NHS National Services Scotland

NHSScotland Sustainable Design and Construction (SDaC) Guide

Scottish Health Technical Note 02-01

SHTN 02-01

Version 2 August 2025

Contents

Preface

Scottish Health Technical Memorandums (SHTMs), Scottish Health Planning Notes (SHPNs), Scottish Health Facilities Notes (SHFNs), Health Building Notes (HBNs) and Scottish Health Technical Notes (SHTNs) provide comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare. The focus of SHTM, SHPN, HBN, SHFN and SHTN guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable across the Healthcare Estate in Scotland to new and existing facilities, to be used at various stages during the whole building lifecycle.

Technical guidance is vital in ensuring the safe and efficient operation of healthcare facilities and SHTNs provide NHS boards with guidance on healthcare standards, policies, and best practices. These resources are essential in helping NHS boards meet their duty of care while safeguarding the health, safety, and wellbeing of both individuals and the environment.

This guidance (SHTN 02-01) has been developed to support NHS boards in making informed decisions that enhance their role in mitigating, adapting and reducing the effects of the global climate emergency.

It is recognised that SHTN 02-01 sits amongst an extensive suite of guidance documents and Scottish Government policy for the Healthcare Estate in Scotland. It is also acknowledged that in addition to guidance and policy, application of the Sustainable Design and Construction Guide (SDaC) will have to recognise the clinical environments in which it will be applied and therefore consider models of care, clinical pathways, service delivery, infection control and so on.

The intention of this document is not to be viewed or applied in isolation, it should be used to promote sustainability, ensuring it is embedded as part of all decision making. It is expected that adherence with agreed applicable guidance will be achieved by following the contents of such guidance and that application of SDaC will ensure guidance is adhered to in a sustainable way.

It is a requirement that all NHS boards adopt and follow this guidance to help deliver sustainable outcomes when undertaking any works that impact the physical built environment, for example new build, refurbishment, minor works or any other preplanned work across the estate, throughout the lifecycle of an asset.

The extent of application of this guidance will be dependent on the scope and scale of the project being undertaken.

Language usage in technical guidance

In technical Guidance, verbs such as “must”, “should” and “may” are used as defined terms to convey obligation, recommendation or permission. The choice of modal verb will reflect the level of obligation needed to be compliant.

The following describes the implications and use of these modal verbs in SHTNs (readers should note that these meanings may differ from those of industry standards and legal documents), as follows:

- “Must” is compulsory and is used when indicating compliance with a legal requirement
- “Should” indicates a benchmark standard that should normally be adhered to. An alternative method may be acceptable provided it can be evidenced that it meets or exceeds the benchmark standard
- “May” indicates a permissible course of action

Executive summary

Aim of the guidance

This guidance was developed by NHSScotland in response to Scottish Government's climate emergency declarations and related national commitments set out in Director Letter (DL) (2021) 38. It details the process, actions and additional supporting standards required for NHS boards to evidence and deliver the performance outcomes needed to mitigate the health impacts of climate change and achieve sustainable quality in the present and future delivery of the Healthcare Built Environment (HBE) across Scotland.

The Sustainable Design and Construction (SDaC) Evaluation Toolkit is designed to complement this guidance and provides a framework for NHS boards to ensure that they use all necessary methodologies and tools and understand good practice approaches to assist them in meeting policy requirements that will deliver a robust, sustainable healthcare environment. The Toolkit should be used to demonstrate their decision-making process when implementing the SDaC guidance.

The SDaC Evaluation Toolkit is designed to be applied throughout the project lifecycle from strategic definition, preparation and briefing, through to handover and in use (Royal Institute British Architects (RIBA) stages 0 through 7) (see ref 1) and has defined reporting stages to align with project development.

The Toolkit should be completed by the project lead or designated SDaC champion(s) as part of the documentation of their self-assessment and decision-making processes.

It is acknowledged that the role and identity of the SDaC champion may vary depending on the project's size, scope, and complexity, as well as the resources available within the NHS board. NHS boards are therefore encouraged to determine the most appropriate way to fulfil this role from the earliest stages of the project. This may involve allocating internal resources or, where necessary, procuring external consultancy support.

It is also recognised that the SDaC champion role may be shared among multiple individuals, regardless of which, the SDaC champion(s) should operate within an integrated project team, fostering regular collaboration among all key stakeholders, including architectural, mechanical, electrical, and clinical teams from the outset of the project.

Given NHS boards' climate emergency duties, the principles outlined in the SDaC guidance should be embedded across all capital investment decision-making not just those projects that meet Scottish Government threshold for third party assessment. NHS boards should apply SDaC tools, relevant sections and associated targets as appropriate to evidence their governance and alignment with sustainability objectives.

While research has demonstrated the challenge in delivering a zero emissions built environment, it has also highlighted an optimum net-zero position which can be achieved. While these optimised net-zero operational targets are listed within the guidance, NHS boards should aspire to exceed them.

Scope and application of Guidance

Scottish Health Technical Note (SHTN) 02-01 is specifically designed for use by NHS board staff, contractors and consultants and reflects best practice for NHSScotland. It includes references to Scottish regulations and other relevant requirements drawn from associated UK-wide guidance. As the guidance has been designed for NHS board staff as well as contractors and consultants, NHS boards should consider the roles, responsibilities and deliverables within the guidance and ensure these are included accordingly within any procurement exercise for those being appointed as part of any project.

Since NHS boards should adopt and adhere to this guidance, it is vital that completion of the SDaC Evaluation Toolkit, along with the required evidence, are incorporated into the capital procurement and governance processes, to ensure:

- **sustainability compliance** - all projects align with NHSScotland and national net zero goals
- **budget and whole-life costing** - early planning ensures financial sustainability
- **stakeholder accountability** - clear sustainability benchmarks for contractors and suppliers
- **regulatory adherence** - meeting Scottish/ NHSScotland specific sustainability mandates

