NHS England

NHS Net Zero Building Standard

User Guide

Contents

Introduction

Climate change threatens the foundation of good health, with direct and immediate consequences for our patients, the public and the NHS. In 2020, the NHS became the first national health system in the world to commit to net zero emissions, launching its National Programme for a Greener NHS.

The Delivering a Net Zero National Health Service report plots an ambitious, yet achievable, set of actions to respond to climate change with clear targets for delivering a net zero health service for direct emissions by 2040 (the **NHS Carbon Footprint**) and indirect emissions by 2045 (the **NHS Carbon Footprint Plus**).

NHS estate and facilities has a critical role to play in achieving this ambition. The operation of NHS facilities currently makes up 15% of the NHS Carbon Footprint Plus, of which 10% is building energy (operational carbon). Furthermore, emissions from construction projects (known as embodied carbon) also contribute to the NHS Carbon Footprint Plus.

This urgent need for action led the NHS to create its own building standard – the NHS Net Zero Building Standard (hereafter referred to as 'the Standard').

The Standard has been designed to be used throughout the project lifecycle – from preparation and briefing, through to hand over and in-use [RIBA stages 1 through 7].

The Standard is supported by this user guide, aimed to assist project teams in their understanding of its application. The guide contains information to ensure consistency of application of the methodologies and processes outlined in the Standard, including information on reporting and compliance requirements.

It includes guidance information to support project teams with some of the decisions and considerations required to deliver a sustainable and net zero NHS. It contains key case studies to illustrate the key principles for success.

The Standard, the user guide and relevant compliance tools should be read in conjunction with one another.

Guidance prompts

To aid navigation and interpretation of the principles and requirements of the Standard, the following navigation prompts are used throughout.

Signpost:

Included throughout this document are signposts to related documents (often hyperlinked) that provide background or further details relevant to the section. They include policy documents, Building Regulations, or applicable standards.

Rule of Thumb:

The rule of thumb icon indicates where consideration needs to be given to best practice that should be incorporated where feasible within the proposed development.

Whole Life Cycle Carbon Flag:

These flags note where there may be design parameters that require consideration and discussion of different aspects of whole life carbon performance, or other criteria that could impact decision making e.g. cost, risk and complexity. Typically, a flag may also indicate a juncture where the Project Team will need to make a judgement on what is the most appropriate solution or pathway to meeting the requirements of Energy or Carbon Limits set out in the Standard.

Case Study

Included in this document are case studies of projects which have been delivered successfully. These projects highlight implementation of best practice and innovation in terms of energy and carbon reduction and provide examples of front runners for integration of emerging technology.

Named documents and terms

The following summarises the documents and Compliance Tools that sit alongside the Standard and are required to either demonstrate or achieve requirements outlined within the Standard.

These tools have been developed to help assist Project Teams comply with a new process and suite of requirements, and standardise reporting for ease of quality assurance, business case approvals and learning across capital investments.

- **Energy and Carbon Strategy (early stages) and Report (later design stages)** – A combined report used to report the decisions for the building energy source(s), as well as capture other aspects of design decision-making and information that affect the energy and carbon performance of the building across the whole energy hierarchy. Also used as the basis of compliance to the Standard to capture reporting tabs from the Compliance Tools. This report should be updated across the design stages. See Section 5 for more information.
- **Adaptability Strategy** – A building strategy developed at an early stage with the Client Team to outline the proposals for building flexibility and convertibility, aligned to the Clinical model and Estate Strategy.
- **Monitoring and Verification (M&V) Plan** – A Design Team document to establish project specific plans, processes, and responsibilities to monitor and verify building performance across hand-over and the first three years of operation. The M&V Plan should be considered as early as RIBA 2, to help refine the metering and monitoring strategy for the building and informed by specific building outcomes that need verification. The M&V Plan should then be refined across the detailed design stages and embedded within the construction contract and handover processes.
- **Whole Life Carbon (WLC) Compliance Tool** – This Excel tool is needed to demonstrate compliance against operational Energy Limits, Performance Targets and provides a space allocation tab which is used to determine requirements for both upfront carbon and operational energy.
- **Operational Energy and Carbon (OE&C) Compliance Tool** – This Excel tool is provided to demonstrate compliance against Upfront Carbon Limits and WLC reporting.
- **Design Management Tool** – This Excel tool is provided specifically for the Net Zero Carbon Coordinator to manage the delivery of the net zero carbon requirements and capture qualitative elements of compliance.

A. Supporting business case guidance notes using the NHS Net Zero Building Standard

SOC[1]	OBC	FBC	Item description	Guidance
Strategic case				
✓	✓		Have carbon benefits and impacts associated with different options been presented within the options appraisal, and is there evidence that these have been factored into the decision-making process?	Investments must help decarbonise NHS services, therefore impacts on the NHS' carbon footprint need to be identified and used to help inform decision making at the earliest stages.
			Has the scheme fully explored the opportunities of reusing existing spaces compared to new build, to significantly reduce upfront carbon? E.g., including assets that need intervention to make fit for purpose.	See SOC guidance within Section 3 of the Standard for typical areas of focus and potential carbon impacts of decision making.
				The WLC Compliance Tool (Tab 1.0 Project Information) and the Operational Energy and Carbon Compliance Tool (Tabs 1.0 - 3.0), may be used to estimate indicative Upfront and Operational Carbon Limits to create comparisons between different development options to support decision making.
				At OBC there should be evidence that the carbon benefits and impacts of the preferred option have been further developed and refined.
✓	✓		Is there evidence that modern models of care, including increased use of digital services, have been considered when forming the brief to help rationalise and optimise any building's design brief?	The NHS Estate should be as efficient as possible to support decarbonising healthcare services. An efficient clinical strategy is pertinent to achieve this.
✓	✓	✓	Does the proposal align with the Operational Energy and Carbon Strategy requirements of the Standard?	The proposal must address any planning opportunities and limitations that may influence the potential of the proposed building to align with the Heat Sources Hierarchy and the Energy Limits and/or the Building Services Performance Targets.
✓	✓		Has engagement with parties within the Local Authority and region been carried out in respect to local opportunities/requirements for zero carbon energy sources and also infrastructure capacity plans and constraints?	This includes the heat and energy network connection requirements, and UK Power Networks engagement as electrical infrastructure may be a restraint for all electric solutions.
				Specialist(s) involvement should have been sought as necessary.

1 Strategic Outline Case / Outline Business Case / Full Business Case

SOC[1]	OBC	FBC	Item description	Guidance
✓	✓	✓	Does the proposal outline how adaptation and flexibility should be provided and a means to use actual data to inform the approach?	The proposal must address how actual data on change of space use within the Trust and/or wider NHS estate will be used to inform decisions on adaptation and flexibility.
Economic Case				
	✓	✓	Have all relevant capital and running costs been identified and properly assessed? [Note this question is a minor amendment to that already in the business case checklist but is pertinent for net zero carbon decision making].	The costs should cover the whole life of the investment for all IT projects and most build projects, where possible. They should take into account (if appropriate): annual building running costs (inc. ongoing maintenance and replacement), lifecycle costs (building-related and equipment/IT replacements), residual values, monitoring and evaluation costs, health organisational development costs, opportunity costs, second-round effects, avoided costs and costs borne by others. Care should be taken not to double-count costs. See HM Treasury Green Book.
				Cost sources should be identified for all costs, including where these are estimates.
				Note that costs must be assessed on a 'bottom-up' basis: that is, the case must show the total costs of each option, not just costs incremental above existing levels of expenditure.
				Descriptions of how all costs have been quantified should be available along with supporting spreadsheets.
Commercial case				
	✓	✓	Has a whole life cycle carbon assessment been submitted, using the proforma provided in the Standard?	All mandatory Tier 1 and Tier 2 elements must be assessed and reported at OBC and FBC using the relevant tab of the Whole Life Carbon Compliance Tool (namely OBC – WLC Reporting and FBC – WLC Reporting) for both new-build and refurbishment projects.
				For refurbishment projects – only new elements are required to be included.
				Assumptions and reference material must be provided and suitably justified where these deviate from the recommendations in the Standard.
				Uplift factors and quantity estimations may be used in the absence of detailed calculation at OBC.
	✓	✓	Has a strategy for long term adaptability of the building been provided, clearly quantifying the carbon impacts of decisions on adaptability and flexibility? E.g. potential impact(s) on Upfront Carbon Limits for implementing these changes.	The strategy should align to the Standard approach to adaptability and flexibility using Space-type Technology Groups to assist.
				The approach must use actual data from the Clinical Strategy and historic change of spatial use within the Trust and wider NHS estate to inform decisions and reduce potential over-design.

SOC[1]	OBC	FBC	Item description	Guidance
	✓	✓	Does the design satisfy the embodied carbon requirements of the Standard?	Compliance with Upfront Carbon Limits must be demonstrated through submitting the WLC Compliance Tool Tabs. The Design Register must be submitted alongside supporting evidence as required to demonstrate the activities required in the Standard have been undertaken and used to inform decision making.
	✓	✓	Does the design satisfy the operational energy requirements of the Standard and has an Energy and Carbon Strategy been submitted?	Compliance must be demonstrated through submitting the OE&C Compliance Tool Tabs. The Design Register (see Design Management Tool) must be submitted alongside supporting evidence as required to demonstrate the activities required in the Standard have been undertaken and used to inform decision making.
	✓		Do the proposed solutions demonstrate carbon value beyond other options considered?	The results of optioneering studies required in the Standard should be presented to demonstrate how options have been assessed for whole life carbon and that reasonable decisions have been made on this basis demonstrating carbon value for the selected option.
	✓	✓	Have derogations been identified and reported where Carbon Limits, Energy Limits or other performance targets have not been achieved?	Where derogations have been identified, justified reasons and quantified impacts must be provided.
	✓	✓	Do all energy sources have a clear decarbonisation strategy and plan?	All energy sources must have a clear decarbonisation strategy at OBC submission. At FBC submission decarbonisation strategies for existing energy sources must have a committed decarbonisation action plan.
Management Case				
	✓	✓	Have the relevant reports from all of the Tool tabs been compiled along with supporting evidence to demonstrate full compliance with the requirements of the Standard?	Specified in the Design Management Tool Checklist. This is the responsibility of the NZC Coordinator.
	✓	✓	Is the Trust satisfied that the Carbon Limits and performance targets are reflective of the Brief and that the impact of changes have been suitably reviewed?	The Design Management Tool should be used to track and record changes and progress through the design stages.

B. Space Allocation

B.1 The space allocation is key to setting both the upfront carbon and operational energy and carbon limits. This exercise is undertaken in Tab 1.0 of the Operational Energy and Carbon (OE&C) Compliance Tool. The guidance supports the decision making required to input the necessary data.

Space-type categories

B.2 Space-type categories have been introduced to group spaces with similar requirements to set specific limits and targets based on space usage.

B.3 There are 12 space-type categories. These are outlined in Figure 1 with typical examples of spaces that fall under each category. Note, this is not a complete list of all the possible space types that fall into these category groups. Matching spaces should be based on internal parameters within the allowable bands. See Table 1 below that provides further information for the categories, with a description and detailed internal conditions

B.4 A limited amount of floor space will not be allocated to any space categories. These include lifts, risers and wall areas (as departmental areas are typically measured to faces of walls) – these areas must be estimated and inputted separately with categorisation as N/A as these aren't considered in the energy requirements.

Figure 1: Examples of space-types that fit into the space-type categories

Medium Tech Spaces

Med Tech Type 1
- Triage
- Birthing Room
- Single Room ICU
- Infectious Diseases Isolation
- Neutropenic patient ward
- Ward Isolation Room

Med Tech Type 2
- Exam / Treatment
- Enhanced Procedure Room - Endoscopy
- Rehabilitation
- Enhanced Procedure Room
- Post mortem room

Med Tech Type 3
- Consult / Exam Room
- Phlebotomy

Med Tech Type 4
- Single Bedrooms
- Ward Toilet
- Maternity Ward (Not birthing room)
- Touchdown Base
- Clean Supply Room
- Dirty Utility: bedpan processing

High Tech Spaces

High Tech Type 1
- Operating Theatre
- Preparation Room
- Scrub
- Anaesthetic
- Utility (Op Theatre)
- Recovery Bay: Post Anesthetic
- Sterile pack store

High Tech Type 2
- High Tech General Labs

Ultra High and Specialist
- Imaging Rooms
- Containment level 3 laboratory
- Catheterisation Room
- Hydrotherapy Pool
- Burns Unit
- Audiology Testing Booth
- Consult/Exam Room: Ultrasound

Low Tech Spaces

Low Tech Type 1
- Public Circulation
- Reception
- Waiting Rooms
- Stair cores

Low Tech Type 2
- Offices
- Teaching
- Eat / Drink
- Gyms

Support Spaces

Support Type 1
- Catering

Support Type 2
- Server Rooms

Support Type 3
- Plant rooms
- Unconditioned Storage

B.5 The table below presents the seven distinct clinical and five non-clinical space categories used in the Standard. The table provides assumptions within each space regarding occupancy schedules, ventilation rates and equipment loads.

B.6 These Space Categories are to be used by the Design Team to describe as closely as possible respective spaces in their brief. The detailed internal conditions have been provided so that the Design Team can match the spaces in their brief with one of the NHS Net Zero Building Standard space types.

B.7 Internal conditions should be tailored to each project and all spaces should be compliant with the HTM documents. Should room schedules differ significantly from the internal conditions provided for each space-type based on specific clinical decisions at Trust or project level, derogations and justifications should be added to the compliance tools to explain this.

Table 1: NHS Net Zero Hospital Standard Space-type Categories

NHS Net Zero Building Standard Space-type Categories – Clinical

Tech Category	Medium Tech				High Tech		Ultra High Tech/ Specialist
Assigned Energy Limits or Building Services PT	Energy Limit	Energy Limit	Energy Limit	Energy Limit	Energy Limit	Energy Limit	Building Services PT
Space Categories	Medium Tech Type 1	Medium Tech Type 2	Medium Tech Type 3	Medium Tech Type 4	High Tech Type 1	High Tech Type 2	Ultra High Tech and Specialist Spaces
Space Type Description	- Clinical spaces containing consulting/ exam/ treatment work areas and intensive care units which are occupied 24 hours a day.	- Clinical spaces containing treatment work areas which are occupied during the day only.	- Clinical spaces containing consulting work areas which are occupied during the day only.	- Clinical spaces containing beds ranging from single bedrooms to multiple patient units in wards. This space type includes bed and sanitary facilities, and patient support facilities and are occupied 24 hours a day.	- Clinical spaces including the main operating theatre and any operating theatre ancillary spaces such as anaesthetic, scrub and preparation rooms which are occupied during the day only.	- Clinical spaces including most types of high-tech general hospital laboratories. This space type does not include low-tech laboratories. This space type includes both the bench work areas and any areas used for support equipment which are occupied during the day only.	- Clinical spaces that have very high equipment loads or specialist requirements such as containment labs, diagnostic and imaging.
	All categories include waiting areas, support spaces, stores, toilets and circulation.						
Space Occupied Schedule	24/7	7am to 8pm	7am to 8pm	24/7	7am to 10pm	7am to 8pm	
Ventilation	10 ach	10 ach	6 ach	6 ach	21 ach*	10 ach	
Equipment (W/m²) - Low/High Load	10 19	10 19	10 19	10 22	43 60	22 50	
Typical spaces that commonly fall under this category	Triage	Exam/Treatment	Consult/ Exam Room	Single Bedrooms	Operating Theatre	High Tech General Labs	Imaging Rooms
	Birthing Room	Enhanced Procedure Room - Endoscopy	Phlebotomy	Communal Ward Toilet	Preparation Room		Containment level 3 laboratory
	Single Room ICU	Rehabilitation	Consult/Exam Room: Ultrasound	Maternity Ward	Scrub		Catheterisation Room
	Infectious Diseases Isolation	Enhanced Procedure Room		Touchdown Base	Anaesthetic		Hydrotherapy Pool
	Neutropenic patient ward	Post mortem room		Clean Supply Room	Utility (Op Theatre)		Burns Unit
	Ward Isolation Room			Dirty Utility: bedpan processing	Recovery Bay: Post Anaesthetic		Hybrid operating theatres
					Sterile pack store		

Detailed Internal Conditions

Schedule	24 hours	07 - 20	07 - 20	24 hours	07 - 22	07 - 20	
Lighting (W/m²)	7.7	7.7	7.7	7.7	13	10	
Lux (lux)	500	500	500	300	760*	500	
Daylight Control	No	No	No	Yes	No	Yes	
Occupant Light Control	No	No	No	No	No	No	
Equipment (W/m²)	10 / 19	10 / 19	10 / 19	10 / 22	43 / 60	22 / 50	
Occupancy (Pers/m2)	0.07	0.07	0.07	0.175	0.125	0.08	
Ventilation (ach)	10	10	6	6	21	10	
Setpoints (°C)	21 / 25	21 / 25	21 / 25	20 / 26	20 / 22	21 / 25	
DHW Demand (l/d/m²)	0.21 / 1.05	0.21 / 0.525	0.21 / 0.525	2.18 / 3.46	1.06 / 1.255	0.33 / 0.66	

*Values have been averaged out over the total operating room area which includes scrub, prep and anaesthetic rooms.

NHS Net Zero Building Standard Space-type Categories – Non-Clinical

Tech Category	Low Tech		Support		
Assigned Energy Limits or Building Services PT	Energy Limit	Energy Limit	Building Services PT	Building Services PT	Building Services PT
Space Categories	Low Tech Type 1	Low Tech Type 2	Support Type 1	Support Type 2	Support Type 3
Space Type Description	- Non-clinical conditioned circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	- Non-clinical spaces with low equipment requirement such as office, teaching spaces,eat/drink areas, gyms inclusive of all circulation strictly associated with that space.	- High load, conditioned and ventilated spaces such as catering.	- Server rooms	-Large unconditioned spaces such as plant rooms, large stores and waste facilities.
	All categories include waiting areas, support spaces, stores, toilets and circulation.				

Space splitting and allocation methodology

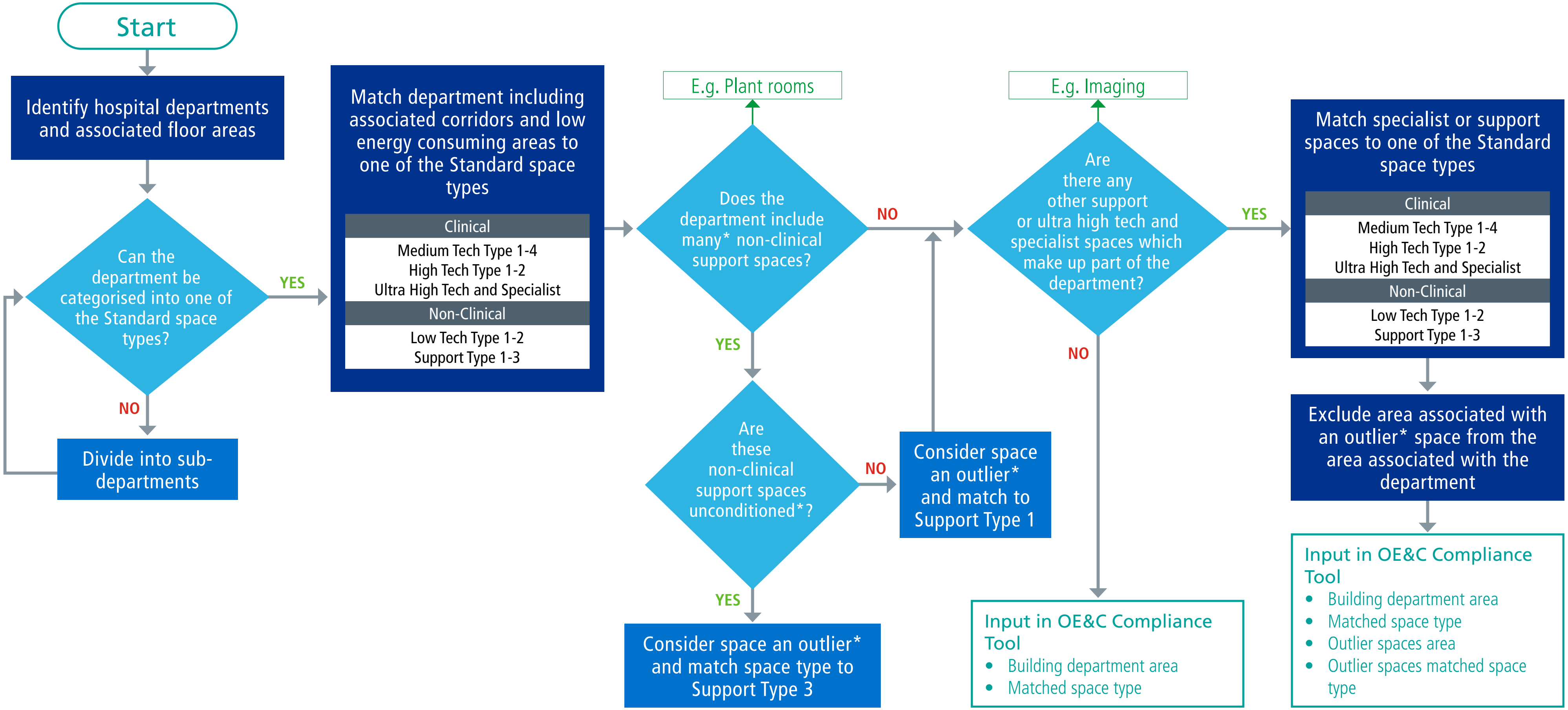
B.8 An exercise is required to attribute all spaces to their associated categories. The methodology for which is to be based on departments, with the selection of space categories based on the most common space-type in the department.

B.9 Figure 2 below illustrates the workflow to split spaces and match them to the NHS Net Zero Building Standard space categories.

B.10 The following steps should be observed.

- *Identify healthcare building departments and their associated areas. Each department should be matched to one of the NHS Net Zero Building Standard space categories.*
- *If the department includes more than one main NHS Net Zero Building Standard space category, then the department should be sub-divided. Each sub-division should be matched to one of the NHS Net Zero Building Standard space categories.*
- *The area allocated to each department should include circulation and low energy consuming support spaces such as corridors, small waiting areas, stores and WCs.*
- *If the department includes considerable non-clinical support spaces which are mainly unconditioned (such as plant rooms), then these areas should be assigned as Support Type 3.*
- *Support Type 3 spaces are not assigned with an Energy Limit but applicable building services Performance Targets should be complied with.*
- *If the department includes considerable non-clinical support spaces which are conditioned (such as catering spaces), then these areas should be considered an outlier space and should be matched to Support Type 1 or Type 2.*
- *If the department includes any support or ultra-high tech/specialist spaces (such as server rooms), then these spaces should be considered outlier spaces and matched to one of the NHS Net Zero Building Standard space categories.*
- *Areas that don't fall under any of the space types (e.g. risers, lifts, walls) must be estimated based on the level of information available.*

Figure 2: OE&C Compliance Tool Space Splitting Methodology



* *Unconditioned spaces refer to spaces with no cooling or heating.*

* *Outlier spaces refer to spaces which are classified as ultra-high tech/specialist space types or support spaces that form part of a department associated with another Standard space category.*

* *Many non-clinical support spaces refer to spaces which take up a considerable proportion of the floor area such as large plant rooms, engineering workshops or switch rooms. Unconditioned areas allocated to smaller support spaces such as stores should be included as part of the main space-type technology category.*

Building element categories

B.11 Tab 1.0 'Space Allocation' requires a Building Element category to be selected for each space. This input determines the floor area allocations which are required for the Whole Life Carbon Compliance Tool.

B.12 The following categories can be selected (refer to Figure 3 for graphical illustration):

- Category 1 – In contact with ground with internal floors (Category 4 space) above.
- Category 2 – In contact with ground with exposed roof* above.
- Category 3 – In contact with ground with lightweight covering** above.
- Category 4 – Intermediate level with internal floors (Category 4 or 5 Space) or enclosed roof (Category 6 Space) above.
- Category 5 – Intermediate level with exposed roof* above.
- Category 6 – Intermediate or Roof level with lightweight covering** above.
- Category 7 - Internal spaces not provided with a space allocation (e.g. lifts, risers, walls).***

** Exposed roof is a structural roof at any level where the space is not enclosed, typical examples include plant space that doesn't require enclosure, green roofs, roof terraces, PV areas.*

*** Lightweight coverings refer to enclosures that are non-structural i.e. typically only accessible for maintenance, examples include plant room enclosures (for HTM and durability requirements) and canopies.*

**** Internal spaces only, so this does not include exposed roof areas.*

B.13 If a particular department area sits in between two categories, the category based on the greater area should be selected.

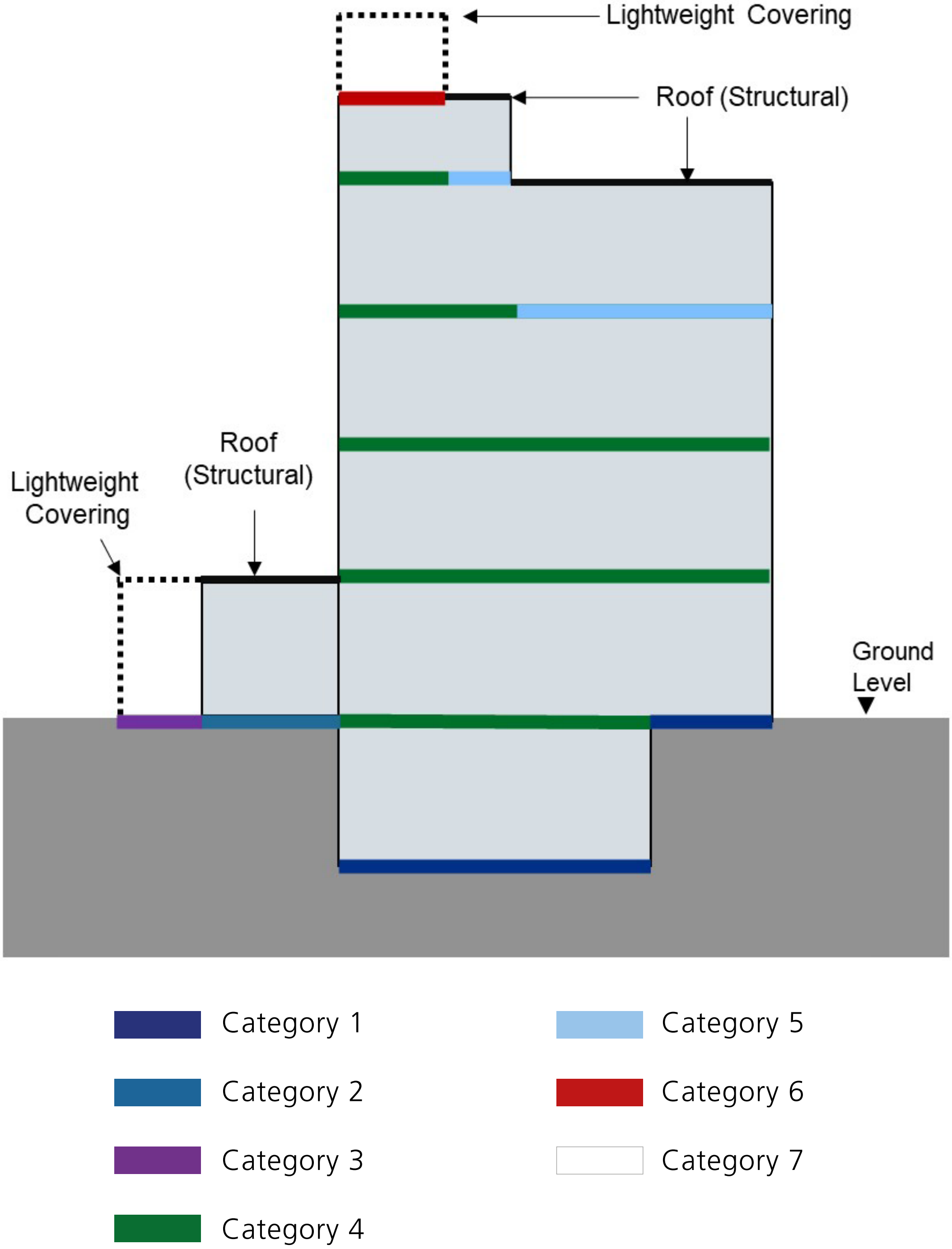
B.14 The areas in Categories 1-7 should sum to the gross internal area (GIA), with category 7 used to pick up all areas that aren't allocated a space type.

B.15 The GIA calculated from the space allocation tool must be within +/- 5% compared against the GIA estimated from layouts and modelling.

B.16 As well as areas, the number of floors and basement levels must be input into the space allocation tab. Basements shall be input in increments of 0.5 to represent partial basements, e.g. one full level and a partial second level basement would be input as 1.5.

B.17 The output from the space allocation is the input required for the carbon limits. This is shown in Figure 3 below, these must be input for both OBC and FBC stages.

Figure 3: OE&C Compliance Tool – Building Element Categories



If a particular department area sits between two categories, choose the category based on the greater area.

