Estates Services

Sustainability Design Guide 2024 – SDG24

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Reasons for latest revision:

Updated in 2024 to align with the Environmental Sustainability Strategy, current policy requirements, best practice and lessons learned since the publication of the previous guidance.

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Contents

1 – Introduction and background

Oxford University's Environmental Sustainability Strategy was approved by Council on 15 March 2021. The strategy sets two ambitious targets: to achieve net zero carbon and to achieve biodiversity net gain, both by 2035.

In 2017, Estates Services issued the *Sustainability Design Guide (SDG)* to inform the specification and standards of our new build and refurbishment projects.

This guidance has been updated in 2024 to align with the Environmental Sustainability Strategy (ESS), current policy requirements, best practice and lessons learnt since the publication of the previous guidance.

The ESS focuses on ten priority areas, three of which are underpinned and supported within this guidance document.

- **Carbon emissions from University buildings** – Minimise carbon emissions from our energy consumption.
- **Biodiversity** - Identify and address the University's principal biodiversity impacts through its operations and supply chain, and enhance biodiversity on its estate.
- **Local travel** - Limit transport emissions by reducing the need to travel, encouraging walking, cycling and the use of public transport, and managing the demand to travel by car.

The strategy is further underpinned by a set of enabling practices, two of which are integrated into the *SDG*:

- **Governance** - Embedding environmental sustainability in the University's governance and decision-making for capital projects.
- **Reporting** - Developing a system of measuring and verifying carbon emissions and biodiversity impacts to support delivery of the ESS.

The main themes that have been addressed in the *SDG* to align with the current sustainability, carbon, and biodiversity strategic objectives include:

1. Focusing on reducing project operational energy and embodied carbon, using standard methodologies and certified standards.
2. Providing a clear pathway for energy and emissions reduction in retrofit and refurbishment projects.
3. Updating biodiversity requirements in line with the ESS and best practice.
4. Defining stepped and specific derogation standards where necessary in order to help design and project teams make more informed decisions.

The SDG24's principal target audience is project design teams and project managers. It aims to define practical, cost-effective approaches for new build and refurbishment projects, suitable for delivery across the Oxford estate, which can be implemented by project teams and their consultants. It defines the standards required of large building projects at the University and introduces a gateway process for reviewing, agreeing, and implementing any derogations from these standards.

It is envisaged that future revisions to this guidance will focus on updating the technical requirements, as standards tighten, rather than the principles contained within the guide.

2 - Key principles and objectives

The overall objective of the SDG24 is to provide buildings that perform as well as they are designed to perform. This will mean University buildings deliver the ESS's objectives while also supporting the University's core mission of education and research.

This document builds on past iterations of the *SDG*, and on the University's experience of implementing these standards. In addition, it incorporates a review of the latest University and industry standards, including those from RIBA, LETI, Green Building Council, AECB and the Passivhaus Institute, among others. It also incorporates feedback from University stakeholders.

The following objectives should be considered by capital project teams and are supported by the revised guidance:

Key sustainability objectives for project teams

Environmental impact

- Develop and deliver net biodiversity gain strategies.
- Drive design for long life, low environmental impact, low maintenance, and flexibility.
- Design for circular economy – deconstruction not demolition, recovering materials at the end of life.
- Reduce water consumption.
- Promote and support sustainable travel modes.
- Default to refurbishment instead of new build.
- Assess and minimise embodied carbon.

Energy efficiency

- Focus on primary energy use through building efficiency and reducing demand.
- Reduce complexity and increase occupant ownership of the energy consumed by buildings.
- Do not install new gas supplies, and remove gas in refurbishments.
- Enable heating systems to be compatible with renewable sources.
- Maximise draught-proofing and insulation.
- Remove the need for fossil fuels through low-temperature heating, sharing waste heat and using available energy efficiency measures.

Other

- Enhance occupant comfort, experience, and productivity.
- Apply other key estates guidance, such as security requirements and the *Building Services Design Guide*.

3 - Governance, compliance and performance validation

All University of Oxford capital projects proceed through a gateway review at stage 0, 1, 1A, and 2 as detailed in the capital planning process. Funds for minor works projects are released at gateway 2, and funds for strategic capital projects (those over £5m in 2023) are released at gateway 3.

SDG24 details the project standards required to support the delivery of the ESS's objectives of achieving net zero carbon and biodiversity net gain by 2035 and within the University Estate Strategy.

All projects should be designed, built, and validated to have achieved the standards set out in the SDG.

It is recognised that there may be circumstances where achieving these standards is disproportionately expensive or may result in unacceptable compromises to building functionality. To provide clarity and support to design teams, in these circumstances the relevant standard is identified with the flowchart symbol , and details of the required derogation pathway are provided below.

In general, as in the 2017 version of this SDG, all capital projects with a construction value over £1m are required to be designed using the Passivhaus methodology. The expectation is that a project will target Passivhaus Certification but with the understanding that PSGs may exercise discretion over the feasibility of full certification

In practice, all projects should aim from the start to achieve the higher standards set out in this guidance. If a project needs to follow the specified derogation pathway, this can be identified in the gateway review process, before or at gate 2 for a minor works project, and before or at gate 3 for a strategic capital project. See the *Capital Projects Guide* for more information.

The Environmental Sustainability team and colleagues from the Capital Projects team are on hand to provide guidance and advice, as are the Passivhaus Institute and a plethora of teams which have a track record in this arena – for a project to achieve these high standards at reasonable cost takes great skill, an attention to both the broad objectives of the project as well as the minute detail, and a genuine passion. Getting the right people on board from the outset is important, and in this fast-moving world, learning from existing projects is a very useful way to maximise the chances of achieving a high-quality project with long term benefits to all, without excessive cost and time. The SROs and Project Boards have to carry out a balancing act between cost and sustainability and this should be benchmarked with other projects.

The rationale for derogation will need to be approved by both the Project Board and the Head of Environmental Sustainability. In the case of a dispute, the request will be referred to the Building and Estates Subcommittee (BESC) for approval.

Details of team composition, roles and responsibilities are given in the *Capital Projects Guide*, which also provides a breakdown of activities by RIBA stage.

4 - Biodiversity and ecology

4.1 - Biodiversity net gain

Project team:

Architect, Ecologist or Biodiversity Lead, Sustainability Consultant, Project Manager, Quantity Surveyor

Rationale:

The University affects biodiversity both directly and indirectly. Most of the direct impacts relate to the management and development of the University estate. These can be mitigated through commitments to increasing biodiversity across the University managed estate and its developments, as well as by reducing operational carbon emissions and embodied carbon.

Project biodiversity impacts need to be accounted for, with negative impacts mitigated and positive impacts enhanced, so that the University can demonstrate an overall gain in biodiversity from all its activities.

The Oxford-developed framework known as the Mitigation and Conservation Hierarchy must be used on projects to address biodiversity impacts through these actions:

1. **Refrain** from actions that damage biodiversity
2. **Reduce** the damage our remaining actions create
3. **Restore** biodiversity that has been damaged
4. **Renew** and enhance nature

Requirements:

The following principles and targets concern not only the University's commitments to biodiversity net gain for new developments, but also the delivery of ecosystem services for all new build and refurbishment projects. These directions are informed by Natural England's *Green Infrastructure Framework*[1].

Biodiversity

1. All projects should work to identify biodiversity enhancements from the initial briefing stage. For mandatory 10% biodiversity net gain for all development projects from 2nd of February 2024, see derogations.
2. All new build and refurbishment schemes that require planning permission should aim to demonstrate a 20% biodiversity net gain post development. The University notes that this might not always be possible but encourages all development projects to target 20% BNG. This is in line with the DEFRA guidance that 10% BNG is a minimum for biodiversity gains. This must be established through pre- and post-development baseline biodiversity surveys, using the current Statutory Biodiversity Metric[2].
3. Where a project could affect existing habitats, an extended phase one habitat survey should be carried out at RIBA stage 2, and the recommendations acted upon. We encourage this

extended survey to include legally protected species and other important wildlife. This survey should be repeated in the event of a project pause exceeding one year and recommendations acted upon.

4. A Habitat Management and Monitoring Plan should be developed during the project, detailing the scope of biodiversity to be incorporated, the improvement goals to be achieved, and how they will be managed post completion. Delivery, monitoring, and reporting of the biodiversity improvement goals will be shared with Estates Environmental Sustainability team on the first, third and tenth anniversary of practical completion.
5. The impact of lighting on bats, birds and moths etc. should be reviewed with an ecologist and recommendations acted upon.
6. Ancient woodlands and trees must be protected with a buffer zone of at least 15 metres from the boundary of any woodland to the new development. For ancient or veteran trees, the buffer zone must be 15 times larger than the diameter of the tree trunk, or 5 metres from the edge of the tree canopy if that area is larger.
7. Green Roofs meet the Green Roof Organisation (GRO) Standards[3] for Biodiverse Green Roofs or Biosolar Roofs, which encourage features to enhance the ecological value of the space.
8. The requirements of any new biodiversity measures must be clearly set out by the project team and understood by facilities teams, and the ongoing cost of that maintenance included in life cycle costings.
9. If a 20% biodiversity net gain cannot be achieved on site, an approach can be agreed upon and approved by the project sponsor and a brief written proposal should be submitted to the Chair of the Oxford Green Estate Governance in accordance with current best practices at the University. This approach will set out how any shortfall against the 20% biodiversity net gain target for the project will be achieved elsewhere within the University estate.

Green space

10. Target minimum 40% green cover for a project. Green cover is all non-sealed surfaces, including tree canopy cover (even over sealed surfaces), green roofs and green walls. Target 30% of this area to be nature-rich. (See Natural England's Habitat Mosaic Approach[3].)
11. Protect, retain, and enhance existing features wherever possible, such as trees. woodlands, hedges, wetland areas and other natural features.
12. There must be no net loss of green space, trees, and woodland.
13. Behavioural and experiential planting (eg green walls) must be considered.
14. Green roofs must include fire breaks at 40m intervals, and designs must be reviewed with the University's insurers at RIBA Stage 2.

Connectivity

15. Lay out a connected network of green infrastructure and sustainable drainage systems at the first stage of design, before the location of roads or buildings is determined, to ensure that this network is integrated with the natural hydrology, topography and existing natural features of the site.

16. Retain and enhance linear green and blue features such as streams, hedges, lines of trees and species-rich verges as part of the site design. These features should not form part of property boundaries, as that could later lead to replacement by householders (eg hedges being replaced with fences).
17. Retain and enhance any existing rights of way with adequate green buffers to maintain their character as greenways.
18. Ensure safe, traffic-free walking and cycling links from the development to the external public rights of way (PROW) network.
19. Create and protect wildlife corridors (eg hedgehog holes in fences, unlit bat corridors).
20. Provide linear green features (lines of trees, tall hedges or woodland strips) that act as noise and pollution barriers between homes, schools etc and busy roads.
21. Design on-site Sustainable Drainage Systems (SuDs) as part of a water-management train that links to natural flood management and other nature-based solutions in the wider catchment area.
22. Protect water courses from pollution with buffers of semi natural grass, scrub, or trees.

Sustainable Drainage Systems (SuDS)

23. Design SuDS as the first stage of new development, taking account of the site's natural hydrology, topology and ecology.
24. Design SuDS as a treatment chain of detention basins, retention ponds, raingardens and wetlands, connected with open, vegetated channels ('bioswales'). Combine with use of green walls and roofs, urban parks and trees to reduce runoff at source. See the CIRIA *SuDS Manual* [5] for further detail.
25. Natural SuDs must be shallow sided, more than 0.6m deep and with gently sloping banks that allow safe access for small mammals.
26. Consider public safety and use an attractive design that incorporate benches and natural play features where appropriate.
27. Maximise benefits for water management by capturing water for onsite irrigation and non-potable uses where possible, or else allowing water to infiltrate into the ground. If the ground is contaminated, water must be attenuated for gradual release to a water body.
28. Natural SuDs schemes need to have a specific Management Plan.

Embodied carbon

29. In keeping with the University's efforts to reduce scope 1,2 and 3 carbon emissions and embodied biodiversity, projects should aim to reduce utility consumption and environmental impacts through the supply chain. Consideration must be given to the origin of hard landscape materials (eg using European rather than Chinese granite).

Local character

30. Secure the involvement of the local community to ensure that natural and heritage features that are of particular value to them are identified, protected, and enhanced.

31. Incorporate local culture and historic heritage in green infrastructure, and allow local knowledge to inform innovative design features that celebrate local identity, such as outdoor sculptures and murals.
32. For further guidance, see *National Model Design Code*[6] (part 2 p4).

Planting and maintenance

Guidance on planting choices and habitat management are available in **Appendix 1 - Habitats and Planting**.

Derogations:

Biodiversity net gain 20%

The Environment Act introduced mandatory 10% biodiversity net gain for all development projects from 2 February 2024. The University encourages all development projects to achieve 20% BNG.