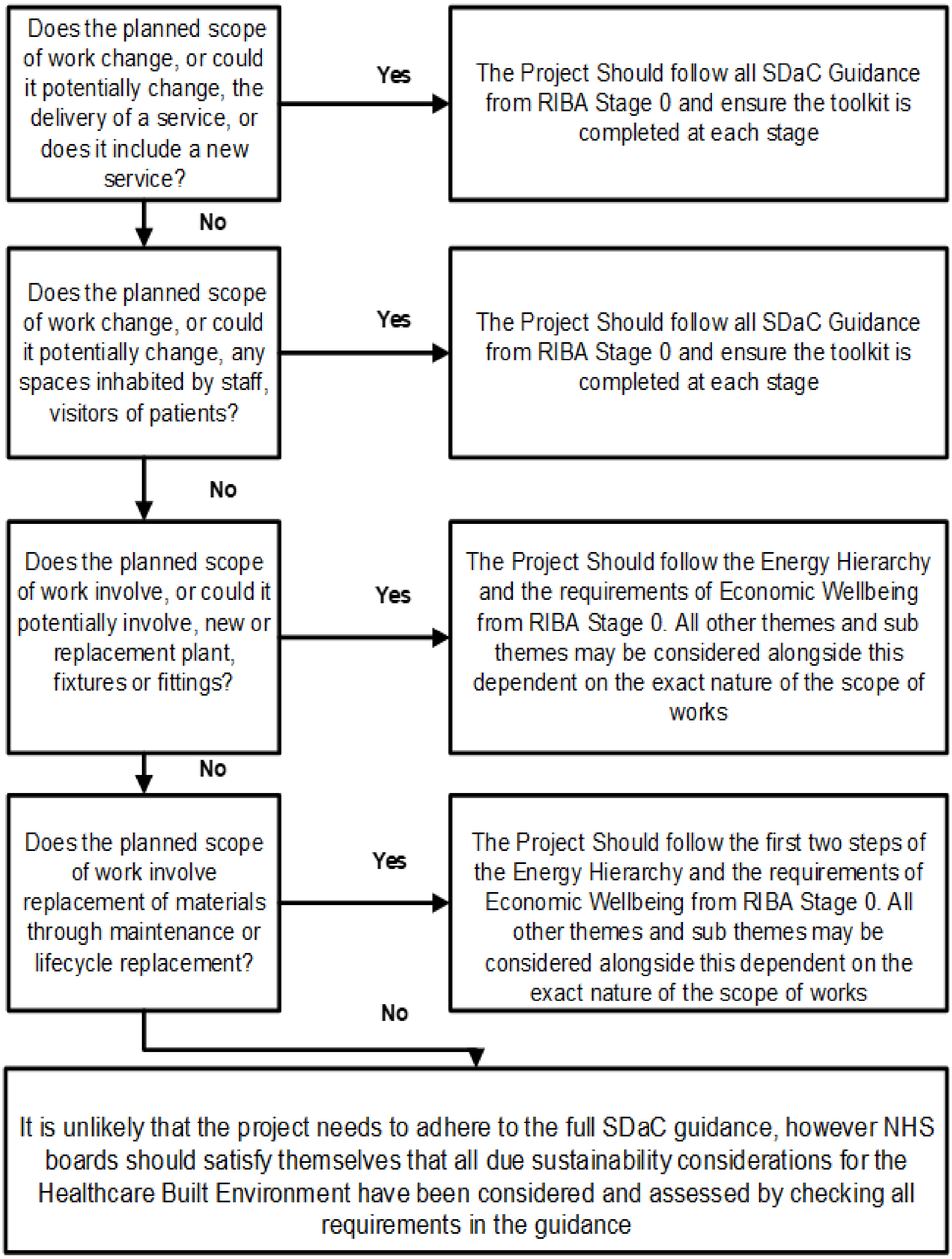
As such NHS boards should take cognisance of the following:

- **procurement teams and suppliers** - teams may request that key suppliers or national sourcing teams provide product specific life cycle assessments as part of any tendering process
- **use of specialist consultants** - NHS boards may engage sustainability consultants or in-house specialists to conduct Whole Life Carbon Assessments (WLCA) or Life Cycle Analysis
- **external bodies** - NHS boards may consider using organisations, including Building Research Establishment (BRE) or the UK Green Building Council (UKGBC) for specialist advice

The scope and scale of each project will determine the level to which the guidance should be applied. NHS boards should therefore assess a project's impact on service delivery, occupied spaces, equipment, fixtures, fittings, and materials to establish the extent of application required.

The following diagram provides direction to NHS boards on the process they should follow to assess the scope of work required as part of the SDaC guidance.

Figure 0.1 - SDaC Application Process



For each project the NHS board is required to nominate an independent client-side SDaC champion(s), such as the NHS board Climate Emergency and Sustainability Champion. This person should act as a liaison with both internal and external project or design teams and coordinate efforts in identifying and securing the successful delivery of the project's desired outcomes.

The SDaC champion(s) should demonstrate a broad range of knowledge and high levels of competency, as follows:

- guide the briefing, design, delivery, and operational stages of the project lifecycle
- challenge traditional approaches and drive cultural change
- integrate sustainability into capital and asset processes and decision-making

Where appropriate, the SDaC champion(s) will also engage with end user groups to identify and promote mechanisms that encourage positive behavioural changes in relation to operation, management, maintenance and interaction with the building and its services, features and controls.

While this approach is typical and recommended for larger-scale projects, all staff involved in procuring services or managing estates and facilities should ensure that their NHS board meets its sustainability responsibilities and complies with national policy. For smaller projects, NHS boards should use the SDaC to guide the procurement process and apply the applicable elements within the Priority Themes in the guidance.

To promote best practice and support continuous learning, NHS boards and their champions should actively collaborate with colleagues across NHSScotland and NHSScotland Assure to exchange insights and share lessons learned from projects delivered through the SDaC guidance.

1. Introduction

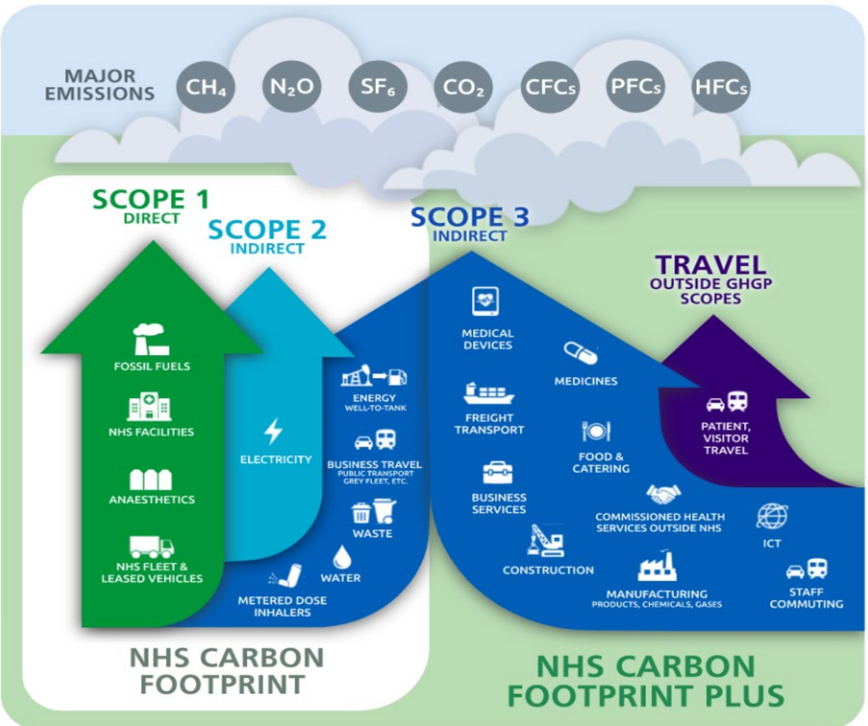
1.1. NHSScotland is committed to delivering a high-quality, resilient, and person-centred healthcare service. In addition to adopting a quality driven approach that supports this vision, NHSScotland acknowledges the urgent need to respond to the climate emergency. This response is essential to mitigate associated health impacts and to ensure the sustainability of healthcare services across Scotland both now and in the future.

1.2. Figure 1.1 highlights the different emission scopes across the NHS carbon footprint, these are split into:

- **Scope 1: Direct** - emissions from sources that are owned or controlled by the organisation
- **Scope 2: Indirect** - emissions from the generation of purchased electricity, steam, heating, and cooling consumed by the organisation
- **Scope 3: Indirect** - all other indirect emissions that occur in an organisation's value chain, both upstream and downstream

It is these emission scopes that the guidance is seeking to address and are covered in further detail in the Energy Hierarchy (Section 4).

