University of Liverpool

Carbon Management Plan

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Contents

Important Note

The University now has a target of achieving a

Net Zero Carbon Campus by 2035

The targets within the Carbon Management Plan 2017-2030 have therefore been superseded.

Further detail can be found in the University's Sustainability Strategy 2021 (to be published). The target comprises scope 1 & 2 emissions; meanwhile scope 3 emissions (including from waste, travel and supply chain) are addressed within the University's sustainability governance.

To progress delivery of Net Zero by 2035, a roadmap to decarbonisation is in development. It sits within the University's sustainability governance structure; specifically, within the Climate Action Group, a cross-institutional working group with representation from academia, professional services, and the Liverpool Guild of Students, Energy Services Team, University of Liverpool Energy Company, and Sustainability Team. Pathway options speak to energy efficiency, demand side reduction, future fuel mixes and technologies, optimisation and decarbonisation of existing District Network, increased renewable generation, and carbon offsetting. These options will take into account existing planned projects, and those to be considered. Further technical feasibility and scoping will be undertaken following this to inform a more detailed and operational plan for the longer term. KPI reporting against both the Carbon Management Plan and Net Zero by 2035 are available upon request.

While the decarbonisation plan is being developed, those projects for energy efficiency and carbon reduction identified within the 2017-2030 Carbon Management Plan continue to be implemented. For further detail please see Carbon Management Plan.

Please note that the carbon targets included within the Carbon Management Plan do not account for broader grid decarbonisation (the latter is included within all public reporting and within the new Net Zero by 2035 commitment).

For further detail on specific energy efficiency and carbon reduction projects, including those that may be developed in addition to those listed in the Carbon Management Plan, please contact the University's Energy Services Team and lead for the Climate Action Group on 0151 794 1554.

November 2020

Executive summary

What is the purpose of CMP?

This Carbon Management Plan (CMP) has been developed to help set a carbon emissions target as part of the University of Liverpool's commitment to improve energy efficiency across its estate, reduce emissions and contribute to sustainable development.

What were the emissions in 2014/15 baseline year?

Baseline	2014/15
tCO_2e	42,979
$kgCO_2/m^2$	1,768
$kgCO_2$/FTE	89

What is included in the target?

The targets cover scope 1 and 2 emissions.

Scope 1
Direct emissions from heating systems and vehicles

Scope 2
Indirect emissions from purchased electricity

What is the target?

The University has set targets, to reduce carbon emissions by…

A **Net Zero Carbon by 2035 target** has replaced these targets (see previous page)

	2020	2026	2030
Absolute Target			
tCO_2e	1.8%	6.1%	6.1%
Efficiency Target			
$kgCO_2/m^2$	3.8%	15.4%	15.4%
$kgCO_2$/FTE	29.7%	36.7%	39.1%

...these are set against the 2014/15 baseline.

How will the University meet these targets?

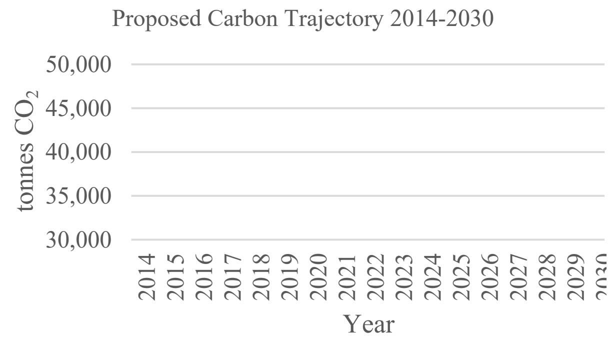
The University aims to achieve the carbon targets:

- by adopting Estates Strategy 2026+ and Master-Plan 2026+
- through improved space use and measured utilisation
- by ensuring that new and refurbished buildings are designed to maximise realistic carbon savings
- through energy generation projects
- via behaviour change and engagement activities

Impacts of changes to absolute emissions

What if the University…	2020	2030
…does nothing?	0.0%	0.0%
…experiences grid decarbonisation at the Committee on Climate Change (CCC) rate?	-8.6%	-19.3%
…undertakes just the demolition activities outlined in the Estates Strategy 2026+?	-4.5%	-18.5%
…secures a sleeved PPA for a low carbon electricity supply in 2022?	-1.8%	-10.4%
…implements the CMP baseline scenario but achieves higher levels of improvements on refurbishment projects?	-2.6%	-7.7%
…implements the CMP baseline scenario?	-1.8%	-6.1%
…implements the CMP baseline scenario but achieves lower levels of improvements on refurbishment projects?	-1.5%	-5.4%
…implements just a 3MW PV installation at Leahurst in 2022?	0.0%	-3.1%
…implements the identified DEC Advisory Report recommendations only?	-1.4%	-2.6%
…undertakes just the major refurbishment work outlined in the Estates Strategy 2026+?	-1.0%	-1.6%
…implements funding projects only?	-0.9%	-0.9%
…implements the Estates Strategy 2026+ actions only?	0.8%	0.3%
…implements the Estates Strategy 2026+ new build projects only?	6.3%	20.2%

What do we think the journey to achieve these carbon reductions looks like?



Future predicted growth at the University brings requirements for new buildings, adding to the total emissions. However, at the same time the University will be taking actions to improve energy efficiency and generation.

The peaked increase in 2018, as shown in the chart above, is largely due to the University's new MIF building that will accommodate innovative and intensive research and teaching activities for students and staff being fully utilised.

What is the CMP tool and how can it be used to investigate further options to exceed targets?

To help inform the current carbon trajectory and assist in future carbon management planning, the University have collaborated with Arup to develop a Carbon Management Plan Tool.

The tool allows energy saving interventions and other opportunities to be modelled in line with the Estates Strategy 2026+ and the results can be used to determine the relative impacts on carbon emissions.

The University will continue to use the tool as a means of investigating opportunities to exceed the current trajectory.

1 Introduction

As part of a commitment to reduce carbon emissions, the University of Liverpool has produced this Carbon Management Plan (CMP). This CMP sets out a carbon management strategy and new carbon reduction target. It covers the emissions that are most directly within the control of the University. These emissions are termed Scope 1 and Scope 2 emissions under the widely accepted Greenhouse Gas Protocol.

Emissions	Definition
Scope 1: Direct Emissions	Direct emissions occur from sources that are owned or controlled by the University (such as heating systems or vehicles).
Scope 2: Electricity indirect emissions	Emissions from the generation of purchased electricity consumed by the University.
Scope 3: Other indirect emissions	Scope 3 emissions are a consequence of the activities of the University, but occur from sources not owned or controlled by the University. Examples include emissions from staff commuting or purchased goods.

It is worth remembering that the impact of universities (and other education institutions) reaches far beyond the relatively simplistic evaluation of direct and indirect emissions. As a member of the Russell Group and a research-intensive institution, the University of Liverpool works in many areas to progress the science and engineering of climate change mitigation and seeks to embed sustainability into its curriculum to constantly equip its graduates with the skills needed to contribute to solutions across many fields of study.

Stephenson Institute For Renewable Energy (SIRE) is specialist energy materials research institute focusing on the physics and chemistry that will transform the future of energy generation, storage, transmission and energy efficiency. Its research has the potential to facilitate reduced emissions far beyond that of the University.

Previous Target

It has been acknowledged that the University's previous emissions target of a 36% reduction in carbon emissions by 2020 from the 2005 baseline will not realistically be achieved. This is largely because of the observed and expected future growth of the University. This situation is occurring at many higher education institutions, as found in the recent Brite Green review. The same review found that at best some of the HE sector is on track to achieve only half of its target reduction by 2020.

This CMP provides a trajectory up to 2030, mirroring the approximate timescales of the new Estates Strategy 2026+. Revised targets have been set for absolute carbon and carbon intensities relative to the size of the University. These targets take account of the growth in staff and student numbers of 21% by 2018, and 1% per annum year-on-year following that as set out in the Estates Strategy 2026+. Given this growth relative targets are considered more realistic and appropriate for decision making than an absolute target.