If a 20% biodiversity net gain cannot be achieved on site, an approach can be agreed upon and approved by the project sponsor and a brief written proposal should be submitted to the chair of the Oxford Green Estate Governance in accordance with current best practices at the University. This approach will set out how any shortfall against the 20% biodiversity net gain target for the project will be achieved elsewhere within the University estate.

The legally mandated 10% should be achieved in accordance with legislation, and the additional portion up to 20% should be quantified in the same way through pre- and post-development baseline biodiversity surveys, using the current Statutory Biodiversity Metric, but does not need to be covered by maintenance agreements (such as section 106) in the same way.

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the Project Handbook.

References:

1. Natural England *Green Infrastructure Framework* 2023
2. *Statutory Defra metric*
3. *The Mosaic Approach: Managing Habitats for Species (B2020-009)*, Natural England
4. Green Roof Organisation Standards
5. *SuDS Manual (C753)* 2015, CIRIA
6. *National Model Design Code*

4.2 -Pollution prevention

Project team:

Architect, MEP consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor.

Rationale:

The ESS requires that appropriate controls be put in place to prevent pollution. This means preventing the presence of or introduction into the environment of substances which have harmful or poisonous effects.

Building materials, systems, positioning, layout, and features (including the installation of equipment to reduce or detect pollution) should be considered from project Stage 1 to support the University in meeting its compliance obligations and to prevent pollution during normal, abnormal, and emergency scenarios. Consideration should also be given to preventing or managing connections between pollution sources (eg backup generators, chemical stores, kitchens, and carparks), pathways (drains, land, extraction) and receptors (air, land, water).

Careful specification of insulation and of systems containing refrigerants can help limit ozone layer damage and climate change impact. Attention to the design of these systems can also reduce maintenance requirements and energy costs.

Oil traps, sump-pumps (including appropriate detection alarms and isolation) and the location and design of spaces containing chemical stores, waste management and backup generators should all be considered in relation to potential pathways and receptors. Basement groundwater sump-pump systems also introduce a problematic maintenance burden, discharge costs and compliance risk to the University and must be avoided in project design.

Requirements:

- All specified insulation (thermal, pipe, fire, acoustic) must have a GWP of <5 and a zero Ozone Depletion Potential (ODP) wherever practicable.
- For building services using refrigerants, the Direct Effect Life Cycle (DELC) CO_2 per kW cooling must be calculated to *BS EN 378-1* and must be $\leq$ 1 T CO_2e/kW.
- Refrigerant specifications must be approved in advance. Specified refrigerant must ideally have a GWP of $\leq$ 675.
- A pollution risk assessment must be undertaken for the scheme design at Stage 2 and for design of generators, chemical stores, kitchens, and car parks at Stage 3.
- The requirement for groundwater sump-pumps must be designed out wherever possible.
- Grease traps (*BS EN 1825-1:2004/1825-2:2002*) must be designed into all food preparation areas to comply with Part H of the Building Regulations.

Derogations: none

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

- *DEFRA F Gas Regulation in Great Britain*, December 2022
- *BS EN 378 -1* Refrigerating Systems and Heat Pumps
- *BS EN 1825-1:2004/1825-2:2002* Grease Separators
- Estates Services *Building Services Design Guide*

4.3 - Waste prevention

Project team:

Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor

Rationale:

Waste production and disposal is a substantial cost to the University, a key external reporting metric and a significant environmental impact. Construction projects present a strong opportunity for waste minimisation and embodied carbon reduction through reuse and recycling. There are many opportunities to re-use building components, fixtures, fittings, and furniture if suitably audited before a refurbishment commences.

Projects must always plan and design to avoid waste being produced on site and mitigate it by following the waste hierarchy:

1. **Reduce** the amount of waste by only buying what is needed and planning its use effectively.
2. **Re-use** materials to avoid creating waste.
3. **Recycle** materials from site where they cannot be re-used.

To achieve this, project teams must design for waste-efficient procurement, materials optimisation, off-site construction (where practical and economic), re-use and recovery, and deconstruction and flexibility.

Requirements:

Projects must ensure that waste provision for the completed building will be adequate to integrate with the central non-hazardous waste contract.

A Resource Management Plan must be completed for all projects. This must comprise a pre-refurbishment and/or pre-demolition audit detailing all waste streams, quantified by estimated weight and identifying disposal routes.

Items that could be re-used must be listed on WARPit[1] for a minimum of a month, and high-value equipment reviewed with the University Green Scheme. A deconstruction plan should be completed for key building assets that have not reached the end of their serviceable lives.

Diversion of non-hazardous waste from landfill must be evidenced by waste transfer notes and a summary monthly report: *PAS 402*[2]-certified waste contractor 85%, non-*PAS 402* certified waste contractor 95%.

Derogations: none

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

1. WARPit – A network for redistributing unwanted items or resources within the University
2. *BSI PAS 402*

4.4 - Water use

Project team:

Architect, MEP Consultant, Sustainability Consultant, Project Manager, Quantity Surveyor

Rationale:

The University's ESS and Water Management Strategy both set out targets for sustainable resource use and reducing the University's water consumption. Water is a significant cost to departments and projects must go as far as possible towards minimising its use. Beyond this, water is a finite resource and efforts must be made to avoid wastage and to channel supplies efficiently.

Requirements:

Design principles

Careful attention to the design and specification of water systems is required, and project teams must follow the following design principles:

- Determine the water metering requirements for the project to monitor and manage water use.
- Develop a strategy and specification that supports water quality, particularly in building refits.
- Design to reduce leaks and avoid inaccessible pipework where possible and where there is a risk of leakage.
- Specify water-efficient fittings and equipment.
- Explore the whole life carbon and cost benefits of rainwater harvesting and grey water recycling, noting that University projects have encountered significant issues and costs derived from the specification of rainwater harvesting systems.
- Avoid supplying boiling or chilled potable water

Specific requirements

1. Large water-using equipment must be sub metered and connected to the University's remote monitoring system. Refer to the Estates *Building Services Design Guide* Appendix E for detailed guidance.
2. Water pressure must be tested, and fittings must be specified to the following max flow rates up to 5 bar with pressure-reducing valves installed for pressures in excess of this:

Table 1: Maximum water flow rates

Installation type	Maximum flow rate
WC (dual flush)	6/4 litre
Showers	< 6 litres/min

Urinals (inc. control devices or waterless)	< 1 litres/hour
Kitchen/ette taps (must be aerating)	< 4 litres/min
Basin taps (must be aerating and with minimised percussion timing)	< 4 litres/min

3. Flow rates must be verified at commissioning.
4. Boiling water taps must be avoided and, where specified, must have simple user interfaces allowing control to hours of operation and must not require specialist maintenance contracts.
5. Where used, rainwater harvesting systems must be limited to gravity fed designs providing for landscaping maintenance.

Derogations: none

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

1. Estates Services *Building Services Design Guide*
2. Estates Services *Legionella Policy & Procedure Document*
3. *ACOP L8* & *HSG274*
4. *CIBSE Guide G*

5 - Whole-life carbon

Project team:

Passivhaus Certified Consultant/Designer, Passivhaus Certifier, Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor, Consultant (Construction), Consultant (Design)

Rationale:

As a responsible developer, the University of Oxford is committed to minimising its carbon emissions and aims to achieve a net zero built environment. It is therefore important to measure embodied carbon in the construction supply chain and throughout the build process for all developments. On an annual basis these construction emissions will exceed the operational emissions, and the margin by which they do this will increase as we transition from fossil fuels towards low-carbon electricity.

The University has a clear preference for retrofitting existing buildings. A new building will only be considered when it has been demonstrated that space reallocation, retrofit and/or repurposing cannot deliver the functionality required. It is important to retain existing building structure and foundations, as these account for most of the total embodied carbon. Where a new building is required, evidence of the lowest possible whole-life carbon emissions must be provided.

The University's approach places higher priority on short term carbon emissions than predicted future emissions, which by their nature are uncertain. A breakdown of the Carbon Life Cycle by stage is given below followed by a table displaying our priorities for emissions reduction. Upfront Embodied Carbon and Life Cycle Embodied Carbon are a high priority, and sequestered carbon is an extremely high priority, as these aspects provide an immediate carbon emissions reduction.

As the calculation methodology for embodied carbon improves and new low-carbon materials are developed, the University's requirements will increase. It is expected that design teams will take an ambitious approach to minimising emissions, particularly those occurring at construction.

Figure 1: Lifecycle carbon categorisation

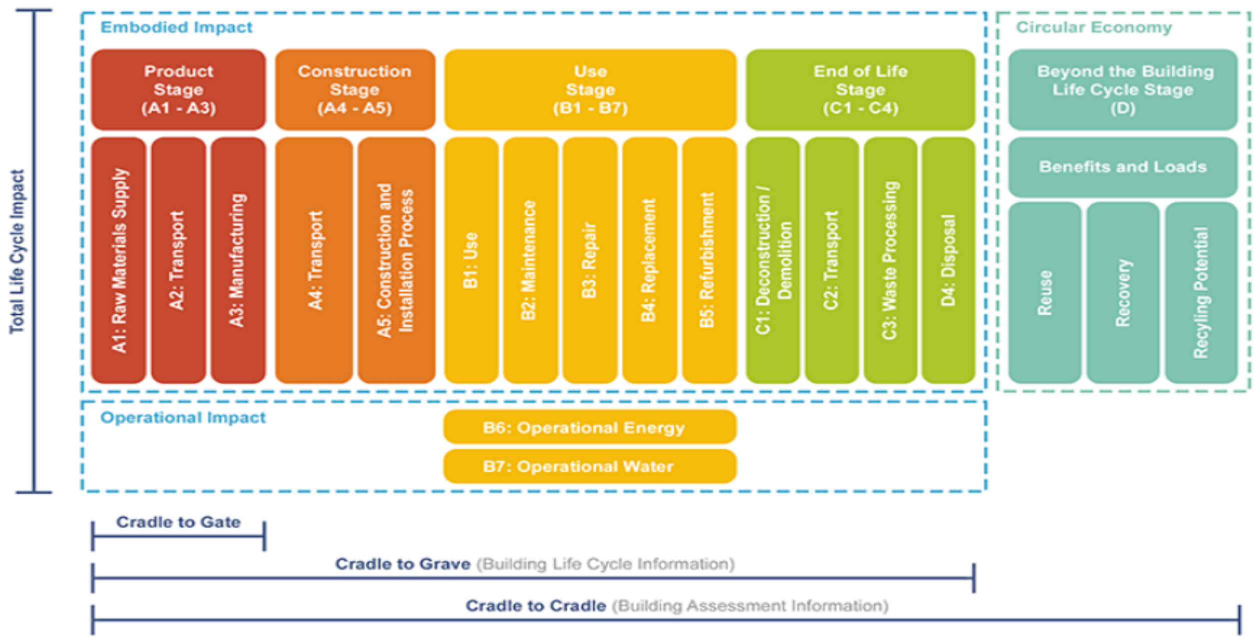


Table 2: Priorities for WLC strategies

Whole-life carbon strategy	Priority
Upfront Embodied Carbon A1-5 exc. Sequestration	Very high
Sequestered Carbon A1-3. Mainly A1	Very high
Life Cycle Embodied Carbon A1-5, B1-5, excluding C1-4	High
Life Cycle Embodied Carbon C1-4	Medium
Module D	Medium

Requirements – new build:

1. Full reporting of WLC and Upfront Carbon with and without sequestration, using the LETI protocol and completed at the end of RIBA stages 3 and 5.
2. Demonstrate the impact of key design decisions on calculated emissions, and specifically how these decisions have reduced WLC emissions.
3. Prioritise opportunities for sequestered carbon emissions.
4. Upfront and life cycle emissions also to be prioritised.

(See **6 – Operational Energy**.)

Time-based targets:

(These are liable to be updated by the University from time to time, and the team must review any Technical Annexes before agreeing project targets.)

Figure 2 – Embodied carbon standards targetss

Embodied Carbon Standards

Draw from:
- **RICS (methodology & definitions)**
- **LETI**

Progressive targets:

2023-2025: Targets, non enforced

2025-2030: Mandatory targets, to be set by the University

>2030: Improved targets

Methodology:
- Should be consistent e.g, RICSs + LETI
- Focus should be on upfront carbon
- Less focus on end of life- we don't know the future.

Upfront Embodied Carbon, A1-5 (exc. sequestration)

Target	Band	Office	Residential (6+ storeys)	Education	Retail
	A++	<100	<100	<100	<100
	A+	<225	<200	<200	<200
LETI 2030 Design Target	A	<350	<300	<300	<300
	B	<475	<400	<400	<425
LETI 2020 Design Target	C	<600	<500	<500	<550
	D	<775	<675	<625	<700
	E	<950	<850	<750	<850
	F	<1100	<1000	<875	<1000
	G	<1300	<1200	<1100	<1200

Life Cycle Embodied Carbon, A1-5, B1-5, C1-4

Target	Band	Office	Residential (6+ storeys)	Education	Retail
	A++	<150	<150	<125	<125
	A+	<345	<300	<260	<250
	A	<530	<450	<400	<380
RIBA 2030 Design Target	B	<750	<625	<540	<535
	C	<970	<800	<675	<690
	D	<1180	<1000	<835	<870
	E	<1400	<1200	<1000	<1050
	F	<1625	<1400	<1175	<1250
	G	<1900	<1600	<1350	<1450

The team should submit calculations to demonstrate compliance with the above, and in line with RICS guidelines, using approved software and a suitably qualified professional. The LETI Embodied Carbon Declaration report format must be used to report the results of the study, and compliance with the LETI targets.