Figure 1.1 - Greenhouse Gas (GHG) Protocol Diagram - Scopes



GHG Protocol scopes in the context of NHS Source: [Delivering a net zero National Health Service](), October 2020.

1.3. In 2015, all United Nations (UN) Member States adopted the 2030 Agenda for Sustainable Development; a shared blueprint that has at its heart seventeen Sustainable Development Goals (SDGs) (see ref 2). The Scottish Government has embedded these SDGs throughout the current National Performance Framework (NPF) (see ref 3).

1.4. The NPF outlines a vision for Scotland encompassing social, economic, and environmental factors, emphasising the importance of a 'whole system approach' to successfully achieve its national health outcomes. It also acknowledges the critical role of NHSScotland in supporting this goal while ensuring that high-quality healthcare services remain accessible to all.

1.5. In response to Scottish Government’s climate emergency declarations and related national commitments, NHSScotland agreed to a framework of actions to:

- address the various associated health risks and social impacts that the climate emergency brings
- meet Scottish Government’s direction regarding GHG emissions
- meet Scottish Government’s direction regarding the NPF outcomes

The above actions are addressed in the content of this guidance, which aims to provide reassurance that the Sustainable Design and Construction (SDaC) guide will help NHS boards respond to these framework actions.

1.6. Embedding and meeting these priorities requires considerable collaborative effort from all who specify, design, deliver, make use of and benefit from the NHSScotland estate and assets. The SDaC has been developed to support these efforts by providing a consolidated and structured approach, aligning with additional supporting standards, best practice case studies, and leading industry frameworks, methodologies, and sustainability targets.

1.7. This guidance sets out two main priority themes, namely Wellbeing and Energy Hierarchy, and emphasises their significance and the balance required to achieve optimal sustainable outcomes across the NHSScotland estate.

1.8. These core themes encompass interrelated sub-themes and influencing factors that should be considered as part of a holistic approach. They are supported by guidance outlining how and when NHS boards should respond to them and provide appropriate evidence.

2. Priority themes

2.1. This guidance has identified Wellbeing and Energy Hierarchy as key priority themes that will shape the future development of the NHSScotland estate and are designed to ensure that all projects contribute to the long-term sustainability, functionality, and overall effectiveness of healthcare facilities.

2.2. These themes and their associated sub-themes will serve as a framework for decision-making across all NHSScotland estate projects. This will ensure alignment with broader healthcare, sustainability, and wellbeing objectives and should be considered as determined by Figure 0.1.

Wellbeing

2.3. Promoting environments that support the health, safety, comfort, and quality of life for patients, staff, other building users and neighbouring communities.

Wellbeing sub-themes

2.4. Wellbeing is made up of the following sub-themes, which provide a more detailed framework for creating spaces that enhance health and wellbeing, as follows:

- **social wellbeing** - encouraging inclusive, supportive, and community-focused environments that foster connection and collaboration. This includes designing spaces that promote interaction and social engagement for patients, staff, and visitors
- **mental wellbeing** - prioritising spaces that reduce stress and anxiety while promoting a sense of calm and emotional resilience. Factors such as natural lighting, green spaces, quiet areas, biophilic design and use of natural materials play a crucial role in supporting mental health
- **physical wellbeing** - ensuring that buildings and outdoor areas promote physical health through active design principles. This includes indoor environmental quality (IEQ) issues, accessible routes, ergonomic workspaces, opportunities for movement, and spaces that encourage physical activity
- **occupational wellbeing** - creating safe, comfortable, and efficient work environments that support staff wellbeing and productivity. This involves factors such as air quality, temperature control, acoustics, and ergonomic design to enhance working conditions for healthcare teams
- **economic wellbeing** - the ability of individuals, healthcare staff, and organisations to manage financial resources effectively, ensuring long-term stability and security. Within NHSScotland's estate development, economic wellbeing is considered an essential factor in creating a sustainable, cost-effective, and accessible healthcare system

Energy Hierarchy

2.5. The Energy Hierarchy is a recognised framework used to prioritise actions in energy management and sustainability. It emphasises that the most effective strategies are those that reduce the need for energy in the first place, rather than relying solely on shifting the type of energy used.

2.6. This approach aligns with broader sustainability goals and net-zero commitments by integrating renewable energy sources, optimising resource use, and employing circular economy principles to minimise environmental impact at every stage.

Energy Hierarchy sub-themes

2.7. Energy Hierarchy is made up of the following sub-themes, which provide a more detailed framework for reducing energy demand and optimising resource use, as follows:

- **energy conservation** - reduce the demand for energy by avoiding using energy unnecessarily. This can be achieved by optimising building design through better insulation, passive solar design, or improvements to reduce heating, cooling, or transportation needs
- **energy efficiency** - use energy efficiently by upgrading to high-efficiency appliances, light-emitting diode (LED) lighting, or advanced heating, ventilation and air conditioning (HVAC) systems so that the same function requires less energy
- **renewable energy and sustainable energy sources** - the remaining energy needs can be met with renewable sources such as photovoltaic (PV) solar panels, wind turbines, or geothermal systems to provide cleaner energy with a lower environmental impact or sustainable energy sources, such as a decarbonised electrical grid
- **insetting** - while NHSScotland's net-zero strategy does not rely on carbon offsetting, it prioritises reducing emissions as far as possible before considering any compensation for residual emissions. In line with this approach, NHS boards are encouraged to explore opportunities for insetting, that is, reducing emissions within their own operations or supply chains, within project boundaries. This aligns with the broader NHSScotland Climate Emergency and Sustainability Strategy (2022-2026) by ensuring that any remaining emissions are addressed through direct, certifiable actions that benefit NHSScotland's own infrastructure and services. Further detail on this approach is provided in paragraph 4.84

Balancing sustainable needs

2.8. The Sustainable Design and Construction (SDaC) guide covers the main themes and requirements relating to sustainability through design and construction. The guidance provides information on the tools needed to assess and ways to address the themes and sub themes while ensuring alignment with Scottish Government policy.

2.9. It is vital to note that in addressing each theme, and sub theme, there is a need to balance the outcomes and ambitions of each element.

2.10. For example, a ward redevelopment project including an adjacent courtyard space aiming to improve economic wellbeing may seek to exclude works to the courtyard space for ‘financial benefit’. In this event, where the scope does not extend to include the adjacent courtyard space, the overall impact of the project could be diminished by missing opportunities for physical, mental, and social wellbeing, as well as shading solutions that could have supported the initial aim of improving wellbeing as part of the overall scope.

2.11. As some of the decision making undertaken as part of this ‘balancing’ can be challenging, it is important that the SDaC Evaluation Toolkit is used to evidence decisions made.

2.12. In addition to balancing the themes noted, consideration must also be given to other competing priorities within the Healthcare Built Environment (HBE), requirements from other policies and NHSScotland technical guidance. While these may seem to conflict with efforts to reduce Greenhouse Gas (GHG) emissions and address the climate emergency, the same balancing principles should be applied, recognising that the climate emergency is also a health emergency, and that the sustainability goals outlined here will contribute to public health improvements.

2.13. An overarching theme throughout this guide is the pursuit of operational performance optimisation for Wellbeing and Energy Hierarchy with evidence required at key stages of the decision-making process. This should be achieved through early and continuous engagement with key stakeholders, using workshops at each critical phase to collaboratively document and enhance performance across the priority themes. As an example, this process may involve identifying opportunities to eliminate waste through design, enhancing performance at every stage of the project lifecycle, and streamlining production and supply chain processes.