Future Forecasting

The University has collaborated with Arup to develop a CMP Tool (see Section 2.3). The tool developed provides the University with the ability to investigate future scenarios and assess the impacts projects and other interventions might have on energy and emissions levels. The tool also forecasts changes to the estate due to new buildings, expansion, demolition and disposal. The spreadsheet-based tool has been used to derive the CMP emissions target set by the University and will be used for future planning.

This plan is structured to show the following elements of carbon management at the University:

2 Context	Explains how the CMP fits into University policy, sets out current and previous emissions levels and the methodology for calculating emissions
3 Carbon saving projects	The options available to the University to reduce emissions examining the impact of the recent Estates Strategy 2026+ along with opportunities related to efficiency and energy generation and the impact of pursuing programmes that address wider sustainability
4 Carbon targets	Sets out the targets to 2020 and 2030 that the University is committed to achieving based on the available carbon saving projects
5 Implementation plan and recommendations	Summarises the CMP implementation and provides recommendations for future actions to investigate additional opportunities

This plan is also supported by a technical appendix which further explains the methodologies used in the development of this plan and provides more detail on potential mitigating actions.

2 Context

Carbon management is becoming increasingly important at a global level. Under current legislation, the UK Government is required to meet a carbon reduction target of 80% by 2050 against 1990 levels, with an interim target of a 34% by 2020. The Higher Education sector recognises its role in achieving these targets and is actively addressing this through developing carbon management strategies and plans.

Over recent years, the University has made considerable investment in its energy infrastructure and made efficiency improvements to its building estate. This CMP been developed to express the University of Liverpool's continued commitment to reduce its impact on climate change, through improved efficiency and reduced emission.

The actions and commitments outlined in this CMP also makes good business sense:

- Enhancing the University's reputation as an institution committed to energy efficiency and sustainability is an important aspect of the University's profile
- Improvements in efficiency will reduce spend associated with utilities, particularly at a time when energy prices are volatile and rising
- CMP implementation will help to conserve finite resources and reduce waste
- As part of the academic research the University will continue to lead in the development of new technology and research, which in turn will attract new students and staff. Central to this is the provision of specialist facilities

This CMP also responds to key University documents, placing it firmly within the leadership and governance structure to ensure delivery:

Our Strategy 2026	Includes the goal of maintaining and developing a sustainable estate and facilities and ennoblement of life.
Environmental Policy	Sets out that the University is committed to the protection of the environment including the prevention of pollution, the protection of biodiversity and ecosystems, climate change mitigation and adaptation and the sustainable use of resources.
Sustainability Policy	Reiterates the commitment to develop and maintain the estate and surrounding landscape with due regard to environmental impact and social value.
Estates Strategy 2026+	Objectives of this strategy are to develop a sustainable University campus that meets the organisation's strategic goals, create a master-plan that will provide an environment worthy of a global, top 100 University and provide a safe, well maintained environment for all users to work and live.

Progress made by the University of Liverpool against the absolute target will be measured and monitored via HESA's annual Estates Management Report. However, the University has also set normalised targets based on emissions per m^2

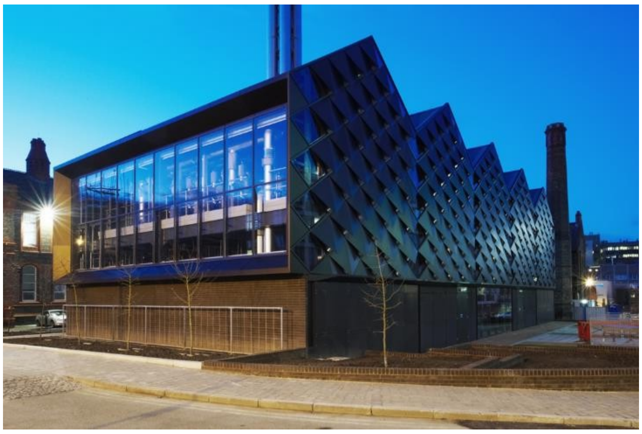
and number of full time equivalent (FTE) staff and students. This will allow the University to monitor increases in efficiency and provide a greater insight into the University's carbon performance.

2.1 Recent project activity

Future targets and the activities associated with achieving them, need to be seen in the context of previous and current emissions levels in order understand how recent actions may have reduced the opportunities available for future action.

2.1.1 Interventions since the 2011 CMP

The University has already introduced considerable measures to improve the energy efficiency of its estate, including:



1. Further 4.0MW to the existing 3.5MW Combined Heat and Power (CHP) plant that is housed in the New Energy Centre in Ashton Street. The Combined Heat and Power technology allows the University to generate most of its electricity needs on site and to use the heat derived from the generation process to heat the campus through its district heating network.
2. Efficiency improvements with external lighting across the City Campus (2500 lighting fixtures).
3. Efficiency improvements with internal lighting across the Leahurst Campus (external lighting currently under review and change).

4. Solar PV installation at Ness Gardens.
5. Air Conditioning – improving efficiencies.
6. External Campus LED Lighting Scheme.
7. Voltage Optimisation of electrical installations.
8. Swimming Pool cover installation.
9. Evaporative Cooling Project.
10. Motor Inverter Drives.

The University has also been very proactive and successful in gaining Salix funding to the extent that they have exhausted this funding stream. Implemented projects are estimated to save 2,185tCO_2/annum with a further 1,100tCO_2/annum in the pipeline with approved funding. Across the estate, Salix funded projects and tCO_2 saved/annum include:

LED related lighting improvements 300 tCO_2/year	Lighting control improvements 197 tCO_2/year	Draft proofing of buildings 322 tCO_2/year
Remotely manage BMS 218 tCO_2/year	Variable Speed driver on motor controls 531 tCO_2/year	Heating pipework insulation 323 tCO_2/year
	Cooling plant replacement 155 tCO_2/year	

2.1.2 Current/pending interventions

In addition to completed projects, there are a number of active projects. A Building Energy Management System (BEMS) update through improvement of current individual BEMS across the campus and their addition to a centralised system is currently in the pipeline with funding secured. Implementation is planned in two phases:

- Connection of modern buildings whose BEMS need little to no servicing. These are predicted to provide working case studies for future connections
- Connection of older buildings which require work on the individual systems before addition to the centralised system

The advent of a centralised BEMS will improve visibility of issues and error reporting across the campus. Combined with a greater availability of data, this is expected to reduce energy consumption through more effective and efficient management and maintenance of buildings.

A review of control set points (such as temperature) and schedules, including synchronising operating times with occupancy times is advised. This can be further linked to University IT systems such as room booking. This can feed into the current maintenance schedule, and allow more proactive maintenance to be undertaken.

Visibility of the BEMS, which is not currently available, to maintenance engineers will improve their effectiveness and understanding of trends within building faults.

A review of the Heating Ventilation and Air Conditioning and lighting strategies across the University is also currently underway.

2.2 Emissions trajectory since 2005/06 baseline

From 2005/06 to 2014/15, carbon emissions from energy use in University buildings increased by approximately 6.3% from 40,582tCO_2e to 43,063tCO_2e.