Where a specific (LETI) target is not available, the team should propose the nearest target, or a bespoke target, with justification for this. The University will approve any non-standard target before design and construction commence.

In all cases, the most recent version of any guidance document should be referred to for targets and approach. Where there are conflicts, the LETI targets and guidance are to take priority.

Note: refrigerants will be much more commonplace in electrified buildings, and therefore leakage and recharge rates will have a significant effect on total carbon emissions during Stages B2-B5. The design team must minimize refrigerant volumes and select refrigerants with a GWP of ≤ 675.

Design for adaptability

One of the reasons many buildings are demolished is the limited extent to which they can be feasibly adapted to suit new user requirements. Failure to consider future adaptivity can also lead to more frequent and extensive refurbishments, which have their own associated environmental impact.

The project team will consider design elements which allow for future adaptability including:

- Structural spans and grids for maximum flexibility
- Stair core positions
- Circulation routes

- Partitioning – this must be capable of being altered with relative ease to change room layouts
- Servicing strategies which can be easily modified or extended to suit new room layouts. This is particularly important for ventilation systems and may lead to local or zonal systems rather than central, or plenum-based air distribution.
- Spare plant capacity
- Space for additional future plant

Requirements – retrofit:

There are not currently any agreed emissions targets for retrofit projects, and WLC outcomes vary depending on the extent of the retrofit planned. Bespoke targets are therefore to be agreed on a project-by-project basis prior to design work commencing. In general, it is expected that any retrofit project will demonstrate lower WLC emissions than an equivalent new building. As with new build projects, retrofit projects should maximise sequestered carbon.

Retrofit WLC outputs required:

1. Team to propose bespoke WLC targets and agree these with the University.
2. Refurbishment to consider deconstruction in place of demolition during refit – any opportunity to repurpose existing structure, infrastructure, mechanical and electrical (M&E) or furniture, fixtures, and equipment (FF&E) should be reviewed.
3. Full reporting of WLC and Upfront Carbon with and without sequestration, using the LETI protocol and completed at the end of RIBA stages 3 and 5.
4. Savings over a 'build new' equivalent to be reported.
5. Demonstrate the impact of key design decisions on calculated emissions.
6. Prioritise opportunities for sequestered carbon emissions.
7. Upfront and life cycle emissions also to be prioritized.

(See 6 – Operational Energy.)

Responsible Retrofit Approach

All retrofit projects carry risks associated with the unknowns of existing buildings and the unintended consequences of upgrading the fabric of a building. *PAS 2038* provides a framework for safe management and delivery of the retrofit process for non-domestic buildings[13] and is recommended for use by design teams to help identify and manage such risks.

Design for adaptability

Project teams should consider how refurbishments can be carried out with future adaption in mind. See 6.11 Requirements – new build.

Requirements – operational carbon

Operational energy demand will be calculated by modelling required to meet the energy performance standards of the project. (See **6 – Operational energy**.)

When calculating operational carbon emissions over the life of the building, it is important to use realistic and consistent grid carbon factors which relate to predicted UK grid decarbonisation.

For consistency, designers must use the GridESO Future Energy Scenarios 'Leading the way' data.

Derogations: none

References:

1. LETI *Circular economy for the build environment: a summary* (April 2022)
2. LETI *Embodied Carbon declaration v0.4*
3. LETI, RIBA, WLCN *Whole Life Carbon* – 1-pager
4. LETI, RIBA, WLCN *Embodied Carbon* – 1-pager
5. LETI, RIBA, WLCN *Embodied carbon target alignment* (2022)
6. LETI, RIBA, WLCN *Improving consistency in whole life carbon assessment and reporting* (May 2021)
7. RIBA *Embodied and whole life carbon assessment for architects*
8. CIBSE *TM65 Embodied carbon in building services: a calculation methodology* (2021)
9. iStructE *How to calculate embodied carbon* (2020)
10. RICS *Whole life carbon assessment for the built environment, 1st Edition* (2017)
11. *EN 15978 Sustainability of construction works - Assessment of environmental performance of buildings* (2011)
12. *EN 15804 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products* (2019)
13. *PAS 2038:2021 Retrofitting non-domestic buildings for improved energy efficiency – specification* BEIS (2021)

6 - Operational energy

6.1 -Energy standards

Project team:

Passivhaus Consultant/Designer (CEPH), Passivhaus Certifier, Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor Contractor (Design), Contractor (Construction), Moisture Specialist (retrofit projects only)

Rationale:

In developing the estate, the university has a preference to retrofit, to avoid the impact of new build construction and its associated carbon emissions. Retrofitting aims to achieve energy efficiency across older, often historic buildings, many of which were built before the introduction of energy consumption regulations. It brings with it the added advantage of improving occupant wellbeing, so that older buildings can be newly designated fit- for-purpose, avoiding the need for costly replacement.

New build projects in excess of £1m are expected to reach the energy efficiency of Passivhaus Classic. Retrofit projects in excess of £1m are expected to meet Passivhaus EnerPHit.

At the heart of delivering the performance of Passivhaus buildings is the certification process. Certification provides clear requirements for the design team and contractor, and meaningful recognition of the level of quality achieved for design and construction (ie a Passivhaus certificate).

A Certifier, appointed independently of the design team and contractor, provides a crucial 'golden thread' for energy performance from early-stage design to completion, giving impartial scrutiny to the design and construction standards.

Achieving Passivhaus requirements is challenging and minimising any uplift in costs requires early engagement of an experienced Passivhaus Designer/Consultant.

Energy modelling

The use of the **Passivhaus Planning Package (PHPP)** for assessing building performance against targets means that a building energy model will be available from the initial stages of a project.

1. During detailed design this should be developed into a full operational energy model using the *CIBSE TM54* methodology, and at handover, a *CIBSE TM63* in-use operational energy model which can be used to validate seasonal commissioning energy performance.
2. For some building types, **multi-zone Dynamic Simulation Modelling (DSM)** may be appropriate to capture complex and varying energy uses. However, although the DSM calculation methodology can more accurately model building behaviour, modellers must be aware of the intrinsic uncertainties in the assumptions inputted into such models.

6.1.1 - Requirements – new buildings

New buildings of construction value above £1m should seek to achieve the **Passivhaus Classic** standard, with aspiration to achieve **Passivhaus Plus**. The design and construction teams should always aim to have the final building certified by the Passivhaus Institute. Passivhaus Plus requires sufficient availability of space for solar PV, combined with minimising unregulated energy demand. Both of these are challenging for many University projects.

The feasibility of Passivhaus is driven by early-stage decisions on the form of the building and on structural and cladding strategies. Design teams should be mindful of strategies which may be costly for Passivhaus compliance down the line, ensuring that the design is developed to the appropriate level at each stage to verify the suitability of their approach. Design teams need to report Passivhaus certification and compliance in the base cost of the project, not as added or below-the-line optional extras.

It is acknowledged that the University has a wide and varied portfolio of developments, many of which will not fit the Passivhaus Classic model. Where this is the case, the consultants should engage with the Passivhaus Institute to agree a bespoke set of targets for the project as a route to achieving certification. Recognising the challenges of achieving Passivhaus certification for some building types, guidance is provided for suitable derogation pathways, which are designed to offer greater flexibility while maintaining a clear set of targets and the benefits of the Passivhaus certification process.

Derogations – new build

It is recognised that there may be circumstances in which achieving the Passivhaus Classic standard is unachievable or may result in unacceptable compromises in building functionality.

The following are examples of unacceptable reasons for derogation from Passivhaus Classic for new buildings:

- Building shape not suitable for Passivhaus, ie poor form factor – unless the result of severe site constraints.
- Glazing levels too high.
- Building detailing too complex to achieve airtightness.
- Cladding and external features which create excessive thermal bridges.
- Building not sufficiently detailed at budget or tender stage, resulting in large (and unacceptable) uplift in reported project cost.

Where Passivhaus certification is not deemed to be feasible, the rationale should be presented to the SRO and the Estates Environmental Sustainability team. If there are disputes, it will be referred to the Building and Estates Subcommittee (BESC).

In the first instance, the University may derogate to Passivhaus Principles. This involves designing and delivering the scheme as if it were to be fully certified to Passivhaus Classic (or bespoke target were agreed with the PHI), but without following through the certification process.

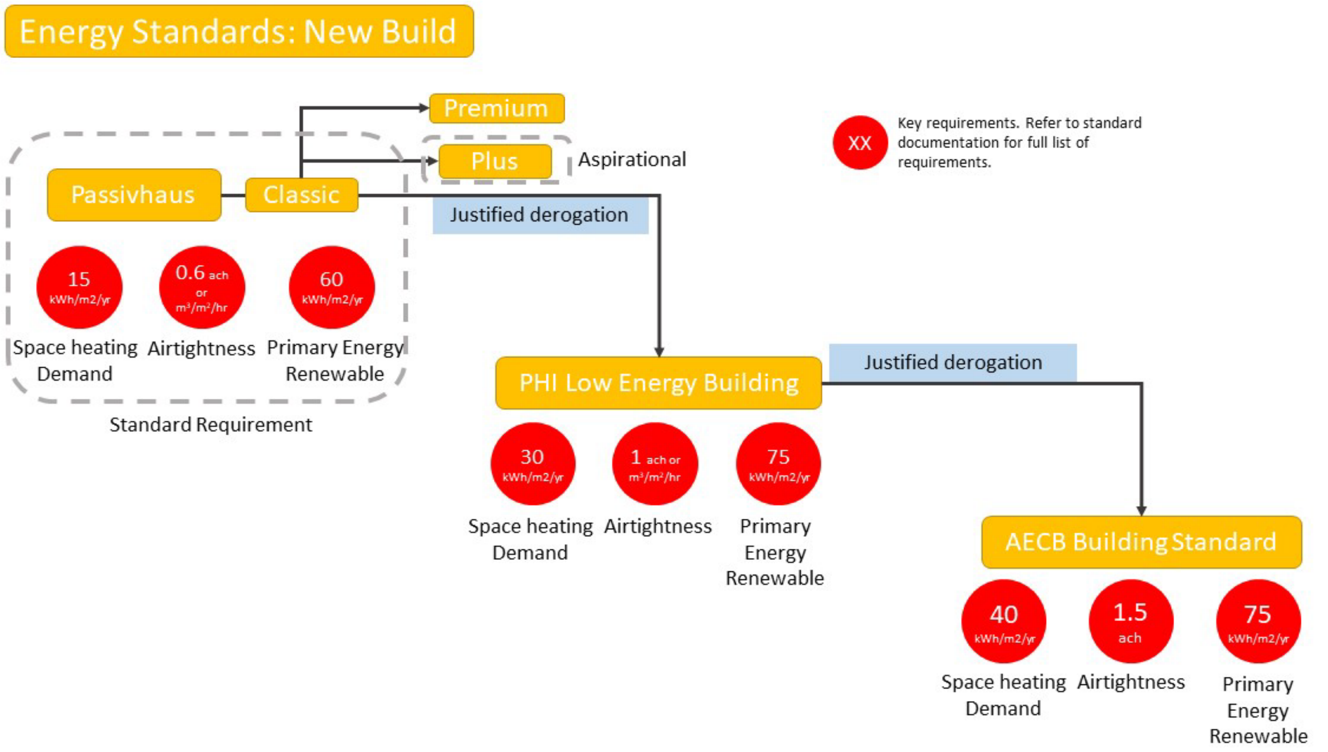
The diagram below gives a pathway to three alternative performance standards:

Passivhaus Principles: designing and delivering the scheme as if it were to be fully certified to Passivhaus.

PHI Low Energy Building- a fully Certified Passivhaus standard, with reduced requirements for heating and airtightness.

AECB Building Standard- uses the same methodology as Passivhaus, with further relaxation of the requirements. Note that while this standard is typically self-certified (ie by the designer) the University would look to the appointment of a third-party Certifier in similar fashion to Passivhaus.

Figure 3: Derogations pathway on energy standards for new build projects



Please note that the University does not recommend that projects target net zero operational carbon emissions. It is rarely possible to match energy demand with on-site PV generation. This means it is better to focus on demand reduction and on zero-gas solutions.