2.14. To support a balanced approach and optimise operational performance, this guidance emphasises the importance of collaborative, interdisciplinary working. In addition to ongoing engagement with key stakeholders, the process should bring together architectural, structural, mechanical, electrical, sustainability, water, medical gas, infection prevention and control and other relevant expertise in a coordinated and integrated manner.

2.15. This collaborative approach enables a shared understanding and review of key design and technical elements such as massing, orientation, spatial planning, engineering strategies, and performance data while also supporting a comprehensive evaluation of sustainability impacts. It should also inform the setting of performance targets outlined in this guidance and support continuous monitoring, delivery, and identification of opportunities for improvement.

3. Wellbeing

3.1. Within the Healthcare Built Environment (HBE), wellbeing consists of spaces that support the health, comfort, and quality of life for patients, staff, other building users and neighbouring communities.

3.2. The wellbeing theme encompasses the following sub-themes; each addressing different priorities with defined criteria and requirements and together will help form individual project wellbeing strategies for implementation within the Sustainable Design and Construction (SDaC) Guide:

- social wellbeing
- mental wellbeing
- physical wellbeing
- occupational wellbeing
- economic wellbeing

3.3. Issues under the wellbeing theme promote the design and operation of an estate that is considerate to and prioritises the wellbeing of users (staff, patients, visitors and the wider community) through the creation of comfortable, inclusive and healthy internal and external spaces, using a place-making led approach.

3.4. The SDaC Evaluation Toolkit should be used to monitor progress from initial intent to implementation of wellbeing and its requirements. It also outlines specific criteria that NHS boards should address to achieve optimal sustainable outcomes.

Wellbeing

3.5. The World Health Organization (WHO) states that wellbeing is "a state of complete physical, mental, and social wellbeing, and not merely the absence of disease or infirmity" (see ref 4). It is vitally important therefore that the design and operation of healthcare facilities support and enhance the total wellbeing of all users.

3.6. Research on faster recovery times highlights wellbeing factors such as views, access to nature, and fresh air as key contributors to patient recovery. There are additional benefits for the HBE including reduced pressure on services from decreased demand, and less need for NHS estate expansion, leading to associated financial benefits.

3.7. The quality of both internal and external environments significantly impacts user wellbeing by promoting social, physical, and mental health benefits that extend to entire communities which is of particular importance to NHSScotland.

3.8. The relationship between building design, green and blue infrastructure and wellbeing is well documented and recognised as having a significant impact on an individual's health and wellbeing. For a development to be considered truly sustainable, the health and wellbeing of all users should be prioritised and provided for.

Social wellbeing

3.9. Social wellbeing can be described as fostering a sense of community and connection among patients, staff, and visitors, while also enhancing the economic and social fabric of the local area.

3.10. To address the above requirements NHS boards should ensure that the design and quality of the built environment enhances social wellbeing and promotes positive interactions where aspects fall within scope, by incorporating the following elements.

Requirements

Communal areas

3.11. For communal areas:

- create both indoor and outdoor spaces where people can gather and interact and that promote social connections
- include family rooms and lounges where patients can spend time with family and visitors
- design flexible spaces that can be used for group activities or social events
- offer a range of spaces that can accommodate varying group sizes, including smaller groups and one-on-one settings for more private discussions
- provide furniture types, fixed and mobile that discourage ownership and allow flexibility in use and location
- ensure that the ability to access and book social spaces is clear and obvious to prevent disruption

Privacy

3.12. For areas requiring privacy:

- ensure that private conversations and personal space are respected
- balance open communal environments with areas that offer privacy
- create environments that can be easily reconfigured to support both lively social interactions and more private moments
- incorporate design features such as partitions, natural landscaping, or architectural elements that subtly delineate areas for quiet reflection or confidential conversations
- use a mix of fixed and mobile furniture to allow spaces to be adjusted according to privacy needs without sacrificing the overall sense of community

- use materials and design techniques that reduce ambient noise, ensuring that even within shared areas, private discussions can occur without disruption
- ensure that the layout and signage clearly guide users to both communal and private areas, facilitating smooth transitions between social interaction and solitude

Inclusivity

3.13. For inclusivity within areas:

- incorporate design elements internally and externally that respect and celebrate diverse cultural backgrounds, creating environments where everyone feels represented
- ensure that all areas are designed to accommodate individuals of all abilities, including features such as ramps, wide doorways, and clear signage
- include formal and informal spaces for social interaction reflective of both planned and impromptu gatherings
- create versatile spaces that can be adapted for various activities and social interactions, catering to the needs of different groups and fostering inclusive participation
- offer a mix of communal and intimate spaces that encourage interactions among people of different ages, backgrounds, and interests, supporting a broad range of social connections

Community wealth building

3.14. For community wealth building:

- implement strategies and initiatives that are designed to reduce inequality and provide benefits across diverse segments of the community
- develop partnerships with local organisations to provide community services and boost the local economy
- use vacant or underutilised land for community gardens or social enterprises that benefit the local population
- encourage collaboration between community organisations, local authorities, and businesses to drive sustainable, locally led economic initiatives
- maximise community benefit opportunities of any infrastructure work, utilising local suppliers, materials and providing employment and education

Mental wellbeing

3.15. An individual's mental health is shaped by a combination of biological, psychological, social, and environmental factors. Mental health can significantly impact physical health, with improved mental health leading to shorter hospital stays, faster recovery times, better learning, enhanced performance, increased productivity, and stronger interpersonal relationships.

3.16. Mental wellbeing has been described as the positive aspect of mental health, and steps to promoting mental wellbeing can include connecting with other people, engaging in physical activity and mindfulness. These steps can all be positively influenced through the design of buildings and their interaction with external spaces.

3.17. To address the above requirements NHS boards should ensure that the design and quality of the built environment enhances mental wellbeing by creating environments that reduce stress, cater to individuals of all physical and cognitive abilities, and promote a positive mindset where aspects fall within scope, by incorporating the following elements.

Requirements

Visual comfort

3.18. For visual comfort within areas:

- optimise window placement and daylight to create a connection with the outdoors to help reduce stress and enhance mood
- design lighting systems that minimise glare and unwanted reflections and meet the requirements of Chartered Institute of Building Services (CIBSE) Lighting Guide (LG02) Lighting for healthcare premises (see ref 5), ensuring that spaces are comfortable for prolonged use
- provide spaces for occupants with adaptable lighting options to allow individuals to tailor the environment to their needs, supporting both focused activities and relaxation
- avoid provision of fully internal spaces with levels of prolonged activity that do not benefit from natural light provision or views to outdoors
- incorporate views of nature or art and where possible access to outdoor areas that inspire tranquillity, helping to maintain a positive mental state and reducing visual fatigue
- use calming colours, natural materials and artwork to create a soothing atmosphere
- ensure wayfinding is intuitive to reduce stress and confusion

Landscape/ biodiversity

3.19. For landscape/ biodiversity:

- provide significant areas of high-quality landscape that is rich in biodiversity
- where appropriate provide elements such as water features or gardens that promote tranquillity by encouraging reflection and relaxation leveraging the calming influence of nature to reduce stress and improve mood
- use a range of native and adapted species to create dynamic and multi-sensory landscapes that reflect natural ecosystems