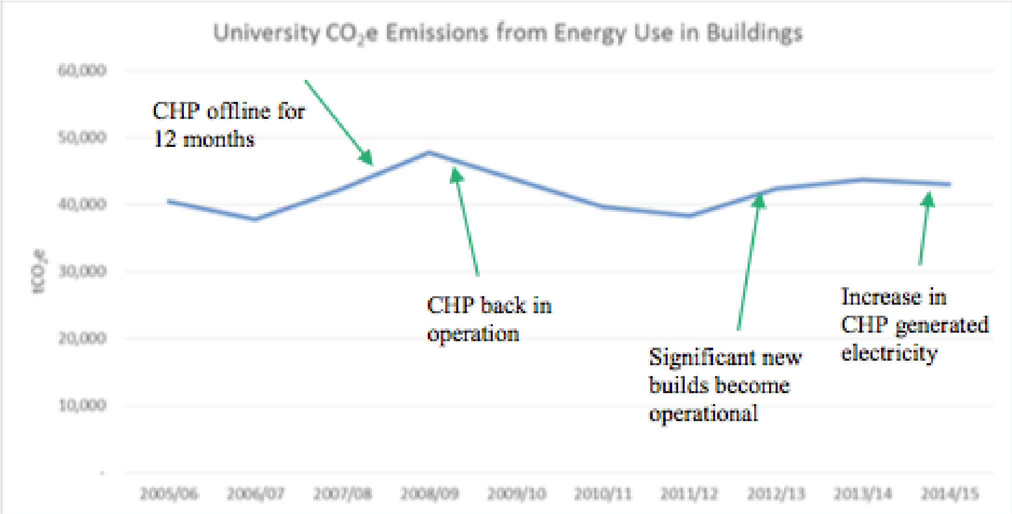


Figure 1: University CO_2e Emissions from Energy Use in Buildings 2005/06-2014/15

Figure 1 shows the emissions fluctuated year-on-year, reasons for this included:

- Changes to on-site CHP electricity generation capacity and fluctuations in availability,
- Fluctuations in/ changes to overall energy demand because of:
  - Growth in University building stock,
  - Space utilisation changes,
  - Changes in student and staff numbers,
  - Additional on-campus accommodation

The technical appendices, to support this report, covers these items in more detail.

As outlined earlier, this increase in emissions is consistent with the experience of many other UK universities, which have seen similar trends as a result of sustained periods of growth in student numbers, campus developments and increases in energy intensive research. Despite an increase in absolute emissions, the carbon footprint per student at the University has decreased by 15% since the baseline and, as of 2014/15, the energy consumption per square metre (kWh/m^2) has decreased by 9%.

Absolute emissions	**Relative to size of estate**	**Relative to no. students**
↑ 6%	↓ 9%	↓ 15%

This increasing efficiency is against a backdrop of an aging estate. A significant proportion of the University's estate was built between 1960 and 1980, and includes buildings with high energy intensity such as science research and low thermal performance.

2.2.1 2014/15 Baseline

Using energy data retained by the University, a baseline position on the existing estate and operation has been developed. This was based on a gross internal area of 483,919m^2 and emissions factors of 0.462kgCO_2e/kWh for electricity and 0.184kgCO_2e/kWh for gas. The technical appendices details the sources of data utilised to inform the baseline.

The emissions trajectory developed from the CMP Tool require a robust understanding of current energy consumption at a building level. 2014/15 was selected as the baseline year as it was the most recent comprehensive and robust dataset available at the time the development of this plan started.

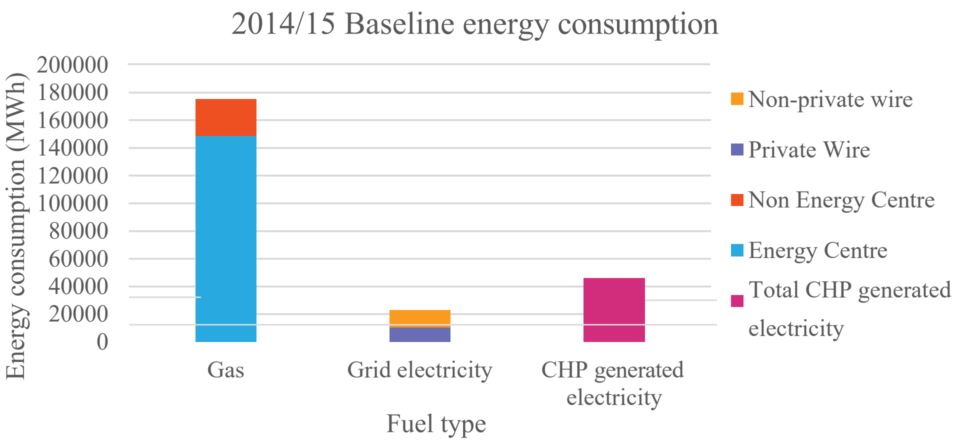


Figure 2: 2014/15 Baseline Energy Consumption

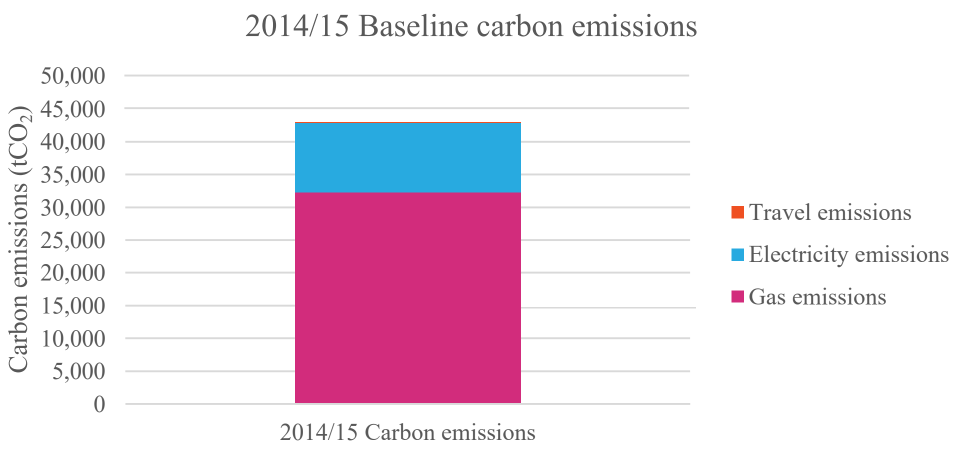


Figure 3: 2014/15 Baseline Total Emissions

Note: The CHP generated electricity is included in the gas emissions shown in Figure 3.

2.2.2 Emissions Factors

Carbon emissions factors are a useful method of quantifying the impact energy interventions will have on the carbon emissions of the University. However, calculating carbon emissions factors for reductions in heat and electricity consumption is a complicated process when having to consider the CHP energy centre.

The following carbon emission factors for 2014/15 are applicable to buildings connected to the energy centre via the private wire network and/or the heat network.

- 0.216kgCO_2e/kWh reduction in boiler heat generated
- 0.409kgCO_2e/kWh reduction in CHP electricity generated
- 0.462kgCO_2e/kWh reduction in imported electricity

For any buildings not connected to the energy centre, the following carbon emission factors apply for 2015 emissions:

- 0.184kgCO_2e/kWh gas consumed
- 0.462kgCO_2e/kWh grid electricity consumed

The above factors utilise the DEFRA carbon intensity metrics which vary for each year. The detail behind the carbon emission factors used is presented in the technical appendices.

2.3 Carbon Management Plan Tool

The aim of the spreadsheet-based CMP Tool is to allow the University to undertake quick and easy assessments of the relative carbon impact of a range of opportunities across the estates, such as refurbishment, installation of zone controls or installation of solar PV panels.

Changes across the estates such as new buildings, expansion, demolition and disposal are also modelled within the tool. The key output from the tool includes a projection of the carbon emissions associated with the University activities.

The tool is made up of a number of input, calculation and outputs sheets. A main dashboard presents a carbon trajectory, costs and energy savings breakdown for the university between 2014 and 2030, as shown in Figure 4.

The model has been designed with flexibility in mind and the user has access to edit all inputs, variables and assumptions within the model. This means that the impacts of any actions can be easily introduced or removed so the changes of individual projects and interventions can be estimated.

There are a number of place-holders available within the tool for the University of Liverpool to add more projects to the CMP tool as and when is needed. It is anticipated that the data contained with the tool will be updated as more detailed costs and impacts of interventions/actions become available.

More detailed instructions explaining how the CMP tool works is provided in the technical appendices.