6.1.2 - Requirements – refurbishment

1. Refurbishment, remodelling, and redevelopment of existing buildings above a construction value of £1m should achieve the **EnerPHit** standard. The design and construction teams should always aim to have the final building certified by the Passivhaus Institute.
2. Teams may use either the **Energy method** or **Component method** of the EnerPHit standard. The latter may allow greater flexibility for some projects, where achieving the space heating target of the energy method would require impractical changes to building elements.
3. If the Component method is chosen, the building energy use should still be calculated using PHPP.
4. Note that extensions must be treated as new buildings and would therefore need to achieve Passivhaus Classic independently of the refurbishment. (See **6.1.1 – Energy standards requirements -new buildings**)

Design teams should always report EnerPHit certification and compliance in the base cost of the project and not as added or below-the-line optional extras.

The EnerPHit standard itself contains various exemptions which may provide the necessary flexibility to deal with common constraints associated with deep retrofit of buildings.

However, it is recognised that even with these exemptions, there will be circumstances where achieving the EnerPHit standard is unachievable, not cost effective, or may result in unacceptable compromises in building functionality. For these circumstances the pathway to derogation is set out below.

Fabric Retrofit Risks

Energy performance upgrades to existing fabric create a risk in respect of moisture accumulation which can lead to mould growth, damage to building finishes and even structural failure. Project teams must take these risks seriously, applying the principles of 'responsible retrofit', including:

- Appoint a building physics specialist with expertise in moisture.
- Carry out a retrofit risk assessment (such as that outlined in the *AECB Retrofit Standard*).
- Follow tried and tested approaches where possible, learning from completed projects.
- Use breathable construction systems and techniques which tend to self-regulate moisture flows.
- Best practice guidance must be followed, including that from:
  - Society for the Protection of Ancient Buildings
  - Historic England
  - BEIS Retrofit guides
  - *PAS 2038*
  - Sustainable Traditional Building Alliance

In particular, *PAS 2038* provides a framework for safe management and delivery of the retrofit process for non-domestic buildings[1], and is recommended for use by design teams to help identify and manage such risks.

Derogations – retrofit:

The feasibility of EnerPHit is driven by early-stage decisions on the building envelope. Design teams must be mindful of strategies which may be costly for EnerPHit compliance down the line, ensuring that the design is developed to the appropriate level at each stage to verify the suitability of their approach. The following are examples of unacceptable reasons for derogation from EnerPHit:

- Proposed glazing levels too high
- New cladding and external features which create excessive thermal bridges.
- Building not sufficiently detailed at budget or tender stage, resulting in large (and unacceptable) uplift in reported project cost.

Where it is deemed that EnerPHit is not feasible, Figure 4 below gives a pathway to two alternative performance standards: AECB Retrofit Standard (Level 2), or a bespoke target suited to high-profile listed buildings.

The rationale for following either of these options should be agreed with the SRO and the Estates Environmental Sustainability team, and if there is a dispute will be passed on to the Building and Estates Subcommittee (BESC).

[1] *PAS 2038 :2021 Retrofitting non-domestic buildings for improved energy efficiency* – specification, BEIS, 2021

In the first instance, the University may derogate to EnerPHit Principles. This involves designing and delivering the scheme as if it were to be fully certified to EnerPHit, but without following though the certification process.

AECB Retrofit Standard (Level 2) uses the same methodology as EnerPHit, but with relaxed requirements. A further relaxation is provided for the space heating target up to 100kWh/m^2/yr for buildings which meet the exemption criteria[2]:

- If required by the historical building preservation authorities.
- Due to legal requirements.
- If implementation of the required thickness or fire-related properties of thermal insulation would result in unacceptable restriction of the use of the building or adjacent outer areas.
- If reliably moisture-robust construction is only possible with a reduced insulation thickness in the case of interior insulation.
- If other compelling reasons relating to construction are present.

Given the level of flexibility available with this approach, it is the University's expectation that projects which (for good reason) cannot achieve the EnerPHit standard will be able to meet the AECB Retrofit Level 2 standard.

Note that while this standard is typically self-certified (ie by the designer) the University would look to the appointment of a third-party Certifier in a similar fashion to Passivhaus.

Bespoke targets

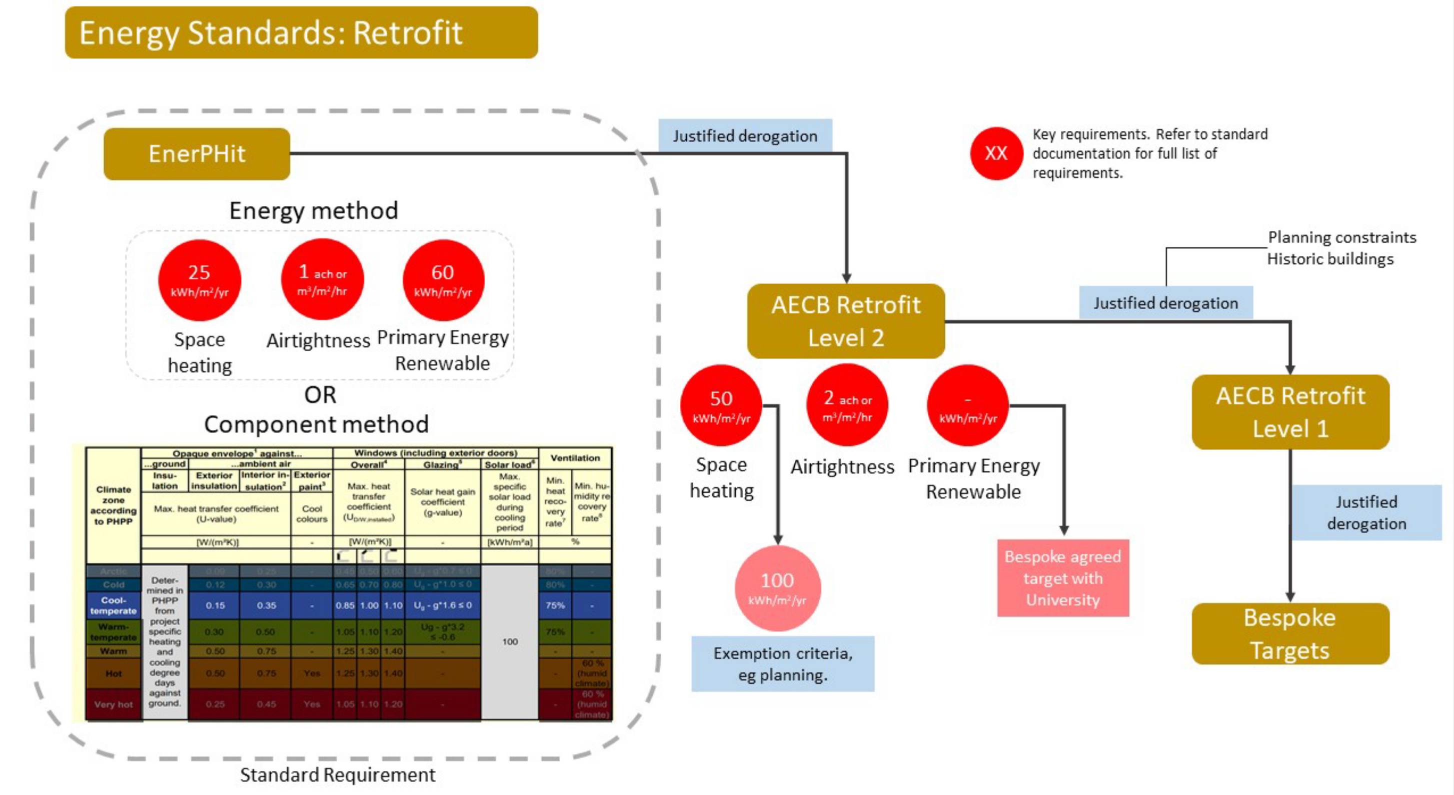
Project teams are encouraged to take an ambitious approach with fabric retrofit, even for historic buildings. However, it is recognised that some buildings exhibit such profound constraints to energy retrofit that fabric upgrades are limited to isolated interventions, which would make even complying with the AECB retrofit standard unfeasible.

This is typically the case for high-profile listed buildings, such as the Old Bodleian library. In such cases, bespoke targets for space heating demand and primary energy renewable (PER) must be agreed with the SRO and the Estates Environmental Sustainability Team, based on PHPP modelling.

In these circumstances, appointment of a Certifier is not required. However, the project team should follow the Passivhaus methodology with respect to energy modelling (PHPP), design detailing and on-site quality assurance monitoring.

[2] AECB Retrofit Standard AECB-Retrofit-Standard-Guidance.pdf

Figure 4: Derogations pathway on energy standards for retrofit projects



Key RIBA stages:

New build and retrofit –0-7. A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References

1. *Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standards* https://passiv.de/downloads/03_building_criteria_en.pdf
2. *AECB Building Standard* https://aecb.net/aecb-building-certification
3. *CIBSE TM54 Evaluating operational energy use at the design stage* (2022), CIBSE, Jan 2022
4. *CIBSE TM63 Operational performance: Building performance modelling* (2020), CIBSE, Aug 2020
5. *PAS 2038:2021 Retrofitting non-domestic buildings for improved energy efficiency – specification*, BEIS, 2021
6. BEIS publications including:
    - *Retrofit internal wall insulation: best practice*
    - *Retrofit insulation for suspended timber floors: best practice*
7. The Society for The Protection of Ancient Buildings, https://www.spab.org.uk
8. Sustainable Traditional Buildings Alliance https://stbauk.org
9. Historic England https://historicengland.org.uk

6.2 - Passive design

6.2.1 - Passive design – form and façade

Project team:

Passivhaus Consultant/Designer (CEPH), Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor, Contractor (Design), Contractor (Construction)

Rationale:

Simplifying architectural forms, and early consideration of passive opportunities to design out risks, can have a significant impact on the deliverability of a stable and comfortable internal environment. This approach can also be a driver for reducing capital costs.

Stable environments minimise the need for heating and cooling. This reduces the requirement for, size and cost of services, delivering comfort for the lowest energy input. Issues such as solar gain, which can be costly to mitigate actively (cooling) or passively (external solar shading/blinds), can be designed out with careful attention to orientation and glazing ratios.

This has significant benefit for both capital and operational building costs, and avoids locking in comfort problems for University staff and students for the lifetime of the building.

Requirements:

The 'heat loss form factor' (HLFF) of the building should be minimised as part of the Passivhaus design development. This is defined as the building envelope area, divided by its treated floor area. A HLFF of between 1 and 2 must be feasible for most University buildings.

Where possible, buildings should be orientated with their prominent façades facing south and north (ie along an east-west axis).

Initial massing studies should consider the impact of shading by other buildings (or self-shading) to ensure there is sufficient availability of daylight at the façade.

Glazing on east and west facades should be minimised, as this results in significant overheating risk, and is difficult to shade effectively. It also provides little useful winter heat gain.

Glazing should be optimised for daylight by maximising head height but avoiding low level (<800mm above FFL) which contributes little useful light and is difficult to shade.

External shading designs should consider:

- Simplicity - deep reveals are preferred to elaborate brise soleils.
- Low maintenance requirements
- Thermal bridging associated with bracketry and its impact on Passivhaus performance.

Eliminate risk of creating pigeon roosts.

Spaces with high occupancy or equipment gain should be located and designed to minimise solar gain and to maximise the potential for natural ventilation (where appropriate to their use).

Thermal mass should be paired with a realistic ventilation strategy (See **6.2.3 – Thermal comfort**).

Consider segregating areas (both physically and in terms of services) likely to require extended or 24-hour operation.

The façade design must consider security implications, particularly in respect of shading devices and deep reveals, which in some locations (such as on the ground floor) can provide climbing aids to potential intruders. Laminated glass is likely to be required for glazed units on the ground floor or other easy-to-reach areas. The energy, daylight and overheating performance implications of this must be considered.

Security Services must be consulted to ensure that designs meet security recommendations.

Derogations: none

Key RIBA stages:

0–5 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

- Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standards, https://passiv.de/downloads/03_building_criteria_en.pdf

6.2.2 - Daylight

Project team:

Architect, Sustainability Consultant, (Daylight Specialist, or MEP Consultant if daylight is not covered by Sustainability Consultant), Project Manager, Quantity Surveyor, Contractor (Design), Contractor (Construction)

Rationale:

Access to daylight and views are significant factors in the wellbeing and productivity of occupants. Maximising these in University buildings is critical to delivering space that is fit for purpose, as well as reducing the energy consumption and cost of artificial lighting.

Over-glazing spaces can however lead to negative effects such as solar gain, glare (requiring continuous use of blinds that negate views), additional costs in provisioning shading and cooling, additional maintenance and occupant discomfort for the lifetime of the building. Careful attention must therefore be given to glazing ratios and design.

Daylight provision is not a part of national regulations for new or retrofitted buildings, and hence a specific set of targets is needed for University buildings.

Requirements:

In the absence of any national regulatory standards for natural daylight, the University makes use of the following two documents:

- Department for Education, *School Output Specification – Technical Annex 2E 'Daylight and Electric lighting'* (2021, or any subsequent update)
- *BRE BR209* (2022) 'Site layout planning for daylight and sunlight'

Primary targets are compliance with *Education and Skills Funding Agency (ESFA)* Annex 2E (2021), Section 3 –Daylight:

1. **Useful Daylight Illuminance (UDI)** – used to measure human daylight benefit and 80% of occupied spaces to achieve 80% score
2. **Spatial Daylight Autonomy** (sDA) – used to measure energy benefit of daylight, with occupied spaces scoring 300lux-50%-50%

The above metrics are intended primarily for teaching spaces and similar. Table 1 in Annex 2E provides relaxations of the above for non-teaching spaces, and these should be applied to University buildings where appropriate.