- incorporate walking paths, meditation spots, and observation areas that encourage people to engage directly with natural surroundings
- plan for year-round visual variety to maintain a connection with seasons and to continuously offer new experiences for mental rejuvenation
- ensure projects deliver a net-gain in biodiversity
- new build and/ or deep retrofit projects should achieve a Green Space Factor (GSF) of 0.4 or greater
- consider future climate impacts in landscape design by incorporating strategies to manage heavier rainfall and rising temperatures, for example, through increased shelter and shade, enhanced water runoff systems, natural drainage, and the use of swales

Quiet spaces

3.20. For quiet space areas:

- designate specific zones where individuals can escape from the noise and bustle of daily activities
- use sound-absorbing materials and arrange massing, departments and room adjacencies to provide separation of inherently noisy, busy spaces to ensure relaxation and privacy
- incorporate muted colour palettes, soft lighting, and design elements that promote tranquillity
- include quiet spaces with natural materials and natural elements such as planting, appropriate provision of water features, or natural views to reduce stress
- provide both private spaces and small group areas to support personal reflection or quiet conversation
- ensure that quiet spaces are easily accessible and clearly marked so users can readily find a peaceful retreat
- design patient rooms and common areas that reduce noise, protect from noise pollution and enhance auditory comfort

Physical wellbeing

3.21. Physical wellbeing can be achieved by ensuring that buildings and outdoor areas promote physical health through active design principles. This includes indoor environmental quality (IEQ) issues, accessible routes, ergonomic workspaces, opportunities for movement, and spaces that encourage physical activity.

3.22. Physical inactivity is one of the leading causes of premature death in Scotland with evidence showing that even small increases in activity can help to prevent and treat chronic diseases and improve quality of life.

3.23. Within hospitals, immobility leads to deconditioning, which can be described as a loss of physical and cognitive functionality that potentially lengthens patient stay and increases risk of complications.

3.24. To address the above requirements NHS boards should ensure that the design and quality of the built environment enhances physical wellbeing and incorporates spaces that promote movement, comfort and safety by incorporating the following elements.

Requirements

Accessibility

3.25. For accessibility within areas:

- design environments with clear and intuitive circulation routes that are accessible, easily navigable for all users, and prioritise safety and security. Ensure appropriate lighting throughout, and incorporate opportunities for rest and respite to accommodate individuals of all physical abilities
- integrate active design features such as prominent accessible staircases, green spaces, walking paths, and designated exercise areas that promote daily physical activity
- provide direct access to green spaces and walking paths that reflect the variety of user types and ensure ease of access. This could be private garden space with direct ward access for rehabilitation or open site path networks for all
- incorporate and promote active travel and links with wider active travel networks
- select furniture and layouts that support healthy posture and reduce physical strain, ensuring comfort and reducing the risk of injury
- enhance indoor air quality, incorporate natural lighting, and use non-toxic materials to create spaces that support overall physical health

Ergonomics

3.26. For ergonomics within areas:

- consider adjustable workstations such as sit-stand desks and height-adjustable chairs to allow users to modify their work setup according to personal comfort and task requirements to support healthy postures, reduce strain and encourage movement throughout the day
- provide ergonomic seating such as chairs with lumbar support, adjustable seat height, and cushioning to promote good posture and reduce musculoskeletal stress
- design spaces with clear circulation paths and strategically placed work areas to minimise awkward movements and reduce the risk of injury
- incorporate dynamic features like active seating or areas that encourage periodic movement, to help combat the effects of prolonged sitting
- ensure that lighting minimises glare and reduces eye strain by using adjustable, well-distributed light sources that accommodate a range of tasks

- provide accessible controls for temperature, lighting, and acoustics to create a comfortable environment that supports overall physical wellbeing

Safety

3.27. For safety within areas:

- design spaces with well-marked, unobstructed circulation routes and clearly visible emergency exits to facilitate safe navigation during daily use and in emergencies
- use handrails, flooring and surface materials that reduce the risk of slips and falls, especially in high-traffic and potentially wet areas
- incorporate features such as surveillance, controlled access, and appropriate lighting to deter unwanted intrusions and enhance overall safety
- ensure appropriate ventilation and air quality to help reduce the likelihood of the spread of infections and meet service needs. This should be developed as part of wider indoor environmental quality considerations, which are covered in further detail in paragraph 3.47
- provide stable thermal comfort levels for the activities being undertaken by ensuring spaces are appropriately designed with a fabric first approach and suitable energy efficient systems, which is covered in further detail in paragraph 4.24
- ensure spaces are designed using an environmental security approach to protect against the impacts of climate change such as overheating and flooding
- minimise the negative impact on air quality and human health from emissions associated with construction products (such as interior paints, wood-based products, adhesives, sealants, acoustic insulation, flooring, ceiling and wall materials) the following indoor air emission concentration limits should be met through the specification of natural and low/ zero emission construction products:
    - Total Volatile Organic Compounds (VOCs) <0.5 milligrams per cubic meter (mg/m^3)
    - Formaldehyde <0.1mg/m^3

3.28. Healthcare developments can also positively impact the health and wellbeing of individuals at a community level through integrated planning and inclusive delivery approaches that promote and support people in being active regularly.

3.29. Providing opportunities to participate in physical activity can build confidence and an individual's level of ability. This can enable people to be physically active throughout their lives and deliver multiple health, social and economic benefits.

Occupational wellbeing

3.30. Occupational wellbeing focuses on the ways in which a working environment affects health and wellbeing and can be enhanced through design by creating a work environment that supports the health, satisfaction, and productivity of healthcare staff.

3.31. Research shows that happier workforces, motivated by their place of employment maintain higher standards of practice and demonstrate levels of increased productivity. There is also evidence to suggest that designs which promote greater interaction, respect, and ownership of or connection with surroundings, deliver additional benefits including lower levels of absenteeism, improved morale and motivation and fewer work-related injuries.

3.32. To address the above requirements, NHS boards should ensure that the design and quality of the built environment enhances occupational wellbeing by creating attractive, functional spaces that foster enjoyment and appreciation of the workplace and its surroundings where aspects fall within scope, by incorporating the following elements.