Figure 4 – Space Allocation Tab outputs in the OE&C Compliance Tool into the WLC Compliance Tool – Tab 1.0

Inputs for WLC Tool

Note: To be copied to WLC Tab 1.0

Number of Floors	0
Number of Basement Levels	0
Floor GIA in contact with Ground (Cat 1-3), [m2]	0
Roof Area (Area above Cat 2 & 5), [m2]	0
Lightweight Covering (Area above Cat 3 & 6), [m2]	0
Area of the following at Upper Levels (Cat 4-6):	
Support (Plant/Storage) [m2]	0
Low Tech [m2]	0
Medium Tech [m2]	0
High Tech [m2]	0
Ultra High Tech/Specialist [m2]	0
All Other Internal Area (Cat 7), [m2]	0

Inputs from Brief Please paste in area values from Tab 1 in Operational Energy and Carbon Tool	**OBC**		**FBC**	
No. Floors		Low Rise		Low Rise
No. Basement Levels		-		-
- Floor in Contact with Ground (Area of Cat 1-3)		m²		m²
- Exposed Roof (Area above Cat 2 and 5)		m²		m²
- Lightweight Covering (Area above Cat 3 and 6)		m²		m²
Area of the following at Upper Levels (Cat 4-6):				
- Support (Plant/ Storage)		m²		m²
- Low Tech		m²		m²
- Medium Tech		m²		m²
- High Tech		m²		m²
- Ultra High Tech		m²		m²
- All Other Internal Areas (Cat 7)		m²		m²
Total GIA	-	m²	-	m²

Other inputs for space allocation

Building locations

B.18 Tab 1.0 of the OE&C Compliance Tool requires the user to select one of four location zones covering different weather characteristics across England. The location zone affects the Energy Limits for Medium and High-tech spaces derived in the OE&C Compliance Tool. Typical TRY weather files (a 'typical' weather year, designed to be used for making estimates of predicted energy consumption) in England that match each location zone are included below. Further detail regarding location zones is provided in Figure 25, Section 5 of the 'Operational Carbon' section of the Standard'.

B.19 TRY weather files that match each location.

- Location Zone A: London.
- Location Zone B: Birmingham, Cardiff, Leeds, Manchester, Norwich, Nottingham, Southampton.
- Location Zone C: Newcastle.
- Location Zone D: Plymouth.

Minimise areas that are not assigned with an Energy Limit

B.20 Support spaces and Ultra-high Tech/Specialist spaces do not have an allocated Energy Limit, however, building services Performance Targets (when applicable) are assigned to these spaces. Area assigned to spaces without an Energy Limit should be minimised.

Unconditioned areas – Support Type 3

B.21 The Standard space category Support Type 3 covers large unconditioned spaces such as plant rooms, large stores and waste facilities. Any spaces assigned as Support Type 3 in the OE&C Compliance Tool are excluded from the Energy Limit calculation. Where applicable, Building Services Performance Targets should be complied with (such as large stores with a minimum temperature requirement or a ventilation system).

Compliant operation of these spaces to be addressed through the BMS and included in the metering and monitoring framework set out.

Floor areas

B.22 Areas associated with a space type should be inclusive of circulation and low energy consuming support spaces such as corridors, small waiting areas, stores and WCs. Areas should be measured to the internal face of the internal and perimeter walls at each floor level. Voids should not be accounted for in the floor area or space allocation process. Floor areas occupied by lifts, risers, walls or any other element not associated with a space type should be entered separately and assigned as Building Element Category 7.

Outlier spaces

B.23 If the department matched to a Standard space category includes outlier spaces which can be assigned to Ultra-High Tech/Specialist, Support Type 1-3, then these spaces are considered to be outlier spaces and should be excluded from the area assigned to that department. These outlier spaces should be matched to one of the NHS NZ Standard space categories.

Fully Conditioned Spaces

B.24 The current Standard includes energy limits which are focused on fully conditioned spaces. A fully conditioned space is a space requiring heating, cooling or mechanical ventilation to control temperature and/or humidity.

Circulation percentages

B.25 Clinical areas associated with a Standard space category should include circulation and low energy consuming support spaces such as corridors, small waiting areas, stores and WCs. The tool allows a variable percentage between 20-40% with a 5% increment and the Energy Limits will be adjusted accordingly.

B.26 To determine the circulation percentage, the sum of areas of the low energy consuming support spaces should be divided by the total area of the department.

B.27 Note that Energy Limits for Low Tech space categories cannot be adjusted to a different circulation percentage.

Equipment usage

B.28 Each clinical Standard space associated with an energy limit (Medium or High Tech) is also associated with an equipment usage. Equipment usage affects the heating and cooling energy consumption of the space and has a direct impact on the energy limits. Unregulated energy associated with equipment usage is only provided for reference and is not included in the energy limits for Medium or High-Tech spaces.

B.29 A low and a high equipment usage value is provided for each Medium or High-Tech space. The equipment parameter (Low or High) should be selected based on how closely it matches to the equipment usage design value in the project brief. Values associated with low or high equipment usage can be observed in the Equipment Gain (W/m2) column in Tab 1.0 Space Allocation.

C. Operational Energy and Carbon Compliance Tool

Introduction

C.1 This guide describes the use of the **Operational Energy and Carbon (OE&C) Compliance Tool** as part of the Operational Energy Modelling and Carbon Assessment approach, as well as the modelling requirements that must be covered as part of the process to demonstrate compliance with the Standard. This will demonstrate the energy usage and carbon impact of the building project.

C.2 The OE&C Compliance Tool must be used to set the total Energy Limits, building services Performance Targets and to report compliance. The total Energy Limits and building services Performance Targets in the Standard depend on the Space Allocation. The OE&C Compliance Tool must be revised and completed at every RIBA Stage and when significant layout changes affect the space allocation.

C.3 The OE&C Compliance Tool must be fully completed and submitted at the end of each RIBA Stage for review by the NZC Coordinator. Design simulation modelling (DSM) outputs are reported in the relevant Tabs alongside design assumptions within the Energy and Carbon Strategy. Beyond being a platform for demonstrating compliance for a proposed building, a key purpose of the tool is to help set up a consistent NHS building benchmarking database to help drive collective improvement.

Tool workflow

C.4 The figure below (Figure 5) illustrates the OE&C Compliance Tool workflow, the nine different Tabs in the tool and the inputs required at each process. The following sections include detailed steps to be followed in the OE&C Compliance Tool. Guidelines for these inputs are provided in the following section – Tool and Methodology Guidelines.

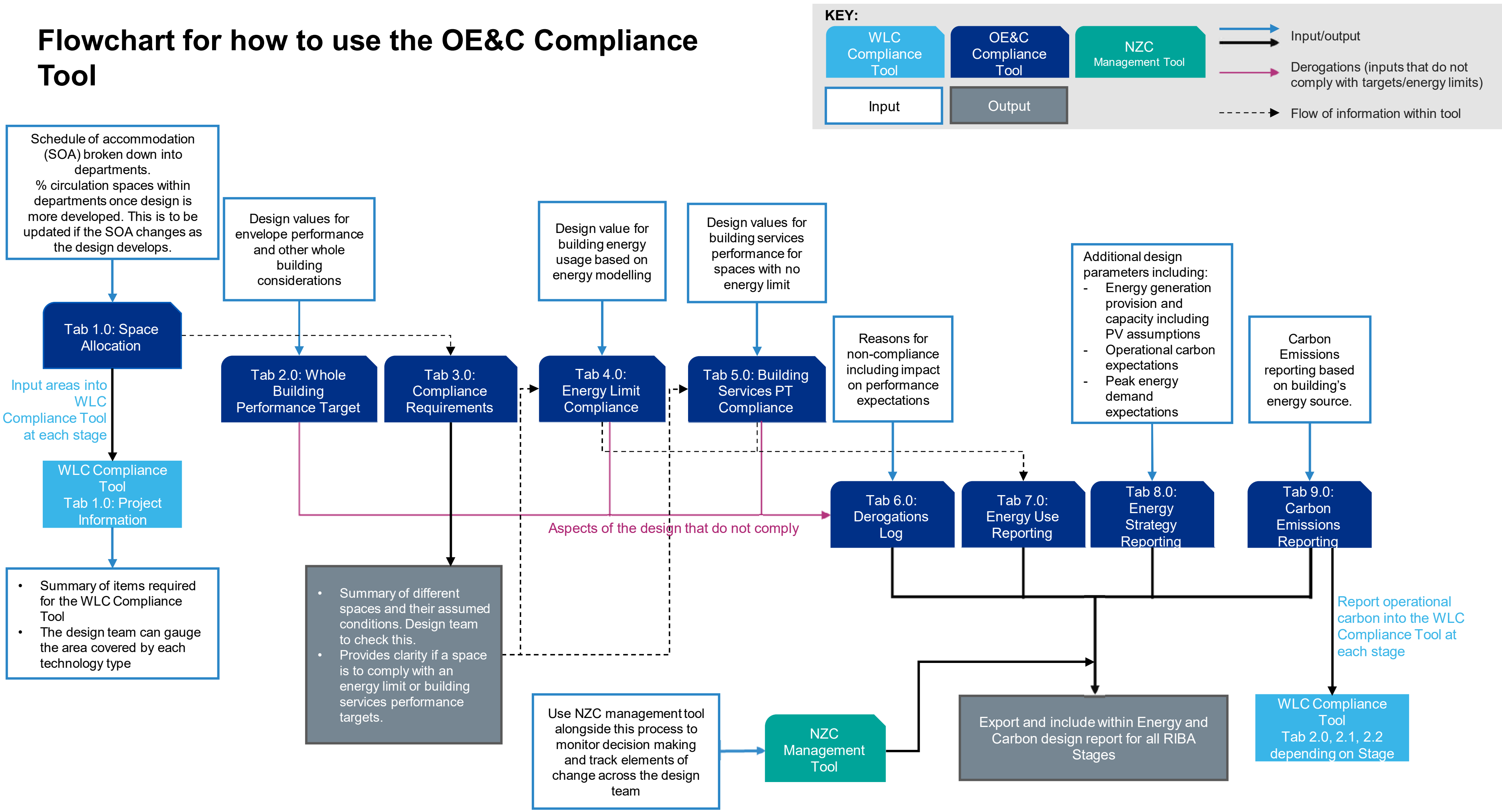
OE&C Compliance Tool File Guidelines

C.5 Macros should be enabled in the OE&C Compliance Tool. These macros are used to refresh tables which require input and calculate the total Energy Limit.

C.6 To remove an entry, use the delete function. Avoid cutting cells using the 'cut and paste' method.

C.7 Inputs required by the tool are highlighted in **GREEN**.

Figure 5 – Flow chart for using the Operational Energy & Carbon Compliance Tool. *Please read in conjunction with the Figure 6 for the WLC tool workflow that shows the interdependencies of the tools.*



Step 1 - Space Allocation

- Tab 1.0 of the OE&C Compliance Tool, 'Space Allocation' requires user inputs for the building location zone, the total number of floors, and areas associated with each space as in Appendix B. These set the energy limits and performance targets outlined in this section.
- Some inputs such as the number of floors (including basements) feed into the Whole Life Carbon Compliance Tool and have no impact on the Operational Energy or Carbon results. Values in the "Inputs for WLC" Table should be copied to the "1.0 Project Information" tab within Whole Life Carbon Compliance Tool at the end of the space allocation exercise.
- The table below provides a step-by-step guide to the space allocation process.

Steps to follow in Tab 1.0

1.1	Select the suitable location zone, insert the number of floors of the building (including any basements) and the estimated total floor GIA.
1.2	Insert information relating to the level, department, and the space name for each space.
1.3	Assign a building element Category 1-7 for each space. This category selection determines the areas required for the upfront carbon limit calculation. The first five entries in the space allocation table are fixed and cover areas taken up by lifts, risers, walls and lightweight coverings assigned to building element Categories 3,6 and 7. Only the floor area is required for the first five entries.
1.4	Determine if the space is a main space or an outlier space, and a clinical space or a non-clinical space. Space-type technology categories are dependent on this selection.
1.5	Match each space to one of the NHS NZ Standard space categories. A brief space description for each space-type is provided for reference.
1.6	Input the departmental areas in m2 for each space.
1.7	For Medium and High-tech space types only, select a low or a high equipment gain. The equipment gain in W/m2 associated with the space-type selected is provided for reference.
1.8	For Medium and High tech spaces only, select the department circulation percentage. Circulation areas include both corridors and low energy consuming support spaces such as small waiting areas, stores and WCs.
1.9	Values in the "Inputs for WLC Tool" Table should be copied to the "1.0 Project Information" tab within Whole Life Carbon Compliance Tool (see overleaf).

GENERAL INFORMATION

Select Location Zone	A	
Number of Floors, including basement	4	To[1.1]ber of floors including basement. For vertical and horizontal extensions - or[1.1] floors associated with new construction
Number of Basement Levels	1	N[1.1]f levels below ground. Partial basements should be represented by 0.5 increements.
Estimated Total Floor Area	4000	The GIA estimated by the architect should be reported here and a discrepency of +/- 5% should be investigated and space allocation updated. This figure includes the area for plant spaces with lightweight covering or canopies

1.1

SPACE ALLOCATIO

Note: Do not cut cells, please manually delete incorrect entries.

Level	Building Element Category*	Department	Space Name	Main / Outlier Space	Clinical/ Non-Clinical	Assigned Space Type*
All	Category 7: Internal spaces not provided with a space allocation (e.g. lifts, risers, walls)	All	Risers	All	All	N/A

1.3 1.2 1.4 1.5

ACE ALLOCATION

igned Space Type*	Space Description	Floor Area [m2]*	Equipment Usage	Equipment Gain [W/m2]	% Circulation in Department
	N/A	30	N/A	N/A	N/A
	N/A	75	N/A	N/A	N/A

1.6 1.7 1.8

1.9

Inputs for WLC Tool

Note: To be copied to WLC Tab 1.0

'Select and copy cells outlined by red border, and directly paste into Tab 1.0 of the WLC Tool - Cell D19 (OBC) or Cell F19 (FBC)

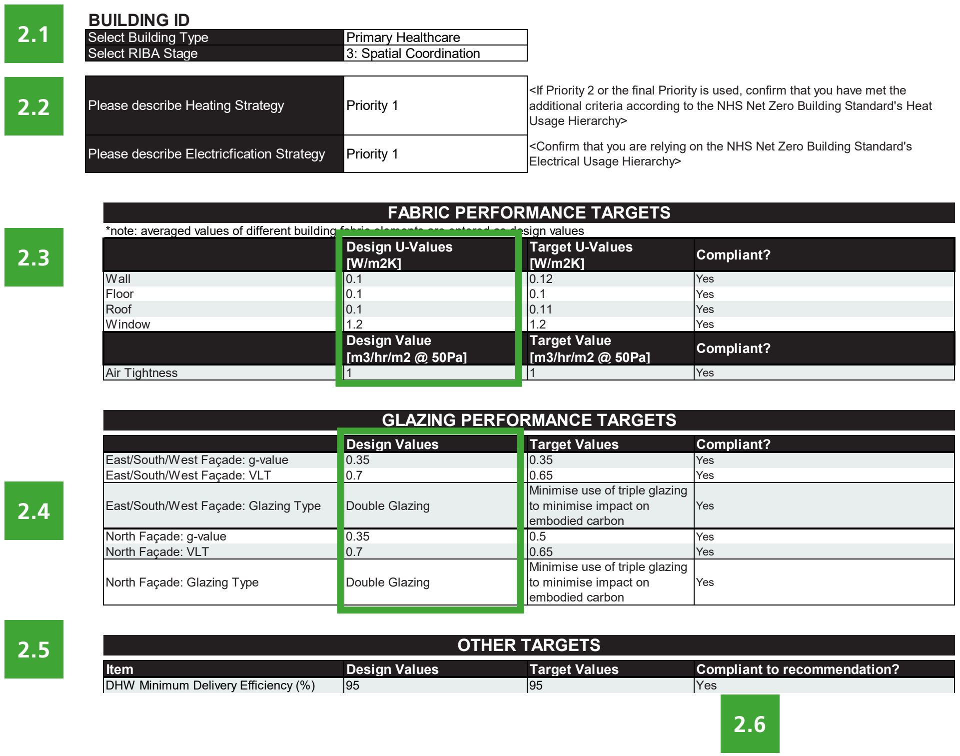
Number of Floors	4
Number of Basement Levels	1
Floor GIA in contact with Ground (Category 1-3), [m2]	1350
Roof Area (Area above Category 2 and 5), [m2]	815
Lightweight Covering (Area above Category 3 and 6), [m2]	300
Area of the following at Upper Levels (Cat 4-6):	
Support (Plant/Storage) [m2]	300
Low Tech [m2]	680
Medium Tech [m2]	1045
High Tech [m2]	670
Ultra High Tech/Specialist [m2]	0
All Other Internal Area (Category 7), [m2]	130

Step 2 - Whole Building Performance Targets

- In Tab 2.0 of the OE&C Compliance Tool: ‘Whole Building Performance Targets’, the user is required to select the type of building (Primary or Secondary Healthcare) and the RIBA Stage applicable. Detailed descriptions for the Heating Strategy and Electrification Strategy are also required.
- The tool will derive applicable fabric Performance Targets for the whole building, depending on the building type selected. The user is required to input the design area weighted average values for fabric, glazing and other building performance properties that are applied to the whole building. If the design values are not compliant with the target values, a reason for derogation is required which must be addressed in Tab 6.0 Derogations.

Steps to follow in Tab 2.0

2.1	Select Building Type (Primary or Secondary). This selection defines the target values for fabric performance. Select the RIBA Stage. This input is used to keep track of the RIBA stage and has no effect on the results.
2.2	Input detailed descriptions of the heating and electrification strategies in the text box.
2.3	Input the averaged fabric performance design values.
2.4	Input the averaged glazing performance values.
2.5	Input design values for DHW properties and PV efficiency.
2.6	Provide a Yes/No answer to the DHW provision, metering and monitoring and the Global Warming Potential questions.



2.1

BUILDING ID

Select Building Type	Primary Healthcare
Select RIBA Stage	3: Spatial Coordination

2.2

Please describe Heating Strategy	Priority 1	<If Priority 2 or the final Priority is used, confirm that you have met the additional criteria according to the NHS Net Zero Building Standard's Heat Usage Hierarchy>
Please describe Electricfication Strategy	Priority 1	<Confirm that you are relying on the NHS Net Zero Building Standard's Electrical Usage Hierarchy>

2.3

FABRIC PERFORMANCE TARGETS

*note: averaged values of different building fabric elements are entered as design values

	Design U-Values [W/m2K]	Target U-Values [W/m2K]	Compliant?
Wall	0.1	0.12	Yes
Floor	0.1	0.1	Yes
Roof	0.1	0.11	Yes
Window	1.2	1.2	Yes
	Design Value [m3/hr/m2 @ 50Pa]	**Target Value [m3/hr/m2 @ 50Pa]**	**Compliant?**
Air Tightness	1	1	Yes

2.4

GLAZING PERFORMANCE TARGETS

	Design Values	Target Values	Compliant?
East/South/West Façade: g-value	0.35	0.35	Yes
East/South/West Façade: VLT	0.7	0.65	Yes
East/South/West Façade: Glazing Type	Double Glazing	Minimise use of triple glazing to minimise impact on embodied carbon	Yes
North Façade: g-value	0.35	0.5	Yes
North Façade: VLT	0.7	0.65	Yes
North Façade: Glazing Type	Double Glazing	Minimise use of triple glazing to minimise impact on embodied carbon	Yes

2.5

OTHER TARGETS

Item	Design Values	Target Values	Compliant to recommendation?
DHW Minimum Delivery Efficiency (%)	95	95	Yes

2.6

Step 3 - Compliance Requirements

» Tab 3.0 of the OE&C Compliance Tool: 'Compliance Requirements' informs the user on the compliance requirement applicable to each space specified during Step 1 in Tab 1.0 Space Allocation.

» Tab 3.0 includes a summary of the different space-types and their assumed conditions, an indication as to whether the space is to comply with an Energy Limit or a building services Performance Target, and the Energy Limit for each space. No user input is required in this tab. Note that the unregulated and domestic hot water (DHW) Energy Limits are provided for reference purposes only and are not included in the Total Energy Limit calculation.

Steps to follow in Tab 3.0

3.1	Observe spaces which require an Energy Limit compliance and the associated kWh/m2/year Energy Limit. Any spaces which include "Error" values are missing inputs in Tab 1.0 Space Allocation.
3.2	Observe spaces which require Building Services Performance Target compliance.
3.3	Observe required Building Services Performance Target values.

COMPLIANCE REQUIREMENTS

												ASSOCIATED ENERGY LIMIT			
Level	Department	Space Name	Main / Outlier Space	Clinical/ Non-Clinical	Assigned Space Type	Space Description	Floor Area [m2]	% Total Circulation in Dept.	Equipment Usage	Equipment Load [W/m2]	DHW Heating Source (for reference)	Energy Limit [kWh/m2/yr]	DHW [kWh/m2/yr] (reference figure for space type)	Unregulated [kWh/m2/yr] (reference figure for space type)	Building Services Performance Targets
1	test 1	test 1	Main_Space	Clinical_M	High Tech Type 1	- Spaces including the main operating theatre and any operating theatre ancillary spaces. - Occupancy Period: 7am - 10pm -Ventilations: 21 ach	10	35	Low	43	ASHP	152	8 - 9	152	-
2	test 2	test 2	Main_Space	Clinical_M	High Tech Type 2	- Clinical spaces including most types of high-tech general hospital laboratories. Does not include low-tech laboratories. - Occupancy Period: 7am - 8pm -Ventilations: 10 ach	10	30	Low	22	ASHP	77	3 - 5	80	-
3	test 3	test 3	Main_Space	Clinical_M	Medium Tech Type 1	- Spaces containing consulting / exam / treatment work areas and intensive care units. - Occupancy Period: 24/7 - Ventilation: 10 ach	10	30	High	19	ASHP	94	3 - 8	80	-
						- Clinical spaces including most types of high-									

3.1 3.2

Step 4 - Energy Limit Compliance

- Tab 4.0 of the OE&C Compliance Tool: 'Energy Limit Compliance' includes the list of spaces which are required to comply with an Energy Limit only. The total Energy Limit in kWh/year for the whole building is calculated. The user is required to input the design value for the total energy consumed by the building. If the design value does not comply with the Energy Limit, detailed derogations are required in Step 6.

- The total Energy Limit set out by the tool includes:
  - regulated energy for Medium and High-Tech space-types (excludes energy consumed by equipment). This regulated energy excludes energy consumed for DHW.
  - regulated and unregulated energy for Low tech space types.
- and excludes:
  - energy consumed by Ultra-High Tech / Specialist Spaces, Support Type 1 Support Type 2 and Support Type 3 Spaces.

- The NHS NZ Standard Compliance Energy value is extracted from an NHS NZ Standard Compliance DSM. This DSM exercise should be set up in line with the NHS NZ Standard Compliance methodology and should also include/exclude the items listed above.

Steps to follow in Tab 4.0

4.1	Click on Tabulate. This command will refresh the table which includes spaces that are required to comply with an Energy Limit only.
4.2	Ensure that all spaces which should be assigned an Energy Limit are included in the table. Ensure there are no "Error" cells in the table. If errors occur, go back to Tab 1.0 Space Allocation and ensure all required data has been entered. Re-tabulate to refresh table.
4.3	Observe the Total Energy Limit for the building in kWh/year. The Total Energy Limit is a summation of the Energy Limits of all the spaces inserted in Tab 1.0 Space Allocation
4.4	Input the NHS NZ Standard Compliance Energy in kWh/year calculated in the NHS NZ Standard Compliance DSM.
4.5	Ensure that the NHS NZ Standard Compliance Energy is compliant with the Total Energy Limit. Where there is non-compliance, detailed derogations must be entered in Tab 6.0 Derogations'.

ENERGY LIMIT COMPLIANCE

4.4 4.5

Total Energy Limit [kWh/yr]	NHS NZ Standard Compliance Energy [kWh/yr]	Compliant to Energy Limit?
6160	4000	Yes

4.3

Please Tabulate Table to obtain department and space names from Compliance Requirement Table

4.1

Tabulate

						ASSOCIATED ENERGY LIMIT			ASSOCIATED ENERGY LIMIT		
						Compliance Target	For reference		Compliance Target	For reference	
Level	Department	Space Name	Assigned Space Type	Floor Area [m2]	DHW Heating Source (for reference)	Energy Limit [kWh/m2/yr]	DHW [kWh/m2/yr] (reference figure for space type)	Unregulated [kWh/m2/yr] (reference figure for space type)	Total Energy Limit [kWh/yr]	DHW [kWh/yr] (reference figure for space type)	Unregulated [kWh/yr] (reference figure for space type)
1	test 1	test 1	High Tech Type 1	10.0	ASHP	152	8 - 9	152	1520	77 - 88	1520
2	test 2	test 2	High Tech Type 2	10.0	ASHP	77	3 - 5	80	770	26 - 50	800
3	test 3	test 3	Medium Tech Type 1	10.0	ASHP	94	3 - 8	80	940	33 - 79	800
4	test 4	test 4	High Tech Type 2	10.0	ASHP	89	3 - 6	201	890	29 - 57	2010
5	test 5	test 5	Medium Tech Type 3	10.0	ASHP	43	2 - 4	43	430	18 - 42	430
6	test 6	test 6	Medium Tech Type 4	10.0	ASHP	56	18 - 28	104	560	183 - 280	1040

4.2

Step 5 - Building Services Performance Target Compliance

- Tab 5.0 of the OE&C Compliance Tool: 'Building Services Performance Target (BSPT) Compliance' includes the list of spaces that are required to comply with the Building Services Performance Targets only.
- Tab 5.0 requires design input values for HVAC and lighting systems in ultra-high tech/specialist and support space-types. The design value reported should be an area weighted average value for the space-type. The design values should comply with the target values set out for each space. If the design values do not comply with the target values, detailed derogations are required in Step 6. If a HEPA filter or equivalent is required, the increase to the SFP and the filter type should be included in the derogations.

Steps to follow in Tab 5.0

5.1	Click on Tabulate. This command will refresh the table which includes the spaces required to comply with the Building Services Performance Targets only.
5.2	Determine if the BSPT is applicable for each space. For example, Cooling SEER is not applicable to unconditioned plant rooms. For targets with no applicable BSPT, a '-' will appear in the target value. The user is required to input '-' in the design value cells.
5.3	Input the Design Values for Lighting in W/m2/100 lux for each space.
5.4	Input the Design Values for AHU SFP in W/l/s for each space.
5.5	Input the type of Heat Recovery Exchanger and the design value for heat recovery efficiency. If Run-Around Coils are required, a specific derogation is required for their use and efficiency.
5.6	Input the Space Heating SCOP, Space Cooling SEER and DHW COP design values.
5.7	Ensure that the design values are compliant with the Building Services Performance Targets.
5.8	If HEPA filters or equivalent are required, the increase to the SFP and the type of filter must be included in Tab 6.0 Derogations.

BUILDING SERVICES PERFORMANCE TA

Please Tabulate Table to obtain department and space names from Compliance Requirement Table

5.1

					Lighting			AHU SFP			Heat Recovery				
Level	Department	Space Name	Assigned Space Type	Floor Area [m2]	Is BSPT Applicable?	Design Value [W/m2/100lux]	Target Value [W/m2/100lux]	Is BSPT Applicable?	Design Value [W/l/s]	Target Value [W/l/s]	HR Type	General HR Devices Design Value [%]	General HR Devices Target Value [%]	Run Around Coil Design Value [%]	Tar
L-01	Plant Room	Plant Room	Support Type 3	430	Yes	2	2	Yes	1.3	1.3	General HR Devices	80	80	-	
L-01	Radiology	Radiology	Ultra High Tech/Specialist Spaces	250	Yes	2	2	Yes	1.3	1.3	General HR Devices	80	80	-	-
L-01	Catering	Catering	Support Type 1	200	Ye	2	2	Yes	1.3	1.3	General HR De	80	80	-	-

5.2 5.3 5.4 5.5

ERFORMANCE TARGETS COMPLIANCE

very			Space Heating			Cooling			DHW				
HR get	Run Around Coil Design Value [%]	Run Around Coil Target Value [%]	Is BSPT Applicable?	SCOP Design Value	SCOP Target Value	Is BSPT Applicable?	SEER Design Value	SEER Target Value	Is BSPT Applicable?	DHW COP Design Value	DHW COP Target Value	Compliant to BSPT?	Note on HEPA filters or similar
	-	-	No	-	-	No	-	-	No	-	-	Yes	if HEPA filter or equivalent is included, state the increase to the SFP and the filter type in the derogations tab
	-	-	Yes	3.5	3.5	Yes	5.5	5.5	Yes	2.8	2.5	Yes	if HEPA filter or equivalent is included, state the increase to the SFP and the filter type in the derogations tab
	-	-	Yes	3	3.5	Yes	5.5	5.5	Yes	2.8	2.5	Y	if HEPA filter or equivalent is included, state the incr SFP and the filter type in the der

5.6 5.7 5.8

Step 6 - Derogations Log

» Items that require an explanation for non-compliance are tabulated in Tab 6.0 of the OE&C Compliance Tool: 'Derogations'. This section tabulates any necessary derogations required if the spaces do not comply with either the Total Energy Limit or the Building Services Performance Targets. Please refer to the Derogation process section for a description of the derogations required and the acceptable level of evidence.

Steps to follow in Tab 6.0

6.1	Click on Tabulate. This command will refresh the derogations table which includes the items that do not comply with the Energy Limit or the Performance Targets and require detailed derogations.
6.2	Insert the reason for derogation for the items which do not comply with the NZC Standard Methodology

6.1 Tabulate Derogations Table

Other Derogations	Explanation
DHW distribution loses within the hospital (%)	**6.2**
Storage Insulation Type	
Storage Insulation Thickness	
Pipework circulation heat losses for secondary circulation (W)	
PV Efficiency	
General DHW Provision	
Design does not comply to Energy Limit	
Space is not compliant to BSPT - L00, Dept: A - test 12	
Space is not compliant to BSPT - L00, Dept: A - test 15	

Step 7 - Energy Use Reporting

» Tab 7.0 of the OE&C Compliance Tool: 'Energy Use Reporting' includes tables which summarise the inputs entered in Tabs 1.0 to 5.0. The summary tables include building areas, the targets to be complied with and the total Energy Limit to be complied with. Note that the Building Services Performance Design Values in this summary sheet are area weighted average values for all the spaces. This tab requires user inputs for the Team member responsible for compliance and user inputs for the design values for energy consumption per end use.