Where a space is primarily residential in nature (eg a student study bedroom), the above should be targeted as primary objectives, but *BR209* requirements given in Table C3 in Appendix C can be used as an alternative route to compliance, with the University's agreement. In the case of a student study bedroom, for example, the daylight factor targets for a living room in Table C3 would be a suitable lowest acceptable standard, in the case where the primary UDI and sDA targets were not achievable.

BR209 also provides wide ranging guidance on solar access and site planning for daylight, and this more general guidance must be used to inform building position, effects on neighbouring buildings and amenity space planning.

Daylight control for luminaires must be incorporated into all schemes. Provision and details are covered in the Estates *Building Services Design Guide*.

Derogations: none

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

1. Department for Education, *School Output Specification – Technical Annex 2E 'Daylight and Electric lighting'* (2021 or any subsequent update)
2. *BRE BR209* (2022) 'Site layout planning for daylight and sunlight'
3. Estates Services *Building Services Design Guide*

6.2.3 - Thermal comfort

Project team:

Passivhaus Consultant/Designer (CEPH), Passivhaus Certifier, Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor Contractor (Design), Contractor (Construction)

Rationale:

Buildings which are not comfortable for occupants are not fit for purpose, making them unsustainable in the long term. Low or excessively high temperatures inevitably lead to an increase in carbon emissions using higher setpoints (or lower in the case of cooling), or retrofit of cooling systems, both of which increase operational energy consumption. Building-wide occupant discomfort also feeds the case for building replacement, with the indirect embodied carbon impact of new construction.

Comfort is subjective, complex and dependent on a wide range of factors including occupant activity, clothing, radiant temperature, relative air velocity and relative humidity. Robust passive design will reduce the impact of many of these factors, but detailed modelling is essential to ensure risks to providing an appropriate environment for staff and students are understood. CIBSE and Passivhaus compliant comfort can be provided without the need for comfort cooling in most circumstances. University experience of the impact of density of occupation, ventilation, and thermal mass and industry best practice must all play a part in ensuring this is delivered.

Changes to the UK's climate over the coming years and decades are likely to alter the usability of many buildings. Sustainable design must include 'climate resilience' to avoid future carbon emissions associated with later retrofit of passive or active measures required to achieve an acceptable indoor environment. Passivhaus plays a key role in this by reducing ingress of heat into a building during periods of high external temperature, which are likely to become more frequent in future.

Requirements:

For projects over £1m construction cost, design teams are expected to design buildings to meet the appropriate thermal comfort standards as listed in table 3 below, according to the building type and level of environmental conditioning ('free running' or mechanically cooled). Compliance with these standards will be demonstrated using dynamic thermal modelling or other simulation tools (such as radiant asymmetry calculators).

The table below summarises the key requirements of each standard for thermal comfort.

Table 3 – Thermal comfort standards applicable to University buildings

Standard	Summary of key requirements
CIBSE TM52	Thermal comfort standard for non-domestic buildings: • **'Free running' buildings/spaces** • Adaptive comfort methodology and targets for limiting overheating. • **Mechanical cooled buildings/spaces** • PMV and PPD methodology as per *BS EN 15251*

CIBSE TM59	Thermal comfort standard for dwellings, derived from *TM52*. Typically applied to student bedrooms. Note that *Building Regulations Approved Document O* must take precedence for residential buildings or space.
Building Regulations *Approved Document O*	Sets requirements for residential buildings, or residential areas within buildings, based on *CIBSE TM59*. However, the document also provides useful guidance including: • window security (protection from falling & prevention of casual break ins) • noise assessments • air quality assessments This guidance can be applied to other building types.
Passivhaus	Sets limits on overheating in spaces without cooling as a percentage of time above 25°C. For University projects this must be less than 5% of the hours in a year for each occupied space. For circulation spaces, this must be less than 10% of the hours in a year. Sets limits for internal surface temperatures and supply temperatures from mechanical ventilation systems.
Health & Safety Executive Approved Code of Practice and guidance	Sets minimum temperatures for working environments.
BS EN ISO 7730	Provides local thermal comfort criteria (eg radiant asymmetry, draughts).

Natural Ventilation Openings

Design of natural ventilation openings must allow for occupant control rather than relying on automatic controls.

Design must provide the free area requirements identified by thermal modelling. This is a common area of performance gap, where unrealistic assumptions cannot be delivered in practice, leading to poor ventilation rates and overheating risk. Some key issues to consider:

- Free area calculations for windows must be based on the physical size of aperture, considering constraints imposed by the reveal.
- Wind pressure coefficients for openings must be based on empirical data or CFD analysis.
- Where restrictors are required for safety, this may reduce the physical free area.
- Louvres- free area calculation must consider the frame or any structural elements.
- Security- natural ventilation openings must not compromise building security. This may limit the use of opening windows on ground floors or for night cooling. Secure louvres or perforated panels may be required to achieve adequate free area. The team must consult with Security Services to ensure that the ventilation strategy complies with security recommendations.

Dynamic thermal modelling

DTM must be carried out for both cooled and non-cooled buildings for assessment against comfort standards. The following must be considered:

- Consultants must use well-established dynamic thermal modelling software capable of simulating the dynamic effect of thermal mass.
- Assumptions and diversity of occupant numbers, heat generating equipment and operational hours must be realistic, clearly agreed with occupants and documented.
- Heat gains from building services (eg hot water pipework) must be adequately accounted for.
- Models must be kept synchronised with the architectural, MEP and structural designs throughout the design stages.

Heating and cooling set points

One of the key benefits of Passivhaus is the elimination of cold draughts and cold surfaces which cause occupant discomfort. This makes it possible to deliver winter comfort at lower temperatures.

Design teams must be mindful of this in their choice of heating and cooling design temperatures, which for occupied areas with sedentary activity (eg office space) must be:

- Space heating: 19°C
- Cooling: 26°C

Note that these are *design* temperatures, not setpoints, so they relate to the system's capacity, not the actual achieved temperature.

Derogation may be possible in the case of historic buildings Similarly, in the case of specialist buildings with CL2 & CL3 laboratories and cleanrooms, temperature setpoints may be dictated by the scientific processes being carried out. Additionally, archive storage facilities and some areas of museums may require close control to protect the artefacts (see below).

Design for the future climate

Climate change is expected to deliver more extreme summer conditions for the UK. The University expects buildings to be designed as 'climate resilient' in respect of thermal comfort for their expected lifespan. This will involve providing adequate resilience in the building when constructed, but also the capability for the building to be adapted at its next refurbishment cycle. Derogations on this standard are given below.

Buildings (existing and new) must be designed to achieve thermal comfort standards for the following design summer years (DSY):

Table 4 Thermal comfort standards for future climate

Design for as built performance to next refurbishment cycle:	CIBSE Swindon DSY, 2050 High, 90th percentile
Design for future adaptation:	CIBSE Swindon DSY, 2080 High, 90th percentile

Design to the next refurbishment cycle (2050 weather files)

The CIBSE DSY 2050 weather files are applicable for the years 2041-2070, which therefore includes the refurbishment life cycle for any building constructed up to 2045 (assuming a 25-year cycle). Designing to these weather files therefore provides ‘safe passage’ until the next opportunity to upgrade the building and its various systems, by which time more will be known about the impact of climate change.

Design for future adaptivity (2080 weather files)

Establish what changes may be required to adapt the building to be thermally comfortable under 2080 conditions. In most cases this would include the provision of mechanical cooling, or the increase in cooling capacity where such systems are already planned. However, it may also include the provision of shading devices, or alternative solutions not yet commercially viable.

The building must be designed so that such adaptations could be accommodated at the next refurbishment cycle at minimal cost and disruption. This may include:

- Space allowances in air-handling plant for additions of cooling coils and associate space for chillers.
- Space allowances for cooling plant and distribution (or the ability to increase capacity).
- Fixing points for future shading devices.
- Space allowances for other equipment or technology.
- Spare electrical capacity (within building and authorised) for future installation of cooling equipment.

Other comfort considerations

Designs must also consider the following issues:

- Local discomfort from glazing- solar gains, downdraughts (see *ISO EN 7730*).
- Where Passivhaus is not targeted, triple-glazing must be retained for all elevations enclosing spaces where sedentary work will be undertaken to reduce cold draughts and radiant discomfort.
- Passivhaus buildings have extremely low loads. Designers must size heat emitters appropriately, avoiding slow-response systems (such as underfloor heating) which are more likely to overshoot.

Special considerations for existing buildings

The following must be considered for projects in existing buildings:

- Conversion of roof spaces brings substantial risk in terms of overheating. Feasibility studies must include thermal comfort modelling to inform the specification of insulation and glazing.
- Free area achieved by secondary glazing openings combined with original windows must be carefully considered.
- Thermal modelling must be completed for spaces where there is a significant increase in occupant density.

Passivhaus requirements – overheating

The Passivhaus standard (See **6.1 – Energy standards**) sets limits on the level of overheating occurring in non-cooled buildings. The absolute limit is given as 10% of the year below 25°C. However, this is accepted as too high, and consensus is 5% of hours.

This metric is calculated within PHPP, but for larger, complex buildings, is not an appropriate calculation method. Instead, designers must use dynamic thermal modelling to demonstrate that this number is met for individual spaces. Note that Passivhaus Certification does not require consideration of future climate conditions, but that this is an additional requirement of the University.

Avoidance of cold draughts

Designers must demonstrate that thermal comfort can be achieved without introducing cold draughts. Problem areas can be identified by thermal modelling by using modified rules for window openings (eg do not open when external temperature below a set level). A likely result of this approach is to require reduced levels of glazing in individual spaces.

Heat gains from hot water pipes

MEP designers must consider the impact of heat gains emitted from hot water pipework, particularly for Passivhaus buildings, where the level of airtightness will reduce the natural dissipation of such gains.

Designs must minimise hot water circulation pipework and provide a means for removal of heat build-up where pipework cannot be avoided. For buildings with low hot water demands, electric point of use (ideally without storage) is normally the most efficient approach, as it eliminates the need for hot water circulation.

PHPP provides a calculator for hot water pipework heat losses which can be used for system optimisation.

Derogations:

It is recognised that in some projects, achieving compliance with the above could result in disproportionate complexity and disruption. In some cases, such as listed buildings, it may not be possible to carry out the required fabric interventions for planning reasons.

Heating and cooling set points

In the case of historic buildings, where fabric interventions may be limited, a slightly higher air temperature may be required to offset the effect of unavoidable cold surfaces or draughts. Similarly, in the case of specialist buildings with CL2 & CL3 laboratories and cleanrooms, temperature setpoints may be dictated by the scientific processes being carried out. Additionally, archive storage facilities and some areas of museums may require close control to protect the artefacts.

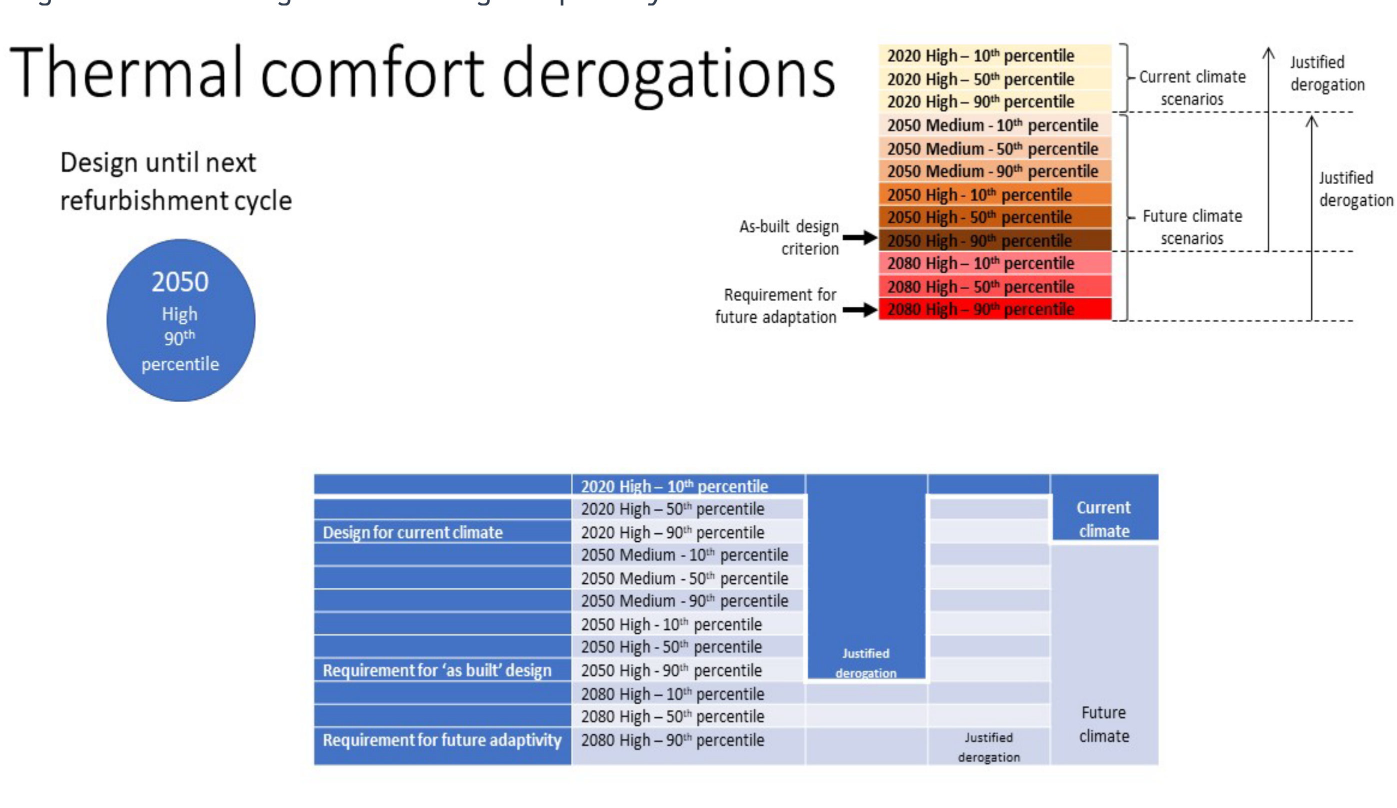
Future climate

If it can be demonstrated that designing for future climate conditions results in disproportionate costs associated with plant and distribution, the team may derogate from these requirements, but must make provision for future expansion and adaptation of the existing system or building envelope.