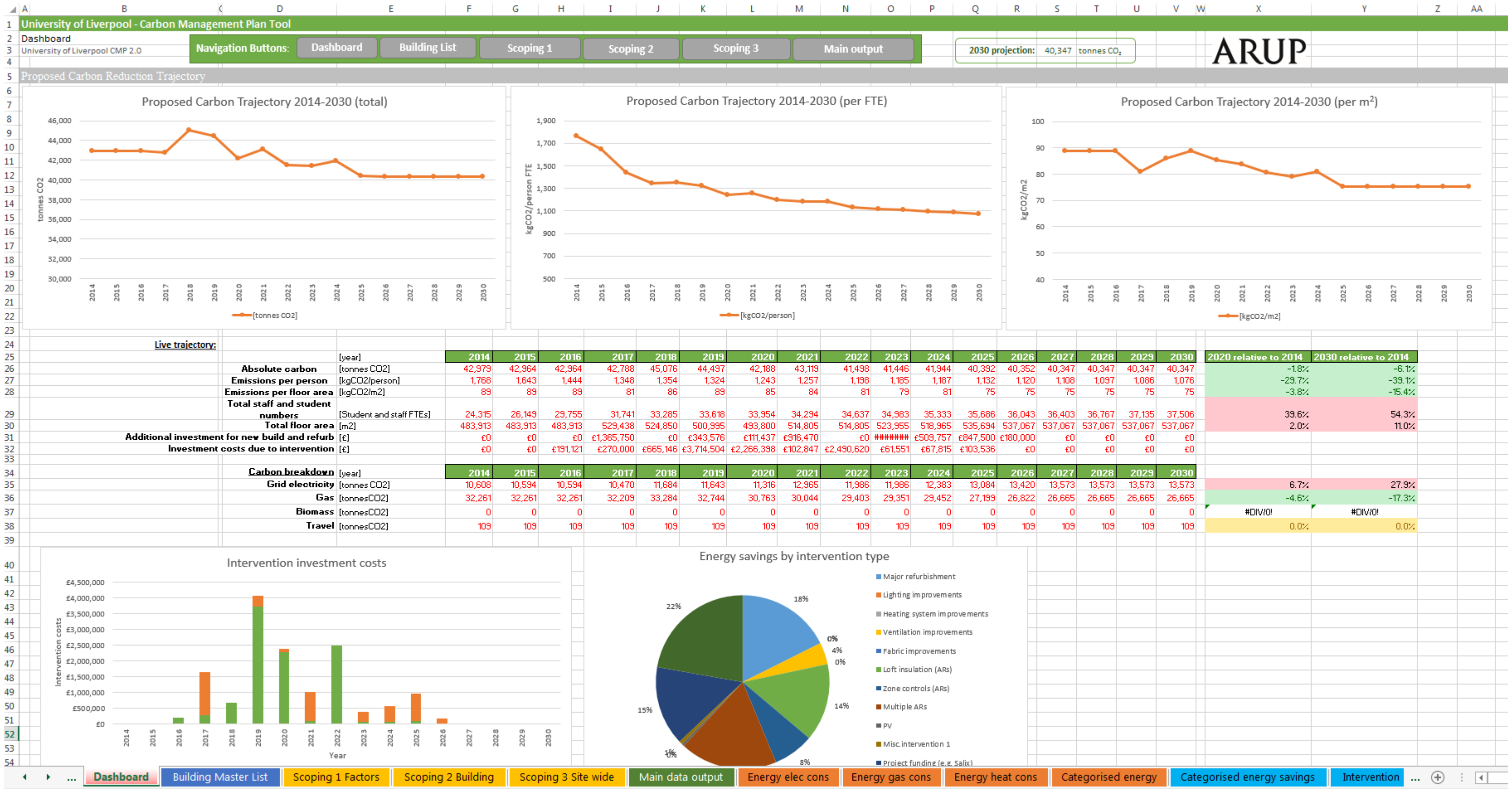


Figure 4: CMP Tool Dashboard

3 Potential Carbon saving projects

3.1 Projects included in the CMP baseline scenario

The University has identified projects to be included in the CMP baseline scenario and they have been used to set the 2020 and 2030 target. Table 1 summarises the projects included and lists those that were considered but excluded. The reasons for exclusion are also shown in Table 1.

The Estates Strategy 2026+ developed by the University sets out the vision up to 2026 and its implementation is seen as key in supporting the future growth of the University. The details outlined in the draft version of the document have informed the CMP carbon trajectory.

Table 1: Summary of projects included and excluded from baseline scenario

Projects		Included	Reason for exclusion
…included in baseline scenario			
Estates Strategy 2026+	New build projects	✓	
	Demolition projects	✓	
	Improvements to existing buildings	✓	
	Space utilisation improvement	✓	
Energy efficient projects	Salix funded projects, where funding has been secured	✓	
	Building fabric improvements (loft insulation) in selected buildings, informed by Advisory Reports (ARs)	✓	
	Zone controls (designed to control heating to defined areas) to reduce over and under heating in selected buildings, informed by ARs.	✓	
Energy generation projects	Ground mounted photovoltaic installation at Leahurst campus	✓	
Indirect interventions	Behavioural change and staff training	✓	
…excluded, considered not feasible			
Radiant Heating opportunities		✗	Already implemented and no other application identified
VSDs for Ventilation		✗	Already implemented and no other application identified
Boiler sequence controls		✗	No application identified
Higher Efficiency Boilers and Chillers		✗	Most buildings served by district heating network, others are upgraded to high efficiency plant at end of life
Compressed Air System improvements		✗	No Compressed Air Systems
Automatic PC Shutdown		✗	Already implemented

Projects	Included	Reason for exclusion
Energy Meters to escalators	✗	No application identified
Intelligent lift sequencing	✗	No application identified
Draft Proofing	✗	Already implemented
Improved insulation for hot and chilled distribution pipework	✗	Primary distribution pipework is relatively new with good insulation
Occupants training for ventilation systems	✗	Occupants have no ability to control heat
Ventilation heat recovery	✗	Implemented in modern buildings and in older buildings with ventilation (many without)
Weather compensator controls	✗	Already implemented and no further opportunities
Identify plant items and systems not connected to BMS and connect where advantageous	✗	Already implemented and no further opportunities
Managed Print Service	✗	Already implemented and no further opportunities
…excluded, considered but may be feasible in the future		
Occupancy Control	✗	Minimal applicability
Daylight Control	✗	No application identified
Vehicle fuel of UoL vehicles	✗	Minimal emissions
Improved insulation for pipework within plant rooms	✗	Minimal improvements available at this stage
Solar Thermal	✗	Funding and capital costs
Engagement with building users	✗	A notional improvement has been included in the baseline scenario but further opportunities may be available.
Light switch labelling	✗	Being implemented
Switching in parallel to windows	✗	Already implemented where possible
Biomass	✗	Funding and high capital cost with lower payback in future

Sections 3.2 to 3.5 include a number of tables, similar to Table 2, to indicate the impacts each project type included in the baseline scenario has in terms of carbon, cost and feasibility.

Table 2: Description and parameters for cost, emissions impact and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Description	Absolute percentages	Categories based on capital cost only	Potential scale of emissions reduction, by 2030	Practicality of implementation at the University
Parameters	Percentage determined directly from CMP tool	Low: < £100k Medium: £100k- £1.5M High: > £1.5M	Low: < 1% Medium: 1% to 2.5% High: > 2.5%	Further information required to determine this. All projects given a 'medium' rating. *

*A feasibility study for each project would be required to assess the physical constraints, risks, maintenance requirements and cost-benefits.

3.2 Estates Strategy 2026+

As part of the CMP development a number of assumptions, summarised below, have been made about the timings and scope of the actions outlined in the Estates Strategy 2026+. The Strategy categorised the actions and the timings assumed are shown in brackets below:

- Key investments planned/underway *(years 2018-2020)*
- Enabling quick wins *(years 2019-2021)*
- Key short to medium term *(years 2021-2022)*
- Key medium term *(years 2024-2025)*
- Further key medium term *(years 2025-2026)*

The Estates Strategy 2026+ covers the development of new buildings, demolition and improvements to existing building, space utilisation and expansion. The overall changes in the estate will result in improved efficiency across the University estate and the timescales may be subject to change.