Steps to follow in Tab 7.0

7.1	Observe the building GIA and compliance summaries.
7.2	Input the team member responsible for compliance.
7.3	Input the design values for energy consumption per end use as calculated in the DSM.

7.1

BUILDING SUMMARY

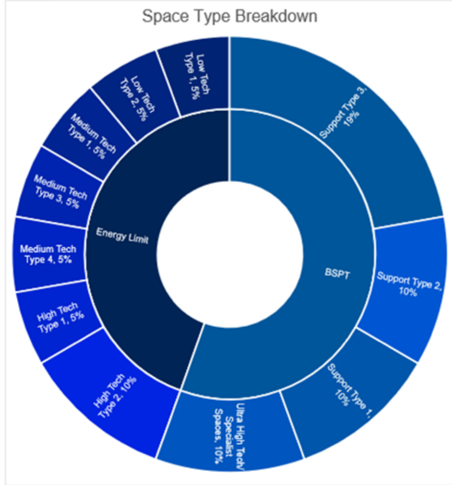
Location Zone	A
Building Type	Primary Healthcare
RIBA Stage	3: Spatial Coordination
Heating Strategy	Priority 1: Use of ASHP and WSHP

For Information: Building GIA Summary

Total building Gross Internal Area [m2]	210	
Breakdown	**Floor Area [m2]**	**% of total building**
Spaces with Energy Limit	80	38%
Spaces with Building Services Performance Target	80	38%

Breakdown	Floor Area [m2]	% of total building
Low Tech Type 1	10	5%
Low Tech Type 2	10	5%
Medium Tech Type 1	10	5%
Medium Tech Type 2	0	0%
Medium Tech Type 3	10	5%
Medium Tech Type 4	10	5%
High Tech Type 1	10	5%
High Tech Type 2	20	10%
Ultra High Tech/Specialist Spaces	20	10%
Support Type 1	20	10%
Support Type 2	20	10%
Support Type 3	40	19%

Space Type Breakdown



7.2

SUMMARY TABLES

Team member responsible for compliance	AA

Step	Compliance Target Type	Compliance Target Element	TARGET Compliance Target Value	DESIGN Achieved Design Value	
Step 1: Whole Building Performance Target	Fabric U Value	Wall [W/m2/K]	0.12	0.12	Compliant
		Floor [W/m2/K]	0.1	0.1	Compliant
		Roof [W/m2/K]	0.11	0.11	Compliant
		Window [W/m2/K]	1.2	1.2	Compliant
	Air Tightness	-	1	1	Compliant
	Glazing Performance	E/S/W Façade: g-value	0.35	0.35	Compliant
		E/S/W Façade: VLT value	0.65	0.7	Compliant
		N Façade: G value	0.5	0.4	Compliant
		N Façade: VLT value	0.65	0.7	Compliant

			Energy Limit in kWh/yr		
			Compliance	Reference	
Step	**Space Type**	**Area it applies to (m^2)**	**Total Energy Limit [kWh/yr]**	**DHW Energy Limit [kWh/yr]**	**Unregulated Energy Limit [kWh/yr]**
Step 2a: Space Type Energy Limit	Low Tech Type 1	10	350	-	-
	Low Tech Type 2	10	700	-	-
	Medium Tech Type 1	10	940	33 - 79	800
	Medium Tech Type 2	0	0	0 - 0	0
	Medium Tech Type 3	10	430	18 - 42	430
	Medium Tech Type 4	10	560	183 - 280	1040
	High Tech Type 1	10	1520	77 - 88	1520
	High Tech Type 2	20	1660	55 - 107	2810
	Support Type 2	20	0	-	-
	Support Type 3	40	0	-	-
	Total Energy Limit	**140**	**6160**	**N/A**	**6600**

Total Energy Limit [kWh/yr]	Total Regulated Energy [kWh/m2/yr]
6160	77.0
NHS Standard Compliance Energy [kWh/yr]	**Total Un-regulated Energy [kWh/m2/yr] (without DHW)**
4000	110.0
Compliant to Energy Limit Target	

7.3

ENERGY CONSUMPTION PER END USE

End Use Type	Design Energy Consumtion [kWh/m2/yr]
Heating	
Cooling	
Auxiliary	
Lighting	
DHW	
Equipment	

Step 8 - Energy Strategy Reporting

» Tab 8.0 of the OE&C Compliance Tool: 'Energy Strategy Reporting' requires user inputs for additional design parameters and expectations including energy generation provision and capacity, PV assumptions, operational carbon expectations, and peak energy demand expectations. Note that the design values for the operational energy and carbon should be extracted from the full DSM.

Steps to follow in Tab 8.0

8.1	For stages 1-6, input the Design Values (extracted from the full DSM) based on the calculated operational energy, to complete the energy, carbon and cost table. For carbon emission entries in the table, values for both the base year (2020) and the expected handover date should be entered.
8.2	For stage 7 only, input the In Use Values based on metered energy. These cells should be kept empty for the previous stages.
8.3	Input the values required for the PV systems. If the development includes more than one PV type, use a new table.
8.4	Input peak demand across energy sources and flexibility.
8.5	If measures are included in the building to reduce peak energy demand, input these measures in the table.

Summary: Energy, Carbon Emissions & Costs

8.1 8.2

Note: The values here should be results extracted from the Full DSM

		Full DSM Values	In Use Value (based on metered energy Stage 7)
ENERGY USAGE			
Total hospital energy usage	kWh/yr		
Total annual electricity consumption	kWh/yr		
Total hospital EUI	kWh/m²/yr		
Daily energy usage per patient bed	kWh/day/bed		
ENERGY GENERATION			
Total energy generated from renewable systems*	kWh/yr		
	kWh/m²/yr		
Total annual electricity exported by renewable energy sources minus storage losses (e.g. photovoltaics)	kWh	N/A	
ELECTRICITY PROCUREMENT			
Total annual electricity consumption: (a row per procurement where applicable)	kWh/yr and % of total consumption		
CARBON EMISSION - Base year using BEIS carbon factors for 2020 [1]			
Total annual direct CO_2e emissions from self-generation and consumption (Scope 1)	$kgCO_2e/yr$		
Total annual direct CO_2e emissions from imported electricity (Scope 2)	$kgCO_2e/yr$		
Total annual indirect CO_2e emissions from combustion of fuels (e.g. CHP or on-site fossil fuels) per fuel type, used for primary energy (i.e. non back-up)	$kgCO_2e/yr$ (per fuel)		
Total annual indirect CO_2e emissions from combustion of fuels (e.g. CHP or on-site fossil fuels) per fuel type, used for back-up purposes across site	$kgCO_2e/yr$	N/A	
Total annual indirect CO_2e emissions from combustion of fuels (all other sources, e.g. heat networks) per fuel type	$kgCO_2e/yr$		
Total annual CO_2e for Scope 1 and 2 emissions	$kgCO_2e/yr$		
CARBON EMISSION - at expected Handover date			

Summary: PV Parameter

Note: Please fill in the tables corresponding to different PV systems used across the building

8.3

Parameter	Value
PV module nominal efficiency (%)	
Nominal cell temperature (NOCT) (°C)	
Reference irradiance for NOCT (W/m2)	
Temperature coefficient for module efficiency (1/°C)	
Electrical conversion efficiency	
Panel surface area (m2)	
Array size (kW)	
Electricity generated (kWh/yr)	
Carbon savings (tCO_2/yr) (using BEIS GHG reporting factors for grid electricity)	

Summary: Site Wide peak demand, capacity & flexibility potent

8.4

Flexibility achieved through...	Yes/No	Details
Electrical energy storage capacity (kWh)		
Heat energy storage capacity (kWh)		
Renewable energy generation (load matching)		
Gateway to enable automated demand response		
Smart system integration (e.g. smart charging points for EV, gateway etc.)		

Summary: Site Wide peak demand, capacity & flexibility potential

8.5

Reporting item	Electrical	Heat	Enabled through...
Estimate peak demand (MW)			
Available capacity (MW)			
Flexibility potential (MW)			
Revised peak demand (MW)			
Percentage flexibility predicted (%)			
Notes:			

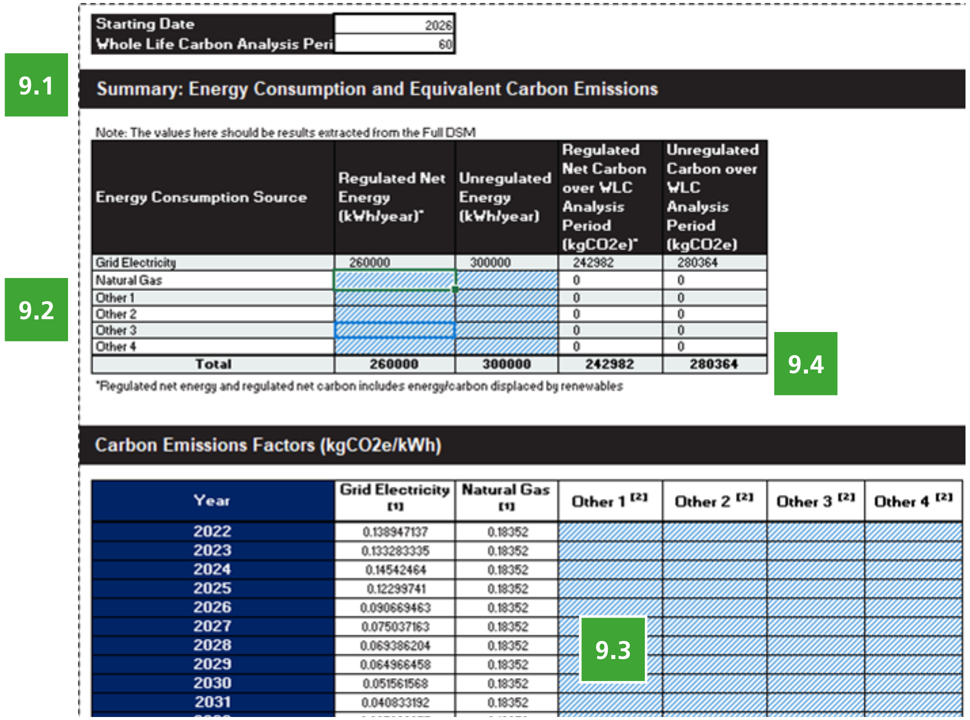
Step 9 - Carbon Emissions Reporting

» Tab 9.0 of the OE&C Compliance Tool: 'Carbon Emissions Reporting' includes a carbon calculator used to determine the carbon emissions per fuel type for the whole life carbon analysis period.

» This tab requires inputs for the analysis period starting date as well as the whole life carbon analysis period. It also requires user inputs for the net regulated and unregulated energy extracted from the full DSM. Note that the regulated energy should include offset energy from renewables. If energy sources other than electricity or gas are used, the carbon factors should be entered in the "Carbon Emissions Factors" table.

Steps to follow in Tab 9.0

9.1	Input the Whole Life Carbon analysis period starting date and duration.
9.2	Input the net regulated and unregulated energy results extracted from the full DSM for one year in kWh/year.
9.3	If energy sources other than electricity or natural gas are used, enter the carbon factors
9.4	Copy the Carbon Emissions over WLC Analysis Period into the Operational Carbon reporting sections of the Whole Life Carbon Compliance Tool.



Starting Date	2026
Whole Life Carbon Analysis Peri	60

9.1

Summary: Energy Consumption and Equivalent Carbon Emissions

Note: The values here should be results extracted from the Full DSM

Energy Consumption Source	Regulated Net Energy (kWh/year)*	Unregulated Energy (kWh/year)	Regulated Net Carbon over WLC Analysis Period (kgCO2e)*	Unregulated Carbon over WLC Analysis Period (kgCO2e)
Grid Electricity	260000	300000	242982	280364
Natural Gas			0	0
Other 1			0	0
Other 2			0	0
Other 3			0	0
Other 4			0	0
Total	260000	300000	242982	280364

9.2

9.4

*Regulated net energy and regulated net carbon includes energy/carbon displaced by renewables

Carbon Emissions Factors (kgCO2e/kWh)

Year	Grid Electricity [1]	Natural Gas [1]	Other 1 [2]	Other 2 [2]	Other 3 [2]	Other 4 [2]
2022	0.138947137	0.18352				
2023	0.133283335	0.18352				
2024	0.14542464	0.18352				
2025	0.12299741	0.18352				
2026	0.090669463	0.18352				
2027	0.075037163	0.18352				
2028	0.069386204	0.18352				
2029	0.064966458	0.18352				
2030	0.051561568	0.18352				
2031	0.040833192	0.18352				

9.3

DSM Methodology Checklist

C.8 Two DSM exercises are required for the completion of the OE&C Compliance Tool. The first (NHS NZ Standard compliance DSM) is for the operational energy element of the Standard and results from it are to be reported in Tab 7.0. The second is a full DSM, including DHW and equipment for all spaces, both in the setup of the model and in the reporting of the outputs. Results from the second exercise are to be reported in Tab 8.0 of the OE&C Compliance Tool.

C.9 The checklist below aims to assist the Design Team with a summary of key actions that need to be taken to ensure that the models are correctly set up, in line with the requirements of the Standard and the methodology applicable:

- ☐ Set operating hours and occupancy levels for each Space Category using input from the brief.
- ☐ Establish the floor areas in the DSM in line with the information in Tab 1.0 Space Allocation.
- ☐ Work out in the OE&C Compliance Tool the Total Energy Limit for compliance with the Standard.
- ☐ Collect data for internal gain inputs to all spaces in the DSM; should include occupancy, lighting, small power, plant and equipment gains, server gains and catering gains and should be bespoke to the building.
- ☐ Calculate expected energy use for lighting in line with CIBSE TM 54 approach; this is to include emergency lighting, parasitic power and parasitic power of controls.
- ☐ Calculate expected energy use for small power based on equipment schedule and expected hours of operation from the brief.
- ☐ Calculate expected energy use for lifts and escalators, if present.
- ☐ Calculate expected energy use for catering; CIBSE benchmarks can be used if inputs are not available, or energy data from similar space in completed building if available.
- ☐ Calculate expected energy use for server rooms, using rated power demand, ration of operated to operational power demand (can be taken in line with CIBSE TM54 assumptions, or provided by IT specialist) and hours of operation.
- ☐ Calculate expected DHW energy use.
- ☐ Set detailed HVAC model per system and assign to relevant spaces.
- ☐ Set BMS controls in line with the HVAC and lighting controls metering and monitoring strategy set out by the controls specialist team, within the detailed HVAC model.
- ☐ Set weather file in DSM, which must be the future TRY (2020) of the actual location of the building; the location zone in the OE&C Compliance Tool is set to represent as closely as possible the expected weather characteristics of the building's location.
- ☐ Set simulations in the DSMs in a suitable way to derive the following outputs.

C.10 For compliance with the operational energy element of the Standard (NHS NZ Standard compliance DSM):

- Extract NHS NZ Standard Compliance Energy for the whole building, in line with the methodology in the Standard and as described in the Tool Workflow herein (excluding Ultra-High Tech, Specialist Spaces, Support Type 1 and Support Type 3 spaces) and populate result in Tab 7.0 in the OE&C Compliance Tool.

C.11 For comparison with As-Built and In-Use values (Full DSM):

- Extract total healthcare building energy usage and all other outputs required to populate results in Tab 8.0 in the OE&C Compliance Tool.
- Extra scenarios for weather/occupancy (highly recommended).

D. Whole Life Carbon Compliance Tool

Introduction

D.1 The Whole Life Carbon Compliance Tool must be used at Outline Business Case (OBC), Full Business Case (FBC), and at building handover to:

- Calculate the project's mandatory upfront carbon limit
- Report the whole life cycle carbon assessment
- Report carbon assumptions
- Report any derogations (If Upfront Carbon Limit has not been met).

D.2 The upfront carbon limit must be revised and updated at each stage, to account for any significant changes to the space allocation.

D.3 The tool must be fully completed and submitted to the Client at OBC, FBC, and handover. A detailed breakdown of reporting requirements can be found in ***the Standard Section 6 - Delivery Stages and Reporting***.

D.4 Beyond being a platform to demonstrate compliance with the Standard, a key purpose of the tool is to facilitate the development of a benchmarking database to help drive collective improvement.

How to use

D.5 The following steps must be undertaken when using the tool. Refer to the worked examples in Section 5 for further detail.

Step 1 - Space Allocation

» The space allocation is undertaken in the OE&C Compliance Tool as outlined in Appendix B, with the outputs required for the Upfront Carbon Limits summarised in Tab 1 Space Allocation in the Operational Carbon Tool. These can then be input into Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool for the relevant project stage. This is a manual process but requires only copy and pasting of a small number of values.

» The tool makes a calculation of all areas of space based on departmental areas and other inputs, and makes allowances for other areas of the floor plates (e.g risers, lifts, walls, etc) that typically aren't included in departmental totals. The total GIA calculated should be checked against those estimated in the layout drawings and models to ensure alignment.

Step 2 - Upfront Carbon Limit

- The areas are then used by the tool to automatically calculate the project bespoke Upfront Carbon Limit, which is summarised in Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool.
- The methodology for calculating the upfront carbon limit is provided below, with all formulas and values behind the calculation provided for transparency. These have been informed by significant benchmarking, modelling and consultation.
- It is critical to highlight that whilst meeting the Upfront Carbon Limit is mandatory, the element breakdown is only indicative and sub element limits should not be used as this creates a siloed approach to design. There are many ways to meet the carbon limits which will vary for every building, as outlined in the Standard.

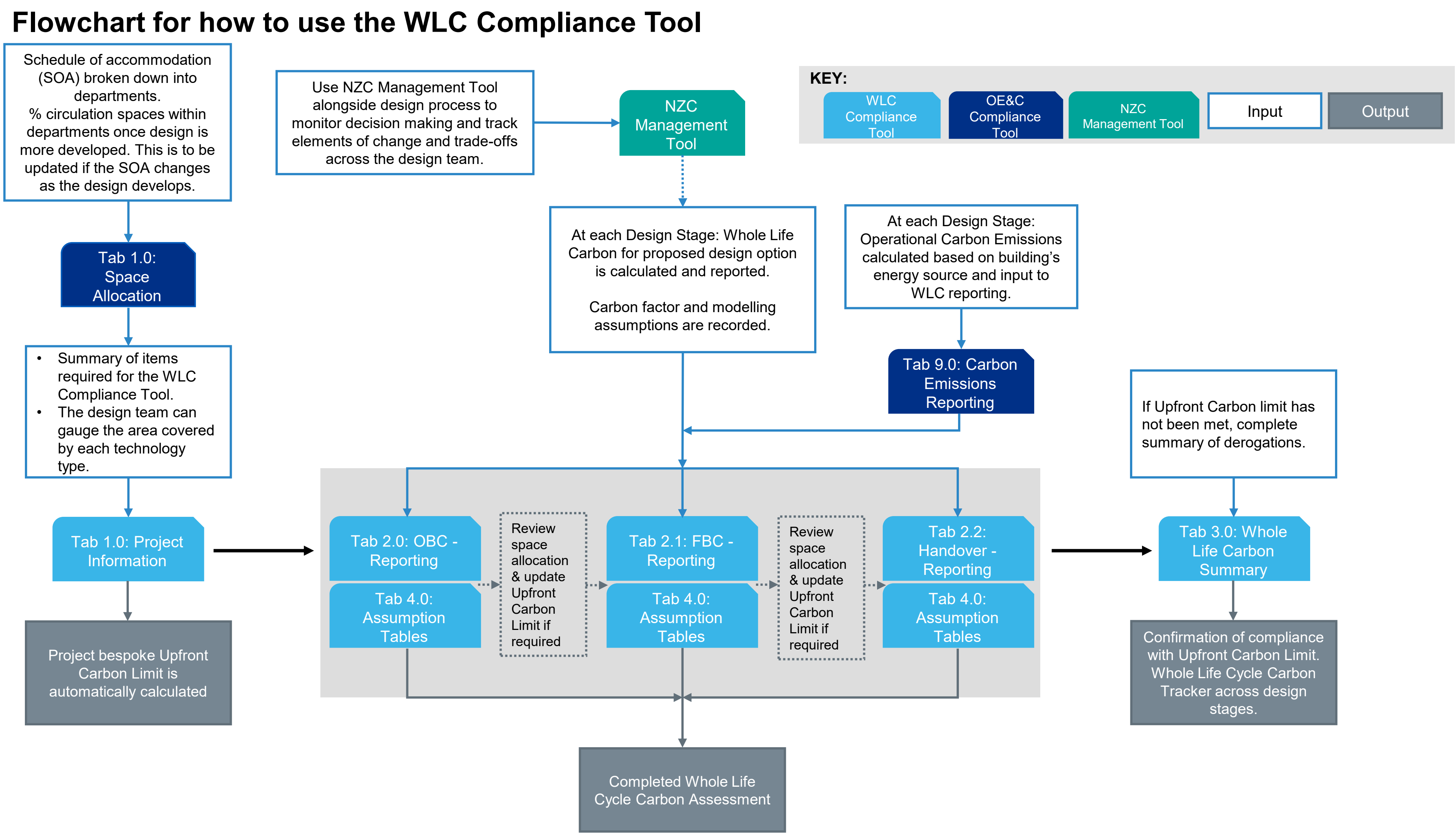
Step 3 - Whole Life Carbon Reporting

- The whole life carbon must be reported within the relevant WLC Reporting tab to the stage of the project (either OBC, FBC, or Handover). The upfront carbon limit will automatically populate from Tab 1.0 to the top of the relevant WLC Reporting Tab, and life cycle assessment information must be completed to provide up to date project information at each stage. As this is a standardised reporting tool, no rows are to be added. All information should be input to the most appropriate rows.
- All carbon data must be reported in kgCO2e.
- Modelling and carbon assumptions must also be reported in the Whole Life Carbon Compliance Tool Tab 4.0 Assumption Tables.

Step 4 - Whole Life Carbon Reporting Summary

- The whole life carbon summary for OBC, FBC, and Handover is included in Tab 3.0 Whole Life Carbon Summary, which summarises results of the whole life carbon assessment, shows compliance with the Upfront Carbon Limit, and – if the limit has been exceeded – allows derogations to be logged.
- The following process chart (Figure 6 - also included in the Introduction tab of the tool) is provided for guidance.

Figure 6 – Flow chart for using the Whole Life Carbon Compliance Tool - Please read in conjunction with the Figure 4 for the OE&C tool workflow which shows the interdependencies of the tools



Upfront Carbon Limit Calculation Methodology

D.6 The limit setting methodology used in the WLC Compliance Tool Tab 1.0 is outlined below. This has been informed by significant benchmarking and modelling studies, shared and adapted following the consultation period.

D.7 The limit is a sum of five distinct allowances; floors, vertical structure, foundations, basement and facades.

D.8 The floor limit uses a carbon factor/m^2 of floor area, this varies depending on whether the floor is in contact with ground, a roof level, or otherwise based on the technology level that the space has been assigned in the OE&C space allocation tool. The carbon factors increase with technology level due to the additional loading or vibration requirements.

D.9 The vertical structure limit applies an uplift factor to the floor limit total based on the height of the building (simplified as low (<4 levels), medium (4-8 levels), or high rise (>8 levels)). The uplift factors increase with building height to reflect the additional carbon impact of these systems.

D.10 The foundation limit applies an uplift factor to the floor and vertical structure total based on the height of the building (as above). The uplift factors increase with building height, to reflect the additional carbon impact of these systems.

D.11 The basement limit multiplies the area of slab in contact with ground with the number of basement levels and a carbon factor. This is based on the following:

- The basement levels input, with partial basements represented using 0.5 increments, e.g. a single storey basement with partial second storey would be 1.5 levels.
- The total area of basement slab is then estimated based on the total area in contact with ground and no. basement levels, for a 1.5 storey basement this captures the area not in contact with ground above the second storey.
- It is noted that this is only an estimation, so it is suggested to round up when selecting basement levels (i.e. if the basement area is 70% of ground floor area, this should be selected as a full level basement (1.0 levels) rather than a partial basement (0.5 levels) to ensure a sufficient limit is allowed for.
- The carbon factors for basements increase with depth to account for additional wall thicknesses and propping requirements associated with increased ground and water pressures.
- A typical rectangular floor plan and basement depth is assumed for converting carbon factors for walls to floor areas which are used in the calculation.

D.12 The façade limit multiplies the area of slab above ground with carbon factors for the facades. This is based on the following:

- The floor area above ground, estimated by taking the estimation of area below ground from the total GIA.
- Two carbon factors are then applied, one to the façade associated with the lightweight roof coverings, and one to the rest of the façade.
- As above, the carbon factors for facades are based on floor areas, so assumptions for a typical rectangular floor plan and floor to floor heights have been assumed.

D.13 It is appreciated that there are some approximations, estimations, and assumptions within the methodology with some simplifications required to create a process that isn't overburdening on the users. Sensitivity testing of the methodology has been undertaken to ensure the impacts of changing various factors is within the typical accuracy of assessments. The aim has been to create a methodology that finds a balance between complexity and usability, accounting for key variables that affect carbon, whilst appreciating that not all variables can be incorporated.

Inputs from Project Brief		
No. Floors	N1	
No. Basement Levels	N2	
Floor Area in Contact with Ground (Area of Cat 1-3)	Ar1	m^2
Exposed Roof* (Area above Cat 2 and 5)	Ar2	m^2
Lightweight Covering (Area above Cat 3 and 6)**	Ar3	m^2
Area of the following at Upper Levels (Cat 4-6):		
• **Support - Plant/ Storage**	Ar4	m^2
• **Low Tech**	Ar5	m^2
• **Medium Tech**	Ar6	m^2
• **High Tech**	Ar7	m^2
• **Ultra High Tech**	Ar8	m^2
All Other Internal Areas (Cat 7)	Ar9	
Total GIA	Ar10	m^2

* Exposed roof refers to a structural roof at any level where the space is not enclosed, typical examples include plant space that doesn't require enclosing, green roofs, roof terraces, PV areas.
** Lightweight covering refer to enclosures that are non-structural i.e. typically only accessible for maintenance.

1 Floors Benchmark

The benchmark for floors is determined by multiplying the areas reported within the brief inputs by the carbon factors stated below.

	Carbon Factor (CF_A)	
In Contact with Ground (Ar1)	113	$kgCO_2e/m^2$
Exposed Roof* (Ar2)	146	$kgCO_2e/m^2$
Lightweight Covering (Ar3)**	96	$kgCO_2e/m^2$
At Upper Levels:		
• **Support - Plant/ Storage (Ar4)**	146	$kgCO_2e/m^2$
• **Low Tech (Ar5)**	130	$kgCO_2e/m^2$
• **Medium Tech (Ar6)**	146	$kgCO_2e/m^2$
• **High Tech (Ar7)**	163	$kgCO_2e/m^2$
• **Ultra High Tech (Ar8)**	180	$kgCO_2e/m^2$
All Other Internal Areas (Ar9)	130	$kgCO_2e/m^2$
Floors Total, FT	$\Sigma(Ar \times CF_A)$	$kgCO_2e$

2 Vertical Structure Benchmark

The benchmark for vertical structure is determined by applying a factor to the carbon in the floors, FT. Three factors are presented in the table, with the appropriate factor to be used depending on the designation of building height.

	Carbon Factor (CF_B)	
• **Low Rise**	0.16	
• **Medium Rise**	0.20	
• **High Rise**	0.22	
Vertical Structure Total, VT	$FT \times CF_B$	$kgCO_2e$

Floors | Vertical Structure |

3 Foundations Benchmark

The benchmark for foundations is determined by applying a factor to the carbon in the floors and vertical structure, FT + VT. Three factors are presented in the table, with the appropriate factor to be used depending on the designation of building height.

	Carbon Factor (CF_C)	
• Low Rise	0.10	
• Medium Rise	0.12	
• High Rise	0.15	
Foundations Total, GT	(FT + VT) x CF_C	$kgCO_2e$

Floors | Vertical Structure | Foundations |

4 Basement Benchmark

The benchmark for the basement is determined by selecting the number of basement levels (N2) and multiplying the area of slab in contact with ground (Ar1) by the associated per m^2 carbon factor.

	No. basement levels (N2)	Carbon Factor (CF_D)	
• Partial Single Storey Basement	0.5	168	$kgCO_2e/m^2$
• Single Storey Basement	1.0	168	$kgCO_2e/m^2$
• Full Single + Partial Double Storey	1.5	224	$kgCO_2e/m^2$
• Double Storey Basement	2.0	224	$kgCO_2e/m^2$
• Full Double + Partial Third Storey	2.5	280	$kgCO_2e/m^2$
• Three Storey Basement	3.0	280	$kgCO_2e/m^2$
Basement Total, BT		Ar1 x N2 x CF_D	$kgCO_2e$

Floors | Vertical Structure | Foundations | Basement |

5 Façade Benchmark

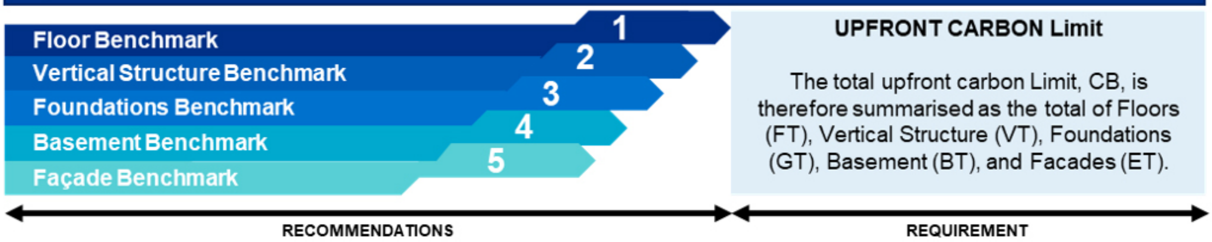
The above and below ground floor areas are estimated according to the number of basement levels, N2.