In such cases the team must identify the climate conditions to which the building is designed and those to which it can be adapted, and provide a timescale on which such adaptations will be required. The diagram below shows an example of how this would be carried out.

Design elements which allow for future adaptation can easily be lost through the design process and must be protected during value engineering or contractor design.

Figure 5: Climate design files and derogation pathways



Key RIBA stages:

0–5 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

1. *CIBSE TM52: The limits of thermal comfort: avoiding overheating* (2013), CIBSE, 2013
2. *CIBSE TM59: Design methodology for the assessment of overheating risk in homes* (2017), CIBSE, 2017
3. *Building Regulations Approved Document O*, HM Government, June 2022
4. *Passivhaus criteria for the Passive House*, EnerPHit and PHI Low Energy Building Standards, 03_building_criteria_en.pdf (passiv.de)
5. *Health & Safety Executive Approved Code of Practice and guidance*, HSE, 2013
6. *BS EN ISO 7730: Ergonomics of the thermal environment. Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria*, BSI, 2006
7. Estates Services *Building Services Design Guide*

6.3 - Ventilation and cooling

Project team:

Passivhaus certified consultant/designer (CEPH), Passivhaus Certifier, Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Quantity Surveyor, Contractor (Design), Contractor (Construction)

Rationale:

Effective and controllable ventilation is fundamental to providing comfortable, productive University workspaces. Research clearly demonstrates a connection between air quality and productivity, and well-designed ventilation is critical to delivering year-round thermal comfort (see **6.2.3 – Thermal comfort**).

Ventilation is also the source of considerable carbon emissions within the University and must be considered at the initial stages of a project. Lack of timely input to design solutions can lead to costly alterations later in the project, or a requirement to retrofit.

Active cooling is also a significant ongoing cost in terms of maintenance, departmental energy bills and University carbon emissions as well as creating additional compliance requirements.

To be effective and to deliver energy reductions for the long-term, ventilation designs must be simple and engage users in their effective operation.

Requirements:

Cooling hierarchy

Designers must follow the "cooling hierarchy" for developing cooling strategies for buildings (in order of priority):

1. **Minimise internal heat generation** through energy efficient design (see **6.1 Energy standards**).
2. **Reduce the amount of heat entering a building in summer** through orientation, shading, albedo, fenestration, insulation and green roofs and walls (see **6.2 – Passive design**).
3. **Manage the heat within the building** through exposed internal thermal mass and high ceilings (see **6.2 – Passive design**)
4. **Natural ventilation**
5. **Mechanical ventilation**
6. **Active cooling systems** (ensuring they are the lowest carbon options).

Designing for natural ventilation

Natural ventilation is prioritised above mechanical ventilation, noting however that natural ventilation options are limited where buildings are designed to Passivhaus energy targets. Designers must follow the guidelines of *Building Bulletin 101* with the following additional considerations:

- High-density office spaces must ideally provide for cross-ventilation.

- Ventilation designs must consider conflict with the operation of glare blinds.
- Natural ventilation controls must be accessible, with consideration of furniture design and location.
- Openings must be adjustable over a range of positions.
- Security must be considered for openings, particularly where they are to be used out of hours (eg for night purge). No ground floor, or easy-to-reach windows or doors must be left open overnight when building occupancy is at its lowest, unless suitable security devices are provided (eg secure louvres).
- The University Crime Prevention Design Advisor must be consulted in relation to security vulnerabilities and suitable mitigation methods.
- Safety must be considered for openings where there is a risk of falls or collisions, or in the use of actuators.

Mechanical ventilation

- Passivhaus buildings will necessitate the inclusion of mechanical ventilation and heat recovery, and this must be considered within the context of building design from the outset.
- Air distribution systems must be designed to avoid cold draughts.
- Plant serving spaces with varying occupancy (such as meeting rooms or lecture theatres) must be demand-controlled.
- Wet laboratories have significant levels of ventilation which dominate energy use. Opportunities to minimise peak rates using demand control must be explored. (See **7.2 – Laboratories**).
- The location of fresh air intake points must be considered carefully to limit the ingress of pollutants to buildings. The potential for malicious contamination of building intakes must also be considered.
- The university requires that MVHR units incorporate Trend controls. Where possible, units must be Passivhaus-certified.

Cooling system design

- Cooling must be local to the space and controlled to deliver parity with naturally ventilated spaces.
- Localised cooling must be disabled by opened windows in the same space. This must normally be via contacts on widows interlocked with the space cooling controls.
- Cooling units (eg fan coil units) must be designed to avoid cold draughts.
- Systems with low global warming potential refrigerants must be selected.

General air quality standards

- As a rule, daily average CO_2 levels must not exceed 1,000ppm in occupied spaces. This correlates with fresh air provisions of around 8 litres/s (~30m^3/hr), and sets a reasonable balance between air quality, energy and winter humidity.
- *Approved Document F* provides further guidance on recommended maximum pollutant levels.

Passivhaus air quality standards

- Recommended ventilation rates are 30m^3/hr per person (approx. 8 litres/s per person). Where higher rates are required (eg for compliance with building regulations), these must be incorporated into energy modelling, and checked for impact on relative humidity.
- As a rule, Relative Humidity levels must not drop below 30% during the winter to avoid occupant discomfort.

Derogations:

It is recognised that the University requirement to incorporate Trend controls limits the range of products available. Where Passivhaus Certified units are not chosen, the designer must consult with the Passivhaus Certifier to ensure that proposed ventilation units meet Passivhaus performance requirements.

Key RIBA stages:

1–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

1. *GLA London Plan*, 2016
2. *Building Bulletin 101*: Guidelines on ventilation, thermal comfort and indoor air quality in schools, version 1, 2018
3. *Approved Document F* – statutory guidance on ventilation: https://www.gov.uk/government/publications/ventilation-approved-document-f

6.4 - Controls

Project team:

Passivhaus Consultant/Designer (CEPH), Passivhaus Certifier, MEP Consultant, Project Manager, Quantity Surveyor, Contractor (Construction), Contractor (Design)

Rationale:

Poorly designed or over-complex controls will disengage building occupants and are likely to lead to performance issues and dissatisfaction. University projects have demonstrated that giving occupants influence over their environment through simple, well-explained, easy-to-understand and accessible controls is the most successful approach.

Complex controls have resulted in buildings being challenging to commission, incurring excessive capital costs and a long-term maintenance burden and cost, and in some cases requiring replacement. The design of controls should foster a shared responsibility for delivering on the building's design intent.

Third-party control systems have left a legacy of costs for the University, caused delays for modifications and are frequently a barrier to the effective control, optimisation and continuous commissioning of buildings.

Requirements:

1. Detailed requirements for building management system controls are outlined in the Estates Services *Building Services Design Guide* Appendix D.
2. Controls must be simple, intuitive, appropriate to the technical knowledge of occupants. They must be reviewed with users prior to being confirmed.
3. BEMS equipment & software (including, but not limited to, all outstations and loose controls) must be manufactured by Trend Controls. BEMS contractors must be Trend Approved Partners. All equipment – including (but not limited to) air-handling units (AHUs), fan-coil units (FCUs) and variable-air valves (VAVs) – must be fitted with Trend outstations networked back to the main BEMS. Manufacturers' closed-protocol proprietary control systems and other third-party systems will not be accepted.
4. Controls must be considered during the detailed design stage. Operations philosophy, points list and schematics must be developed by the designer and provided to the contractor.

Derogations:

Recognising the University requirement that all equipment must be provided with Trend controls, it is noted that these are not available for packaged heat pump units and split/multi-split DX systems. In this case, derogation to a BACnet or Modbus linked to the BEMS systems is allowed. Details of the engineering are given in Appendix D of the *Building Services Design Guide*.

Key RIBA stages:

2–5 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

1. Estates Services *Building Services Design Guide*, Appendix D
2. Trend controls https://buildings.honeywell.com/gb/en/brands/our-brands/trend-controls

6.5 - Performance monitoring and verification

Project team:

Passivhaus Contractor/Designer (CEPH), MEP Consultant, Project Manager, Contractor (Construction), Contractor (Design)

Rationale:

The ability to monitor the performance of buildings, and verify this against design predictions, is fundamental for learning lessons and continuous improvement. In the past, poor implementation of metering and monitoring systems in University buildings have limited its ability to understand where energy is used, making it impossible to quantify opportunities to reduce consumption. It is essential that the University can access continuous, detailed energy data for its buildings, allowing it to understand energy uses, and to identify problem areas and opportunities for investment in energy efficiency measures.

It is also important to establish standard metrics for buildings which enable direct comparison and can be benchmarked with industry data. Energy Use Intensity (EUI, $kWh/m^2GIA/yr$) is a suitable metric which can be easily derived from energy monitoring and assessed from meter readings.

Requirements:

Design teams should develop metering and monitoring strategies from an early stage and ensure these are delivered correctly on site.

Metering of utilities and heat should ensure that the consumption and performance of major plant, systems and loads can be monitored effectively. Designs must anticipate the needs of both continuous commissioning and the potential future sub-division of space between different occupiers to ensure that sufficient granularity of data can be extracted.

The metering strategy must be agreed before the end of stage 3.

- Renewable systems metering must comply with Ofgem requirements.
- Construction site metering must be installed and the contractual arrangement for bill settlement agreed with the Energy team within Environmental Sustainability before commencing work.
- Meters must be accessible and readable without the need for access equipment or manual handling.
- External locations must be used wherever possible to facilitate automatic meter reading.
- All meters must be connected, commissioned and verified pre-occupation.
- Meters used to recharge energy to third parties must be to the MID standards.

All meters must be connected to the Estates Services 'System Link' Schneider EcoStruxure Power Monitoring Expert (PME) remote monitoring system (this will require separate meters in-line with revenue meters) to enable the significant cost savings that this affords. Previous projects have shown the importance of completing, properly commissioning and verifying this work prior to occupation.

Construction site supplies must be separately metered, and the basis of billing and settlement agreed with the contractor prior to site set-up.

Energy metrics

In addition to the metrics used by the Passivhaus standard, design teams must report on building Energy Use Intensity (EUI, $kWh/m^2GIA/yr$), which can be easily benchmarked against wider industry standards (LETI, CIBSE, RIBA etc).

The table below summarises the energy metrics that apply to University buildings.

Table 5 – Key building energy metrics

Metric	Unit	Description	Metered?
Space heating demand	$kWh/m^2_{TFA}/yr$	Calculated heating requirement of building, equivalent to heat supplied by heat emitters[3]. Key criterion of Passivhaus.	Yes, if possible- sub meter space heating circuit.
Primary Energy Renewable	$kWh/m^2_{TFA}/yr$	Equivalent renewable energy required to supply building	Yes- derived from sum of main building meters.
Renewable Energy Generation	$kWh/m^2_{foorprint}/yr$	Annual energy generation from PV systems, per m2 of building footprint.	Yes- PV generation meter
Energy Use Intensity (, EUI)	$kWh/m^2_{GIA}/yr$	Total building energy use through utility meters, as used by LETI, comparable with CIBSE benchmarks.	Yes- derived from sum of main building meters.
Air test result	Air changes per hour at 50Pa **and** $m^3/hr/m^2$ (permeability)	Result of building air pressure test.	n/a

Technical requirements for the metering and PME system are detailed in the Estates Services *Building Services Design Guide*, Appendix E.