Requirements

Workspaces

3.33. For workspace areas:

- provide comfortable and functional areas, both internally and externally, where staff can both work efficiently and rest
- design workspaces with ergonomic principles to minimise physical strain
- provide furniture types, soft furnishings, fixed and mobile that discourage individual ownership and allow flexibility in use and location
- provide staff with appropriate storage space and changing facilities ensuring that staff areas are separate from patient areas to provide respite
- use fixtures, finishes and furniture suitable for the working environment and activity and recognise that not all spaces need a clinical aesthetic

Support facilities

3.34. For support facilities areas:

- provide flexible spaces that can accommodate workforce and individual team changes, reduction or expansion
- provide space that accommodates a variety of use types such as open plan working but can also facilitate more private conversations and work
- provide ergonomically designed workstations and flexible workspace layouts that support various working styles while reducing physical strain
- create internal and external areas for staff to rest and recharge, ensuring these spaces are separate from patient care areas for clear respite
- offer secure storage and easily accessible changing facilities to enhance staff convenience and comfort
- use a combination of fixed and mobile furniture to accommodate different tasks and discourage territorial claims, promoting a collaborative environment

- include spaces such as staff lounges, break rooms, gyms, quiet rooms and outdoor relaxation areas that encourage downtime
- integrate access to on-site support services, such as employee assistance programs, or dedicated quiet rooms for mindfulness and reflection

Professional development

3.35. For professional development areas:

- design spaces for training and continuing education and ensure clinical pathways allow for training opportunities. This should include extra activity space for trainees to be present within the direct working environment
- provide space for training and continued education suitable for group training and individual working related to statutory and mandatory training and personal development that cannot always be accommodated within an individual's direct working environment
- ensure spaces are equipped with multimedia technology, digital tools for e-learning and flexible furniture with spaces for sharing ideas
- design spaces with acoustics and lighting that support concentration and task-focused activities
- create spaces that encourage informal collaboration as well as private areas for personal reflection
- provide spaces for mental well-being and recovery

Economic wellbeing

3.36. Inclusive growth is a central component of Scotland's economic strategy, which aims to tackle inequalities in outcomes and opportunities and encourages all public sector bodies to work together and promote collaborative approaches that are focused on achieving multiple economic and place outcomes.

3.37. Healthcare developments can serve as 'anchor institutions' within local economies and project teams should identify where collaborative opportunities exist between professions, public sector organisations, businesses, and communities to maximise wellbeing benefits and enhance the integration of healthcare services. This should include exploring the potential for community wealth building as an approach to delivering inclusive economic growth.

3.38. The Place Standard tool can be used at the outset of both a new build and a refurbishment project to provide a framework to structure conversations about place and encourage consideration of the physical elements of a place (for example its buildings, spaces, and transport links) as well as the social aspects (for example whether people feel they have a say in decision making). This is covered in further detail in the Additional Considerations Section 5 (paragraph 5.19).

3.39. Economic wellbeing can be achieved by designing cost-effective spaces that reduce financial stress for both the healthcare facility and its users. It focuses on the value and optimisation of spending rather than eliminating spending on any individual requirement.

3.40. To address the above requirements NHS boards should ensure that the planning and design of the built environment enhances economic wellbeing and incorporates spaces that are accessible and affordable for all where aspects fall within scope, by integrating the following elements.

Requirements

Efficiency

3.41. For efficiency:

- use design strategies that maximise the efficient use of space and reduce operational costs
- emphasise passive design principles and a fabric first approach over high-maintenance system solutions (refer to paragraph 4.24 for details)
- design multi-functional spaces that can adapt over time to meet evolving needs
- use energy-saving systems and smart controls to reduce long-term utility costs
- adopt a circular construction approach by selecting materials that extend the building's lifecycle, minimise future repair and replacement costs, and support recycling and reuse, either through established pathways or by using materials that have already been recycled
- maximise daylighting and natural airflow to reduce reliance on artificial lighting and mechanical ventilation
- introduce smart building management systems (BMS) for real-time monitoring and control of energy, water, and waste to drive efficiency
- where feasible, include renewable energy sources to lower overall energy costs
- design for ease of maintenance and operational efficiency, reducing labour and service costs

Sustainability

3.42. For sustainability:

- implement energy-efficient systems to lower utility expenditure
- use high quality, low maintenance, durable materials that require less maintenance, extend the building lifecycle and reduce replacement costs
- incorporate renewable energy sources, such as photovoltaic (PV) solar panels, to decrease reliance on non-renewable energy sources and increase resilience
- utilise building orientation, insulation, natural ventilation, and shading to minimise energy demand and reduce the need for mechanical intervention

- design multi-functional and adaptable spaces that maximise usage, reduce waste, and lower operational costs
- install water-saving fixtures to reduce water consumption and lower operational costs
- integrate automated monitoring and control systems to continuously optimise energy, water, and resource use
- encourage eco-friendly construction techniques and materials that minimise environmental impact while ensuring long-term performance
- prioritise lifecycle cost analysis in design decisions to balance upfront investments with long-term economic and environmental benefits
- plan for flexible design solutions that accommodate evolving needs, minimising the need for costly renovations over time
- consider the ability for the building to adapt to the changing climate, or factor in the ability to retrofit adaptation measures when needed to avoid issues including, for example overheating or flooding

Affordability

3.43. For affordability:

- consider the incorporation of Modern Methods of Construction to achieve a balance between cost, risk and programme
- ensure that design choices do not result in excessive costs by prioritising cost-effective and value-driven solutions
- select energy-efficient, durable materials and systems to minimise long-term operational and maintenance costs
- implement value engineering practices to identify and integrate cost-saving measures without compromising quality
- use Building Information Modelling (BIM) and other digital tools to enhance planning accuracy and control project budgets
- design spaces with flexibility to accommodate future changes, reducing the need for expensive renovations or upgrades

3.44. Healthy places that are accessible to all that they serve and that support a variety of desirable purposes, including healthcare, employment, education, leisure, recreation, and attractive public spaces have the potential to demonstrate resilience to wider economic change and can more easily adapt to changing circumstances.

Wellbeing - key influencing factors

3.45. As noted within the above wellbeing sub themes there are several key themes that influence how to maximise wellbeing in the built environment. The following section looks to expand on these areas and help contextualise the requirements for addressing wellbeing.

3.46. These influencing factors should be embedded in all NHS board projects. By prioritising healthy indoor environments, access to nature, and active and sustainable travel options, NHSScotland aims to create welcoming, inclusive, and environmentally responsible healthcare spaces that enhance wellbeing for patients, staff, and communities alike.

Indoor environmental quality

3.47. IEQ encompasses a variety of factors that affect the comfort, health, and wellbeing of patients, staff, and visitors within healthcare facilities. A well-designed indoor environment enhances concentration, recovery rates, and overall health outcomes. The following are key considerations of IEQ:

- **air quality and ventilation** - ensuring high air quality through effective ventilation systems, consideration of external air quality and air filtration to reduce indoor pollutants and minimise respiratory issues and airborne disease transmission
- **lighting design** - maximising natural daylight while incorporating high-quality artificial lighting to improve mood, reduce eye strain, and support natural circadian rhythms for better sleep and recovery
- **thermal comfort** - maintaining consistent indoor temperatures, adaptive climate control, and energy-efficient heating and cooling systems to prevent discomfort and support patient healing
- **acoustic comfort** - managing noise levels through soundproofing materials, quiet zones, and thoughtful spatial design to reduce stress, enhance communication, maintain privacy and support rest and recovery

3.48. By prioritising IEQ, NHSScotland can create healthier, more comfortable healthcare environments that contribute to both patient recovery and staff wellbeing.

Active travel

3.49. Changing travel behaviour in favour of more active and sustainable options, will have a significant impact on the environment and local air quality while contributing towards Scottish Government net zero targets.

3.50. An active, accessible and sustainable transport strategy that encourages walking, wheeling, cycling, and the use of sustainable transport options supports physical health, environmental sustainability, and economic wellbeing. This will contribute to the Wellbeing priority theme by supporting the transition to a healthier and more inclusive society (see ref 6).

3.51. Early transport appraisals are essential to understanding local infrastructure and pinpointing opportunities for active, sustainable improvements. Additionally, health impacts can be assessed along with Regional Transport Partnerships (RTPs) to determine the health, economic, and sustainability impacts of a development. The location of development sites should be evaluated based on their connectivity to existing transport hubs and potential to join active travel networks, ensuring healthcare facilities are accessible to all.