	Area m^2	
• Area Above Ground (A_{above})	Ar10 - A_{below}	m^2
• Area Below Ground (A_{below})	Ar1 x N2	m^2

The benchmark for the facade is determined by multiplying the areas defined above and below ground by the relevant per m^2 carbon factors stated below.

	Area (A_i) m^2	Carbon Factor (CF_E) $kgCO_2e/m^2$	
• Above Ground	(A_{above} - Ar3)	112	
• Below Ground	A_{below}	0	
• Lightweight Covering	Ar3	84	
Facade Total, ET		$\Sigma(A_i \times CF_E)$	$kgCO_2e$

Upfront Carbon Limit – Tier 1

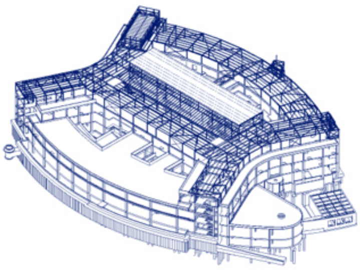


The Upfront Carbon Limit considers Life Cycle Stages A1-A5, excluding A5a.
The Limit can be divided through by GIA (Ar10) to determine the Carbon/m^2 metric used for comparisons to industry benchmarks.

Upfront Carbon Limit Calculation Example

D.14 An example limit calculation using the above methodology with the following brief is presented below.

Hospital 1



No. Floors	N1 = 5	Med Rise
No. Basement Levels	N2 = 1	
Floor Area in Contact with Ground (Area of Cat 1-3)	Ar1 = 7000	m^2
Exposed Roof* (Area above Cat 2 and 5)	Ar2 = 5600	m^2
Lightweight Covering (Area above Cat 3 and 6)**	Ar3 = 1400	m^2
Area of the following at Upper Levels (Cat 4-6):		
• **Support - Plant/ Storage**	Ar4 = 2381	m^2
• **Low Tech**	Ar5 = 5426	m^2
• **Medium Tech**	Ar6 = 19178	m^2
• **High Tech**	Ar7 = 2700	m^2
• **Ultra High Tech**	Ar8 = 163	m^2
All Other Internal Areas (Cat 7)	Ar9 = 100	
Total GIA	Ar10 = 36948	m^2

1 Floors Benchmark

	Area m^2	**Carbon Factor (CF_A)** $kgCO_2e/m^2$	**Area x CF_A** tCO_2e
In Contact with Ground	Ar1 = 7000	113	791
Exposed Roof*	Ar2 = 5600	146	818
Lightweight Covering**	Ar3 = 1400	96	135
At Upper Levels:			
• Support - Plant/ Storage	Ar4 = 2381	146	348
• Low Tech	Ar5 = 5426	130	705
• Medium Tech	Ar6 = 19178	146	2800
• High Tech	Ar7 = 2700	163	440
• Ultra High Tech	Ar8 = 163	180	29
All Other Internal Areas	Ar9 = 100	130	13
Floors Total, FT		$\Sigma(Ar \times CF_A)$	**6079**

Floors

2 Vertical Structure Benchmark

	Carbon Factor (CF_B)	**Floors Total (FT)** tCO_2e	**FT x CF_B** tCO_2e
• **Medium Rise**	0.20	6079	1216
Vertical Structure Total, VT			**1216**

Floors Vertical Structure

3 Foundations Benchmark

	Carbon Factor (CF_C)	**Floors + Vertical Total (FT+VT)** tCO_2e	**(FT+VT) x CF_C** tCO_2e
• **Medium Rise**	0.12	7295	875
Foundations Total, GT			**875**

Figure 7: Example benchmark

Floors | Vertical Structure | Foundations | **4 Basement Benchmark**

	Basement Levels (N2)	Carbon Factor (CF_D) $kgCO_2e/m^2$	Ground Floor Area (Ar1) m^2	N2 x Ar1 x CF_D tCO_2e
• **Single Storey Basement**	1	168	7000	1176
Basement Total, BT				**1176**

Floors | Vertical Structure | Foundations | Basement | **5 Façade Benchmark**

	Area m^2	
• Area Above Ground (A_{above})	29948	m^2
• Area Below Ground (A_{below})	7000	m^2

	Area (Ai) m^2	**Carbon Factor (CF_E)** $kgCO_2e/m^2$	**$\Sigma(A_i \times CF_E)$** tCO_2e
• Above Ground	29948	112	3354
• Below Ground	7000	0	0
• Lightweight Covering	1400	84	118
Facade Total, ET			**3472**

Upfront Carbon Limit – for Tier 1 Elements

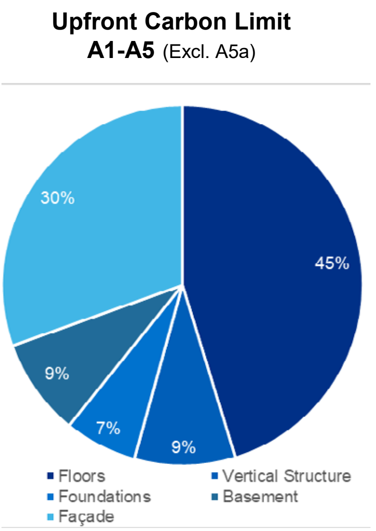
Benchmark	tCO_2e
Floor Benchmark	6 0 7 9
Vertical Structure Benchmark	1 2 1 6
Foundations Benchmark	8 7 5
Basement Benchmark	1 1 7 6
Façade Benchmark	3 4 7 2

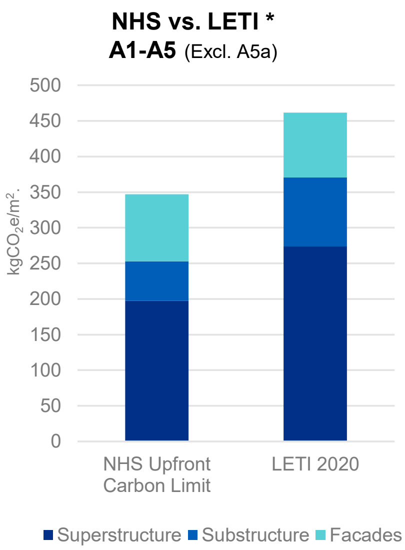
UPFRONT CARBON LIMIT

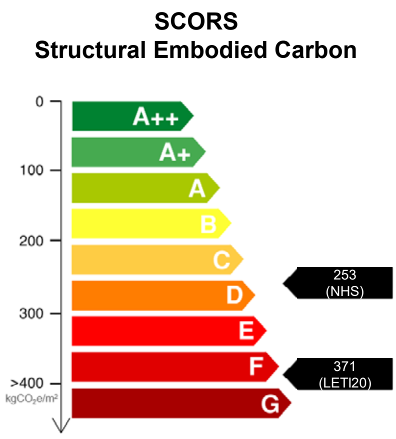
12 818 tCO_2e

Equivalent to **346 $kgCO_2e/m^2$ of GIA**

RECOMMENDATIONS | **REQUIREMENT**







SCORS Rating for A1-A5 (Excl. A5a) Structural Embodied Carbon (i.e. Excluding Facades)

*Note: To account for the exclusion of A5a in the NHS targets, a 5% reduction of LETI Values has been applied.

Upfront Carbon Limit Assumptions

Notes:

» Transport values adopted from RICS guidance and modified based on judgement to align with A1-A3 values, e.g., steel consumed in the UK is ~ 50% from UK and 50% from Europe, so average value has been taken.

» Transport distances should be based on average laden vehicles to and from site.

» Waste Rates adopted from Wrap database.

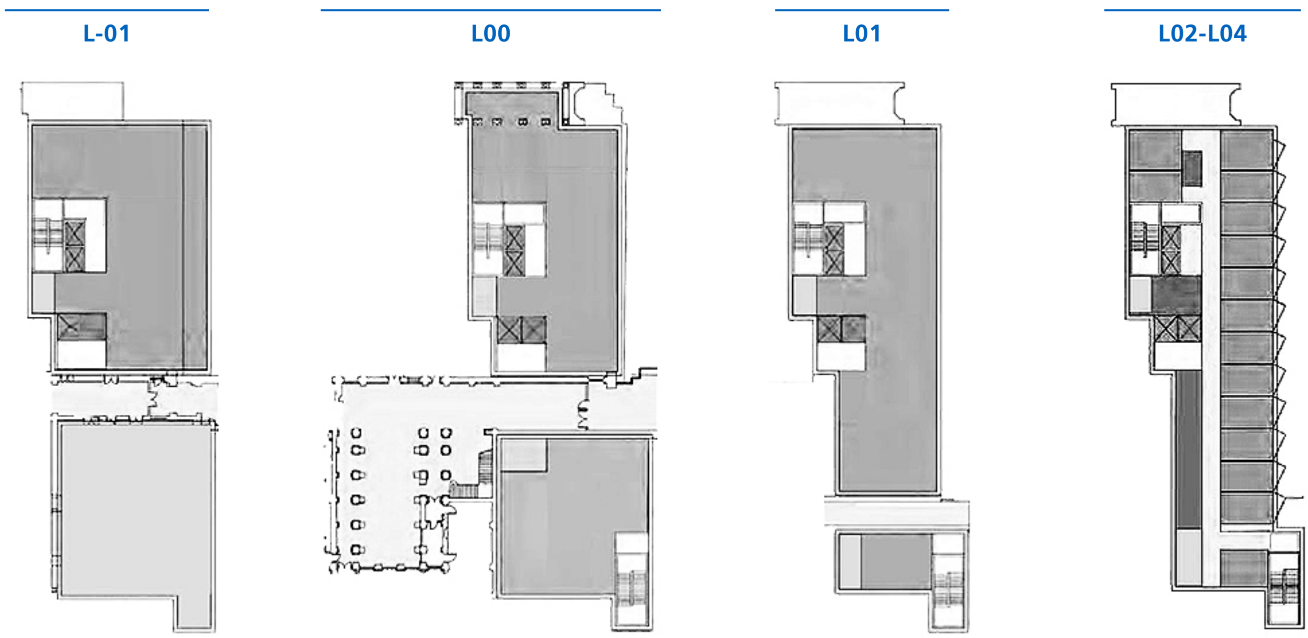
CARBON FACTOR TABLE	ASSUMPTION / DATA SOURCE		
TIER 1 - MATERIALS	**A1-A3**	**A4**	**A5W**
Concrete			
Sand only	ICE Database V3	50km	5%
Screed	ICE Database V3 - 25% GGBS	50km	5%
In-situ Concrete	ICE Database V3 - 25% GGBS	50km	5%
Precast Concrete	ICE Database V3 - 25% GGBS	300km	1%
All reinforcement inc. mesh	UK CARES EPD	300km	5%
Steel			
Steelwork S355 inc. connections	Average of TATA EPD (UK) and Bauforumstahl EPD (Europe)	900km	1%
Steelwork plate, deck (e.g. composite slabs), studs	TATA EPD (UK)	300km	1%
Timber			
CLT/ Glulam	ICE Database V3 or EPD	1500km	5%
Sequestration	Excluded for Stage A Limits	-	-
Aluminium			
Sheet	ICE Database V3 – 31% recycled content (Europe)	1500km	1%
Profile	ICE Database V3 – 31% recycled content (Europe)	1500km	1%
Glass			
General	ICE Database V3	1500km	5%
Insulation Materials			
Mineral wool	EPD (UK)	300km	15%
Mineral Materials			
Gypsum	ICE database V3 or EPD (UK)	300km	15%
Fibre Cement Board	EPD (UK)	300km	15%
Plastic Materials			
All	EPD (UK)	300km	5%

E. Worked examples

Worked Example A

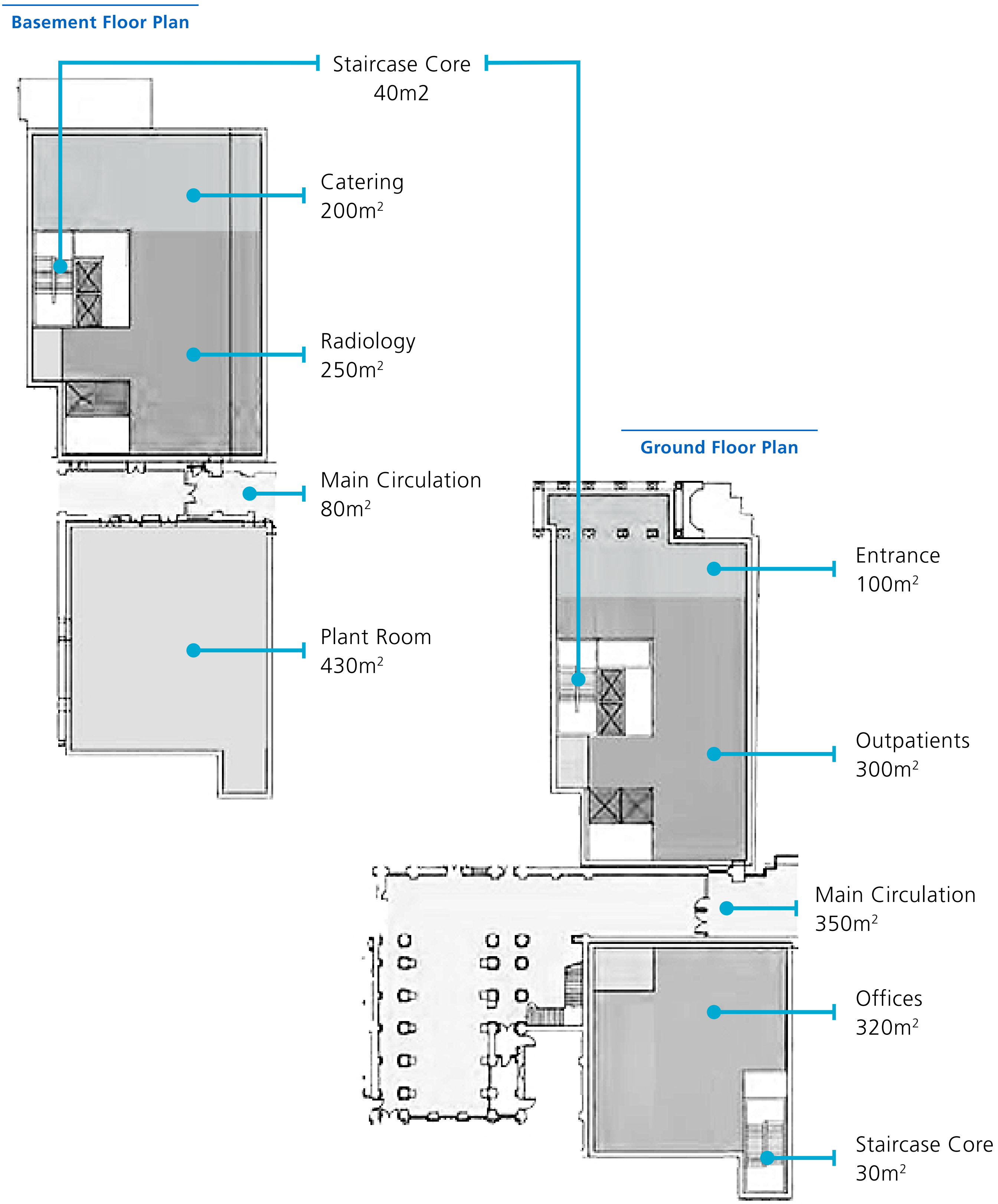
E.1 The following section includes a worked example based on a four-storey secondary healthcare development in London. This example illustrates how the Operational Energy and Carbon methodology and Compliance Tools can be used for an early-stage design (RIBA Stage 2). The NHS Standard Compliance Energy for the whole building was found to be 195 MWh/year, calculated using a DSM following the DSM Methodology Checklist in section D.4 of this user guide. Only steps 1 and 7 of the OE&C Compliance Tool have been included in this worked example.

E.2 Each floor plan has been sub-divided into departments and each department is associated with a floor area (m2) and matched to an NHS NZ Standard space category. For this project, the staircase cores, lobby areas and main circulation spaces are conditioned public circulation spaces and have therefore been assigned to Low Tech Type 1.



Operational carbon

Step 1 - Space Allocation



Extract from Tab 1.0 Space Allocation: Space allocation for the Basement and Ground Floors

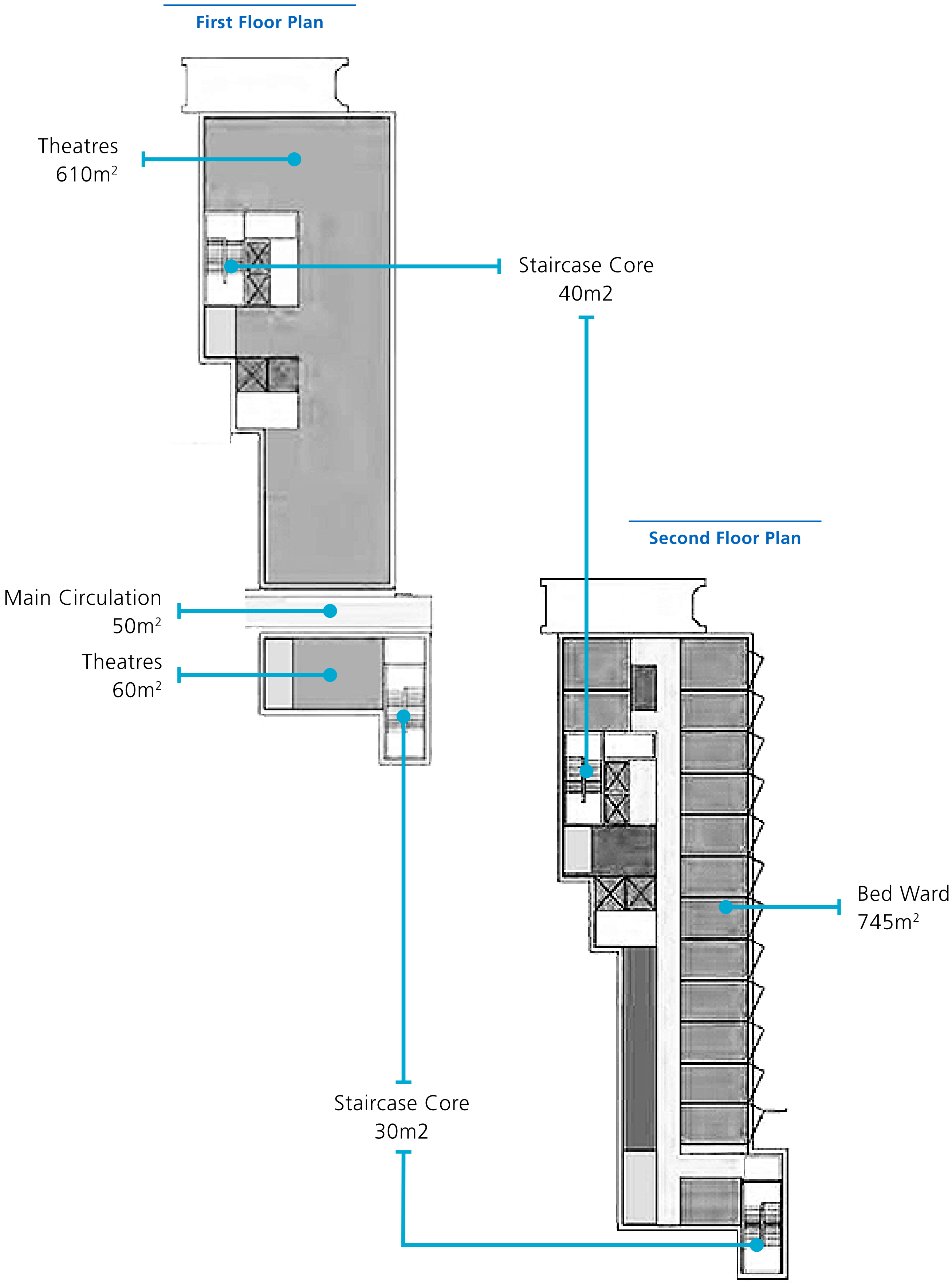
GENERAL INFORMATION

Select Location Zone	A
Enter number of floors*	4

SPACE ALLOCATION

Note: Do not cut cells, please manually delete incorrect entries.

Level	Building Element Category*	Department	Space Name	Main / Outlier Space	Clinical/ Non-Clinical	Assigned Space Type*	Space Description	Gross Internal Area [m2]*	Equipment Usage	Equipment Gain [W/m2]	% Circulation in Department
L-01	Category 1: In contact with ground, WITH floors above	Plant Room	Plant Room	Main_Space	Non_Clinical_M	Support Type 3	-Sizeable areas including unconditioned spaces such as plant rooms, large stores and waste facilities.	430	-	-	-
L-01	Category 1: In contact with ground, WITH floors above	Radiology	Radiology	Main_Space	Clinical_M	Ultra High Tech/Specialist Spaces	- Spaces that have very high equipment loads or specialist requirements such as containment labs, diagnostic and imaging.	250	-	-	-
L-01	Category 1: In contact with ground, WITH floors above	Catering	Catering	Main_Space	Non_Clinical_M	Support Type 1	- Conditioned and ventilated spaces with high loads, such as catering.	200	-	-	-
L-01	Category 1: In contact with ground, WITH floors above	Main Circulation	Main Circulation	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	80	-	-	-
L-01	Category 1: In contact with ground, WITH floors above	Staircase Core	Staircase Core	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	40	-	-	-
L00	Category 1: In contact with ground, WITH floors above	Main Circulation	Main Circulation	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	350	-	-	-
L00	Category 3: Intermediate Level, WITH floors above	Entrance	Entrance	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	100	-	-	-
L00	Category 3: Intermediate Level, WITH floors above	Outpatients	Outpatients	Main_Space	Clinical_M	Medium Tech Type 3	- Spaces containing consulting work areas. - Occupancy Period: 7am - 8pm - Ventilation: 6 ach	300	Low	10	30
L00	Category 3: Intermediate Level, WITH floors above	Offices	Offices	Main_Space	Non_Clinical_M	Low Tech Type 2	- Spaces with low equipment requirement such as office, teaching spaces,eat/drink areas, gyms inclusive of all circulation strictly associated with that space.	320	-	-	-
L00	Category 3: Intermediate Level, WITH floors above	Staircase Core 1	Staircase Core 1	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	30	-	-	-
L00	Category 3: Intermediate Level, WITH floors above	Staircase Core 2	Staircase Core 2	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	40	-	-	-


First Floor Plan
Theatres
610m²
Staircase Core
40m2
Main Circulation
50m²
Theatres
60m²
Second Floor Plan
Bed Ward
745m²
Staircase Core
30m2

Extract from Tab 1.0 Space Allocation: Space allocation for the First and Second Floors

L01	Category 3: Intermediate Level, WITH floors above	Theatres	Theatres 1	Main_Space	Clinical_M	High Tech Type 1	- Spaces including the main operating theatre and any operating theatre ancillary spaces. - Occupancy Period: 7am - 10pm -Ventilations: 21 ach	610	Low	43	30
L01	Category 3: Intermediate Level, WITH floors above	Theatres	Theatres 2	Main_Space	Clinical_M	High Tech Type 1	- Spaces including the main operating theatre and any operating theatre ancillary spaces. - Occupancy Period: 7am - 10pm -Ventilations: 21 ach	60	Low	43	25
L01	Category 3: Intermediate Level, WITH floors above	Main Circulation	Main Circulation	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	50	-	-	-
L01	Category 3: Intermediate Level, WITH floors above	Staircase Core 1	Staircase Core 1	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	30	-	-	-
L01	Category 3: Intermediate Level, WITH floors above	Staircase Core 2	Staircase Core 2	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	40	-	-	-
L02	Category 4: Intermediate Level, NO floors above	Bed Ward	Bed Ward	Main_Space	Clinical_M	Medium Tech Type 4	- Spaces containing beds ranging from single bedrooms to multiple patient units in wards. - Occupancy Period: 24/7 -Ventilations: 6 ach	745	Low	10	30
L02	Category 4: Intermediate Level, NO floors above	Staircase Core 1	Staircase Core 1	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	40	-	-	-
L02	Category 4: Intermediate Level, NO floors above	Staircase Core 2	Staircase Core 2	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	30	-	-	-

Step 7 - Energy Use Reporting

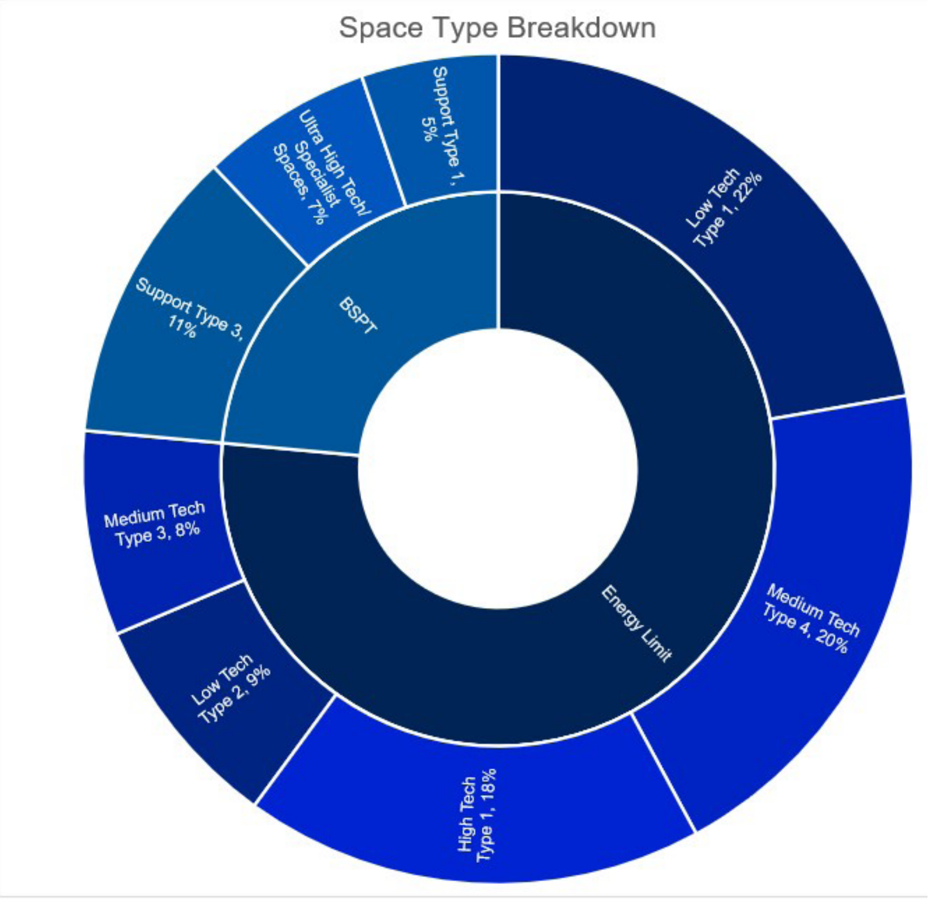
Extract from Tab 7.0 Energy Use Reporting: Building Summary

BUILDING SUMMARY

Location Zone	A
Building Type	Secondary Healthcare
RIBA Stage	2: Concept Design
Heating Strategy	Priority 1

For Information: Building GIA Summary		
Total building Gross Internal Area [m2]	3745	
Breakdown	Gross Internal Area [m2]	% of total building
Spaces with Energy Limit	2865	77%
Spaces with Building Services Performance Target	880	23%

Breakdown	Gross Internal Area [m2]	% of total building
Low Tech Type 1	830	22%
Low Tech Type 2	320	9%
Medium Tech Type 1	0	0%
Medium Tech Type 2	0	0%
Medium Tech Type 3	300	8%
Medium Tech Type 4	745	20%
High Tech Type 1	670	18%
High Tech Type 2	0	0%
Ultra High Tech/Specialist Spaces	250	7%
Support Type 1	200	5%
Support Type 2	0	0%
Support Type 3	430	11%



Extract from Tab 7.0 Energy Use Reporting: Whole Building Performance Target Compliance

Step	Compliance Target Type	Compliance Target Element	TARGET Compliance Target Value	DESIGN Achieved Design Value	
Step 1: Whole Building Performance Target	Fabric U Value	Wall [W/m2/K]	**0.15**	0.13	Compliant
		Floor [W/m2/K]	**0.12**	0.1	Compliant
		Roof [W/m2/K]	**0.12**	0.1	Compliant
		Window [W/m2/K]	**1.2**	1.2	Compliant
	Air Tightness	-	**2.5**	2	Compliant
	Glazing Performance	E/S/W Façade: g-value	**0.35**	0.35	Compliant
		E/S/W Façade: VLT value	**0.7**	0.7	Compliant
		N Façade: G value	**0.4**	0.4	Compliant
		N Façade: VLT value	**0.7**	0.7	Compliant

Total Energy Limit [kWh/yr]
210585
NHS Standard Compliance Energy [kWh/yr]
195000
Compliant to Energy Limit Target

Extract from Tab 7.0 Energy Use Reporting: Building Services Performance Target Compliance

Step	Space Type	Compliance Target Element	GIA it applies to (m^2)	TARGET Compliance Target Value: Regulated Energy Limit	DESIGN Achieved Design Value: Regulated Energy Limit
Step 2b: Space Type Building Services Performance Target	Ultra High Tech/Specialist Spaces + Support Type 1	AHU SFP (W/l/s)	0	1.3	N/A
		Heat Recovery (General HR Devices)	0	80%	N/A
		Heat Recovery (Run Around Coil)	0	60%	N/A
		Lighting (W/m2/100 lux)	0	2	N/A
		Heating SCOP	0	3.5	N/A
		Cooling SEER	0	5.5	N/A
		DHW COP	0	2.4	N/A

Upfront carbon

Step 1 - Space Allocation

E.3 The Space Allocation for this project has been described above. The floor area breakdown by space category, summarised in Tab 1 Space Allocation in the Operational Energy and Carbon Tool, can then be input into Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool.