Derogations: none

[3] It is normally only possible to estimate actual space heating demand, as heat meters placed on the heating circuit will also capture non-useful distribution losses (typically <10%).

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

1. *LETI Climate Emergency Design Guide*, LETI, Jan 2020
2. *RIBA Sustainable Outcomes Guide*, Royal Institute of British Architects, 2019
3. CIBSE Energy Benchmark data: https://www.cibse.org/knowledge-research/knowledge-resources/knowledge-toolbox/energy-benchmarking-tool
4. Estates Services *Building Services Design Guide*, Appendix E

6.6 - Renewable energy

Project team:

Passivhaus Consultant/Designer, Passivhaus Certifier, Architect, MEP Consultant, Structural Engineer, Project Manager, Quantity Surveyor, Contractor (Construction), Contractor (Design)

Rationale:

Solar PV has proven successful on many University projects and is a simple, low-cost means of removing carbon emissions by directly meeting building electrical demands. Technological developments in recent years have led to significant increases in performance, as well as products that may be more suitable for application on historic buildings.

Optimising the form of new buildings to maximise available unshaded roof space can enable a large fraction of their energy needs to be met directly. Furthermore, solar PV generation can play a significant role in achieving Passivhaus Plus for new buildings (See **6.1.1 – Energy Standards – New Build**).

Other renewable energy systems, such as solar hot water, micro hydro or wind, are unlikely to play a significant role in University projects due to limited opportunities or constraints such as planning. However, the University encourages project teams to consider a wide range of solutions for decarbonisation.

Requirements:

1. Designers must maximise opportunities for solar PV generation on new and existing buildings.
2. For new buildings, form and orientation of roofs should be optimised for solar PV provision, with minimal shading.
3. For existing buildings, condition and integrity of existing roofs must be reviewed with the Heritage and Building Maintenance team.
4. PV systems must only be installed on roof finishes with a design life >20 years, where this does not contravene warranty conditions.
5. Access for maintenance and cleaning solar PV systems must be considered. This must be via handrail protected walkways. Mansafe systems are not acceptable.
6. Solar PV generation must, where possible, be matched to building energy profiles to maximise self-consumption and associated energy cost savings. This may, for example, encourage the use of east and west facing roofs which result in PV generated energy to be distributed across the day.
7. Use industry recognised software for design of solar PV systems, including load profiling.
8. Risk of DC interference to research equipment must reviewed with the relevant department.
9. Ensure that renewable energy systems are fully metered to enable measurement of performance.
10. Solar hot water systems must only be considered where building hot water demands are dominant. Designs must consider the University’s Legionella policies, ideally avoiding potable hot water storage. The loss of roof area available for solar PV must be considered in comparative energy calculations.

11. Technical requirements for photovoltaic systems are detailed in the Estates Services *Building Services Design Guide* Appendix B16.
12. Early engagement with the utility authorities is essential to ensure the feed-in tariffs for on-site generation are in place at handover.

Derogations: none

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

- Estates Services *Building Services Design Guide*, Appendix B

6.7 - Low-carbon heat

Project team:

Passivhaus Consultant/Designer, Passivhaus Certifier, Architect, MEP Consultant, Structural Engineer, Project Manager, Quantity Surveyor, Contractor (Construction), Contractor (Design)

Rationale:

The elimination of fossil fuel heating plant is a key pillar of the University's decarbonisation strategy, and no new gas boiler installations will be permitted on capital projects. Heat pumps provide a low-carbon heating solution which in the longer term is expected to become zero-carbon, as well as offering significant operation cost savings.

Installation of heat pumps can be particularly challenging in existing buildings. By combining installation with fabric improvements, it is possible to facilitate reductions in plant size and associated electrical infrastructure, maximise performance and reduce operational costs. Where existing heat networks exist, projects must prioritise connection over the installation of new gas boiler plant in preparation for wider decarbonisation.

Requirements:

Heat pumps necessitate a series of effective and well considered interconnected design measures, adopted via a collaborative approach between all project stakeholders, which maximise their performance.

Designers must consider the possibility of connecting to existing or future district heating systems and design to facilitate connection to these systems.

1. No new gas boiler installations are permitted on new build or refurbishment projects.
2. Heat pumps should be integrated into scheme designs from RIBA Stage 1, including consideration of location and electrical infrastructure requirements.
3. Electrical utilities surveys should be carried out at an early stage and allowance for capacity upgrades included in the scheme as required.
4. Design teams should review local waste heat sources and the opportunity to capture them for use in the project.
5. Heat pump system design (particularly controls) should avoid complexity to ensure long-term effective operation.
6. Building fabric must be optimized first to maximise the benefits of heat pumps.
7. Free area and acoustic requirements must be considered at an early stage of the project.
8. The global warming impact of heat pump refrigerants must be considered in plant selection, in consultation with Estates Services. Specified refrigerant must ideally have a GWP of ≤ 675.
9. Heat pump operational costs must be minimized by optimizing plant performance.
10. Provide sub metering of heat pump systems to enable sufficient measurement of performance in use.
11. When quoting coefficient of performance of heat pumps, the average annual figure must be used instead of maximum efficiency.

The Estates Services *Building Services Design Guide* give details on the engineering design of heat-pump systems once the concepts have been agreed. Designers must refer Appendix A and in particular clause A8.

Derogations: none

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

- Estates Services *Building Services Design Guide*, Appendix A8

6.8 - Building operation

6.8.1 – Building User Guide

Project team:

Passivhaus Consultant / Designer (CEPH), MEP Consultant, Architect, Contractor

Rationale:

Occupants' understanding of a building's function is critical to how they experience it and to its long-term energy performance, but full understanding of the building's design intent is likely to be held by a small number of people by occupation. Where University projects have invested time and resources in communicating this to all occupants, this has delivered significant performance improvements and levels of satisfaction.

There is no best-practice pro-forma as appropriate formats will vary significantly based on a buildings function and complexity. Brief, visual instructions that can be left/mounted near controls in workspaces or web-based guidance and videos have proven most successful in engaging users and remaining accessible for new occupants.

For Passivhaus (and other highly efficient standard) buildings, it is particularly important that occupants understand the key principles and how they must interact with the building, particularly in respect of ventilation.

Requirements:

1. User guides should consider the range of staff knowledge and staff turnover.
2. The main contractor should produce detailed user guides for all occupant-facing systems and controls.
3. User guides should signpost the key University sustainability initiatives for operational buildings.
4. Web-based user guides should be considered where thermal comfort strategies require occupants to take a variety of actions dependent on conditions.
5. For Passivhaus and highly efficient buildings, provide specific information on building features and occupant interactions, particularly in respect of ventilation.

Derogations: none

Key RIBA stages:

4–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

- Estates Services *Building Services Design Guide*

6.8.2 – Commissioning, seasonal commissioning and post-completion requirements

Project team:

Passivhaus Consultant/Designer (CEPH), Passivhaus Certifier, Architect, MEP Consultant, Project Manager, Quantity Surveyor, Contractor (Construction), Contractor (Design)

Rationale:

Commissioning and seasonal commissioning have a significant impact on a building's ongoing performance. Applied correctly, this process can significantly reduce or eliminate the performance gap between design and operation. The process is critical for engaging the building's users in operating it effectively, providing insights that could easily be lost in the transition between construction and operation.

Commissioning and handover can cement or undermine design and construction work, defining user experience and successful operation for the long term. Seasonal commissioning is essential to ensure that this process is repeated for the various modes in which the building will operate. Both have been demonstrated to be critical to the success of University projects. Staff can become disengaged quickly, and must be actively engaged in the process of verifying that a building is meeting its design criteria.

Requirements:

1. A clear communication plan for any post-occupation commissioning and seasonal commissioning must be defined and agreed with the occupants during construction as part of the Soft Landings Strategy.
2. Refer to the Estates Services *Building Services Design Guide* for details of commissioning requirements.
3. For Passivhaus projects, particular attention must be given to commissioning of heat-pumps and MVHR systems to ensure they perform as designed.
4. Ensure heating and cooling setpoints are in line with University policy:
    - 19^{0}C for space heating
    - 26^{0}C for space cooling
5. Metering and control systems must be demonstrated to be fully operational, including the comprehensive logging of data before commissioning is complete.
6. M&E services and BEMS on all new or refurbished buildings must be seasonally commissioned on a quarterly basis following handover. Refer to the Estates Services *Building Services Design Guide*[3] and *BSRIA BG44* for details of how this process is to be carried out.
7. Use *TM54* or *TM63* models to validate measured building energy consumption during seasonal commissioning and identify performance gaps.
8. Sustainability elements described by this guide must be integrated into the Soft Landings process to ensure that operational implications are understood by the end users.
9. Gather post-occupancy experience data as part of seasonal commissioning process.
10. Refer to **4.1 Biodiversity net gain** and **4.3 Waste prevention** sections for details of commissioning and post-handover requirements.

Derogations: none

Key RIBA stages:

1–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

1. *CIBSE TM54*
2. *CIBSE TM63*
3. Estates Services *Building Services Design Guide*
4. *BSRIA BG44*

7 - Extraordinary buildings and functional spaces

7.1 - Historic buildings

Project team:

Heritage & Building Maintenance team, Estates Services

Rationale:

The University has 56 listed buildings, 12 of which are at Grade 1, with many more affected by conservation areas around the city. Although these designations do not freeze a building in time, interventions that affect their special interest must be balanced against function, condition, and viability. While the University takes an ambitious approach to carbon reduction in buildings, pragmatism and creativity are needed to balance the requirements in this document with those of conservation.

There are also significant risks of bending historic structures to new purposes, particularly in terms of energy consumption and thermal comfort, as the need to conserve the historic fabric may inhibit the adaptations required to achieve environmental performance. Finally, if not carried out responsibly, thermal upgrades to historic building fabric can lead to long-term moisture damage.

Requirements:

The approach described in **6.1.2 Energy standards – retrofit** must be applied to historic buildings. It is expected that many will be able to meet the AECB Retrofit standard (with space heating target relaxation applied) or to use bespoke targets. Below are some additional considerations in an historic building context:

1. Any project in a listed building must engage with the Head of Heritage & Building Maintenance at Stage 0.
2. The risks to historic assets of fabric thermal upgrades must be well understood. The *PAS 2038* standard provides a suitable framework for safe and responsible retrofit of historic buildings.
3. Historic buildings can place significant constraints on opportunities to improve services provisions, particularly for ventilation. This means in many cases it is not possible to retrofit mechanical ventilation with heat recovery (MVHR; see **6.3 Ventilation & cooling**). Design teams must consider the implications on thermal comfort and indoor air quality of retaining existing natural ventilation provisions, particularly when the use and occupancy of a space changes. Residual impacts must be communicated to the client.

Derogations: none

7.2 - Laboratories

Project team:

Passivhaus Consultant / Designer (CEPH), Passivhaus Certifier, Architect, MEP Consultant, Sustainability Consultant, Structural Engineer

Rationale:

Laboratories are energy intensive by nature; they account for over 70% of the University's carbon emissions but only 15% of floor area. 40% of energy may be consumed by plugged-in equipment and 30-50% by ventilation equipment (all of which also represent a major capital cost). For these reasons their energy efficient design and operation is a key target in the University's Carbon Management Strategy.

Requirements:

1. Innovation in lower energy laboratories has progressed significantly in recent years and designers should use modern design techniques and approaches to maximise performance of buildings.
2. Designers should actively seek to minimise energy use while carefully considering the impacts on safety and the science being carried out within the laboratory.
3. Air change rates should be scrutinised for their measurable safety benefits to ensure appropriate, safe and correctly sized design.
4. Fume cupboard sizes and numbers should be considered carefully, and heat recovery mechanisms must be included in all cases.
5. Fume cupboard face velocities should be discussed with the University Safety Office and the Estates Services team.
6. Demand-based ventilation systems should be considered for all laboratory projects at feasibility stage, and advantages and disadvantages outlined to the team.
7. Plant should be designed to ensure efficient operation at normal as well as peak loads, and close environmental control limited to areas needing this.
8. In-cage ventilation should be prioritised where applicable.
9. Appropriate automated control must be considered for equipment at risk of being left on.
10. Designs should engage users in saving energy, aiming to enable and normalise energy-efficient behaviour such as fume hood closure and equipment sharing.
11. ULT freezers should be co-located in rooms positioned to enable free cooling; cold and warm aisle separation must be implemented wherever possible.
12. The relationship of ULT freezer volume to surface area is a key metric that contributes to energy efficiency and should be considered at the outset of a project.
13. ULT freezer temperatures should be considered in conjunction with building users.
14. Air system heat recovery must be incorporated.
15. Ventilated storage must be provided separate to fume hoods where required.

16. Laboratory Efficiency Assessment Framework (LEAF) and Labs21 Environmental Performance Criteria must be consulted.

17. Provide energy sub-monitoring of systems and equipment to enable measurement of real use, and lessons to be learned for future projects.