3.2.1 Estate Strategy 2026+ – New build assumptions

The baseline scenario includes 22 new builds. Any known details about the new builds/developments identified as 'key investments planned or underway' were used in the CMP baseline scenario. In the remaining cases, the average size of the buildings across the University was generally used (approximately 3,000m^2) and timings were phased between now and 2026, depending on the categorisation. The Carbon Management Tool will be updated as and when more accurate and precise information becomes available.

The operational energy performance of new buildings is difficult to predict and depends on many factors including the hours of operation, equipment and other processes, as well as changes in building regulations and other requirements.

The appropriate CIBSE TM46 benchmarks, for operational energy of buildings, have been used to inform the expected energy performance of new buildings across the university. An average 25% improvement on the figures published have been applied, with further reductions between now and 2030 to reflect the improvements in operational requirements set by the university, changes in building regulations and the improvements in technology expected. It is understood that levels of improvements will vary from project to project, and in many cases the University will strive to exceed the performances assumed.

Assumption: 3000m^2 floor area, 25% improvement on TM46

Table 3: New build - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
New build	20.2% increase	High	Negative	Medium

Building Research Establishment's Environmental Assessment Method

BREEAM (Building Research Establishment's Environmental Assessment Method) is the world's leading and most widely used environmental assessment method for buildings. It sets the standard for best practice in sustainable design and has become the de facto measure used to describe a building's environmental performance. Credits are awarded in ten categories according to performance. These credits are then added together to produce a single overall score on a scale of Pass, Good, Very Good, Excellent and Outstanding.

BREEAM will be part of the norm for the University, with BREEAM 'Excellent' being targeted for all new buildings. The energy efficiencies have been included within the energy performances assumed.

3.2.2 Estate Strategy 2026+ – Demolition assumptions

The demolition of 16 buildings has been assumed for the baseline scenario. The demolition of older buildings considered unfit for purpose and economically unviable to refurbish will reduce the internal areas and allow the development of the overall site master-plan. In many cases the demolished sites will provide room for new buildings, built to a higher level of efficiency than before.

Assumption: Demolishing a building will remove all its associated energy

Demolition will also reintroduce some green public realm, which has been lost in recent years due to the development of new buildings.

The demolition timings have been informed by the prioritisation identified within the Estates Strategy 2026+, starting from 2017 to 2026.

Table 4: Demolition - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Demolition	18.5% reduction	-	High	Medium

3.2.3 Estate Strategy 2026+ – Improvements to existing buildings assumptions

With regards to the Estates Strategy 2026+ actions, the baseline scenario includes major refurbishment/significant improvements to 9 buildings. The University recognises that its estate is made up of older buildings, built when building standards were much lower than the targets of today. The existing buildings are responsible for a significant proportion of the carbon emissions and to address this the University has identified a number of refurbishment projects within their Estates Strategy 2026+.

For the purpose of the CMP it has been assumed that major refurbishment projects will deliver a 20% average improvement in energy performance, compared with the existing

Assumption: On average, 20% reduction in energy consumption building. It is recognised that some refurbishments will exceed this level of improvement, where some may be less. Unless stated in the strategy, it is assumed the footprint of the building will remain the same.

Table 5: Estates Strategy 2026+ refurbishment/improvements to existing buildings - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Estates Strategy 2026+: improvements to existing buildings	1.6% reduction	Medium	Low	Medium

Royal Institute of Chartered Surveyors SKA Assessment

A SKA rating is an environmental assessment tool for sustainable fit-outs. The University is undergoing initial development of an internal SKA-style sustainability self-assessment criteria for use in works across the University estate. This will allow the University to develop its own overarching sustainability benchmarks which can be selected for individual project where applicable. It will also help the University to embed sustainability and a carbon focus in every refurbishment project and allow project managers the flexibility to select project specific objectives and drivers to maximise impact. By addressing sustainability in this manner on projects at every scale, the University can reinforce its commitment to reducing carbon, and provide a means to measure and rank carbon reduction across all projects. The requirement to meet the internal self-assessment should be included in the Energy Targets section of the Capital Projects Design Guide.

The assumptions take account of the improvements resulting from the implementation of the University's version of SKA.

3.2.4 Estate Strategy 2026+ – Space utilisation assumptions

FRCS have assessed the current space utilisation across the University and identified areas where efficiency improvements can be made.

Due to the uncertainties around the savings space utilisation could provide, any energy savings associated with these activities have not been modelled in the current scenario but it is recommended reductions should be sought and savings captured.

Table 6: Space utilisation - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Space utilisation	0% reduction	Unknown	Unknown	Unknown

3.2.5 Estate Strategy 2026+ – combined actions

The combined impacts of the actions outlined in sections 3.2.1 to 3.2.4 are presented in Table 7.

Table 7: Estates Strategy 2026+ - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Estates Strategy 2026+	0.3% increase	High	Negative	Medium

While this cost is high, the majority of these activities are affordable given the fact that the work aligns to the capital plan. It is only listed as a high cost in comparison to other projects too.

3.3 Energy efficiency projects assumptions

A Display Energy Certificate (DEC) indicates, using actual (metered) data, how much energy is being used to operate a building. Currently under the Energy Performance of Buildings Directive, a DEC and advisory report are required for buildings with a total useful floor area over 250m^2 that are occupied by public authorities and frequently visited by the public. For compliance the University ensures DECs for its buildings are produced on an annual basis.

Advisory Reports (ARs) are produced to accompany DECs and contain a list of recommendations selected by the energy assessor for the improvement of the energy performance of the building, following their survey of the building. Recommendations are grouped according to payback periods and the potential impacts for carbon savings are identified as low, medium or high. ARs, however, do not specify the energy savings in terms of percentage reduction nor absolute kWh. The University is under no obligation to act on the AR recommendations for energy improvements however they recognise that by taking action the energy efficiency of their buildings can be improved, reducing carbon emissions and costs.

During the development of the CMP, the ARs for the most recent DECs were reviewed and recommendations were mapped against each building. This results from this exercise are presented in the technical appendix.

3.3.1 Multiple ARs assumptions

Multiple recommendations typically included installing automated controls and monitoring systems to electrical equipment, fitting zone controls, timer controls of energy consuming plant, replacing or improving glazing, applying reflective coating to windows and/or fit shading devices to reduce unwanted solar gains, weather compensator controls on heating and cooling systems etc.

The buildings with multiple ARs recommendations, interpreted as being those with the greatest opportunity for improvement, were included in the CMP:

- Music

- Central Teaching Hub
- Computing Services
- Veterinary Teaching Suite
- Sydney Jones Library
- Sports & Fitness Centre

Assumption: 15% reduction in electricity and thermal consumption

Table 8: Multiple ARs - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Multiple ARs	1.3% reduction	High	Low	Medium

3.3.2 Zone Controls assumptions

Fitting zone controls to better control the heating requirements was a short-term payback recommendation in over 80% of the ARs reviewed and therefore has been included in the CMP baseline scenario presented. The baseline scenario includes zone control implementation in 29 buildings. A phased programme between 2018 and 2025 has been assumed.

Assumption: 5% reduction in thermal consumption

Table 9: Zone controls - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Zone controls	0.4% reduction	Low	Low	Medium

3.3.3 Loft insulation assumptions

The introduction or improvement to loft insulation was recommended in 65% of the ARs reviewed. The baseline scenario includes a loft insulation intervention in a total of 29 buildings. Phased implementation, between 2018 and 2024, has been assumed for the CMP.