3.52. NHSScotland is committed to reducing reliance on private vehicles and promoting healthier, low-carbon transport alternatives by incorporating the following:

- **pedestrian friendly design** - ensuring safe, well-lit, and accessible walkways that encourage walking both within and around healthcare sites
- **cycling infrastructure** - providing secure bicycle parking, cycle lanes, and shower/ changing facilities for staff and visitors who choose to cycle or walk
- **public transport accessibility** - enhancing connectivity with bus stops, train stations, and shuttle services to encourage the use of public transportation
- **green commuting incentives** - supporting staff and visitors with cycle-to-work schemes, subsidies for public transport, and carpooling programs to promote sustainable travel options

3.53. Engagement with national bodies can provide significant contributions when shaping a brief and can also positively influence future concept designs.

Greenspace/ biodiversity

3.54. Access to nature and biodiversity-rich environments has been widely recognised for their positive effects on mental, physical, and social wellbeing. Green spaces within and around healthcare estates provide therapeutic benefits, promote stress reduction, faster recovery, and a stronger connection to nature, all of which contribute to improved wellbeing as well as encouraging outdoor activity, and enhancing environmental sustainability.

3.55. Adopting holistic approaches can support the successful integration of placemaking and green infrastructure requirements, ensuring the delivery of safe, useable, and functional designs and features.

3.56. Using a baseline assessment and adopting a landscape-led approach during early conceptual development stages can add value by finding the right balance between buildings and external spaces. This also ensures that functional green infrastructure is provided which supports the site and its operational needs.

Option/ site appraisal

3.57. It is important to ensure that this is explored during the very early conceptual stages to allow maximum opportunity and benefit to be achieved for the site and the building(s).

Option/ site appraisal should consider strategies for:

- minimising geo-environmental risk
- minimising risk from any external sources of pollution

- optimising site layout and orientation, for buildings and people
- integrating greenspace interventions and green engineering principles

3.58. NHS boards should commit to a purposeful approach to landscaping that will create valuable, high-quality green infrastructure, supporting a network of multi- functional green space and delivering aspects of environmental security that benefit the immediate and wider community, as follows:

- **healing gardens and outdoor areas** - designing accessible green spaces, courtyards, and rooftop gardens where patients, staff, and visitors can relax, reflect, and socialise
- **biophilic design** - integrating natural elements such as planting, water features, and natural materials to create calming, restorative environments
- **biodiversity enhancement** - supporting local ecosystems through sustainable landscaping, tree planting, wildflower meadows, and habitat creation for pollinators and wildlife
- **climate resilience and sustainability** - using green infrastructure, such as green roofs, rain gardens, and permeable surfaces, to support stormwater management, reduce urban heat effects, and improve air quality and adapt to the potential impacts of climate change

3.59. Outdoor space should be accessible and available for use by clinical and non-clinical staff, patients and local communities and deliver a biodiversity net gain. As such, well-designed natural spaces and high-quality green infrastructure that supports a network of multi-functional green spaces, along with other sustainable circularity and climate change co-benefits should be prioritised.

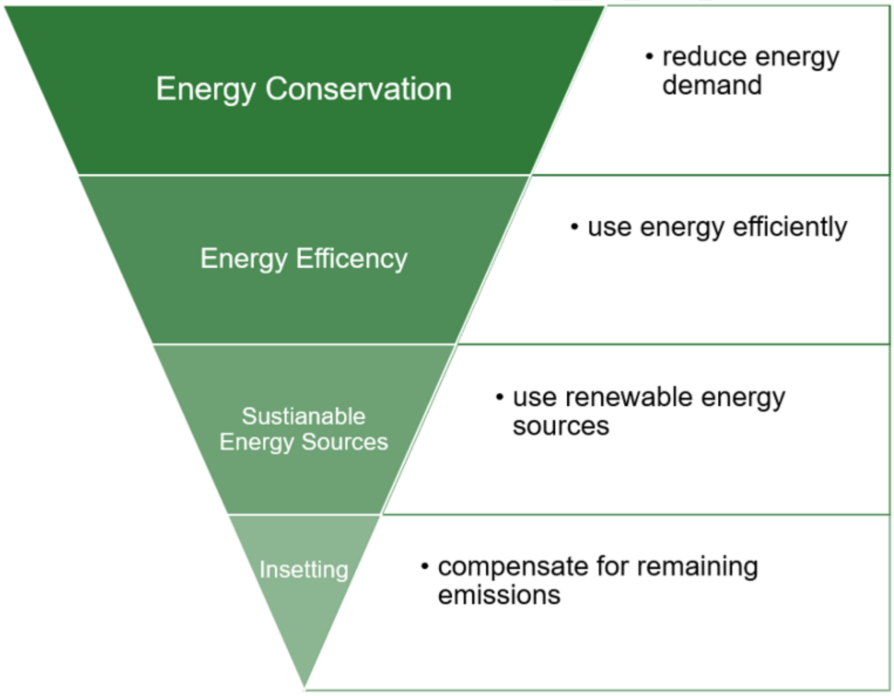
4. Energy Hierarchy

4.1. To meet the ambitions, targets, and requirements of national policy and strategy, it is critical to minimise the overall carbon footprint of every project in the built environment. Healthcare buildings, in particular, face challenges due to their equipment-intensive nature and higher occupancy levels, leading to increased energy use and carbon emissions compared to other sectors. Consequently, a consistent approach is essential to effectively manage these challenges.

4.2. The Energy Hierarchy is a framework and design methodology that prioritises minimising energy consumption and reducing carbon emissions in the built environment. It informs decision-making across design, construction, and refurbishment activities to achieve greater efficiency.

4.3. The key principles of the Energy Hierarchy are outlined below, along with corresponding actions to be applied throughout the design, construction, refurbishment, and maintenance of a building (see ref 7).

Figure 4.1 - Sustainable Design and Construction (SDaC) Energy Hierarchy



4.4. NHS boards should implement the Energy Hierarchy, as a design approach, sequentially to achieve the desired sustainable outcomes.

Energy conservation

4.5. To achieve a lean design, it is essential to minimise the energy needed for both building operations and healthcare services. This requires prioritising adaptive reuse and space optimisation, including digital healthcare strategies, before making the decision to create additional space and providing justification if these approaches are not feasible. Additionally, adopting a fabric-first strategy (see paragraph 4.24), is essential to reducing overall energy demand.

Adaptive reuse

4.6. Adaptive reuse involves repurposing existing buildings for new uses, extending their lifecycle, and reducing the need for new construction. This approach conserves resources, preserves historical structures, and minimises environmental impact. An initial intention to prioritise re-use should be fully exhausted prior to consideration of any new build or replacement assets.

Requirements

4.7. In meeting the above requirements, NHS boards should ensure that when an existing asset is being reused, whether as part of a service change, refurbishment, or maintenance, the following considerations are addressed. For replacement works, these considerations should only be included if they fall within the defined scope of the programme (see Figure 0.1), by incorporating the following elements.