Passivhaus and laboratories

There are currently limited precedents for Passivhaus being applied to laboratories, which are challenging due to their high ventilation and specialist equipment energy demands. However, applying the Passivhaus process will lead to a significantly lower energy building because of the attention to detail given to modelling and design, and the involvement of a Certifier. Design teams should carry out an early feasibility study, in consultation with a Certifier and the Passivhaus Institute directly to agree a bespoke set of energy targets for the project as a route to achieving certification.

Derogations :

Gas-fired process equipment is only permitted once all opportunities to use all-electric alternatives have been exhausted. This in line with the **6.7 Low-carbon heating** section, which prohibits the installation of new gas boilers.

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

1 Estates Services *Building Services Design Guide*

2 University Safety Office *Policy Statement S7/01* on fume cupboards.

3 *UCL Laboratory Efficiency Assessment Framework* https://www.ucl.ac.uk/sustainable/take-action/staff-action/leaf-laboratory-efficiency-assessment-framework

4 Labs 21 https://labs21.lbl.gov/DPM/bestpractices/index.htm

7.3 - IT spaces

Project team:

Passivhaus Consultant / Designer (CEPH), Passivhaus Certifier, MEP Consultant, Project Manager, Contractor (Construction), Contractor (Design)

Rationale:

The provision of IT and data support for research facilities can account for a considerable proportion of a building's energy consumption while driving energy-intensive cooling requirements. University projects have also suffered from the challenge of anticipating the growth of IT requirements, leading to the installation of over-sized, inefficient and costly plant.

Cloud-based and off-site options are inherently more energy efficient, and can deliver operational savings for departments, free up costly space within buildings, reduce power use and carbon emissions.

Requirements:

1. A needs and constraints assessment must be undertaken, considering the feasibility of cloud-based and off-site opportunities, ideally as part of the off-site capacity procured via IT Services.
2. Cooling plant must be designed to ensure efficient operation at a variety of potential load scenarios. It must be separate from the wider environmental cooling systems.
3. Opportunities to recover heat from server rooms or high-intensity IT spaces must be considered.

Key RIBA stages:

2–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

1. Estates Services *Building Services Design Guide*
2. Estates Services *IT Cabling Standards Philosophy Document*
3. Oxford University IT Services – www.it.ox.ac.uk/contact-us

7.4 - Entrance design

Project team:

Passivhaus Consultant/Designer (CEPH), Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor

Rationale:

Balancing requirements for accessibility, traffic volumes, security, comfort, and energy conservation has been challenging for University buildings. Entrance design will be a key architectural element of any project, and considering these often-conflicting priorities at an early project stage is essential to ensure that requirements are adequately incorporated and that the experience of all users of the completed building is optimised.

Small changes to the design including orientation, façade treatments and landscaping can have a significant impact on the effect of wind on heat loss, as well as on the function of automatic door mechanisms.

Requirements:

1. Reduce the number of entrances where possible.
2. Major entrances should be orientated between NE-SE or W-N where possible.
3. Protect entrances and lobbies with windbreaks or landscaping to prevailing wind directions.
4. Draught lobbies are preferred wherever possible.
5. The need for over-door air heaters/curtains should be designed out.
6. Adequately sized draught lobbies should be included where possible to reduce heat loss and reception occupant discomfort.
7. Consider entrance lobby flooring materials to control dirt and water ingress, in order to maintain appearance and to reduce slips and the need for cleaning.
8. Consider the quality and selection of entrance door and window seals to reduce air leakage.
9. Consider the use of waste heat from other areas of the building to supplement these areas.

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

8 - Energy storage and peak load reduction

Project team:

Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager, Quantity Surveyor, Contractor (Construction), Contractor (Design)

Rationale:

The future decarbonisation of the UK national grid depends on a reduction in peak heating requirements that will enable the coverage of renewable energy to be maximised. As buildings are converted to low-carbon heating systems (primarily heat pumps), this needs to occur in two ways:

- Reducing peak electrical loads through demand reduction such as fabric improvements
- Shifting of peak consumption to off-peak periods using energy storage and intelligent controls.

This strategy will also be important for the University for two reasons:

- it will minimise the impact on University electrical infrastructure; and
- it will allow the use of lower-cost electricity during off-peak periods or time of use tariffs.

Requirements:

There are currently no industry recognised standards or metrics for peak load reduction, but design teams should look to develop strategies which consider:

- **Reduction in peak space heating demand**: this will be an outcome of a compliant energy strategy. The Passivhaus standard is 10W/m^2 heating load.
- **Intelligent controls**: responding to grid conditions, availability of lower-cost (and lower-carbon) electricity, or solar generation.
- **Energy storage**: consider opportunities to store energy and shift peak electrical demand.
- **Solar PV design**: optimise systems for maximum usage on site. For example, arrays which face both east and west will spread generation across the day, more closely matching energy demand for many buildings.

Heat Storage

Heat storage using water has a low energy density, so will have limited use for peak shifting, but low-temperature hot water (LTHW) buffer vessels do allow short term peaks (such as hot water generation) to be modulated, avoiding the need to provide these directly with a heat pump.

Phase change heat storage technology is promising due to its high energy density, and may be feasible for peak-shifting space heating demand over a 24-hour period.

Electrical Storage

Battery technology is developing rapidly and offers extremely high energy density compared to heat storage options. Moreover, electrical storage is multi-purpose, and can service all types of energy consumption. When combined with solar PV, battery systems can be used to improve site consumption of generated power.

Current challenges in this area include:

- Environmental impact of manufacture
- Space requirements
- Fire risk

Derogations:

Futureproofing: Where it is not feasible to implement energy storage systems on projects, teams must consider future provision for such systems, eg, plant space, spare ways on distribution boards, pipework connections etc.

Key RIBA stages:

0–7 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook*.

References:

9 - Lifecycle cost and value engineering

Project team:

Quantity Surveyor, Passivhaus Consultant / Designer (CEPH), Architect, MEP Consultant, Sustainability Consultant, Structural Engineer, Project Manager

Rationale:

University projects are often typified by a tension between capital and operational cost considerations. While capital savings may seem attractive to a cost-challenged project, their long-term cost to the University in terms of maintenance, energy, carbon offsetting and potential rectifications must be fully understood. Careful analysis is required before any decision to invest in plant that may require a long-term specialist maintenance contract.

Robust whole-life cost analysis must be undertaken for all decisions and for fabric considerations.

Life-cycle costing and value engineering will typically happen on projects between RIBA stages 2 to 5, when asset whole-life performance and the efficient use of capital and associated operational costs are being considered.

When value engineering or capital cost constraints are being presented as a rationale for derogating from the standards set out in this guidance, a discounted cashflow analysis, or another agreed modelling approach must be presented setting out the alternative options.

The discounted cashflow analysis must be modelled for the envisaged life of the asset under consideration before its planned replacement. This discounted cashflow model must include the initial capital costs of the alternate proposals and their associated operational costs, including energy, maintenance, and carbon offsetting. The variables within any life-cycle costing and value engineering assessment, such as forecast period, inflation, cost of capital, cost of energy and carbon offsetting costs must be agreed with the project sponsor and Sustainability team at gate 0 of the project.

Solutions with a higher net present value outcome will be preferred and agreed where they support the University's ability to deliver the objectives of the ESS.

Requirements:

1. RICS professional standards and guidance, *UK Value management and value engineering* 1st edition, January 2017 – for guidance on how to apply value management and value engineering to construction projects.
2. Value engineering options with energy implications must be evaluated using the *BSI/BCIS PD 15685-5:2008* lifecycle cost tool using PHPP energy data.
3. Market-tested specialist maintenance contract costs must form part of the evaluation for investments in specialist plant such as PV, heat pumps and other renewable technologies.

Derogations: none

Key RIBA stages:

0–5 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

1. RICS professional standards and guidance, *UK Value management and value engineering* 1st edition, January 2017 – for guidance on how to apply value management and value engineering to construction projects
2. *BSI/BCIS PD 15685-5:2008* lifecycle cost tool
3. Estates Services *Building Services Design Guide*

10 - Travel and transport

Project team:

Architect, MEP Consultant, Transport Consultant, Project Manager, Structural Engineer, Quantity Surveyor

Rationale:

Adequate support for connectivity, and in particular for measures that support sustainable transport and removing car trips from the road network, remains a key priority for all projects.

Cycling is the key sustainable transport mode for staff and students and is likely to increase in the future as car journeys decrease. Sufficient facilities for cyclists must be included in all projects, and their careful design is paramount so that they can easily be extended in the future.

Projects must support the objectives of the University's current Transport Strategy.

Requirements:

1. Safe and secure parking with both secure cycle stores and open cycle stands must be provided at the ratio of one space per 2.8 occupants, with the ability to cost-effectively extend this space in the future, if required, by up to 25%.
2. Sheffield stands must be at ≥1m spacings. This distance is always measured from the centre line and at right angles to the longitudinal axis of the stand, even when stands are at an angle to a wall or kerb line.
3. Covered cycle parking is preferable to uncovered in all cases.
4. Staff cycle parking must be secure, covered and accessed either at grade or via a shallow ramp with gradient ≤1:8.
5. Cycle parking must allow e-bikes to be parked and charged securely at the cycle stand, with the ability to flexibility and cost-effectively upgrade non e-bike stands to e-bike stands in the future, if needed.
6. A minimum of one shower must be provided per 10 cycle spaces or 35 staff.
7. Adequate space for drying clothes must be provided in all projects.
8. Car parking and EV charging must only be included in projects where it is a requirement of planning or Building Regulations (Part S).
9. Prioritise car parking for those with disabilities and caring responsibilities.
10. Where EV charges are incorporated into schemes, they must be smart and operated through the University-agreed network provider app. EV chargers must be no closer than 7.5m to a University building, or 10m if they are in proximity to a door or window opening to comply with insurance fire risk requirements. The detailed engineering design for EV chargers is covered in the Estates Services Building Services Design Guide Appendix B clause B13

Derogations: none

Key RIBA stages:

0–4 - A breakdown of activities by RIBA stage is detailed in the *Project Handbook.*

References:

1. University Transport Strategy
2. Estates Services *Building Services Design Guide* Appendix B clause B13 'Electric Vehicle Chargers'

11 - List of tables and figures

Appendix 1 - Additional guidance – habitats and planting

1. Protect, retain, and enhance existing features wherever possible- for example, trees. woodlands, hedges, wetland areas and other natural features.

2. Create a mosaic of habitats and ecological niches, from woodland to scattered trees and scrub, open grassland and wetland. Create structural diversity, including wildlife features such as trees, hedgerows, wildflowers, small patches of bare ground, ponds, bat and bird boxes, bee and bird bricks, logs and stones, to support a range of species and their life cycles. See Natural England's *Habitat Mosaic Approach*[1] for further detail.

3. Prioritise climate-resilient native species, which are maintainable in the longer term, for planting. In new planting, include a diverse mix of native or near-native species that provide nectar, nuts, seeds and berries.

4. Planting must be drought resistant (excluding green wall watering systems), and tree species must be selected to limit disease risk, whilst still favouring a mix of native or near-native species that support biodiversity.

5. Support local species: Protect and restore locally relevant Priority Habitats and species in line with Oxfordshire's Local Nature Recovery Strategy (as it emerges).

6. Consider behavioural and experiential planting (eg green walls).

7. When developing site management plans:

    - Publicly accessible green spaces can be 'future-proofed' using a long-term stewardship agreement such as Fields in Trust's Deed of Dedication, Conservation Covenants, or allowing communities to designate Local Green Spaces to provide special protection against development for green areas of particular importance to local communities, linked to the Local Plan.

    - Manage urban grasslands and verges for nature: mow just once or twice a year in spring and/or autumn and leave an uncut refuge for wildlife.

    - Manage hedgerows by cutting only once every three years, in late winter (eg February) to leave berries for over-wintering birds. Increase the height at each cut, eg by 10cm, to allow hedgerows to become taller and wider, allowing fruit and flowers to develop to support wildlife. This can continue for up to 30 years before the hedgerow needs to be cut back to a lower level and re-laid. Leave a 1m buffer of wildflowers and tall grasses along the base, and cut every 2-3 years on rotation. See Hedgelink and the Hedgelink Management Cycle guidance for further information.

8. Planting for SuDs must incorporate a diverse mix of locally appropriate native species, avoiding barriers in the waterbodies, and contain a mix of submergent, emergent and marginal plants.

9. Where possible create new and accessible green spaces, consistent with Natural England's Natural Green Space.

References

1. *The Mosaic Approach: Managing Habitats for Species (B2020-009)*, Natural England
2. *Urban Meadow and Verge Guidelines Poster*, One Network, University of Oxford website
3. *Growing in the community* second edition, National Association of Allotments and Leisure Gardeners
4. *A place to grow: a supplementary document to Growing in the community*, https://www.nsalg.org.uk/allotment-info/how-to-get-an-allotment

Appendix 2 - Key contacts

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