Assumption: 12% reduction in thermal consumption

Table 10: Loft insulation - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Loft insulation	0.9% reduction	Medium	Low	Medium

3.3.4 Multiple ARs, zone controls and loft insulations

The implementation of all three projects described above is expected to deliver a 2.6% reduction in carbon emissions from the 2014 baseline.

Table 11: Combined ARs - impact, cost and feasibility assessment

Project	Impact on carbon emissions by 2030	Cost	Impact	Feasibility
Multiple ARs, Zone controls and loft insulation	2.6% reduction	High	High	Medium

Many of the other AR recommendations could be included in the CMP, but investigations into the feasibility of such measures is likely to be required by the University, including a balance between payback, carbon savings and how it fits in with the overall strategy for the University and its development.

Further details of the buildings where AR recommendations have been included, along with the timings, are presented in the technical appendix under section A.1.

3.3.5 Externally Funded projects

For many years the University has secured funding from Salix and other streams for energy efficiency project implementation. A small number of projects are currently in the pipeline and have been included in the CMP baseline:

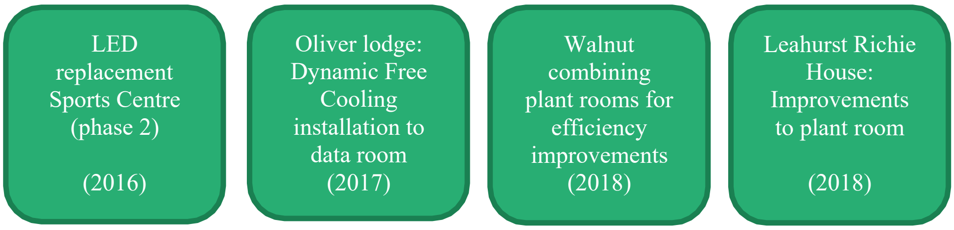


Table 12: Externally funded projects - impact, cost and feasibility assessment

Project	Impact on absolute carbon by 2030	Cost	Impact	Feasibility
Externally funded projects	0.9 % reduction	Low	Low	Medium

3.4 Energy generation projects assumptions

3.4.1 PV

Photovoltaic (PV) panels convert sunlight directly to electricity. The land available around the Leahurst campus offers suitable space for a ground-mounted PV installation. The University plan to undertake a feasibility study for this project, and for the CMP baseline scenario a 3MW installation by 2022 has assumed.

Table 13: PV installation - impact, cost and feasibility assessment

Project	Impact on absolute carbon by 2030	Cost	Impact	Feasibility
PV installation	3.1 % reduction	High	High	Medium

The University recently commissioned a study looking at solar PV feasibility for the various campus roofs. This study revealed a peak demand similar to the scenario above and therefore estimated impacts for this are also likely to be similar.

3.5 Indirect interventions

For the baseline scenario, it has been assumed that the impacts associated with the indirect interventions, such as behavioural change, may deliver up to a 1% improvement in electricity operational performance across the estate. The 1% improvement has been applied to grid electricity only. If similar improvements are applied to the thermal energy, savings are likely to be higher (1%).

Table 14: Operational improvements - impact, cost and feasibility assessment

Project	Impact on absolute carbon by 2030	Cost	Impact	Feasibility
Operational improvements	0.2% reduction	Low	Low	Medium

3.5.1 Behavioural change

The 2010 publication from HEFCE entitled ‘Carbon reduction target and strategy for higher education in England’ clearly stated the case for embedding behavioural change into institutions as an effective way of reducing emissions.

Behavioural change is estimated to provide a significant potential for carbon abatement (0.2MtCO_2 for the HE sector as a whole) which is comparable to the more traditional interventions of building fabric upgrades and renewable energy (0.3 to 0.6 MtCO_2). However, whereas the investment required to realise the savings in building fabric and renewable energy for the sector is estimated as hundreds of millions of pounds, the investment required is described as ‘minimal’.

Behavioural change initiatives are currently considered to be an integral part of the CMP. Deployment of behavioural initiatives can provide cost effective methods for reducing energy demand and carbon emissions across a range of operations.

The University recognises the need to undertake sustainability training and awareness raising for staff and students. Even simple procedures such as checking windows are closed and lights turned off will help to reduce wasted energy.

Social barriers exist to successful implementation of behavioural change programmes and the University are exploring ways to overcome these including:

- Power of social norms
- Teaching within the academic curriculum including integration Education for Sustainable Development
- Utilising ‘game theory’ to introduce energy performance competitions between departments/residences
- Energy champions and staff and student sustainability advocate networks

- Energy saving campaigns e.g. University and Guild of Students Student Switch Off programme
- Effective use of ICT to communicate energy saving messages, such as dashboards/screens/e-newsletters

3.6 Other CMP baseline scenario assumptions

The CMP baseline scenario (outlined in sections 3.1 and 4.1) is based on current 2015 DECC carbon emissions. The tool includes additional emission factors, enabling other scenarios can be tested, including the effects of grid decarbonisation.

The staff and student numbers described in the Estates Strategy 2026+ up to 2019 have been used in the tool, including an assumed growth of 1% year-on-year post 2019 (validated by the Department of Strategic Planning).

Unless an intervention occurs, it is assumed that a building's total energy consumption will remain the same for the following year. It is acknowledged that due to weather conditions varying year-on-year, this is unlikely to be the case, and changes in the heating and cooling requirements will occur. Also, impacts due to climate and technological changes have also not been accounted for in the CMP.

4 Carbon Targets

4.1 University's CMP target

Based on the current plans and future thinking on how the University will develop, the actions and assumptions have been modelled as the baseline scenario in the CMP tool to define the carbon emission targets for the University.

Assuming the Estates Strategy 2026+ progresses according to programme and other interventions are supported, the CMP forecasts total emissions of 42,188 tonnes CO_2 and 40,347 tonnes CO_2 in 2020 and 2030 respectively, against a 2014 baseline of 42,979 tonnes.

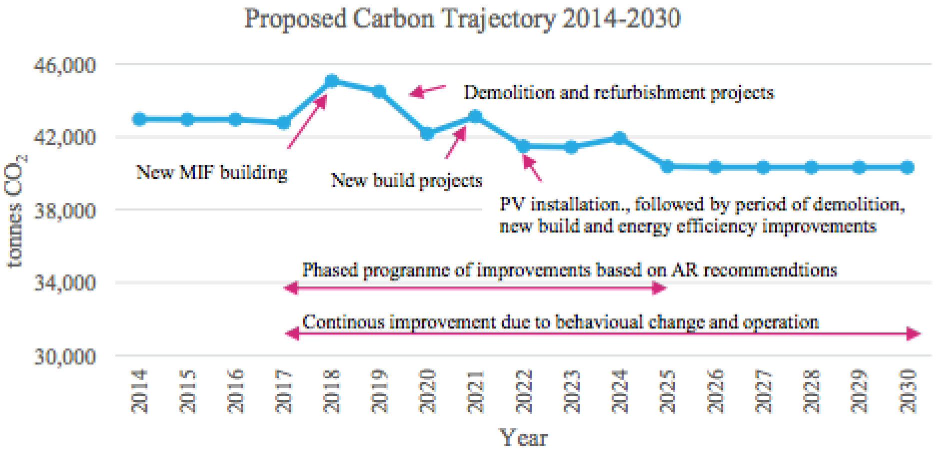
Headline targets, compared with emissions in 2014 are:

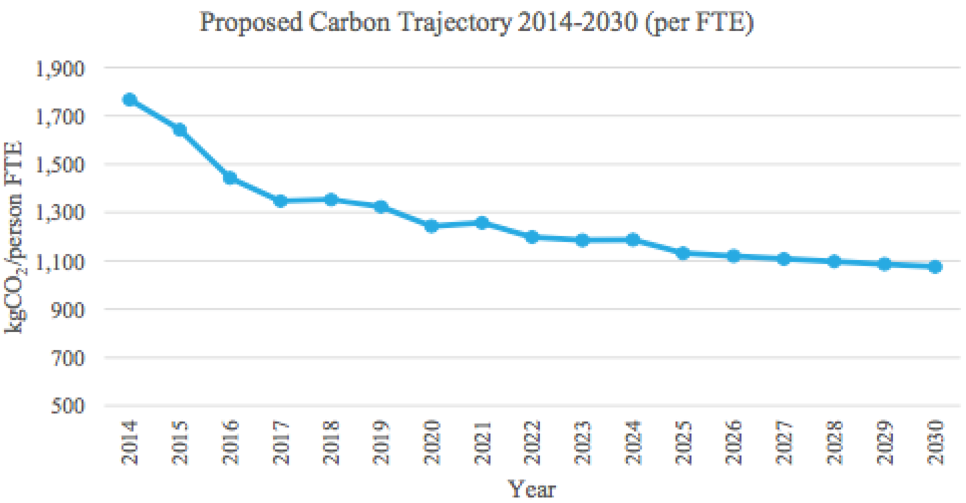
	Absolute emissions	Relative to size of estate	Relative to no. FTE
By 2020	↓ 1.8%	↓ 3.8%	↓ 29.7%
By 2030	↓ 6.1%	↓ 15.4%	↓ 39.1%

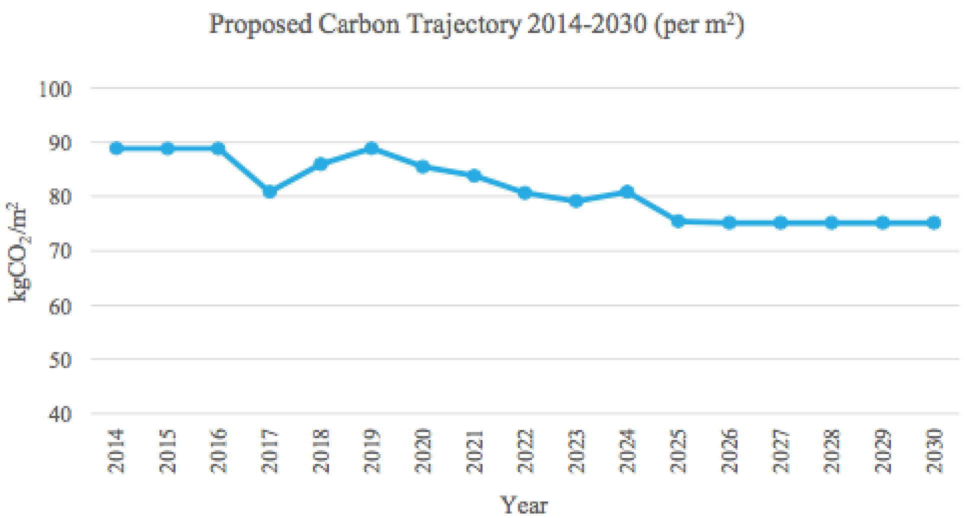
*Metrics relative to size of estate and number of FTE is subject to projected growth and projects being undertaken

The University's journey to an absoute carbon reduction of 6.1% by 2030 is unlikely to be smooth. The growth expected across the University - not only in student and staff numbers – will require expansion and the development of new buildings that will provide access and facilities for learning, research and living spaces.

The three charts below show the trajectories for absolute and relative carbon emissions trajectories. Note the y-axis for each chart does not start at zero.


Proposed Carbon Trajectory 2014-2030
46,000
42,000
38,000
34,000
30,000
tonnes CO2
New MIF building
New build projects
Demolition and refurbishment projects
PV installation., followed by period of demolition, new build and energy efficiency improvements
Phased programme of improvements based on AR recommendtions
Continous improvement due to behavioual change and operation
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Year


Proposed Carbon Trajectory 2014-2030 (per FTE)
1,900
1,700
1,500
1,300
1,100
900
700
500
kgCO2/person FTE
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Year

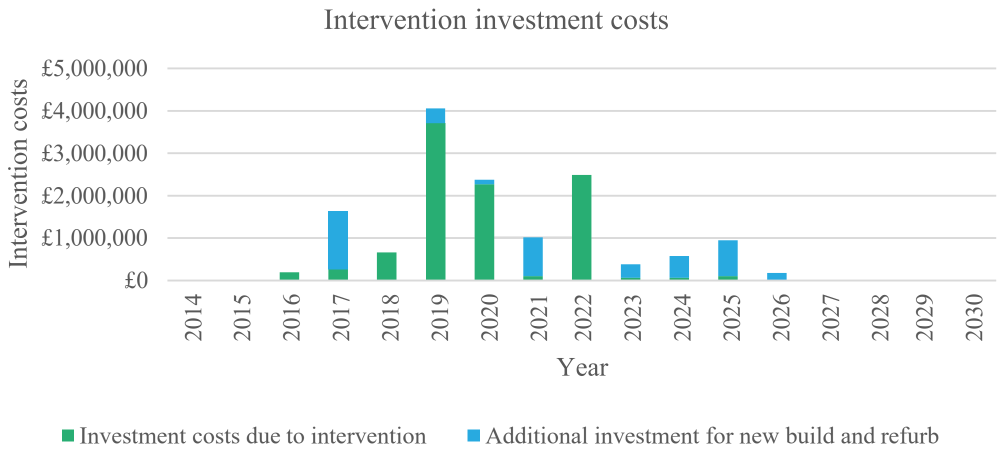

Proposed Carbon Trajectory 2014-2030 (per m2)
100
90
80
70
60
50
40
kgCO2/m2
2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Year

The University is committed to these reductions in CO_2 emissions and will continue to explore opportunities to exceed them.

4.2 Costs

The costs to implement the projects in the baseline scenario have been estimated, as shown below. These have been approximated based on costs relative to the assumed floor areas. The additional investment to deliver more sustainable new buildings and refurbishment projects is estimated to be approximately £4.6 million. Investment costs to implement the other intervention projects identified is estimated to be £9.9 million.

The tool provides a more detailed breakdown of cost, by year and project type.



4.2.1 Payback

The financial savings due to energy reduction have been used to determine the payback of the projects assumed within the baseline scenario. A grid electricity unit cost of 8p/kWh and a gas unit cost of 2p/kWh have been assumed in the calculations. The implementation for these project types range between 2016 and 2030. For the purpose of calculating payback, it has been projects occur in a single year.

Table 15: Payback period by project type

Project	Capital cost	Annual costs savings from utilities	Payback period
New build*	£4,135,200	£346,703	12 years
		-£1,331,011	Due to the scale of new build projects, the utility costs resulting from the implementation of the new build projects are expected to increase.
Demolition	£0	£949,712	0 years
Improvements to existing buildings (as per Estates Strategy 2026)	£1,346,765	£83,567	16 years
Space utilisation	£0	-	-
Multiple ARs	£4,291,515	£66,381	65 years
Zone controls	£82,886	£20,921	4 years
Loft insulation	£1,362,869	£40,155	34 years
Multiple ARs, Zone controls and loft insulation	£5,737,270	£127,457	45 years
Funded projects	£961,121	£49,082	20 years
PV installation	£2,350,000	£231,920	10 years
Operational improvements	£0	£18,362	0 years

*The payback for new build projects has been calculated in two ways. The first is based on the difference in annual utility cost savings delivered through procuring a more energy efficient building compared with a ‘typical’ new build. The second method applies the total expected annual utility cost savings (a cost increase in the case of new build projects). The capital cost for both is based on a cost ‘uplift’ to go from a ‘typical ’new build to a more energy efficient one (BREEAM ‘Excellent’).

It is important to note that these calculations suggest that the implementation of the Estates Strategy 2026+ alone is unlikely to ever payback. This is directly linked to the new build projects and the additional energy use in these buildings.

4.3 Scenario testing

A number of scenarios have been modelled to illustrate the functionality of the carbon management tool and demonstrate the impacts on the carbon trajectories due to changes in assumptions or future carbon emission factors.

