS and also conducts audits using both internal and external resources.

When a nonconformity is identified, the University:

a) reacts to the nonconformity and, as applicable:

   1) takes action to control and correct it;

   2) deals with the consequences;

b) evaluates the need for action to eliminate the cause(s) of the nonconformity, in order that it does not recur or occur elsewhere, by:

   1) reviewing the nonconformity;

   2) determining the causes of the nonconformity;

   3) determining if similar nonconformities exist, or can potentially occur;

c) implements any action needed;

d) reviews the effectiveness of any corrective action taken;

e) makes changes to the EnMS, if necessary.

Corrective actions taken are appropriate to the effects of the nonconformities.

Full details on every nonconformity and the corrective actions taken are recorded in the Corrective and Preventive Action Register (CAPA) database, including the nature of the nonconformities, the subsequent actions taken and the results of any corrective action. All nonconformities have a status of Ongoing, Completed or Verified (if identified after April 2018). Target dates are set to complete each nonconformity, and verification that the solution has worked is agreed in formal CAPA review meetings between the Energy Advisor and the Energy and Environment Manager. The CAPA database is shared with the ISO 14001 EMS and the formal review meetings include the Environmental Advisor. The Energy Advisor and Environmental Advisor also review the CAPA at frequent intervals to ensure action is being taken prior to the formal reviews.

10.2 Continual Improvement

The University continually improves the suitability, adequacy and effectiveness of the EnMS and demonstrates continual energy performance improvement. This is demonstrated by the results against the EnPI(s) and the results of Salix/SEELS projects.

Opportunities for Improvement and recommendations reported in audits are also fully recorded in the CAPA database. They are reviewed and acted upon in exactly the same way as nonconformities but with a lower priority. Progress is subject to the availability of resources and some OFIs may be rejected where they will not lead to any tangible benefit to the EnMS.

OFIs in the same area which have been repeatedly identified are very likely to be prioritised.

10.2.1 Related Documents

Document	Location
CU-ENV-REG-07_CAPA_Register_LIVE.xlsx (Corrective and Preventive Action Register)	Y:\SHEE Management\Environment\REGISTERS

11 Document Control

Document title	Energy Management System Manual
Document number	CU-SHE-PROC3.48
Version number	2.1
Originator name/document owner	Angus Murchie – Energy Advisor
Professional Service Unit/Department	Facilities/Energy and Environment Team
Implementation/effective date	May 2018
Date of last review and version number	July 2020 V2.0
Date of this version	August 2020
Date of next review	May 2021
Standards reference	ISO50001:2018
Signature	
Name	Gareth Ellis
Title	Energy and Environment Manager

Document Review			
Version	**Amendment**	**By**	**Date**
Draft	Not Applicable – First Version	Angus Murchie	May 2017
1.0	Updated from the initial draft reviewed in May 17. Version 1.0 is designed to closely match all the required clauses in the ISO50001 Standard with links to external supporting documentation and databases.	Angus Murchie	May 2018
1.1	Organisational diagram updated, minor textual and layout changes.	Angus Murchie	May 2018
1.2	Hyperlinks checked throughout and edited as required.	Angus Murchie	June 2019
1.2	Updated Radio Tx numbers in Section 6.1 to reflect changes from Radio to LAN and to Supplier Data for gas meters.	Angus Murchie	June 2019
1.2	Reference to MeterWeb2 from Elcomponent in Section 6.1 removed as no longer used.	Angus Murchie	June 2019

Document Review			
Version	**Amendment**	**By**	**Date**
1.2	Updated details on gas meters providing half hourly AMR data in Section 6.1.	Angus Murchie	June 2019
1.2	Updated SHEE reports to include District Heating too in Section 6.3	Angus Murchie	June 2019
1.2	Update to potential EnPI in Section 6.4	Angus Murchie	June 2019
1.2	Update to training provided in Section 7.2.	Angus Murchie	June 2019
1.2	Addition of monthly CHP and District Heating meetings to Section 7.4	Angus Murchie	June 2019
1.2	Update to Salix details in Section 8.3	Angus Murchie	June 2019
2.0	Entire Manual updated to the 2018 version of ISO 50001. This required a complete renumbering of the sections and considerable amendment to some of the detail. (The Section Numbers detailed above have been edited to match the new locations of those amendments.)	Angus Murchie	July 2020
2.0	More explanation provided about COTEC and its energy use.	Angus Murchie	July 2020
2.1	Add in additional Interested Parties following Transition Audit Review. Also add a little more detail on how Compliance is reviewed for DECs, EPCs, ACIs and external billing.	Angus Murchie	August 2020