Tab 1.0 Space Allocation in the Operational Energy and Carbon Tool

Inputs for WLC Tool	
Note: To be copied to WLC Tab 1.0 'Select and copy cells outlined by red border, and directly paste into Tab 1.0 of the WLC Tool - Cell D19 (OBC) or Cell F19 (FBC)	
Number of Floors	4
Number of Basement Levels	1
Floor GIA in contact with Ground (Category 1-3), [m2]	1350
Roof Area (Area above Category 2 and 5), [m2]	815
Lightweight Covering (Area above Category 3 and 6), [m2]	300
Area of the following at Upper Levels (Cat 4-6):	
Support (Plant/Storage) [m2]	300
Low Tech [m2]	680
Medium Tech [m2]	1045
High Tech [m2]	670
Ultra High Tech/Specialist [m2]	0
All Other Internal Area (Category 7), [m2]	130

Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool

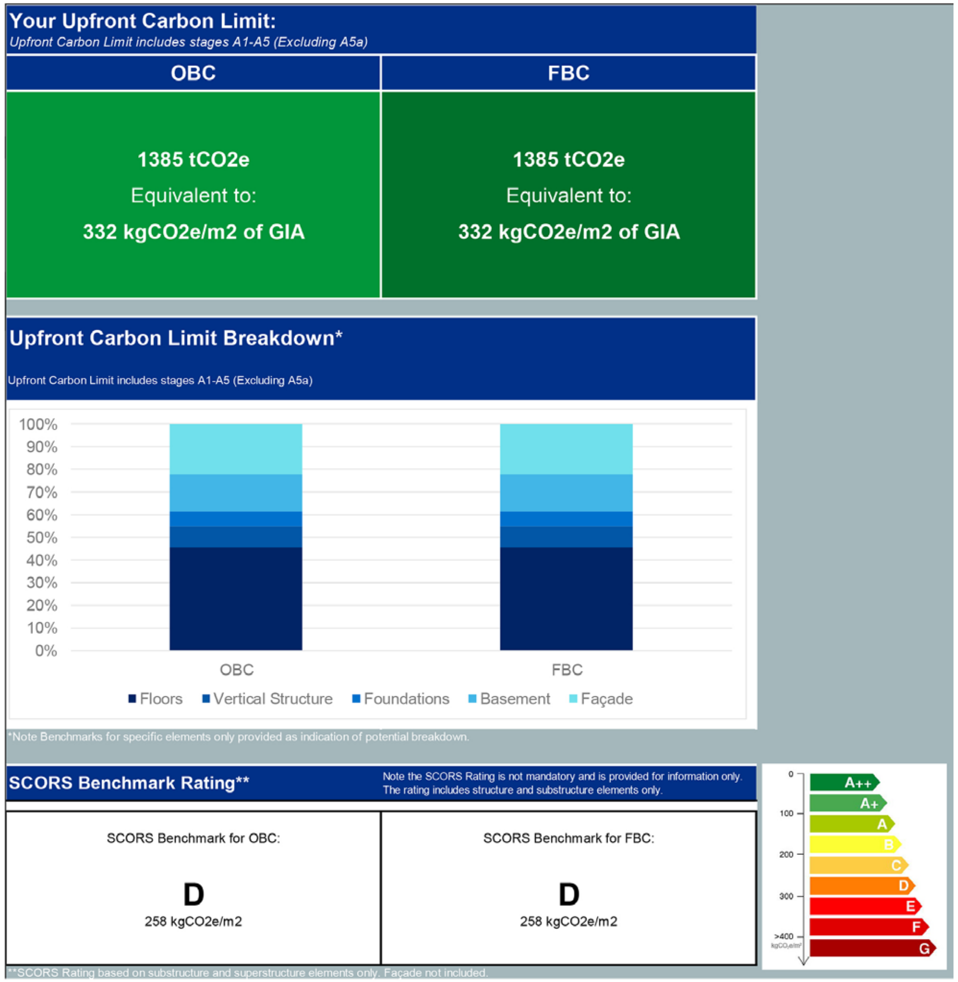
Inputs from Brief Please paste values from Tab 1 in the *Operational Energy and Carbon Tool* in the below cells highlighed by the red border	**OBC**		**FBC**		**Commentary** Please use whilst undertaking space allocation task in OE&C Tool, Tab 1.0)
No. Floors	4	Med Rise	4	Mid Rise	*Total no. Floors inc. basement* *For vertical and horizontal extensions - only state floors associated with new construction*
No. Basement Levels	1.0	-	1.0	-	*No. levels below ground. Partial basements should be represented by 0.5 increment*
- Floor in Contact with Ground (Area of Cat 1-3)	1,350	m²	1,350	m²	*Total area in contact with ground, may be over multiple levels e.g. partial basement*
- Exposed Roof (Area above Cat 2 and 5)	815	m²	815	m²	*Total exposed roof area at all levels (structural roof used for supporting exposed plant, PV, green roof, terraces, etc)*
- Lightweight Covering (Area above Cat 3 and 6)	300	m²	300	m²	*Total Lightweight Covering area at all levels (refers to non-structural, access only roof e.g. covering over plant or canopies)*
Area of the following at Upper Levels (Cat 4-6):					*Only internal floor areas not in contact with ground should be reported below, this includes enclosed areas at roof level (as these form part of GIA)*
- Support (Plant/ Storage)	300	m²	300	m²	*Please ensure that the total area is allocated in the space allocation tab including circulation space and stairwells.* *For vertical and horizontal extensions - please input new-build areas only.*
- Low Tech	680	m²	680	m²	
- Medium Tech	1,045	m²	1,045	m²	
- High Tech	670	m²	670	m²	
- Ultra High Tech		m²		m²	
- All Other Internal Areas (Cat 7)	131	m²	131	m²	*These include Lifts, Risers, Walls and other non-departmental areas not given a space allocation, and should ensure the GIA sum is accurate*
Total GIA	4,176	m²	4,176	m²	Note that, in line with RICS definitions, only covered roof area counts towards GIA.

Step 2 - Upfront Carbon Limit

E.4 The areas are then used by the tool to automatically calculate the project bespoke Upfront Carbon Limit, which is summarised in Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool.

E.5 The total calculated Upfront Carbon Limit for the project is 1385 tCO2e, or 332 kg CO2e/m2 of GIA at OBC and FBC.

Project bespoke mandatory Upfront Carbon Limit shown in Tab 1.0 Project Information



Step 3 - Whole Life Carbon Reporting

E.6 The whole life carbon must be reported within the relevant WLC Reporting Tab to the stage of the project. The upfront carbon limit must be copied from the calculation tool in Tab 1.0 to the top of the relevant WLC Reporting Tab and the operational carbon copied from Tab 9.0 of the OE&C Compliance Tool into the relevant cells, as shown below.

E.7 All carbon data must be reported in kgCO2e.

Tab 9 Carbon Emissions Reporting in the Operational Carbon Tool

Summary: Energy Consumption and Equivalent Carbon Emissions

The values here should be results extracted from the Full DSM

Energy Consumption Source	Regulated Net Energy (kWh/year) [1]	Unregulated Energy (kWh/year)	Regulated Net Carbon Emissions over WLC Analysis Period (kgCO2e) [1] [2]	Unregulated Carbon Emissions over WLC Analysis Period (kgCO2e) [2]
Grid Electricity	260000	300000	242982	280364
Natural Gas			0	0
Other 1			0	0
Other 2			0	0
Other 3			0	0
Other 4			0	0
Total	**260000**	**300000**	**242982**	**280364**

Footnote:
[1] Regulated net energy and regulated net carbon includes energy/carbon displaced by renewables
[2] To be copied to the Whole Life Carbon Compliance Tool

Tab 2.0 OBC - WLC Reporting of the Whole Life Carbon Compliance Tool showing inputs for the limits (above the table) and inputs from the Operational Carbon Tool. Embodied carbon data isn't available for this case study, but should be added in the appropriate rows

Outline Business Case - Whole Life Carbon Reporting

RIBA Stage:	RIBA 2			
GIA:	4219.6 m2			
LCA Tool Used for Assessment:		If Other - Please Specify:		*Please fill out information relating to project stage and carbon assessment*
Date LCA was carried out:				
Upfront Carbon Limit at OBC:	1526 tCO2e	Equivalent to	362 kgCO2e/m2 of GIA	

Assessment			**Whole Life Carbon, $kgCO_2e$** *Please input data below*								
	Tier 1	**Tier 2**	**Sequestered Carbon** (Negative Number)	**A1-A3**	**A4**	**A5w**	**A5a**	**B1**	**B6**	**B7**	**Commentary**
Operational Carbon											
Regulated Energy											
Regulated Net - Grid Electricity		Yes							242982		Input from operational energy assessment
Regulated Net - Natural Gas		Yes									
Regulated Net - Other 1		Yes									
Regulated Net - Other 2		Yes									
Regulated Net - Other 3		Yes									
Regulated Net - Other 4		Yes									
Unregulated Energy											
Unregulated - Grid Electricity		Yes							280364		Input from operational energy assessment
Unregulated - Natural Gas		Yes									
Unregulated - Other 1		Yes									
Unregulated - Other 2		Yes									
Unregulated - Other 3		Yes									
Unregulated - Other 4		Yes									
On-Site Energy Generation	Optional Requirement not included in whole life carbon assessment total										
This is requested to assess the whole life impact of installing on-site PV, or other on-site electricity generation systems. The operational carbon saving from local PV, or other on-site electricity generation systems, will be a negative Stage B value for reporting purposes (noting the energy generated will already have been subtracted from the energy usage used to determine operational carbon in the subheadings above). This is therefore an optional requirement and this value won't be used in the summary tables (to avoid double-counting).											
Embodied Carbon of (local) PV											
Estimated Operational Carbon saving from (local) PV											
Embodied Carbon of other local electricity generation system											
Estimated Operational Carbon saving from (local) electricity generation system											

E.8 Modelling and carbon assumptions must also be reported in the Whole Life Carbon Compliance Tool Tab 4.0 Assumption Tables.

Step 4 - Whole Life Carbon Reporting Summary

E.9 The whole life carbon summary is included in Tab 3.0 Whole Life Carbon Summary.

E.10 A summary for this example is shown below (as EC data isn't available mock values have been used to achieve compliance). As the design complies with the upfront carbon limit, no derogations are required.

Tab 4.0 Whole Life Carbon Summary in the Operational Carbon Tool

Whole Life Carbon Project Summary

Capital Carbon Values include stages A1-A5 (Excluding A5a)

Summary: OBC

Capital Carbon						
Capital Carbon Limit for OBC		1629 tCO_2e	equivalent to	347 $kgCO_2/m^2$ of GIA		
Calculated Capital Carbon (A1-A5)	Tier 1 Elements	1348 tCO_2e	equivalent to	287 $kgCO_2/m^2$ of GIA		
Outcome:		Design complies with Capital Carbon Limit				
Estimated Whole Life Cycle Carbon Emissions						
Calculated Whole Life Carbon (A-C)	Tier 1&2 Elements	2360 tCO_2e	equivalent to	503 $kgCO_2/m^2$ of GIA		
Calculated Operational Energy (B)		523 tCO_2e	equivalent to	111 $kgCO_2/m^2$ of GIA		
Calculated Generated On-Site Energy (B)		0 tCO_2e	equivalent to	0 $kgCO_2/m^2$ of GIA		

	Sequestered Carbon	Module A1-A5	Module B1-B5	Module B6-B7	Module C1-C4	Module D (Reported Separately)
Total tCO2e	0	1348	304	523	154	0
Total kgCO2/m2 of GIA	0	287	65	111	33	0

Derogations

Detailed reason for derogation must be provided with estimated quantitative impact on carbon, following requirements in Section 6.3

Derogations: OBC

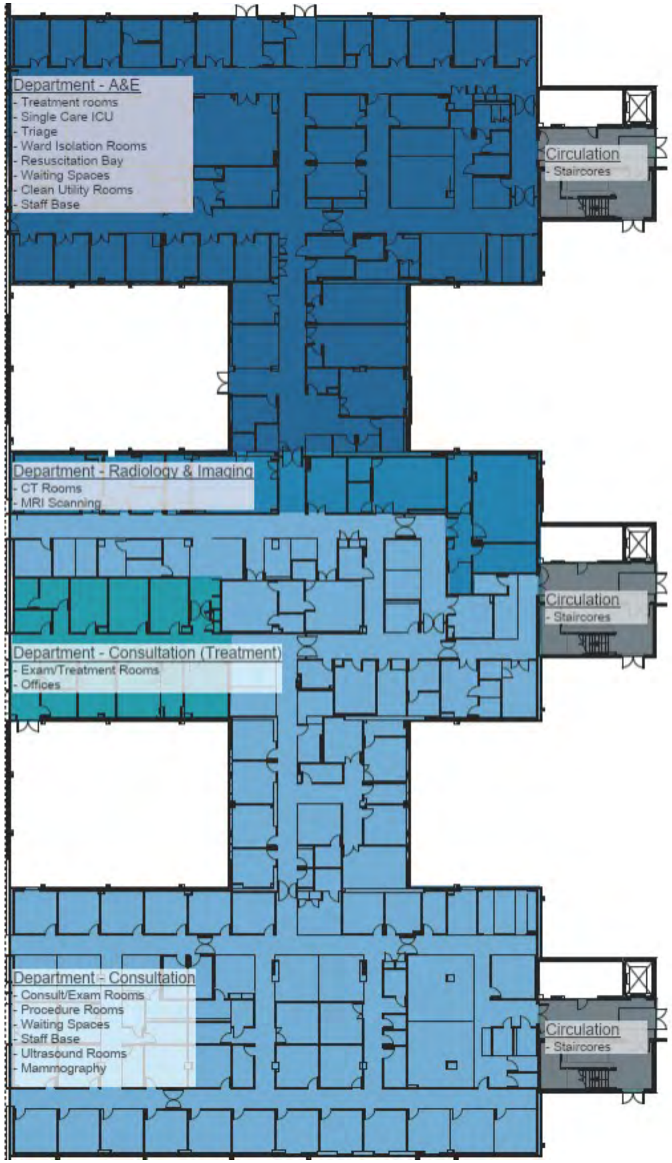
Derogation	*Please input comments and reasoning*
RIBA 2 Conservatism	
Poor Ground Conditions	
Carbon Assumptions	

Worked Example B

E.11 This section specifically demonstrates the methodology behind allocating the most appropriate space-types technology categories to the space usage defined in a detailed RIBA Stage 4 development. A section of the example healthcare building, located on the ground floor, has been taken for this example. An extract of the healthcare building floor plan is shown in the image below. Only steps 1 and 7 of the OE&C Compliance Tool have been included in this worked example.

E.12 Principles of space allocation shown in 'Worked Example A' has been applied here. There are 3 main departmental areas, where the general space usage has been taken as the main space-type technology categories such as Medium Tech Type 1, Medium Tech Type 2, Medium Tech Type 3 and Ultra High Tech/ Specialist Spaces. Any spaces with more defined usage types have been assigned a different space-type technology category than the main space. Lifts and riser areas have been excluded, while staircase cores that do not fall within the department have been assigned to Low Tech Type 1.

Extract from the Ground Floor Plan



Operational carbon

Step 1 - Space Allocation

E.13 The table below shows the area associated with each space-type technology category assigned. The percentage of total circulation in the department has also been calculated.

Extract from Tab 1.0 Space Allocation: Space allocation for the Ground Floor

SPACE ALLOCATION

Note: Do not cut cells, please manually delete incorrect entries.

Level	Building Element Category*	Department	Space Name	Main / Outlier Space	Clinical/ Non-Clinical	Assigned Space Type*	Space Description	Gross Internal Area [m2]*	Equipment Usage	Equipment Gain [W/m2]	% Circulation in Department
L00	Category 1: In contact with ground, WITH floors above	A&E	Treatment Rooms, Single care ICU, Triage, Ward Isolation, Resus Bay	Main_Space	Clinical_M	Medium Tech Type 1	- Spaces containing consulting / exam / treatment work areas and intensive care units. - Occupancy Period: 24/7 - Ventilation: 10 ach	1458	Low	10	25
L00	Category 1: In contact with ground, WITH floors above	Radiology and Imaging	CT Rooms, MRI Scanning	Main_Space	Clinical_M	Ultra High Tech/Specialist Spaces	- Spaces that have very high equipment loads or specialist requirements such as containment labs, diagnostic and imaging.	296	-	-	-
L00	Category 1: In contact with ground, WITH floors above	Consultation (Treatment)	Exam/Treatment Rooms	Main_Space	Clinical_M	Medium Tech Type 2	- Spaces containing treatment work areas. - Occupancy Period: 7am - 8pm - Ventilation: 10 ach	248	Low	10	30
L00	Category 1: In contact with ground, WITH floors above	Consultation	Consult/exam Rooms, Procedure Rooms, Ultrasound Rooms, Mammography	Main_Space	Clinical_M	Medium Tech Type 3	- Spaces containing consulting work areas. - Occupancy Period: 7am - 8pm - Ventilation: 6 ach	2025	Low	10	30
L00	Category 1: In contact with ground, WITH floors above	Circulation	Staircores	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	264	-	-	-

Step 7 - Energy Use Reporting

E.14 The percentage distribution of each space-type technology category can be checked in the Energy Use Reporting Tab under Building Summary.

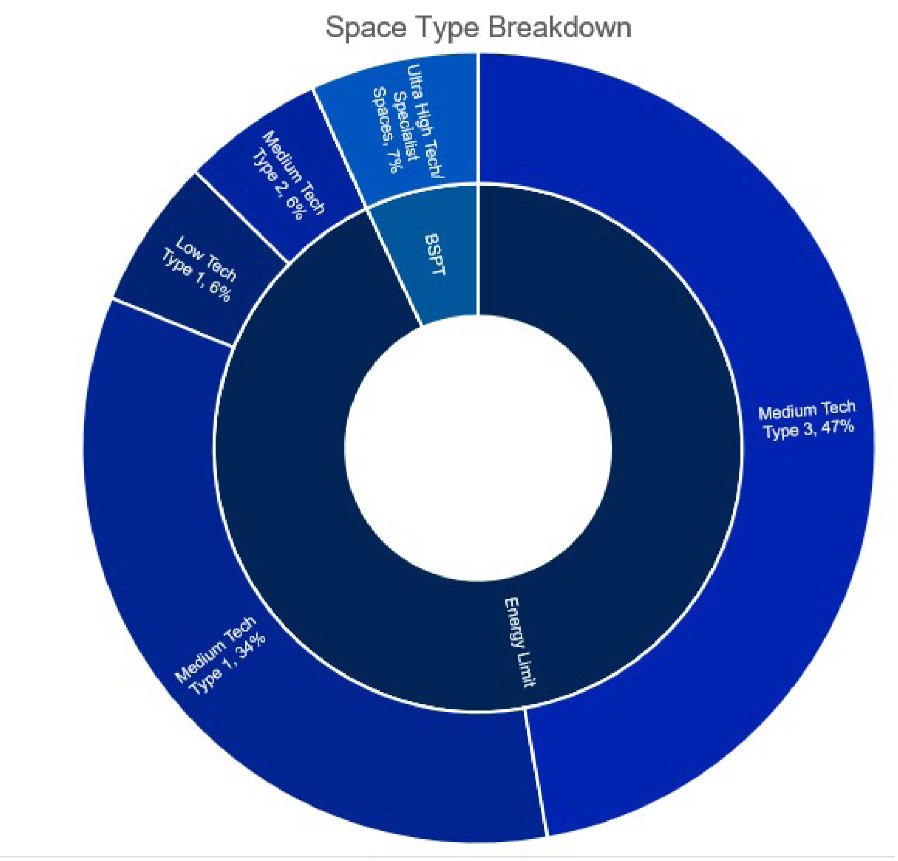
Extract from Tab 7.0 Energy Use Reporting: Building Summary

BUILDING SUMMARY

Location Zone	C
Building Type	Secondary Healthcare
RIBA Stage	4: Technical Design
Heating Strategy	Priority 1

For Information: Building GIA Summary		
Total building Gross Internal Area [m2]	4291	
Breakdown	Gross Internal Area [m2]	% of total building
Spaces with Energy Limit	3995	93%
Spaces with Building Services Performance Target	296	7%

Breakdown	Gross Internal Area [m2]	% of total building
Low Tech Type 1	264	6%
Low Tech Type 2	0	0%
Medium Tech Type 1	1458	34%
Medium Tech Type 2	248	6%
Medium Tech Type 3	2025	47%
Medium Tech Type 4	0	0%
High Tech Type 1	0	0%
High Tech Type 2	0	0%
Ultra High Tech/Specialist Spaces	296	7%
Support Type 1	0	0%
Support Type 2	0	0%
Support Type 3	0	0%



Worked Example C

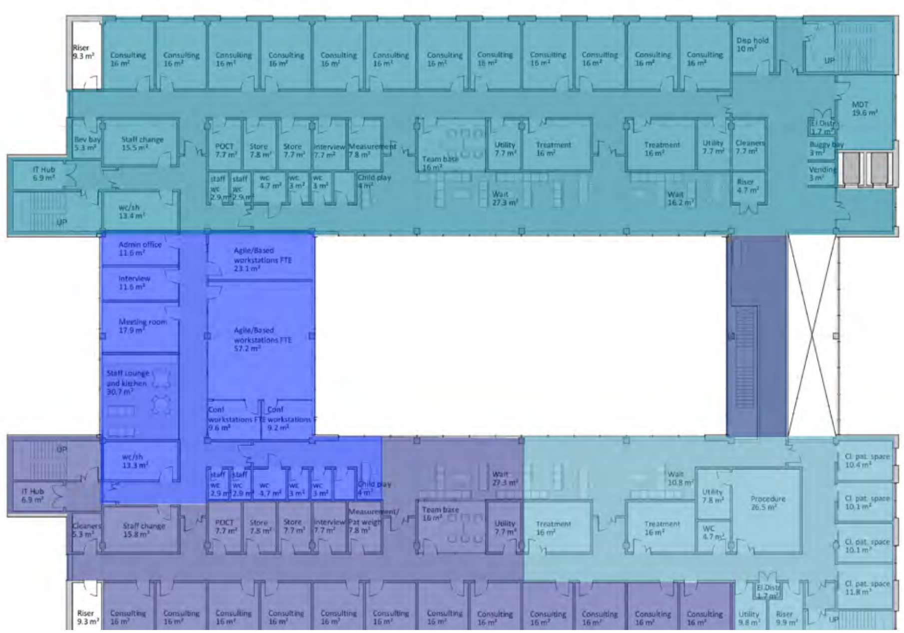
E.15 This worked example demonstrates the methodology behind using the Operational Energy and Carbon Compliance Tools for a RIBA Stage 3 a two-storey primary healthcare development in Birmingham.

E.16 The NHS Standard Compliance Energy for the whole building was found to be 170 MWh/year, calculated using a DSM following the DSM Methodology Checklist in section D.4 of this user guide. Only steps 1 and 7 of the OE&C Compliance Tool and Step 1 and 2 of the WLC Compliance Tool have been included in this worked example.

E.17 The ground floor and first floor plans for the main hub of this development are included below. The development mainly includes consulting and staff support spaces which are used only during the day. IT hubs have been assigned as outlier spaces and matched to Support Type 2. Risers and lifts are excluded from the area calculation. Staircases have been included within the adjacent department since they are considered to be low-energy consuming zones for this worked example.

Ground Floor plan

First Floor plan



Operational carbon

Step 1 - Space Allocation

Ground Floor plan

Department: Mental Health and Therapy
Area: 214m²
Circulation: 38%
Matched Space Type: Medium Tech Type 3

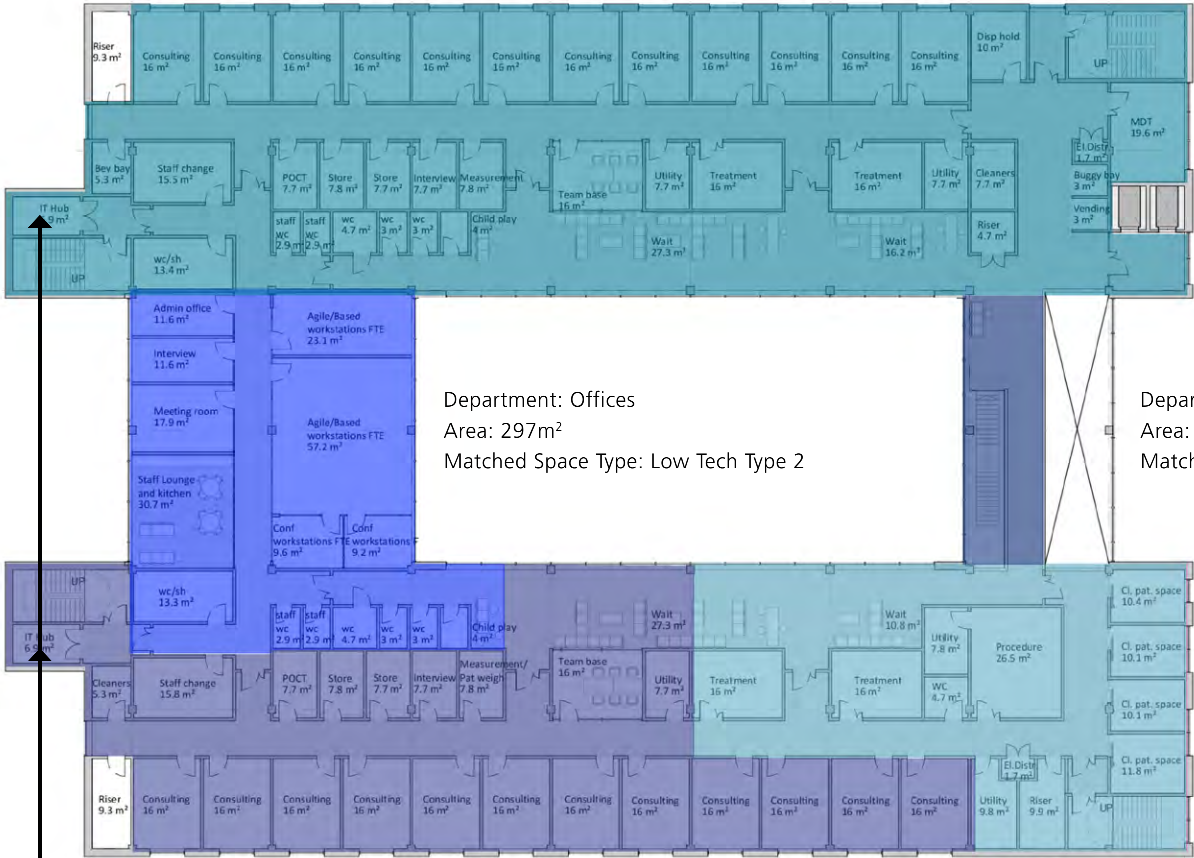
Department: Support and Entrance
Area: 525m²
Matched Space Type: Low Tech Type 1

Department: Offices
Area: 450m²
Matched Space Type: Low Tech Type 2

Department: Outpatient
Area: 820m²
Circulation Percentage: 45%
Matched Space Type: Medium Tech Type 3

Outlier Space: 2 IT hubs
Area: 6.9m² each
Matched Space Type: Support Type 2

First Floor plan



Department: Outpatient
Area: 834m²
Circulation Percentage: 50%
Matched Space Type: Medium Tech Type 2

Department: Offices
Area: 297m²
Matched Space Type: Low Tech Type 2

Department: Circulation
Area: 57m²
Matched Space Type: Low Tech Type 1

Department: Treatment
Area: 308m²
Circulation Percentage: 45%
Matched Space Type: Medium Tech Type 2

Department: Outpatient
Area: 439m²
Circulation Percentage: 30%
Matched Space Type: Medium Tech Type 3

Outlier Space: 2 IT hubs
Area: 13.8m²
Matched Space Type: Support Type 2

Extract from Tab 1.0 Space Allocation: Space allocation for the ground and first floor

SPACE ALLOCATION

Note: Do not cut cells, please manually delete incorrect entries.