The changes in absolute emissions by 2020 and 2030, relative to 2014 for each scenario is shown in Table 16.

The results of scenario testing demonstrate that although the Estates Strategy 2026+ is a key part of the overall strategy to growth and efficiency improvements, the adoption of this alone is unlikely to achieve the targets. Further improvements delivered though energy generation projects such as the installation of a PV installation at Leahurst, and implementation of the recommendations outlined in the DEC advisory reports may also be required.

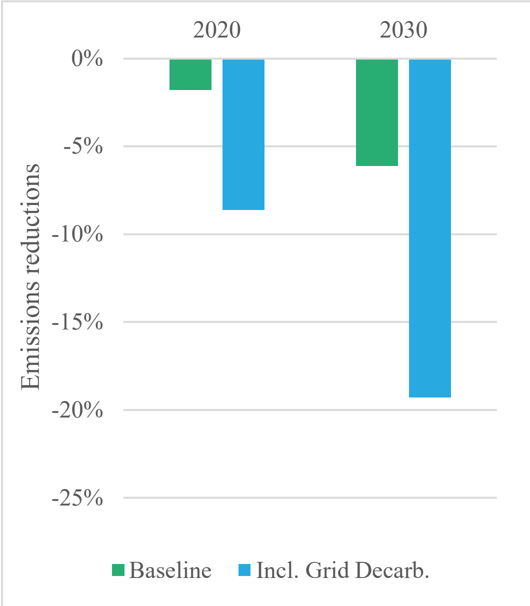
Grid decarbonisation is outside of the University's control and therefore not included in the baseline scenario. However, as can be seen from testing of the carbon management tool, grid decarbonisation could deliver additional significant carbon savings.

Table 16: Scenario testing and carbon emissions impacts

Scenarios	2020	2030
No interventions, i.e. do nothing	0.0%	0.0%
Baseline With Grid Decarbonisation	-8.6%	-19.3%
Estates Strategy 2026+ demolition actions only	-4.5%	-18.5%
Baseline with Sleeved PPA	-1.8%	-10.4%
Baseline with 40% improvements on refurbishment projects, rather than the 20% assumed in baseline scenario	-2.6%	-7.7%
Baseline CMP scenario	**-1.8%**	**-6.1%**
Baseline with 10% improvements on refurbishment projects, rather than the 20% assumed in baseline scenario	-1.5%	-5.4%
Ground-mounted photovoltaic installation at Leahurst in 2022 only	0.0%	-3.1%
Advisory Reports only	-1.4%	-2.6%
Estates Strategy 2026+ major refurbishment only	-1.0%	-1.6%
Funded projects only	-0.9%	-0.9%
Estates Strategy 2026+ actions only (including new build and refurbishment projects)	0.8%	0.3%
Estate Strategy 2026+ new build projects only	6.3%	20.2%

It is worth drawing attention to the effect of electricity grid decarbonisation. The University has chosen to take a prudent approach to not including the impact of grid decarbonisation as a result of the fact that it is beyond their operational control.

However, if the UK's electricity generation mix change as expected, the reduction in carbon emissions by the target dates is significantly greater than the baseline (which assumes a constant emissions factor):



5 Implementation plan and recommendations

5.1 Implementation plan

The University's CMP is built around these main themes:

Adoption of the Estates Strategy 2026+	Many of the buildings were constructed prior to the introduction of improving Building Regulations standards and the stringent performance targets of today. The Estates Strategy 2026+ implementation is seen as key in supporting the future growth of the University and improvement of the quality of the estate. The Strategy includes development, refurbishment, expansion and demolition across the University's estate.
Energy efficiency projects	In addition to the actions outlined in the Estates Strategy 2026+, the University recognises the need to make improvements in other buildings, using measures such as loft insulation and zone controls of heating installations.
Introduce and explore energy generating opportunities	The University is keen to generate as much energy as possible from clean energy sources. The main campus is already connected to a district heating network, where considerable improvements have already been made. Now the University is looking at its other campuses. Future initiatives could include PV installations at the Leahurst campus or on individual rooftops.
Behavioural Change	The University will continue to implement initiatives to target behavioural change. This is likely to include the use of game theory, competitions and other methods of making energy use more visible to the University staff and students. A clear and comprehensive communication strategy for all stakeholders needs to be designed and implemented.

5.2 Additional actions and recommendations

5.2.1 Sleeved PPA

A 'sleeved' power purchase agreement (PPA), officially known as 'PPA Netting (Third Party Netting)', is a form of direct PPA (an agreement made between renewable energy generated and an end user). The purchaser may benefit from supply of electricity that has been generated from renewable energy. In contrast to private wire arrangements, a physical connection between generator and customer is not required for sleeving.

A sleeved PPA is designed to enable renewable generators to directly contract with large electricity customers to deliver their electricity through a local distribution network. Any remainder of electricity that cannot be delivered by the renewable generator, will be topped up by a licenced supplier via a netting arrangement to ensure the customer's demand is met. This balancing service can be borne either by the licensed supplier or the customer, depending on the contract. The PPA Netting allows the large customer to 'sleeve' the generation volume at the same wholesale price as the equivalent supply contract volume.

The netting PPA enables the customer to contract directly with the generator. This agreement tends to be a long term contract for renewable generators that have not yet built or begun operation of their plant and therefore need the security of the long term price guarantee to secure project finance.

The potential advantages and disadvantages to the University in entering into a sleeved PPA arrangement are presented in Table 17.

Table 17: Potential advantages and disadvantages of sleeved PPA

Advantages	Disadvantages
Electricity supply from a renewable source resulting in carbon emissions savings compared to traditional supply.	The carbon emissions savings will diminish over time as the national electricity grid decarbonises.
No upfront CAPEX required compared to University-funded renewable energy scheme.	A price premium would be expected compared to the University's existing electricity tariff.
Physical connection (private wire) is not required between the renewable energy scheme and the University, removing this cost and allowing for wider geographical location for renewable energy schemes.	The more complicated contracting structure means that more legal and financial advice is required compared to traditional electricity supply.
	It is likely that a relatively long term contract would be required compared to traditional electricity supply.

A sleeved PPA has not been assumed in the baseline scenario, but functionality has been built into the tool so it can be assessed in the future.

The University will look to investigate the potential for provision of a sleeved PPA for their existing electricity supply, i.e. for the electricity used by the University that is not generated on site (primarily by the CHP system).

The recommended approach for this is for the University to contact energy suppliers, can include the University's existing electricity supplier. Key considerations which are:

- Comparison of price and indexing compared to existing electricity supply.
- Carbon savings depending on the source of potential sleeved PPA, and how the savings may vary in the future.
- The term of potential sleeved PPA.
- The forecasted required consumption of grid-supplied electricity.

5.2.2 Utilising findings from the Estates Survey database

It is recommended that engagement with the estates survey database be incorporated as a fundamental requirement within University Design Guidance for all project sizes. For the University to meet and surpass carbon targets, ensuring all projects integrate energy saving measures where possible is essential. From a wider perspective, promoting knowledge of, and access to the database will help reduce duplication and ensure work streams are streamlined across required refurbishment and maintenance work.

5.2.3 Monitoring performance

In order for the University to better understand performance and areas where improvements can be made, they recognise the need to invest time and resource in monitoring the energy consumption across the estates.

In addition, improved understanding of energy usage within buildings through metering and monitoring will allow the design teams to put more emphasis on energy reductions within building refurbishments and retrofits. Energy calculations should be included in any applicable project and via the internal Ska methodology in conjunction with greater visibility of the estates survey required actions can be combined across all project works of any size to minimise future costs. Promotion of engagement within the design, energy and sustainability teams are advised to ensure no opportunities are missed.

5.2.4 Reducing electrical baseload

The University runs with approximately 5MW electrical baseload. Given the size and nature of the estate, a high baseload is to be expected, however steps should be taken to decrease this where possible. Initial investigates could focus on highly serviced and high energy usage buildings.