Level	Building Element Category*	Department	Space Name	Main / Outlier Space	Clinical/ Non-Clinical	Assigned Space Type*	Space Description	Gross Internal Area [m2]*	Equipment Usage	Equipment Gain [W/m2]	% Circulation in Department
L00	Category 1: In contact with ground, WITH floors above	Support and Entrance	Support and Entrance	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	525	-	-	-
L00	Category 1: In contact with ground, WITH floors above	Outpatient 1	Outpatient 1	Main_Space	Clinical_M	Medium Tech Type 3	- Spaces containing consulting work areas. - Occupancy Period: 7am - 8pm - Ventilation: 6 ach	820	Low	10	40
L00	Category 1: In contact with ground, WITH floors above	Outpatient 1	IT Hub	Outlier_Space	Non_Clinical_O	Support Type 2	- Server rooms	6.9	-	-	-
L00	Category 1: In contact with ground, WITH floors above	Support	Offices	Main_Space	Non_Clinical_M	Low Tech Type 2	- Spaces with low equipment requirement such as office, teaching spaces,eat/drink areas, gyms inclusive of all circulation strictly associated with that space.	450	-	-	-
L00	Category 1: In contact with ground, WITH floors above	Support	IT Hub	Outlier_Space	Non_Clinical_O	Support Type 2	- Server rooms	6.9	-	-	-
L00	Category 1: In contact with ground, WITH floors above	Mental Health + Therapy	Mental Health + Therapy	Main_Space	Clinical_M	Medium Tech Type 3	- Spaces containing consulting work areas. - Occupancy Period: 7am - 8pm - Ventilation: 6 ach	214	Low	10	35
L01	Category 4: Intermediate Level, WITH ROOF above	Circulation	Circulation	Main_Space	Non_Clinical_M	Low Tech Type 1	- Circulation spaces not associated with a department such as reception spaces staircores or large waiting rooms.	57	-	-	-
L01	Category 4: Intermediate Level, WITH ROOF above	Outpatient 2	Outpatient 2	Main_Space	Clinical_M	Medium Tech Type 3	- Spaces containing consulting work areas. - Occupancy Period: 7am - 8pm - Ventilation: 6 ach	834	Low	10	40
L01	Category 4: Intermediate Level, WITH ROOF above	Outpatient 2	IT Hub	Outlier_Space	Non_Clinical_O	Support Type 2	- Server rooms	6.9	-	-	-
L01	Category 4: Intermediate Level, WITH ROOF above	Support	Offices	Main_Space	Non_Clinical_M	Low Tech Type 2	- Spaces with low equipment requirement such as office, teaching spaces,eat/drink areas, gyms inclusive of all circulation strictly associated with that space.	297	-	-	-
L01	Category 4: Intermediate Level, WITH ROOF above	Outpatient 3	Outpatient 3	Main_Space	Clinical_M	Medium Tech Type 3	- Spaces containing consulting work areas. - Occupancy Period: 7am - 8pm - Ventilation: 6 ach	439	Low	10	30
L01	Category 4: Intermediate Level, WITH ROOF above	Outpatient 3	IT Hub	Outlier_Space	Non_Clinical_O	Support Type 2	- Server rooms	6.9	-	-	-
L01	Category 4: Intermediate Level, WITH ROOF above	Treatment	Treatment	Main_Space	Clinical_M	Medium Tech Type 2	- Spaces containing treatment work areas. - Occupancy Period: 7am - 8pm - Ventilation: 10 ach	308	High	19	40

Step 7 - Energy Use Reporting

Extract from Tab 7.0 Energy Use Reporting: Building Summary

BUILDING SUMMARY

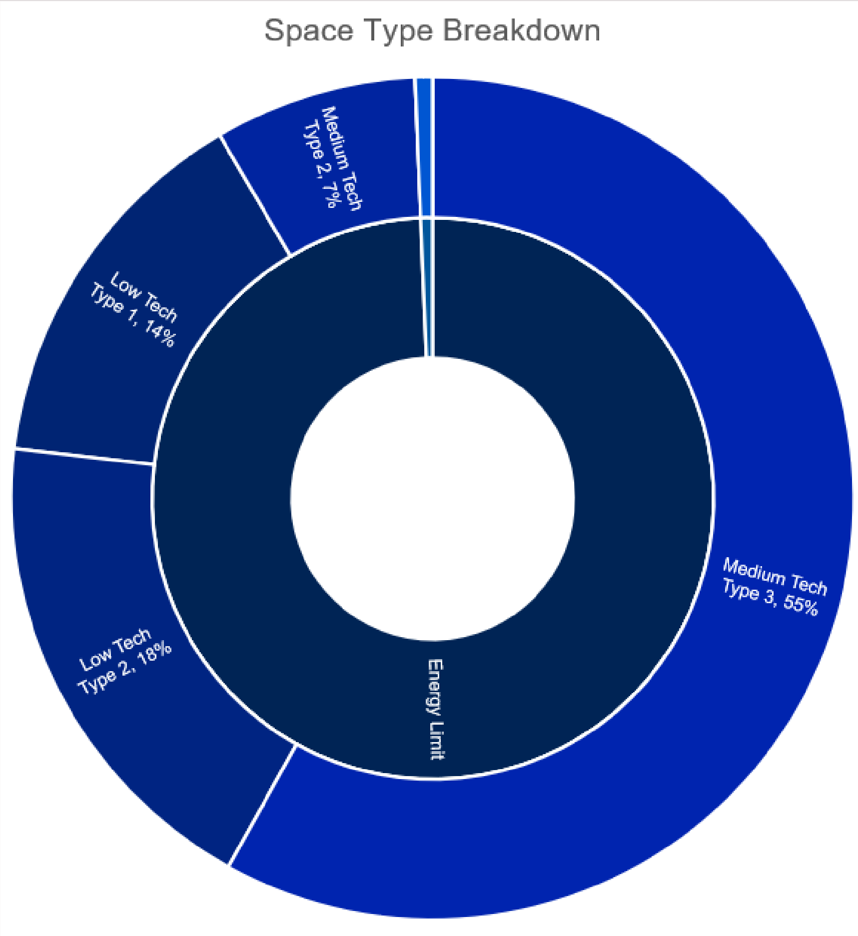
Location Zone	C
Building Type	Primary Healthcare
RIBA Stage	3: Spatial Coordination
Heating Strategy	Priority 1

For Information: Building GIA Summary

Total building Gross Internal Area* [m2]	4219.6	
Breakdown	Floor Area* [m2]	% of total building
Spaces with Energy Limit	3944	93%
Spaces with Building Services Performance Target	27.6	1%

Breakdown	Floor Area* [m2]	% of total building
Low Tech Type 1	582	14%
Low Tech Type 2	747	18%
Medium Tech Type 1	0	0%
Medium Tech Type 2	308	7%
Medium Tech Type 3	2307	55%
Medium Tech Type 4	0	0%
High Tech Type 1	0	0%
High Tech Type 2	0	0%
Ultra High Tech/Specialist Spaces	0	0%
Support Type 1	0	0%
Support Type 2	27.6	1%
Support Type 3	0	0%

*Area excluding plant spaces with lightweight covering or canopies (Category 3 & Category 6)



Extract from Tab 7.0 Energy Use Reporting: Whole Building Performance Target Compliance

Step	Compliance Target Type	Compliance Target Element	TARGET Compliance Target Value	DESIGN Achieved Design Value	
Step 1: Whole Building Performance Target	Fabric U Value	Wall [W/m2/K]	0.12	0.1	Compliant
		Floor [W/m2/K]	0.1	0.1	Compliant
		Roof [W/m2/K]	0.11	0.1	Compliant
		Window [W/m2/K]	1.2	1.2	Compliant
	Air Tightness	-	1	1	Compliant
	Glazing Performance	E/S/W Façade: g-value	0.35	0.35	Compliant
		E/S/W Façade: VLT value	0.7	0.7	Compliant
		N Façade: G value	0.4	0.4	Compliant
		N Façade: VLT value	0.7	0.7	Compliant

Extract from Tab 7.0 Energy Use Reporting: Building Services Performance Target Compliance

Step	Space Type	Compliance Target Element	GIA it applies to (m²)	TARGET Compliance Target Value: Regulated Energy Limit	DESIGN Achieved Design Value: Regulated Energy Limit
Step 2b: Space Type Building Services Performance Target	Ultra High Tech/Specialist Spaces + Support Type 1	AHU SFP (W/l/s)	6.9	1.3	N/A
		Heat Recovery (Thermal Wheel)	6.9	80%	N/A
		Heat Recovery (Run Around Coil)	6.9	60%	N/A
		Lighting (W/m2/100 lux)	6.9	2	2
		Heating SCOP	6.9	3.5	N/A
		Cooling SEER	6.9	5.5	6
		DHW COP	6.9	2.4	N/A

Total Energy Limit [kWh/yr]
170085
NHS Standard Compliance Energy [kWh/yr]
170000
Compliant to Energy Limit Target

Upfront Carbon

Step 1 - Space Allocation

E.18 The Space Allocation for this project has been described above. The floor area breakdown by space category, summarised in Tab 1 Space Allocation in the Operational Energy and Carbon Tool, can then be input into Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool.

E.19 The roof coverings (enclosed roof level plant) and other areas excluded from the space allocation but relevant to GIA (lifts and risers) are known so have been directly inputted, overwriting the tool assumptions.

Tab 1.0 Space Allocation in the Operational Energy and Carbon Tool

Inputs for WLC Tool	
Note: To be copied to WLC Tab 1.0 'Select and copy cells outlined by red border, and directly paste into Tab 1.0 of the WLC Tool - Cell D19 (OBC) or Cell F19 (FBC)	
Number of Floors	2
Number of Basement Levels	0
Floor GIA in contact with Ground (Category 1-3), [m2]	2022.8
Roof Area (Area above Category 2 and 5), [m2]	1948.8
Lightweight Covering (Area above Category 3 and 6), [m2]	0
Area of the following at Upper Levels (Cat 4-6):	
Support (Plant/Storage) [m2]	13.8
Low Tech [m2]	354
Medium Tech [m2]	1581
High Tech [m2]	0
Ultra High Tech/Specialist [m2]	0
All Other Internal Area (Category 7), [m2]	248

Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool

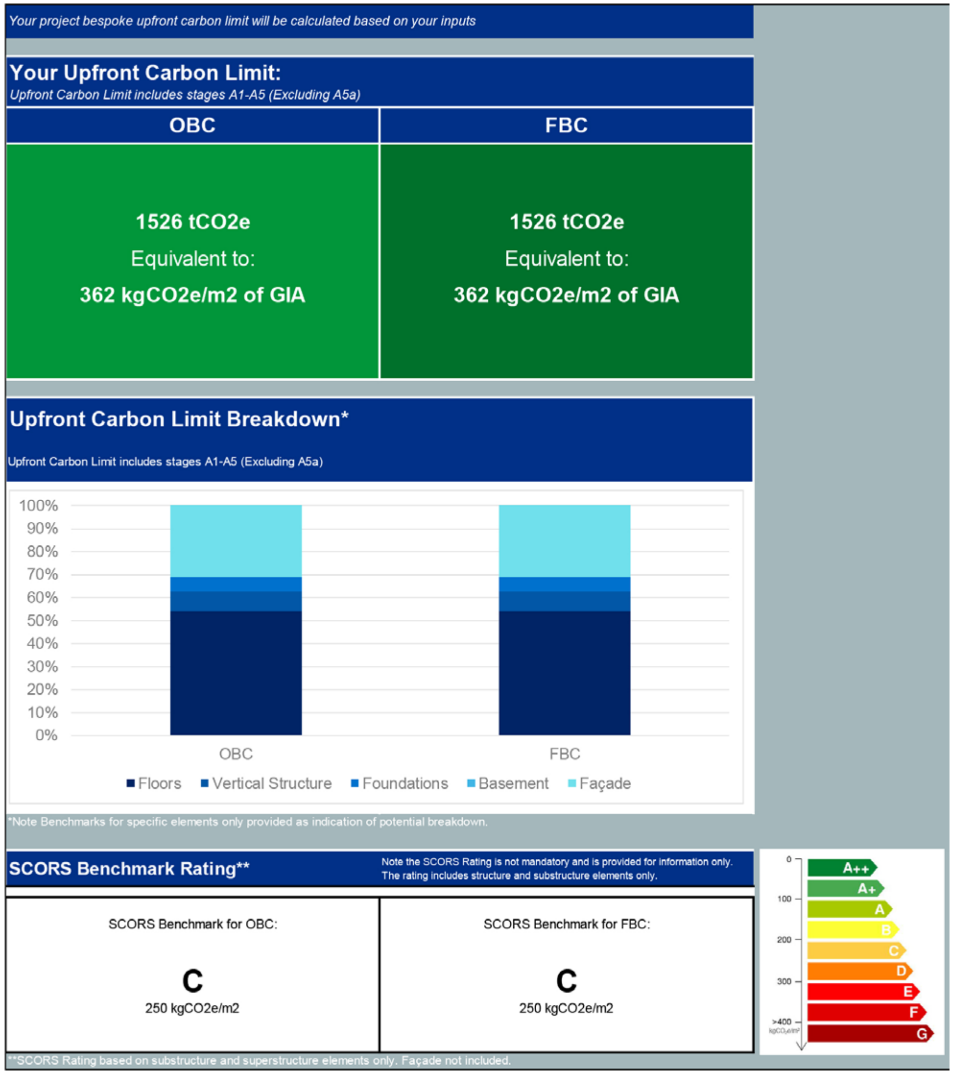
Inputs from Brief Please paste values from Tab 1 in the *Operational Energy and Carbon Tool* in the below cells highlighted by the red border	**OBC**		**FBC**		**Commentary** Please use whilst undertaking space allocation task in OE&C Tool, Tab 1.0)
No. Floors	2	Low Rise	2	Low Rise	*Total no. Floors inc. basement* *For vertical and horizontal extensions - only state floors associated with new construction*
No. Basement Levels	-	-	-	-	*No. levels below ground. Partial basements should be represented by 0.5 increment*
- Floor in Contact with Ground (Area of Cat 1-3)	2,023	m²	2,023	m²	*Total area in contact with ground, may be over multiple levels e.g. partial basement*
- Exposed Roof (Area above Cat 2 and 5)	1,949	m²	1,949	m²	*Total exposed roof area at all levels (structural roof used for supporting exposed plant, PV, green roof, terraces, etc)*
- Lightweight Covering (Area above Cat 3 and 6)	-	m²	-	m²	*Total Lightweight Covering area at all levels (refers to non-structural, access only roof e.g. covering over plant or canopies)*
Area of the following at Upper Levels (Cat 4-6):					*Only internal floor areas not in contact with ground should be reported below, this includes enclosed areas at roof level (as these form part of GIA)*
- Support (Plant/ Storage)	14	m²	14	m²	*Please ensure that the total area is allocated in the space allocation tab including circulation space and stairwells.* *For vertical and horizontal extensions - please input new-build areas only.*
- Low Tech	354	m²	354	m²	
- Medium Tech	1,581	m²	1,581	m²	
- High Tech	-	m²	-	m²	
- Ultra High Tech		m²		m²	
- All Other Internal Areas (Cat 7)	248	m²	248	m²	*These include Lifts, Risers, Walls and other non-departmental areas not given a space allocation, and should ensure the GIA sum is accurate*
Total GIA	4,220	m²	4,220	m²	Note that, in line with RICS definitions, only covered roof area counts towards GIA.

Step 2 - Upfront Carbon Limit

E.20 The areas are then used by the tool to automatically calculate the project bespoke Upfront Carbon Limit, which is summarised in Tab 1.0 Project Information of the Whole Life Carbon Compliance Tool.

E.21 The total calculated Upfront Carbon Limit for the project is 1526tCO2e or 362kgCO2e/m2 of GIA at OBC and FBC.

Project bespoke mandatory Upfront Carbon Limit shown in Tab 1.0 Project Information



F. Design guidance for reducing operational energy demand

Introduction

F.1 The section captures key guidance that should be followed in developing the design of a healthcare building with regards to reducing energy demand, maximising efficiency of core building services and managing energy consumption effectively.

F.2 These considerations cover both passive and active design and look at both the building envelope and building services. As the healthcare building design is developed, these considerations should be included in the design process to help ensure that the Energy Limits and Performance Targets (PTs) noted in the compliance methodology within the Operational carbon compliance section can be feasibly met.

F.3 Implementing passive design requires a balance of several different factors including optimal energy efficiency, thermal comfort, natural daylighting and visual comfort. In relation to passive design, this section describes best practice guidelines for the following:

- External wall thermal performance
- Glazing specification and ratios
- Building air tightness
- Optimisation of building form and orientation to reduce energy consumption
- Maximising daylighting within internal spaces
- Balancing design parameters with respect to energy and health and wellbeing issues.

F.4 Specifically, for building services, this section describes the targets and best practice guidelines around the following systems:

- Ventilation
- Heating and cooling
- Domestic hot water
- Lighting
- Other equipment.

F.5 With energy associated with building services in hospital buildings being significant, specifically ventilation and domestic hot water, it is important that the design and specification of building services are highly efficient, and attention is focused on achieving this efficiency through space design configuration to HVAC controls, commissioning, and monitoring and maintenance.

Passive design

Introduction

F.6 Passive design captures the principle of utilising properties of the layout of a building, fabric, and form to reduce or eliminate the requirement for heating, cooling, ventilation, and artificial lighting. In developing the Standard, key aspects of passive design have been analysed to provide appropriate limits for healthcare buildings, as detailed in Section 5.

F.7 Design Teams should look to undertake detailed environmental modelling as noted in this Appendix, to optimise the passive performance of the building from no later than RIBA Stage 2.

F.8 Building orientation and envelope performance should be optimised to achieve good daylight levels, good thermal comfort and minimise the energy required for cooling and heating. The design of the massing and placement of elements such as courtyards and atria should be developed so that daylight availability is maximised to both reduce lighting energy consumption, but also because of the positive impact of daylight availability on patient and staff wellbeing.

F.9 The impact of passive design on the overall Energy Limits in healthcare buildings is significantly lower compared to the impact of HVAC performance parameters. Still, it is important to follow best practice, where passive design and performance are achievable, and the savings associated with this will increase as HVAC performance improves over time or when being replaced.

Whole Life Cycle Carbon Flag: Balancing design parameters

Implementing passive design requires attention to successfully balance achieving optimal energy efficiency with thermal comfort, natural daylighting, and visual comfort.

Building form and orientation

F.10 The form factor quantifies how the exposed surface area of the building affects energy consumption for space heating and cooling. More compact building massing often means lower form factor and a more energy efficient design, while extensive façade represents a source of conductive heat loss. At the same time, building form is key to achieving good daylight levels in the spaces and it can also be utilised to achieve overshadowing where needed. Careful consideration of internal layout, together with building form should focus on choosing the appropriate orientation for different types of spaces to minimise solar gains and optimise the daylight levels.

F.11 With multiple considerations around building form, it is advisable that these are properly investigated during the design development within the building's context.

Envelope design

F.12 Construction products and techniques are well advanced and can deliver an envelope that balances heat losses and gains, delivers good levels of air tightness, and provides access to optimal levels of natural daylight. This means that associated space heating, cooling, and lighting energy demands can be reduced. Building fabric U-values and infiltration rates are key parameters for reducing unnecessary heat losses and maintaining a high level of construction quality.

F.13 Designing a high performing envelope is critical for any building both from a resilience and human comfort perspective. From a resilience point of view, while currently certain uses in hospitals have high ventilation rates that are the main driver of energy consumption, the specific HVAC requirements for a space or building can and will change throughout its lifespan so that envelope performance will have a larger impact on the overall energy performance. As such, designing a good envelope from the outset represents a resilient solution compatible with a net zero carbon goal.

F.14 From a human comfort perspective, poor thermal performance of the envelope can lead to local thermal discomfort issues. For example, cold surfaces can lead to poor health and wellbeing due to issues such as mould growth, impacts which are not acceptable nor compatible with healthcare buildings. As such, the Standard places envelope fabric efficiency at the core of its target setting methodology.

F.15 Ensuring that the building design addresses daylight considerations to maximise the potential for achieving good average daylight factors is key to creating spaces that are comfortable. With well-designed lighting controls utilising daylight dimming, this will also contribute to better energy efficiency due to reduced requirement for artificial lighting.

F.16 Glazing ratios, U-values, G-values, and Visual Light Transmittance (VLT) values, are essential considerations in achieving desirable levels of solar gains to lower space heating demand and desirable levels of natural light to reduce requirement for artificial lighting.

Materials selection

F.17 Careful consideration of the materials' properties desirable in each space can contribute to achieving a targeted performance. For example, materials with high thermal mass in the case of primary healthcare, can be part of a strategy for overheating risk mitigation, or high reflectance surfaces can enhance natural light levels in a space. This has secondary benefits of improving staff and patient experience.

Natural ventilation

F.18 The current Standard focuses on fully conditioned spaces and the Energy Limits that are developed for the design, as part of Step 2 compliance requirements as detailed in Section 5, assume this. However, where feasible, natural ventilation is recommended for all spaces where this strategy is compliant with the clinical requirements of the space. Where CIBSE Guide A provides a rule of thumb approach, for either buoyancy or wind driven natural ventilation, it is recommended that computational fluid dynamics (CFD) simulation(s) are undertaken to study in detail air flows within spaces and through openings in the building envelope to ensure adequate air flow rates are achieved and air quality is maintained.

F.19 For all the spaces where natural ventilation is proposed, this should be designed so that thermal comfort criteria are met, which should be established in line with CIBSE TM52 and CIBSE TM59 for appropriate spaces.

F.20 However, where natural ventilation is proposed in the heating season, it should be compared against the performance of a mechanical ventilation system with heat recovery (MVHR). It may be the case that the provision of MVHR for heating mode and natural ventilation outside heating mode, would represent optimum energy performance.

Air tightness guidance

F.21 Energy-efficient buildings require careful construction to limit thermal transmissivity and air losses. Particular attention should be paid during design to junctions between prefabricated modules, both horizontally and vertically, and to mechanical ventilation and services penetrations to reduce risk of non-compliance on site.

F.22 Air leakage testing should be undertaken during the construction phase to identify areas of leakage and to allow for management prior to completion.

Rule of Thumb:

It is recommended to adopt the Centre for Curtain Wall and Technology standards from the early design stages to assess and verify the correct water and air tightness of the exterior envelopes.

Designing for natural daylight

F.23 The general space lighting strategy should integrate passive and active design. The strategy should also be developed keeping people at its centre. The needs of staff members, patients and visitors should be considered both from the point of view of the quality and quantity of the light. Opportunities to tailor the level of daylight requirements for each space should be investigated at an early stage to ensure that the need for artificial light usage can be reduced.

F.24 Sufficient access to daylight is beneficial both for occupant health and wellbeing, but also for the reduction of energy use associated with artificial lighting. Key principles for achieving good levels of daylight include:

- Optimisation of room proportions, so that deep rooms, where daylight uniformity cannot be achieved, are avoided.
- Optimisation of window proportions and window positioning on façade.
- High reflectance materials and colours on surfaces.
- Careful integration of shading where applicable, so that daylight access is not compromised.

F.25 Climate Based Daylight Modelling (CBDM) should be carried out to gauge the performance of different spaces within the building across the year, where daylight will be beneficial, including circulation, wards, and other clinical spaces.

F.26 CIBSE Guide LG2 (2019) – Lighting for Hospitals and Healthcare Buildings, should be complied with where deemed appropriate. Within this document, the general recommendation for daylight in healthcare buildings, especially the ward areas, is to achieve an average daylight factor (ADF) between 2% and 5%, with an ADF of >5% being undesirable due to risks of visual discomfort from glare. Most healthcare building areas should aim to achieve an ADF at least 3% as a minimum. Uniformity levels of between 30% and 50% should be targeted, to achieve a good visual balance.

F.27 Considering the risk of excessive heat gains that will impact on space cooling demand is also essential. A glazing ratio of 25%-40% (glazing to external wall) is generally recommended to achieve the balance between solar gain and daylight requirements. Orientation is also important, as different glazing aspect ratios are best for different orientations, in line with access to sunlight.

Thermal comfort and overheating

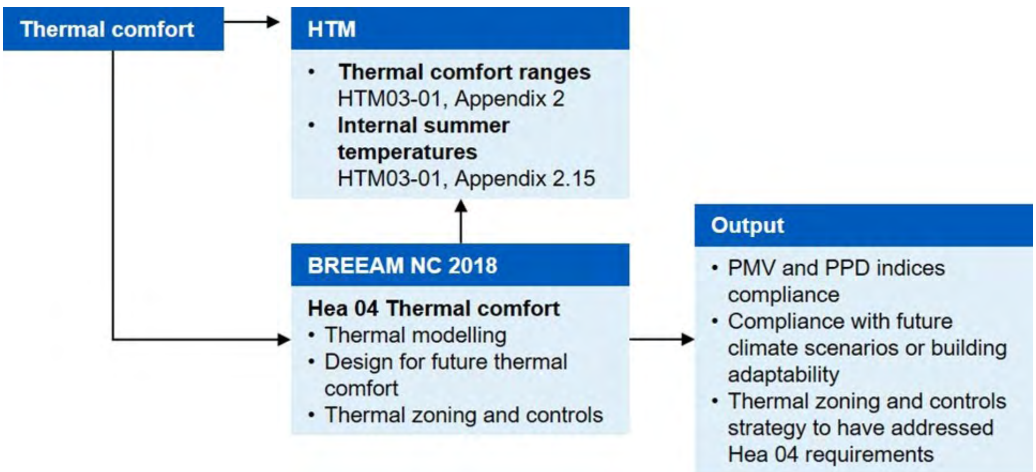
F.28 Thermal comfort needs to be provided in line with the levels dictated for the specific building and space-type. For healthcare buildings, thermal comfort is addressed through HTM 03-01, which sets out thermal comfort levels in patient and clinical areas in accordance with specific ranges, as well as limits for internal summer temperatures. HTM 03-01 recommends temperatures from 18˚C to 28˚C in general wards, and 18˚C to 25˚C for more sensitive areas, such as birthing and recovery rooms. Further specific guidance is provided in the following sections for both fully conditioned and non-mechanically cooled or naturally ventilated spaces.

Whole Life Cycle Carbon Flag: Risk of overheating to health and wellbeing

Attention is required to successfully balance thermal comfort with opportunities for natural ventilation, reduction of artificial lighting and cooling loads. In a healthcare context, human health however takes precedence and should not be significantly compromised in any case.

F.29 The flow chart in Figure 8 summarises the key considerations for meeting thermal comfort expectations associated with this Standard.

Figure 8: Thermal comfort and overheating



Fully conditioned spaces

F.30 For fully conditioned spaces thermal criteria should be based on BS EN ISO 7730:2005, which considers PMV – PPD (predicted mean vote – predicted percentage of dissatisfied) and establishes different categories of the indoor environment. The PMV-PPD index takes into consideration other thermal comfort parameters, such as clothing and activity levels, air and mean radiant temperature, air velocity and humidity. By assuming certain values for these parameters, a range of thermally comfortable temperatures can be established, based on BS EN 15251:2007, which presents those temperatures as a function of the outdoor running mean temperatures.

Whole Life Cycle Carbon Flag: BREEAM vs HTM Comfort Criteria

While BREEAM refers to PMV and PPD in the case of air-conditioned buildings, with these needing to be reported for BREEAM compliance where applicable, it is to be noted that these indices may conflict with temperature set points in the HTM. Designers are therefore advised to ensure that during occupied hours, HTM setpoints are not exceeded by a maximum of 1% of the time.

Naturally ventilated and mixed-mode spaces

F.31 CIBSE TM52 and TM59 assessments should be undertaken for all non-mechanically cooled spaces where appropriate and should preferably pass all criteria within each standard. It is recommended that the assessments are completed in conjunction with NHS users to assess assumptions, outcomes, and potential design solutions.

Thermal zoning

F.32 Ensuring the building is designed with thermal zones in line with both conditioning requirements and setpoints of each space-type, along with the provision of good controls, forms the basis in achieving user comfort and optimising the HVAC strategy so that building services efficiently and appropriately heat or cool each area. Appropriate occupant controls are strongly encouraged to ensure both maximum flexibility and thermal comfort for the majority of the occupants. Where relevant, BREEAM Hea 04 requirements should be considered, with respect to thermal zoning and occupant control.

Signpost to best practice natural and mixed-mode ventilation guidance

CIBSE Applications Manual AM13.

CIBSE Guide A – Environmental Design.

Ventilation system design

Best practice design guidelines

F.33 Ventilation loads are one of the highest energy demands within a healthcare building environment. These loads consist of fresh air heating and cooling, alongside the AHU power consumption required to deliver the air.

F.34 The current guidance is robust on-air volumes for clinical spaces and limits the potential to vary air to occupied spaces. However, consideration should be given to an option to vary airflows to spaces, based on their relative need, where spaces with the highest infection risk operate to greater air volumes, while less sensitive conditions allow reduced air volumes.

F.35 The opportunity to recover heat in the ventilation systems should be prioritised due to the high impact this can have on the energy usage of hospitals. Heat recovery contained within each air handling unit should be the first choice. The use of run around systems should be discouraged unless unavoidable due to their inherent lower efficiencies.

F.36 The following best practice design regarding air distribution systems and AHUs should be considered where appropriate to drive down energy consumption of the ventilation system:

- All AHUs should be capable of enabling variable airflow across the heat recovery sections with the inclusion of summer bypass to optimise the usage of the heat exchangers. This can significantly reduce the cooling and heating loads.
- Motors should be EC motors of efficiency class IE5 or greater and fitted with commando plugs to allow fast exchange should failure occur.
- Variable Speed Drives (VSD) should be implemented on fan systems where appropriate.
- All filters should be low pressure drop, where feasible, to optimise the airflow within the system.
- Localised heat recovery and re-use should be identified at an early stage where heat from neighbouring departments/spaces can be used to heat other local areas, subject to HTM requirements and infection control.
- Other measures such as implementing UV filtration etc may be investigated as an alternative to increased fresh air rate, in terms of achieving the same level of sterilisation or purification.
- Humidification should be designed out where possible. If required for specific spaces, healthcare specific adiabatic humidification equipment will demand a fraction of the energy of a steam humidifier unit.

Whole Life Cycle Carbon Flag:

Attention is required to successfully balance ventilation system energy efficiency with the required air quality within a healthcare facility.

Air quality considerations for health and wellbeing

F.37 The World Health Organisation has produced a paper on indoor air quality, and the website of the Department for Environment, Food and Rural Affairs (DEFRA) gives data for outdoor air quality by postcode for the UK. This enables designers to choose suitable filter grades by location and application (see SVHSoc guidance).

F.38 In some inner-city areas the local airborne particulate level may be particularly high. In those special cases filters to ISO ePM2·5 m50% may be required to achieve the required indoor air quality (reference DEFRA website and SVHSoc guidance).

F.39 The Health and Social Care Act (2022) places a duty of care on healthcare providers. Increased health risks to patients will occur if ventilation systems do not achieve and maintain the required standards. The link between surgical site infection and theatre air quality has been well established. If the ventilation plant has been installed to dilute or contain harmful substances, its failure may expose people to unacceptable levels of risk. Proven breaches of the statutory requirements can result in prosecution and may also give rise to a civil suit against the operators.

F.40 HTM 03-01 Part A (updated 2021) states six air changes for General Wards and Single Rooms and allows for natural ventilation under certain circumstances.

F.41 The HTM refers to patient bedrooms being classified as 'clinical areas', as treatment is often delivered at the bedside rather than in a designated treatment room and therefore there is a requirement for mechanical ventilation and associated heating and cooling services (which clearly has an impact on energy consumption).

F.42 HTM 03-01 Part A also states that in non-clinical areas re-circulated air systems may be considered. It also states that at least 20% of the re-circulated air must be fresh. Additional filtration will be required to remove airborne particulate contamination and, if necessary, odours. This will affect running and maintenance costs and given the high ErP rating of heat recovery devices, it will be necessary to prove that re-circulating the air will be more energy efficient overall.

F.43 Natural ventilation should still be considered for non-clinical ancillary support spaces. With natural ventilation, it is almost impossible to maintain consistent flow rates and ensure that minimum ventilation rates will always be achieved. However, this variability is normally acceptable in such areas as office accommodation, staff areas, library/seminar rooms, dining rooms, waiting, and consulting rooms where opening windows (of a design that facilitates natural ventilation) could be provided.

F.44 Mixed mode ventilation is an assisted form of natural ventilation. Fans are fitted in purpose-made damper-controlled ventilation openings. Alternatively, a separate draw or blow-through ventilation unit may be installed. In both cases the dampers and fans are controlled by temperature and occupancy sensors to ensure a minimum airflow rate while taking advantage of natural ventilation effects when present.

F.45 Where natural or mixed mode ventilation is adopted with complex air paths, the designer should produce an airflow diagram to ensure correct provision of air-transfer devices. CIBSE's Applications Manual AM13 – 'Mixed mode ventilation' gives guidance.

F.46 Split comfort air-conditioners, room conditioners or cassette units may be installed in non-clinical areas, but they should be positioned to ensure that cold draughts are avoided. The control settings should ensure that the external elements of the units are always above dewpoint. Manufacturers of these devices can provide specific advice on the siting and design limits of their equipment.

Signpost to best practice natural and mixed-mode ventilation guidance

CIBSE Applications Manual AM13.

CIBSE Guide A – Environmental Design.

G. Design guidance for supplying energy

G.1 This part of the User Guide design guidance supports the NHS ambition to remove reliance on fossil fuels and reduce its carbon footprint by switching to clean and efficient energy sources.

Introduction

G.2 This section provides information for various existing and emerging technologies that are relevant to the 'Be clean' and 'Be green' part of the Energy Hierarchy, which includes systems for heating, cooling, hot water, on site renewable heat and power generation and energy management. Project Teams are to assess the feasibility of new technologies as part of developing the Energy and Carbon Strategy report.

G.3 Energy and Carbon Strategies can include approaches that achieve a balance between on site renewables, grid connections and other zero or potentially zero carbon technologies. The International Energy Agency (IEA) is a useful body who analyse emerging technologies across the world and their potential for decarbonisation across different sectors, as well as their technology readiness using the Technology Readiness Scale – see figure 9.

G.4 Emergence of future technology is therefore an important consideration for Design Teams, given the expected duration of the new healthcare building programme.

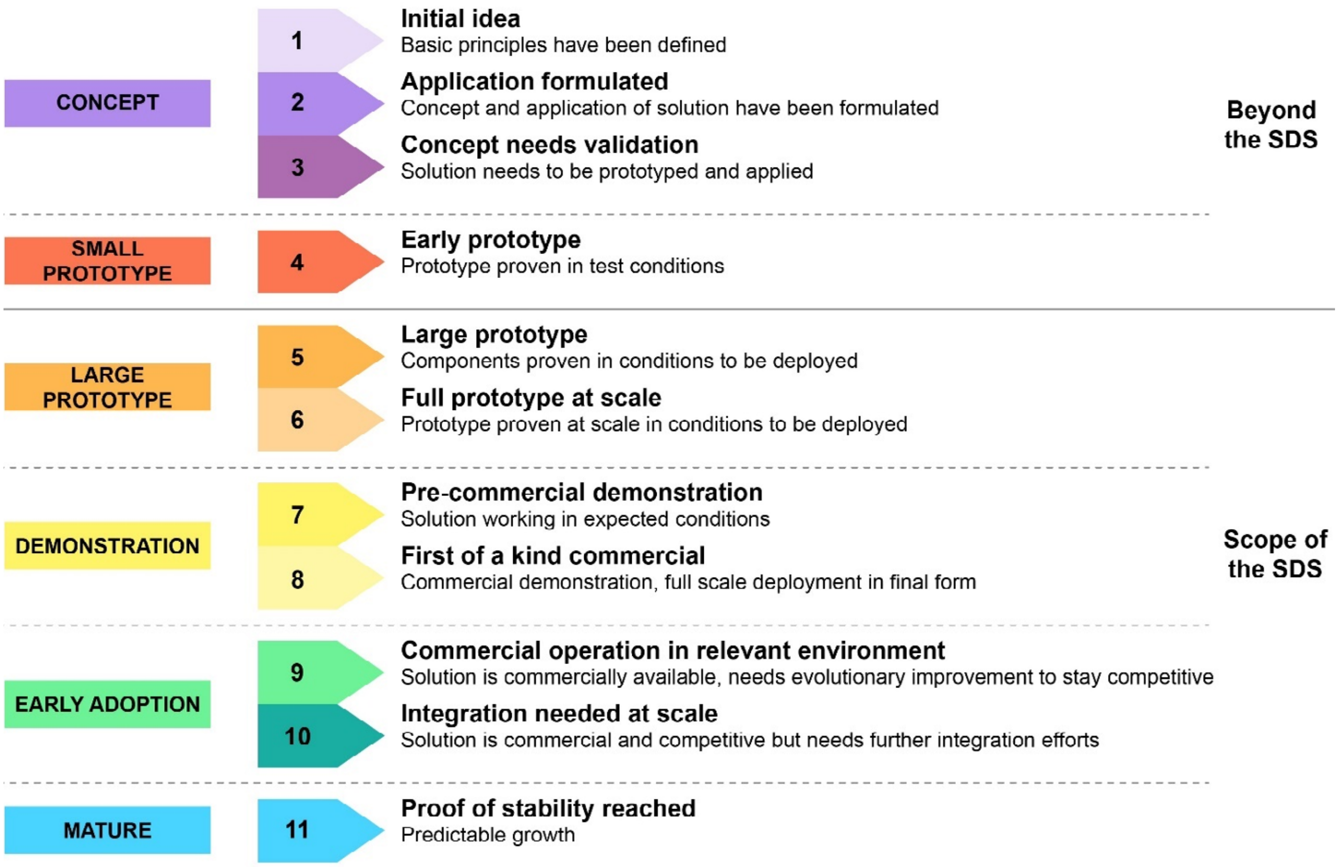
G.5 The following sections provide an overview of the following:

- Emerging technologies that are available on the market now which possess a high Technology Readiness Level (TRL), i.e. 9-11. Design Teams are required to significantly increase the quantum of existing low carbon technologies within capital investments to see them scale in usage across NHS buildings.
- Indication of emerging future technologies that will possibly be viable in the medium to long-term leading up to 2040; Technology Readiness Level (TRL), i.e. 4-8. Emerging and future technologies are those defined that are in demonstration phase and prototype stage.

Background

G.6 A transition to global net zero CO2 emissions of the kind depicted in the IEA's Sustainable Development Scenario (SDS), requires a radical technological transformation of the energy and built environment sectors from energy production at the utility level, down to individual building systems. Energy efficiency and renewables are central pillars, but additional technologies are needed to achieve Net Zero emissions.

Figure 9: Technology Readiness Scale, IEA



G.7 As noted by the IEA, four key technology value chains are expected to contribute about half of the cumulative CO2 savings required for Net Zero across various sectors and includes:

- Technologies to widely electrify buildings and other sub-sectors (such as advanced batteries and heat pump technology).
- Hydrogen and hydrogen-related fuels.
- Bioenergy.
- Carbon capture, utilisation, and storage (CCUS).

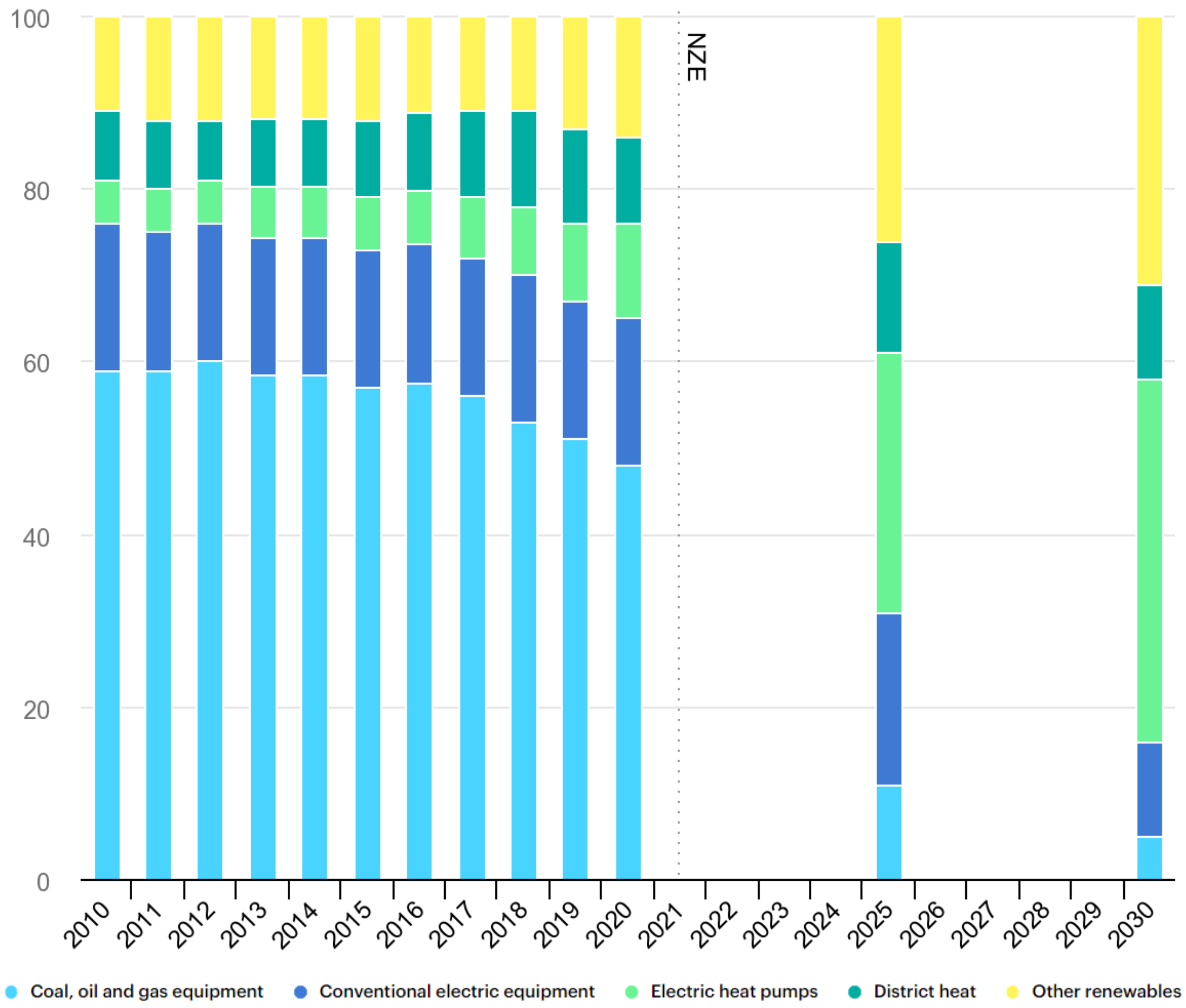
G.8 A further example of this, which is pertinent to buildings, includes the transition to clean heating technologies, which includes heat pumps, district heating, renewable and hydrogen-based heating systems. The contribution from heat pumps and other renewable heat sources including hydrogen needs to more than double to 50% by 2030 to remain in-line with required decarbonisation pathways (Source: IEA). See Figure 10.

Be Clean

G.9 For the 'Be Clean' element of the energy hierarchy, the following existing technologies are expected to be evaluated as part of feasibility studies and increasingly seen within new schemes:

- Heat Pumps – Ground/Air/Water:
  - » Open loop.
  - » Closed loop.
- Heat Reclaim Chillers (i.e. with facility for pre-heating domestic hot water or other systems):
  - » High efficiency air cooled chillers with heat recovery.
  - » Water cooled chillers with heat recovery.
  - » Air to water reversible heat pumps.
  - » Water to water heat pumps.
- Electric boilers.
- Solar thermal.
- Thermal stores in combination with the other technologies above.
- Bivalent Systems for back-up as stated above.

Figure 10: Heating technologies (residential/service buildings) in the Net Zero Scenario, 2010-2030 (Source: IEA)



- Hybrid systems (using more than one of the above technologies to meet demand), e.g. heat pumps for heating, cooling and domestic hot water in synergy with another fuel source for small proportions of the demand profile.
- District heating.

G.10 The choice of energy source for heating, cooling and hot water demands should be taken in close correlation with the typology and characteristics of the scheme i.e., suitability for centralised or decentralised plant.

G.11 See sections below for more information and further guidance for some of these technologies where they are expected to be more prevalent within healthcare schemes.

G.12 Table 1 below includes various examples of emerging and future technologies that will increasingly be seen at scale to help support the UK's decarbonisation journey. Schemes in the very early stages of planning and design should increasingly look to include these as they become more commercially viable.

Table 2: Emerging future technologies and techniques used at scale

Technology	Sub-Technology	Component or Design
Heat Pump	Air-to-air heat pump	State-of-the-art air-to-air technology Membrane heat pump
	Air-to-water heat pump	Natural refrigerant heat pump water heater Integrated heat pump with storage High-temperature heat pumps
	Thermally driven heat pump	Absorption heat pump (thermally driven) Adsorption heat pump (thermally driven) Vuilleurmier heat pump
	Solar thermal water heat pump	High / ultra-high vacuum flat plate collectors
	Hydrogen-driven heat pump	Hydrogen-enriched natural gas heat pump Hydrogen / metal hydride heat pump Synthetic methane heat pump
Evaporative cooling		Liquid or solid desiccant evaporative cooling Evaporative cooling with permeable membrane
Standalone liquid or solid desiccant cooling		Elastocaloric, Barocaloric Magnetocaloric, Thermoelectric

Whole Life Cycle Carbon Flag:

Consideration needs to be given to the use of refrigerant gases. Gases which have a lower Global Warming Potential (GWP) are likely to (a) require larger plant space and this may have an impact on upfront capital and carbon in the design, and (b) may increase the risk of flammability. These areas need to be considered and weighed up against the compared with the carbon impact over the lifetime of tthe building.

Rule of Thumb:

There are two types of cooling associated with hydronic heat pump systems: passive and active. Passive (free cooling) from the ground produces water at around 15°C depending on the time of year, without needing to operate the heat pump. This is ideal for use with underfloor systems and comfort cooling in hot weather, as it also helps to recharge the ground with heat and improves the seasonal performance factor. Active cooling can provide water at 5°C and be used to serve fan coils, air handling units and chilled beams. Minimising the source-sink temperature difference will maximise efficiency.

Conventional heat sources may be used to boost the domestic hot water temperature and considered in case of grid failure or plant breakdown.

The risks of outages can be mitigated by installing multiple heat pumps and minimising the return temperature to the heat pump.

Hybrid heat pumps

G.13 Hybrid systems utilise heat pumps for heating, cooling, and domestic hot water in synergy with another heating source for partial load that can offer significant CAPEX and OPEX benefits. A system where both the heat pump and the supplementary heat source are used together to meet peak loads is known as a parallel bivalent system. A system where another heat source is used instead of the heat pump, for example during very cold weather, is known as an alternative bivalent system. This is less efficient than the parallel bivalent system and should be avoided where possible.

G.14 The following requirements must be considered for hybrid systems:

- The external temperature envelope that the system is being designed for and how this affects the plant performances across the different systems.
- The technical requirement for a parallel bivalent system is that the heat pump should always be the lead heating appliance and operate at maximum possible output during bivalent operation.
- If new healthcare schemes are being built on existing sites and connecting to existing infrastructure, the infrastructure must meet the requirements within Section 5 for existing infrastructure. E.g. no new fossil fuels for primary systems should be installed as part of new developments.

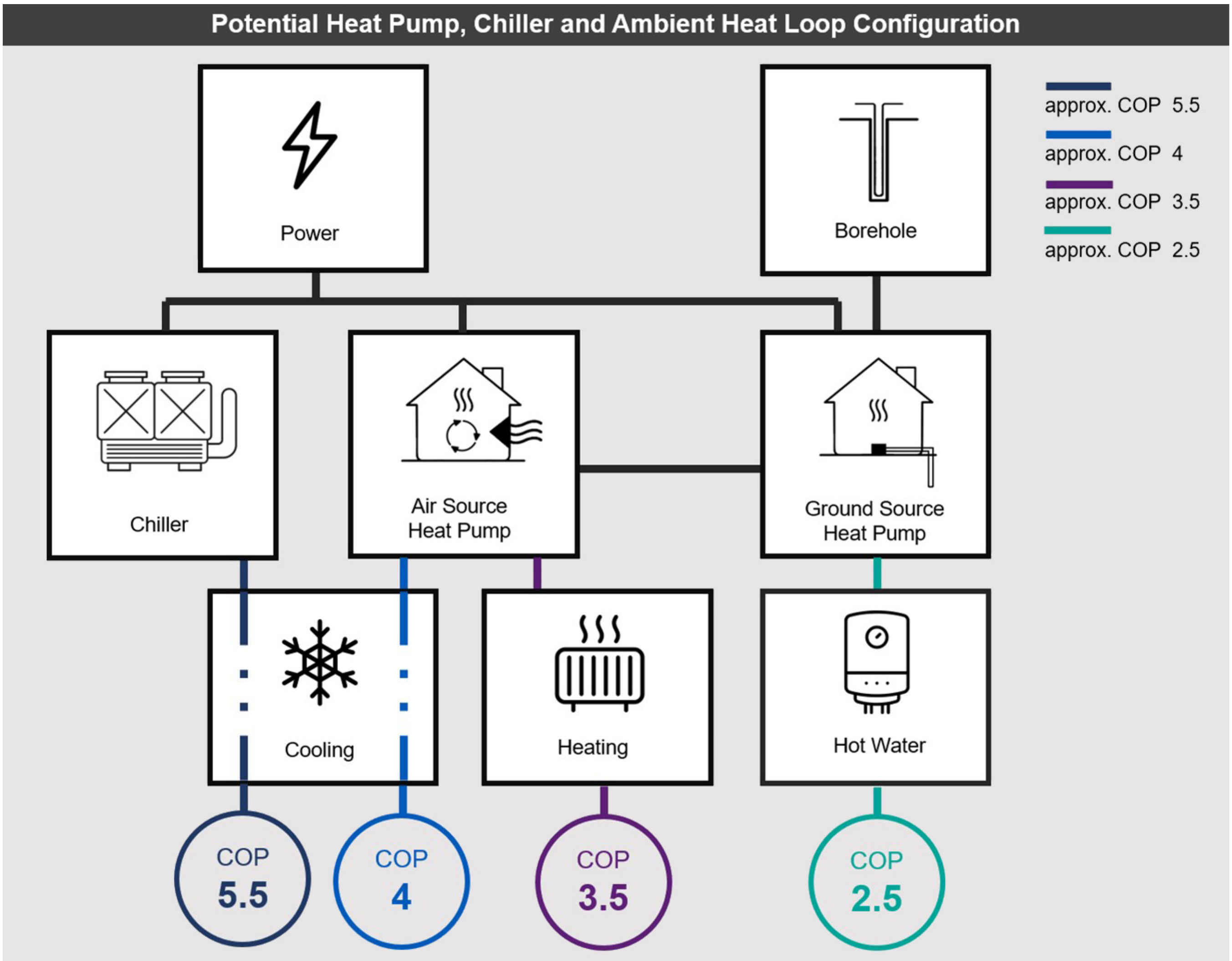
Waste heat recovery and ambient loop networks

G.15 Highly efficient waste heat and cooling recovery, and the implementation of ambient loops, are increasingly being implemented at scale across the Built Environment to support decarbonisation, as shown in Figure 12 below. Healthcare facilities are prime for this technology, are they often have a high and simultaneous cooling and heating demand. This inherent feature provides a potential opportunity in terms of utilising waste recovery systems to significantly increase the efficiencies of heating and cooling systems.

G.16 Opportunities to utilise fifth generation 'ambient loop networks' (which share energy between different buildings and areas requiring simultaneous heating and cooling), should also be explored within the design. Through a fabric first approach, space heating and cooling loads are to be significantly reduced compared to historic benchmarks, which lends itself well to this kind of solution.

G.17 Figure 11 below shows an example of a best practice configuration for heating and cooling systems with different efficiencies for the different systems shown. Note: these efficiencies may vary depending on equipment and technology improvements over time.

Figure 11: Potential heat pump and ambient loop configuration with best practice coefficient of performances for different system types



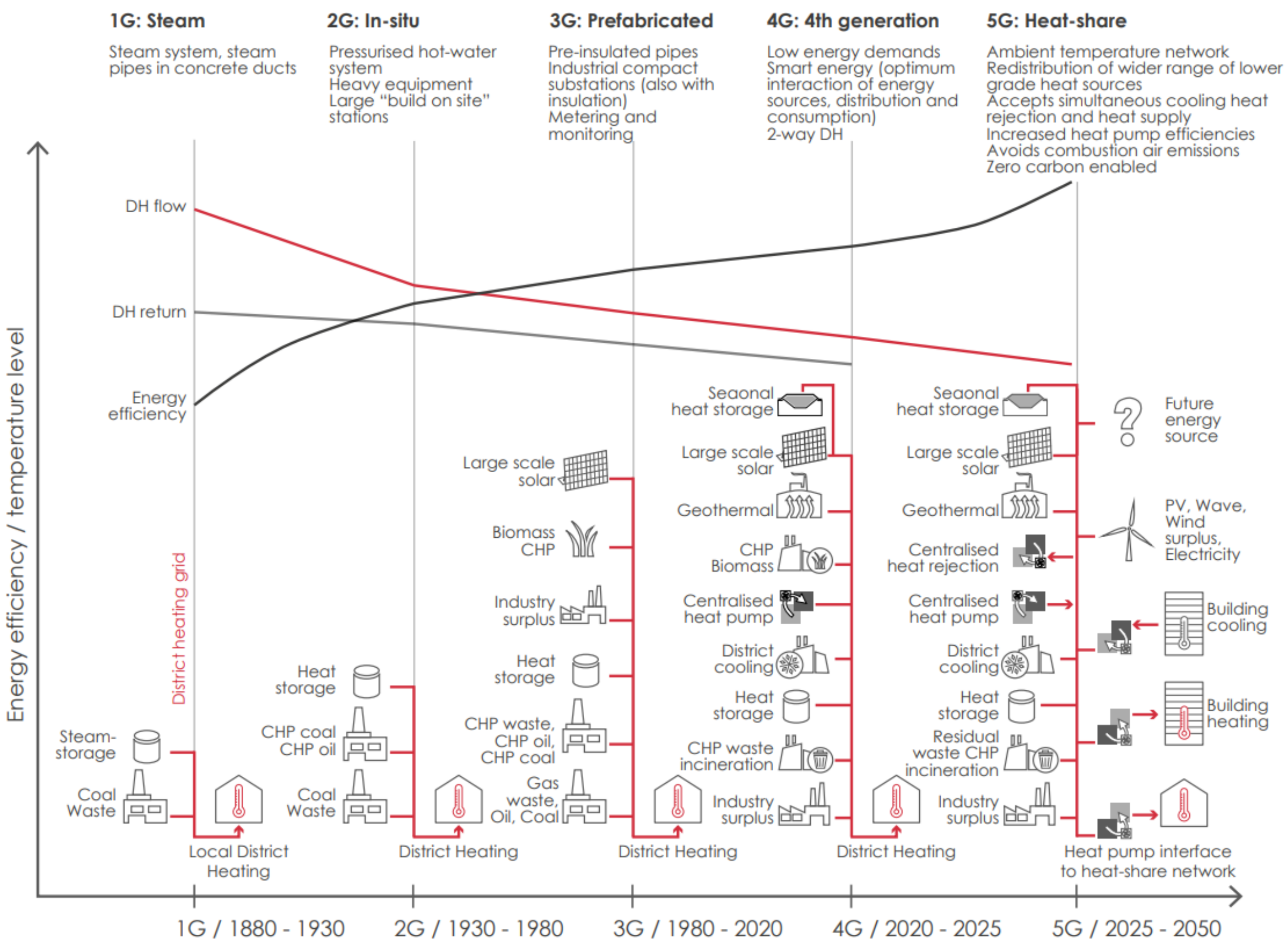
Whole Life Cycle Carbon Flag:

Some of the COPs listed within this diagram above may be impacted by type of refrigerant used within the system. Care should be taken to balance the Direct Effect Life Cycle CO2 (DELC) or Global Warming Potential (GWP) of refrigerants with the achieved coefficient of performance.

G.18 Recovering the heat that is currently wasted on an existing estate will likely increase the efficiency and lower the carbon emissions of the new building due to reduced heating requirements.

G.19 The network also experiences much lower system losses, as the temperature gradient between the network and ambient is very close. This is in comparison to high-temperature networks, where an ongoing issue for many buildings is the standing loss from the distribution network into shared spaces, creating summer overheating.

Figure 12: District heating network evolution (Source: LETI Climate Emergency Design Guide)



Whole Life Cycle Carbon Flag:

Installing ambient loop systems can be intensive from an embodied carbon perspective, depending on the scale and loads within the system. Lifecycle assessments of the equipment should be undertaken to help make informed decisions on the investment.

District Heating

G.20 A significant part of Government and local city strategy for decarbonising heat is the use of district heat networks. These networks are expected to help fight fuel poverty and decarbonise large amounts of building stock across urban areas, typically utilising centralised heat sources and sources of waste heat such as from industrial processes, heat from waste and underground transportation networks where applicable. Therefore, local district heat networks often offer significant short-medium term carbon savings compared to an NHS fossil fuel energy centre while providing social benefits within urban areas.

G.21 As per the energy hierarchy, district heat networks should be explored where there is local intent and support for them, and where they are technically advantageous and efficacious, commercially viable and provide carbon savings for the scheme or Trust, in comparison to other energy sources on site. Energy networks should be assessed based on their actual absolute performance in kgCO2/kWh heat delivered. NHS England expect to see the proposed intent for further decarbonisation of heat networks to enable connection.

G.22 However, the balance of heating and cooling loads and therefore the viability of using heat networks may not be known until room data sheets, scale, and type of clinical equipment e.g., large imaging equipment, are known. Additional sources of heat may not be required other than for peak winter loads, to provide resilience to an estate and/or to serve domestic hot water loads.

Be Green

G.23 As per the requirements of the electricity usage hierarchy within Section 5 of the Standard, the following existing "Be Green" technologies are expected to be increasingly utilised across major healthcare projects. This is critical to support the UK's national decarbonisation strategy:

- **On building PV, and solar thermal where viable – to be informed by a solar radiation analysis and overshadowing:**
  - Maximisation of roof and canopy mounted PV arrays, including covering rooftop plant space and/or amenity spaces where safe and feasible to do so.
  - Maximisation of integration of PV panels within East to West façades, especially where building is high-rise.
- **On site renewable technologies –** Where opportunities on site allow, it would be expected that opportunities are sought on site to maximise generation. Technologies expected to be assessed should include (but not be limited to):
  - PV arrays
  - Ground mounted wind
  - Hydro or tidal energy systems
  - Fuel cells.

Rule of Thumb:

Maximise the dual benefits of adding solar shading to south facades through integrating any solar canopies with PV.

G.24 Renewable feasibility studies for different available land should be generated to support decision making for the most efficacious option.

Rule of Thumb:

For ground mounted wind to demonstrate operational and financial benefits, micro-wind systems need to be sited in locations with an annual average wind speed of at least 5 m/s.

For urban locations, research into micro wind turbines in urban areas by BRE suggests that a scaling factor should be applied to the wind resource assumed to be available in urban areas to account for urban 'roughness' that reduces the effective available wind resource.

All developments should be targeting generating 25–35%+ of building demand on the building itself and seeking 100% across the site, but this is very subjective to site typology and characteristics. The on-building opportunities should be maximised regardless of demand profile, i.e., create a net export to the broader estate where possible.

Whole Life Cycle Carbon Flag:

Carbon payback period for renewable generation elements such as PV i.e. the period of renewable energy generation required to pay back the embodied carbon of manufacturing these elements, must be considered as part of a whole life carbon approach.

G.25 It should be noted that this version of the Standard is only concerned with design and specification of renewable energy generation onsite as part of the 'Be green' step. Procurement and accounting of renewable energy from offsite, e.g., in the form of a Power Purchase Agreement (PPA), is not within this document's scope. In instances where there is feasibility for a 'private-wire' connection to an offsite renewable energy source, this will need to be catered for in the design accordingly. There are no specific requirements for connection into offsite renewable energy supplies within the Standard, as this will be dictated separately by the relevant NHS Trust.

G.26 As part of decarbonisation, in addition to direct electricity-based technologies, such as heat pumps, the following fuels could play an increasing role within decarbonisation of estates in the future as noted within BEIS' Industrial Decarbonisation Strategy, 2020 and CCC's recent publications.

Signpost:

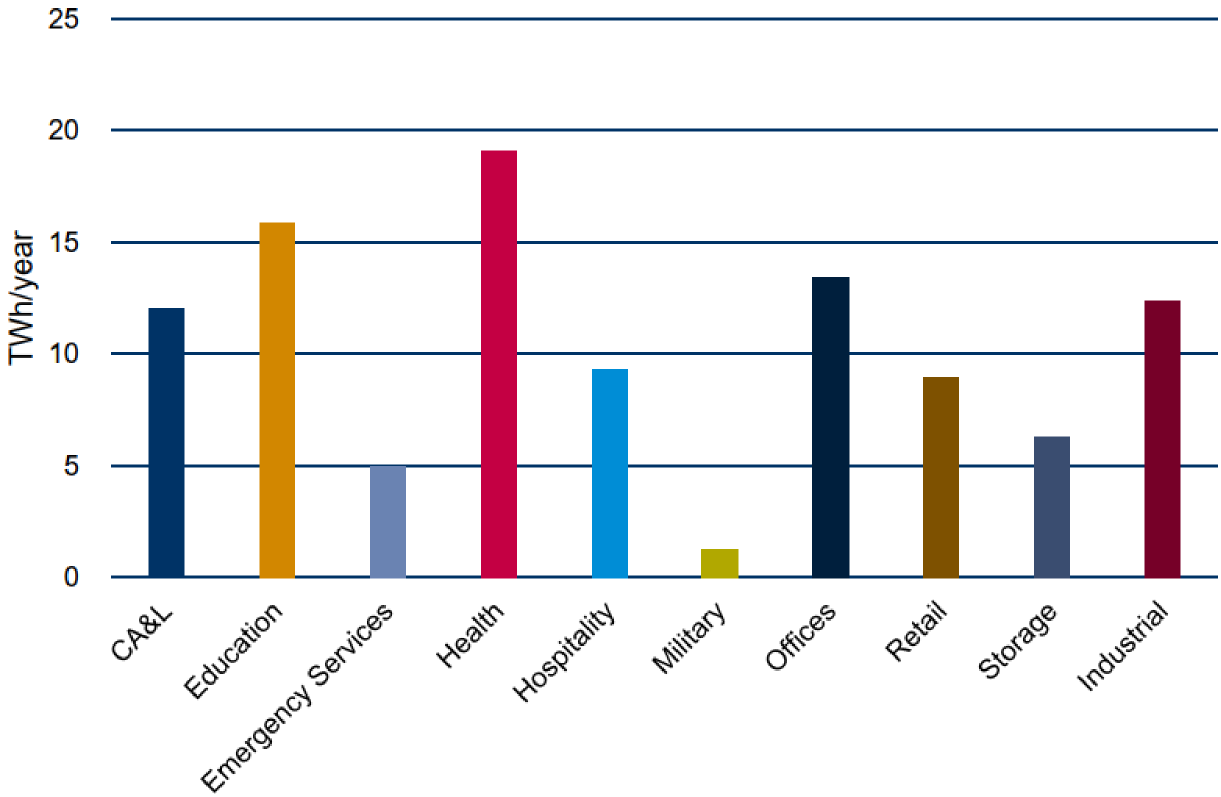
For further reading the Department for Business Energy and Industrial Strategy (BEIS) provides detailed information on future fuels expected to play a role in decarbonising gas networks in the UK.

Hydrogen networks

G.27 The replacement of natural gas with 100% hydrogen to produce heat is currently under consideration as part of the UK energy strategy to meet the 2050 net zero carbon goal. While hydrogen is currently used on some industrial sites and is a product that the gas industry has experience with, it has never been used in occupied domestic or non-domestic buildings in the UK. To demonstrate whether hydrogen can be used for heat in buildings, the Department for Business, Energy, and Industrial Strategy (BEIS) has set up the Hy4Heat programme, which seeks to provide the technical, performance, usability, and safety evidence to achieve this aim.

G.28 As part of the Hy4Heat programme, non-domestic buildings and the type of gas driven appliances that are likely to be used on these sites have been assessed and characterised. The findings highlight the importance of developing decarbonisation solutions for the healthcare sector, which is noted as currently having the highest non-domestic gas consumption by sub-sector, see Figure 13 below.

Figure 13: Commercial Gas Consumption by Subsector - Hy4Heat WP5 Report



G.29 As noted in the BEIS Industrial Decarbonisation Strategy, once the feasibility of hydrogen for providing heat in buildings has been demonstrated, hydrogen is likely to be proposed as a viable solution for non-domestic buildings across some regions of the country, in support of forming four low carbon clusters by 2030 and at least one fully net zero cluster by 2040 (*CP 399, March 2021*). Examples of proposed demonstration projects include the H21 North of England, which extends the H21 Leeds Citygate concept to cover a much more significant area. This project also envisioned a six-phase further rollout that would see 12 million more homes across the rest of Great Britain converted to hydrogen by 2050.

G.30 Based on current government and industry reports, it can be concluded that while hydrogen has the potential to be a viable solution for decarbonisation, the evidence base for how and where it will be used is still under development. This conclusion is also corroborated by the stance taken by BEIS in the December Energy White paper where they noted that a decision on hydrogen is not expected until the mid-2020s: delivering trials in communities, together with the results of wider R&D and testing programmes, will enable strategic decisions around the mid-2020s over the long-term role of hydrogen for heating.

G.31 In the context of the Standard and the decarbonisation plans for NHS estates, it is recommended that particularly for sites close to existing industrial clusters, decarbonisation strategies should maintain hydrogen as an option until mid-2020s when we expect a clear steer on the subject from central government. Engagement with local government and industry could also input into the feasibility study and identify how likely a hydrogen grid is in each area. It is of note that including hydrogen within the decarbonisation planning of a new scheme for the conversion of CHP systems will significantly vary depending on region as well as local infrastructure connections.

G.32 Because of the uncertainty surrounding hydrogen options, we would recommend that any new build healthcare buildings focus on minimising energy consumption and provide resilient clean or low carbon supply in line with the hierarchy identified in the operational carbon compliance section.

Green gas and biomethane

G.33 To support decarbonisation of existing fossil fuel sources, and to support the NHS for backup fuel sources, green gas and biomethane may offer a viable solution.

G.34 In addition to the roll out of a national hydrogen network, more UK biomethane producers are now starting to inject biomethane directly into the gas distribution network. This process is likely to continue due to UK government incentives. Gas injected in this way displaces fossil-derived natural gas giving savings in greenhouse gas emissions.

G.35 Biomethane (also known as 'green gas') can be produced from numerous sources including biogas from anaerobic digestion, landfill gas and synthetic gas ('syngas') from the gasification of biomass.

G.36 Biomethane is currently the only green gas commercially produced in the UK and can be injected into the gas grid for use as a lower carbon substitute for natural gas, helping to decarbonise national gas supplies. Biomethane injection into the gas grid is a cost-effective way of contributing to near term legally binding carbon budgets and decarbonising gas supplies. The Committee on Climate Change (CCC) state that biomethane will be valuable across all decarbonisation pathways, as it is a practical and established way of reducing carbon emissions associated with the National Gas Grid. However, it cannot be produced at the scale needed to fully decarbonise the existing demand.

G.37 The UK government launched the Green Gas Support Scheme (GGSS) in November 2021. This scheme provides tariff support for plants producing biomethane via anaerobic digestion which is injected into the gas grid. Tariffs are calculated to compensate plants for the building of new infrastructure to produce biomethane and ongoing operation costs. It is funded by the Green Gas Levy which is applied to all licenced fossil fuel gas suppliers and will be open to applications for four years.

Energy usage optimisation

G.38 Alongside renewable energy generation, trusts should explore the possibility to include energy and thermal store systems within the design. This has critical importance to help balance peak demands and potential fluctuations within supply of renewable energy. They will also reduce dependence on the local grid infrastructure and provide opportunities for utilising off-peak electricity and therefore benefit from further potential costs and carbon savings. These types of systems will store heat and electrical energy generated during off-peak times for use during peak demand periods and may be in the form of buffer vessels or electric battery storage. Typically, current energy storage is either thermal, electrochemical or electromechanical.

Rule of Thumb:

Energy and thermal storage need to be supported by increased granularity of monitoring and control.

Electrical storage

G.39 Where large scale renewable generation is available on site, battery storage systems can be used to store excess electricity. Battery storage systems should be used for:

- Storing excess generation from solar systems
- Purchasing cheaper/greener electricity at night (i.e. avoiding 'red bands') and storing it for use during peak periods
- Providing balancing services with the grid and electricity trading
- Providing a back-up in the event of a power failure.

G.40 Flow batteries should also be considered, as these have a longer lifespan, but require additional space compared with lithium-ion batteries.

Thermal storage

G.41 Thermal storage systems and buffer tanks are normally required for use with heat pump technology to reduce cycling of the compressors. Domestic hot water buffer vessels or thermal stores such as a hot water cylinders can be used to store heat until it is required.

Whole Life Cycle Carbon Flag:

Legionella risk must be carefully considered when storing or pre-heating hot water - pasteurisation cycles will be required to reduce the risk and further HTM guidance should be sought and followed to reduce the risk.

G.42 Use of thermal storage tank buffers for cooling systems can also reduce chiller compressor plant cycling as well. High temperature air source heat pumps should be installed for domestic hot water systems, together with thermal stores. In larger buildings, heat pumps can also be used for pre-heating the domestic hot water cold feed via a buffer vessel as a form of thermal storage.

Demand response technologies

G.43 Demand response systems should be utilised to help reduce peak power demand and required capacity of plant. The following examples illustrate the different systems and benefits:

- Various forms of storage on site e.g., PV battery storage, thermal stores, phase change materials and EV charging. These could allow an estate to store energy to use at a time when electricity is more expensive, carbon intensive or unavailable.

G.44 Enablers of these systems:

- Building Information Modelling (BIM) can be used to store and manage data on buildings throughout their lifecycle and will play a role in optimising the design and operation of new healthcare buildings.
- Software can be used to simulate HVAC systems and assess how building systems will operate with variable conditions. This can help eliminate the performance gap between design stage and real operation.
- Digital twins can provide similar insights in terms of opportunities for efficiency improvements in existing systems and optimising the lifetime operation of the system.

Refrigerant considerations

G.45 Refrigerants are a necessity where cooling and heating needs are increasing, as well as where there is a move to all electric heat pump-based systems. The selection of the right refrigeration has a great impact on the lifetime Global Warming Potential (GWP) of a system and needs to be considered carefully to reduce emissions.

G.46 Reducing refrigerant GWP impact has been identified as one of the greatest opportunities industry can capitalise on to mitigate climate change. Over the next 30 years, if we could reduce refrigerant leakage to 0.4% of refrigerant used, it would save 89.7 gigatons of CO2e.

G.47 The EU F-gas and the Kigali amendment to the Montreal Protocol are driving users towards eco-friendly refrigerants with reduced greenhouse effect. It is expected that the EU F-Gas regulation on HFCs will be updated in 2022.

G.48 Facing the regulatory pressures to eliminate high-GWP refrigerants, many alternatives are being proposed. However, designers should be aware that there is a trade-off between establishing a lower GWP and the safety concerns around toxicity and flammability. Most of the current refrigerants should be considered from a safety standpoint. Flammability is linked to GWP and refrigerant capacity. Lower GWP and higher capacity comes with increased flammability.

Signpost:

Refrigerants and Environmental Impacts: A Best Practice Guide, Elementa.

LEED v4.1 New Design and Construction.

Refrigerant options now and in the future, Danfoss, Feb 2020.

Considerations for existing energy sources

G.49 The following guidance should be read to support the energy hierarchies presented in Section 5 of the Standard.

G.50 Efficiencies at the estate level are likely to be found where new build developments can be interlinked with existing estates development plans and decarbonisation strategies. To increase efficiency and minimise the quantum of capital cost and carbon, utilising existing infrastructure should be encouraged and able to deliver decarbonisation of all buildings onsite (new and existing) in line with NHS ambitions.

G.51 However, there is a significant challenge in setting out the net zero carbon energy strategy for new healthcare buildings within existing estates, served by an energy centre that is currently powered by full or partial fossil fuels. It is often hard to justify – beyond net zero carbon commitments – a decision to steer away from the existing energy centre especially where there is spare capacity for the new healthcare building(s) to connect into it and where future capacity has already been planned for.

G.52 Traditional natural gas fired boiler systems, CHP, and high temperature-based distribution systems e.g., steam are not considered appropriate long-term solutions. NHS estates will therefore be required to replace natural gas CHP or boilers in energy centres with alternative systems, as well as utilising waste sources of heat. These steps are to be made in combination with shifting to lower temperature networks to enable such changes and increase efficiencies within the plant systems.

Energy centre decarbonisation feasibility study and action plan

G.53 If connection into a fossil fuel-based site wide energy centre is to be implemented, including those that operate a natural gas CHP system, a decarbonisation action plan for the energy centre must be developed, which includes a feasibility study of the different options in the medium and long term.

G.54 This can be an extension to an existing decarbonisation strategy aligned to a Trust's Green Plan (if it already exists) or one newly developed during the project. NHS Trusts and Design Teams should review various emerging zero carbon heat and power generation solutions including those that utilise biomass, biofuels, hydrogen, and heat pumps at OBC Stage to inform the design proposals and cost envelope for the project.

Rule of Thumb:

A decarbonisation strategy for an energy source must not wholly rely upon future technologies that are yet unproved at scale (e.g., hydrogen in 2022) to decarbonise an energy centre or energy source. If this is an option within a decarbonisation strategy, there must be other options presented as alternative solution(s).

Whole Life Cycle Carbon Flag:

There may be other adverse impacts of choosing certain energy sources, such as air quality impacts of combustion of fuels – biomass and biofuels for example. Also, hydrogen is a very energy intensive source to produce and likely to be very expensive, therefore this should be factored into decision making and relative proportions of fuels compared to others.

G.55 A decarbonisation strategy must be completed by the end of RIBA Stage 2 of the project and include or meet the following criteria:

- Factors in existing development plans for the site.
- Assesses viable options based on the best available information in the medium-term leading up to 2028, and in the longer term leading up to 2040.
- Confirms a time-frame over which these energy centre decarbonisation interventions will be made, based on existing operational life spans of plant, and how they align with the most recent targets for NHS estate decarbonisation.
- Options for future interventions, which may include but not be limited to:
    - » Electrical solutions
    - » Hydrogen CHP
    - » Biofuel CHP
    - » Fuel-cell CHP
    - » Biomass boilers.
- Quantifies carbon reductions achievable through energy centre decarbonisation options. As stated in Section 5, a committed decarbonisation action plan for existing energy sources must be included as part of the Energy and Carbon Report at FBC submission.

H. International case studies

Case Study

A series of additional case studies below can be reviewed by Client and Project Teams to support the principles within the Standard and shape design development and detailing.

General links

- UKGBC – case studies.
- IStructE – case studies in response to climate emergency.
- Salix Public Sector Decarbonisation Scheme – case studies.
- CIBSE – case studies.
- Better Buildings Partnerships – resources.
- LETI – *case studies WIP but will be found on their website in 2022*.

Project Links

Project	Description
Timber Square	The Timber Square scheme seeks to deliver a net zero carbon building, addressing both construction and operational impacts in line with the UKGBC Net Zero Carbon Buildings Framework. Through a combination of the partial reuse of the existing structure of the East Building and the use of a hybrid steel / Cross Laminated Timber (CLT) structure, the embodied carbon emissions resulting from 25 Lavington Street will be significantly reduced compared to a typical London office building by about half. In addition, this project will be a pilot for the 'Design for Performance' initiative, which sets verifiable operational energy performance targets.
Zayed Centre for Research into Rare Disease in Children	Designed for Great Ormond Street Hospital and University College London as the first purpose-built paediatric centre of its kind in the world. The building takes a fabric first approach to delivering high levels of thermal efficiency, combined with the use of low and zero carbon technologies including a gas fired CHP and roof mounted photovoltaic panels which help to reduce heating and cooling loads, and demand from the main electricity grid. Water consumption has been reduced by 25 per cent against the BRE industry benchmarks, and the building has a fully integrated Building Management System to ensure optimum efficiency.

Project	Description
Kaiser Permanente	The first carbon neutral health system in the US. First improved energy efficiency in its buildings, installed on-site solar power, and made long-term purchases of new renewable energy generation. Kaiser Permanente then invested in carbon offsets to counter the currently unavoidable emissions from the natural gas power that heats and cools its hospitals.
Fort Irwin Replacement Hospital	Military Hospital in the Mojave Desert, California. Combines LEED Platinum requirements with a Net Zero energy consumption and a Net Zero carbon footprint. Project includes 2MWs of solar capacity.
Kathleen Kilgour Centre	Cancer Treatment centre – built 2014 in South Tauranga, New Zealand. Photovoltaic cells on the building's roof offset the energy consumption of the machines used for treatment. Shaded windows reduce glare while providing natural light, and reducing the need for artificial lighting. A stormwater retention system used in the bathrooms reduces water usage, and a 14 metre high living green wall (containing 3,780 plants) improves indoor air quality and softens the patient experience.
Low-carbon healthcare in the Mediterranean Region	Project run by Healthcare Without Harm aiming to help five hospitals from Mediterranean countries (Spain, Portugal, Greece, and Italy) to establish internal carbon management teams and plans, facilitate knowledge and best practice sharing, and also encourage replication across the Mediterranean region through a low-carbon healthcare toolkit that can be used by other hospitals.
St Vincent's Health Australia	Since 2015-16, St Vincent's Health Australia has been rolling out a National Energy Action Program (NEAP) across its 16 hospitals and 20 aged care facilities to slash its carbon emissions. Installed approximately 13,000 solar panels across 24 hospitals and aged care facilities. The clean energy produced by the solar panels across our facilities is enough to power 3000 houses for one year. Replaced just over 33,000 incandescent and fluorescent lighting with LED alternatives; and introduced a 'plug-smart' system – across 50 of our buildings – to improve the energy efficiency of lighting and other electrical equipment. St Vincent's Hospital Sydney reduced energy required for HVAC by controlling air flow, total energy use drop by 8 per cent and greenhouse gas emissions went from 118,109 tonnes of CO2e in 2015-16 down to 108,638 in 2018-19. Overall reduction of 30% energy consumption and a utility cost reduction of $128,590.

Annex 1: Glossary

Term	Abbrev.	Definition
Additionality (renewable energy)		That is, the extent to which something happens as a result of an intervention that would not have occurred in its absence.
Air Source Heat Pump	ASHP	A low carbon heating solution that absorbs heat from the outside air to heat space and/or water. A liquid is used to transfer the heat, and as heat outputs are greater than electricity inputs, they provide a low carbon heating solution.
Department for Business, Energy and Industrial Strategy	BEIS	This is the UK Government's Department for Business, Energy and Industrial Strategy.
Be Lean		The first stage of the energy hierarchy, focusing on reducing energy demands within the building.
Be Clean		The second stage of the energy hierarchy, achieving efficient supply of energy and heating to the site, using local resources (such as waste heat).
Be Green		The third stage of the energy hierarchy, using renewable energy sources that prioritise energy generation close to point of use e.g. on-site renewable energy generation.
Be Seen		Referring to the understanding and visibility of actual operational energy performance. This requires monitoring and reporting of the actual operational energy performance after construction.
Biomass / bioenergy		'Biomass' is material of biological origin excluding material embedded in geological and/or fossilised formations, with bioenergy being the energy produced by living organisms.
Building elements		Building elements are the basic elements which make up a building e.g. foundations, roof, walls and columns.
Building management systems	BMS	This is an IT system that operates a building and can be responsible for monitoring and optimising its subsystems.
Building Research Establishment Environmental Assessment Methodology	BREEAM	A method of assessing, rating, and certifying the sustainability of buildings. It focuses on: Energy, Land use and ecology, Water, Health and wellbeing, Pollution, Transport, Materials, Waste and Management.
Building Standard Performance Target	BSPT	A BSPT establishes a definition for high-performance buildings and drives all buildings to achieve it.

Term	Abbrev.	Definition
Carbon		Total carbon dioxide equivalent (CO2e).
Circular Economy		The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products if possible, rather than a traditional linear model of materials going to waste.
Carbon capture, utilisation, and storage	CCUS	This is a process of capturing carbon dioxide before it enters the atmosphere, transporting it and storing it (carbon sequestration) ready for reuse.
Carbon factor		The carbon factor is the amount of equivalent carbon dioxide (CO2e) released per kilowatt hour of electricity (generated and distributed) and can be related both to the energy used directly by NHS trusts (scope 1 and 2 carbon), and to the energy used to manufacture and transport construction materials (scope 3 carbon).
Carbon sequestration		Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. A fundamental element of achieving net zero carbon emissions.
Chartered Institution of Building Services Engineers	CIBSE	An international professional association and global network of building services engineers that provides support and guidance to engineers. It works to set the standards for best practice and drives internationally recognised Guidance and Codes for the industry. It is a full member of the Construction Industry Council and licenced by the Engineering Council.
"Clean" energy		Clean energy is energy that comes from renewable, zero operational emission sources that do not pollute the atmosphere when used.
Climate Change Conference of Parties	COP	The United Nations supreme decision-making body of the convention on climate change.
Construction, Design and Management	CDM	The primary set of UK regulations for managing the health, safety and welfare of construction projects.
Direct Effect Lifecycle CO2e or Global Warming Potential	DELC or GWP	A measure of the effect of global warming arising from emissions of refrigerant gases from the equipment to the atmosphere over its lifetime (units: kgCO2e.).
Domestic hot water	DHW	Water used, in any type of building, for domestic purposes, including hand washing sanitation and personal hygiene.
Dynamic simulation modelling	DSM	DSM is an extremely accurate and powerful tool for assessing the environmental performance of a building.
Embodied Carbon		The total amount of CO2e emitted associated with the materials, production and construction processes throughout the whole life cycle of an asset (Modules A1-A5, B1-B5, C1-C4).

Term	Abbrev.	Definition
Energy Modelling		Energy Modelling is a specialist activity that forecasts the operational energy use of a building based upon its design and an understanding of how the building is intended to be used. It applies dynamic simulation and detailed heating, ventilation and air conditioning (HVAC) analysis to determine the impact of both internal and external influences upon the indoor environment and the energy consumed by systems to meet control set-points.
Energy hierarchy		The energy hierarchy was produced by the Greater London Authority to inform the design, construction and operation of new buildings, with stage one being of highest priority, and four the least.
Estates Return Information Collection	ERIC	A mandatory central data collection for estates and facilities services from the NHS in England.
Energy use intensity	EUI	The Energy Use Intensity (EUI) is a measure of the total energy consumed (kWh) in a building per floor area (m2). It includes all of the energy consumed in the building, such as regulated energy and unregulated energy (expressed as kWh/m2). The total amount of energy consumed (kwh) in a building per floor area (m2) excludes any on-site renewable energy generated (expressed as kWh/m2).
Gross internal area	GIA	GIA is the whole enclosed area of a building, all floors (excluding external thickness of the walls)
Greater London Authority	GLA	The GLA is the devolved regional government body of the London region.
Ground Source Heat Pump	GSHP	A low carbon heating system which transfers heat from the ground to heat space and/or water. A liquid is circulated between the ground and the heating system to transfer the heat, resulting in a low carbon emission heating technology.
Heat networks / district heating		A heat network – sometimes called district heating when having a much greater range – is a piped distribution system that takes heat from a central source or number of distributed sources and delivers it to a variety of buildings.
Heating, ventilation, and air conditioning	HVAC	Heating, ventilation, and air conditioning systems control the temperature and ventilation within a space.
Kyoto Protocol		The Kyoto Protocol was an international treaty which extended the 1992 United Nations Framework Convention on Climate Change that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that global warming is occurring and that human-made CO2 emissions are driving it.

Term	Abbrev.	Definition
Internal air quality		Internal air quality describes how polluted the air people breathe is in an internal space. When air quality is poor, pollutants in the air may be hazardous or impact wellbeing of building occupants.
London Energy Transformation Initiative	LETI	A self-governing network of built environment professionals from across the industry, voluntarily working together to drive the industry regarding action on climate change.
Lifecycle		This includes all the stages of a product's life from raw material extraction through to end-of-life disposal or recycling.
Lifecycle Assessment	LCA	A technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.
Limit		The total allowable value, in this instance related to energy and carbon.
Mechanical Ventilation with Heat Recovery	MVHR	Systems that mechanically ventilate a space and provide heating and/or cooling by reusing energy from incoming air.
Modern Methods of Construction	MMC	Is a methodology to evolve construction from traditional ways of working to those that increase value across the supply chain.
Module A, B, C, D emissions		These are emissions which are produced during the lifecycle of a product or building.
Net zero carbon	NZC	All carbon emissions are reduced in line with the Paris Agreement 1.5°C trajectory, with residual emissions offset through carbon removals or avoided emissions.
Net Zero Operational Carbon		Net Zero Operational Carbon is achieved when the total amount of carbon and other greenhouse gas (GHG) emissions associated with the building's operational energy [on an annual basis] is zero.
Operational carbon - Energy		'Operational Carbon – Energy' (Module B6) are the GHG emissions arising from all energy consumed by an asset in-use, over its life cycle.
Operational carbon - Water		'Operational Carbon – Water' (Module B7) are those GHG emissions arising from water supply and wastewater treatment for an asset in-use, over its life cycle.
Operational Energy Limits		This Standard includes operational Energy Limits in the energy usage intensities, expressed in kWh/m^2 of gross internal floor area per year that covers all energy use of the building (typically supplied through its fiscal meters), including loads currently unregulated by Building Standards.
Offsetting		Offsetting means emission reductions or removals achieved by one entity can be used to compensate (offset) emissions from another entity.

Term	Abbrev.	Definition
Performance Target	PT	The required performance level for specific building elements and systems, that are required to achieve energy and/or Carbon Limits. This includes envelope, energy efficiency, heating, lighting, ventilation and cooling systems.
Photovoltaics	PV	The direct conversion of light into electricity usually via photovoltaic panels or cells (commonly referred to as solar panels).
Post-occupancy evaluation	POE	Post-Occupancy Evaluation is the process of obtaining and reviewing feedback from a buildings user(s) on a building's performance during operation.
RACI matrix		A responsibility assignment matrix, also known as RACI matrix, describes the participation of various parties and roles in completing tasks or deliverables or parts of a process. A matrix showing those that have responsibility, accountability, must be consulted and informed (RACI).
Refurbishment		The definition of 'refurbishment' encompasses a wide range of works to improve the performance, function and overall condition of an existing building or asset.
Renewable Energy Guarantee of Origin	REGO	A certification scheme that provides transparency to consumers about the proportion of purchased electricity that suppliers source from renewable energy generation.
Regulated energy		Building energy consumption resulting from the specified design of controlled, fixed building services and fittings e.g. space heating, cooling, hot water, pumps, fans and lighting.
Renewable energy		Renewable energy is the term used to describe energy that occurs naturally and continuously in the environment, such as energy from the sun, wind, waves or tides.
Royal Institution of Chartered Surveyors	RICS	A professional body promoting and enforcing the highest international standards in the valuation, management and development of land, real estate, construction and infrastructure.
Seasonal Coefficient of Performance	SCOP	A measure of energy efficiency as an asset across a 12-consecutive-month period (as efficiency varies seasonally). The annual useful heat output is measured and divided by total electrical input.
Seasonal Energy Efficiency Ratio	SEER	The annual average of the output of cooling energy compared with the electrical energy input.
Scope 1, 2, 3 emissions		Scope 1: Direct emissions from owned or controlled sources. Scope 2: Indirect emissions from the generation of purchased energy. Scope 3: All other indirect emissions that occur in an organisation's value chain. Emissions from all scopes are measured in CO2e.

Term	Abbrev.	Definition
Space-types		Common areas within a healthcare building that undertake the same healthcare activity e.g., laboratories or operating theatres.
Space-type technology category		Space-type technology groups can be further broken down into categories based on defined building performance parameters – there are seven clinical and five non-clinical Space-Type Technology Categories. E.g. Medium Tech Type 1.
Space-type technology group		A healthcare building's space-types can be grouped by technology level (low, medium, high, ultra-high or support) based on common performance parameters.
Technology Readiness Level	TRL	Technology Readiness Levels is a method used to assess the maturity level of a particular technology.
Thermal gain		Thermal gain refers to heat energy absorbed from an outside source resulting in a warming of a particular space. Internal heat gains, can also be generated from equipment loads and occupation of spaces.
Thermal Mass		Thermal mass is the ability of a material to absorb, store and release heat. This is typically achieved through its ability to absorb unwanted heat during the day and then release it at night.
Tiers		The Standard has defined different "tiers" of building components which have different guidance and reporting requirements. Tier 1 components have; industry assessment methodology and relative maturity, robust sources of available data to inform carbon assessments and inform existing benchmarking. Tier 2 materials have not been given defined Carbon Limits due to a current lack of available data and maturity in use of calculation methodologies.
Traded emissions		The emissions that can be traded between countries, and their industries, to cover exceeding their permitted emissions under the Kyoto Protocol.
Unregulated energy		Unregulated energy loads are those energy demands from non-fixed building services and systems, also commonly known as equipment, process and plug loads.
Upfront carbon		'Upfront carbon' emissions are the emissions associated with materials and construction processes up to practical completion (Modules A1-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion. This definition should be used when reporting the embodied carbon up to practical completion.
Variable air volume	VAV	Variable air volume systems, supply constant temperature air to an area while the volume of air varies as opposed to a conventional HVAC system which has constant volume and varies the air temperature.

Term	Abbrev.	Definition
Waste heat		The unused, excess heat produced by a process. It can be captured and reused as a resource for alternative functions.
WELL Building Standard	WELL	The WELL Building Standard is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and wellbeing, through air, water, nourishment, light, fitness, comfort, and mind.
Whole life carbon	WLC	The total sum of carbon emissions and related GHG emissions for all assets and removals, both operational and embodied over the lifecycle of an asset including its disposal (Modules: A1-A5 Upfront; B1-B7 In Use; C1-C4 End of Life). Overall Whole Life Carbon asset performance includes separately reporting the potential benefit from future energy recovery, reuse, and recycling (Module D).

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