Functional adaptation

4.8. For functional adaptation:

- redesign the interior layout to create functional spaces for healthcare services
- incorporate flexible design elements that can adapt to changing needs
- ensure the building is accessible to all users, including persons with disabilities

Structural assessment

4.9. For structural assessment:

- conduct thorough inspections to assess the building's condition and identify necessary repairs, alteration or structural strengthening to accommodate the types of space required and potential new uses
- consider structural engineering principles and include material reuse either direct from site or other sources

Preservation of historical elements

4.10. For preservation of historical element:

- identify and preserve significant architectural features and historical elements

- integrate modern systems and technologies in a way that respects the building's heritage
- use adaptive reuse as an opportunity to celebrate and showcase the building's history

Space optimisation

4.11. Space optimisation involves maximising the use of existing spaces to meet current needs without expanding the building footprint. NHS boards should analyse spaces or service areas to determine exactly how they are used and whether they can be used more efficiently.

4.12. NHS boards should consider the adaptive reuse, flows, occupation types and adjacencies of spaces before considering the need for new space and ensure that whatever space they have or require is designed to work as efficiently as practicable. This approach enhances efficiency, reduces costs, and minimises environmental impact.

Requirements

4.13. To address the above requirements, NHS boards should prioritise space optimisation from the outset of a project, especially when the need is driven by service change and should ensure that assets are fully utilised before considering the development of additional space, where aspects fall within scope, by incorporating the following elements.

Space utilisation analysis

4.14. For space utilisation analysis:

- conduct space audits to understand how existing spaces are used and identify underutilised areas
- engage with staff and stakeholders to gather insights on space needs and preferences
- develop a space optimisation plan based on the analysis

Occupancy management

4.15. For occupancy management:

- use occupancy sensors and data analytics to monitor space usage in real-time
- adjust space allocation based on occupancy patterns and needs to maximise efficiency of space as a resource
- implement booking systems for shared spaces to ensure efficient use

Departmental flow/ pathway analysis

4.16. For departmental flow/ pathway analysis:

- review department patient flows to understand movement between spaces, including movement for both patients and staff

- review key adjacencies for provision as required, and identify opportunities to amend and improve within the existing footprint
- adjust departmental layouts based on optimal arrangement to maximise efficiency of movement and flows within the existing footprint

Digital healthcare solutions

4.17. For digital healthcare solutions:

- implement digital healthcare solutions, including remote monitoring, community working and remote work solutions that support patients at home and reduce the need for physical space
- consider use of mobile service delivery options, for example mobile screening units and vaccination clinics that can reduce wait times and unnecessary hospital admissions

Flexible layouts

4.18. For flexible layouts:

- design multi-functional spaces that can be easily reconfigured for different uses
- use movable partitions, modular furniture, and flexible design elements to adapt spaces as needed
- plan for future adaptability to accommodate changing healthcare demands

Efficient storage solutions

4.19. For efficient storage solutions:

- implement vertical storage systems to maximise space
- use compact and mobile storage units to enhance accessibility and efficiency
- organise storage areas to ensure ease of access and minimise clutter
- design storage spaces to ensure they are appropriate for department needs and not spaces that can be arbitrarily filled
- provide storage space that reflects frequency of stock use and delivery and where possible evaluate the whole life impacts of more or less frequent stocking
- utilise digital storage for records information where practicable

4.20. By focusing on space optimisation, healthcare facilities can create more sustainable, efficient, and adaptable environments that meet the needs of patients and staff while minimising environmental impact and eliminating the need to create additional and/ or unnecessary space.

4.21. Where additional space is required, NHS boards should initially look within their own estate and consider refurbishment or deep retrofit of underutilised assets.

Energy efficiency upgrades

4.22. For energy efficiency upgrades:

- install high-performance insulation, windows, lighting, and heating ventilation and air conditioning (HVAC) systems that will improve energy efficiency
- implement renewable energy solutions, such as photovoltaic (PV) solar panels or wind systems
- use energy-efficient equipment and appliances to reduce operational costs

Compliance with guidance

4.23. For compliance with guidance:

- work with design professionals appropriate to the scope of works to ensure the repurposed building meets all relevant building standards
- work with key stakeholders, Subject Matter Experts (SMEs) and design professionals to determine applicable NHSScotland Technical Guidance and policy for the scope of works
- ensure the design meets all applicable NHSScotland Technical Guidance and NHSScotland Policy. Where necessary, identify proposed derogations brought about through adaptive reuse and, through a clear and engaged governance process, agree those that are acceptable

Fabric first approach

4.24. A fabric first approach prioritises the building's envelope (walls, roof, floors, windows, and doors) to enhance energy efficiency and occupant comfort before considering mechanical systems. This method focuses on optimising the building's physical components to reduce energy demand and improve thermal performance.

Requirements

4.25. To address this, designs should optimise building orientation and layout, use high-performance envelopes, implement passive design strategies and ensure high-quality construction is achieved. The requirements for this are noted below but should be tested utilising design tools such as Dynamic Simulation Modelling (DSM), covered in further detail in section 6 from the outset where aspects fall within scope, by incorporating the following elements.

Thermal bridging

4.26. For thermal bridging:

- use continuous insulation, advanced framing techniques and thermal breaks at junctions and connections to reduce thermal bridging

- conduct thermal imaging on existing structures to identify and address potential thermal bridges
- ensure all construction detailing is assessed, and thermal bridges have a maximum psi value of 0.04 watts per meter Kelvin (W/mK)

U-values

4.27. For u-values:

- select high-performance insulation materials and glazing to achieve low U-values and help maintain stable/ comfortable indoor temperatures using less energy. Refer to Table 4.1 for U-value requirements
- retrofit existing buildings with additional insulation layers and high-performance windows

Low carbon materials

4.28. For low carbon materials:

- select materials and determine design decisions based on the overall carbon impact, prioritise Whole Life Carbon Assessments (WLCA) of material impacts over the full lifecycle, further information in paragraph 6.9

Airtightness

4.29. For airtightness:

- implement meticulous construction practices and use airtight membranes and tapes to seal gaps, penetrations and joints
- conduct blower door tests to identify and rectify air leakage points
- ensure construction teams implement best practice for achieving airtightness (refer to Table 4.1 for target values)

Form factor

4.30. For form factor areas:

- design buildings with simple, compact shapes to minimise external surface area and reduce heat loss. Use Building Information Modelling (BIM) to optimise the form factor during the design phase
- consider modular construction techniques to achieve efficient form factors
- new build or deep retrofit designs should achieve a form factor of less than 3

Orientation

4.31. For orientation:

- position buildings to take advantage of natural light and solar gain, reducing the need for artificial lighting, ventilation and heating

- optimise building positions with cognisance of existing topography and avoid unnecessary earthworks
- use site analysis tools and DSM to determine the optimal orientation for energy efficiency, refer to Section 6 for further details
- incorporate features like atriums and light wells to enhance natural light penetration

Glazing ratios/ quantity

4.32. For glazing ratios/ quantity:

- optimise window size and placement, dependant on orientation, to balance daylighting benefits with thermal performance, using high-performance glazing
- ensure that g-values of glazing are considered, dependant on orientation or consider the use of dynamic glazing technologies, such as electrochromic windows, to adjust light transmission based on external conditions
- implement daylighting controls to maximise the use of natural light while minimising glare and heat gain (refer to section 3)

Shading, overheating, and thermal mass

4.33. For shading, overheating, and thermal mass:

- install external shading devices, such as louvres or overhangs, to control solar gain and reduce cooling loads
- incorporate trees, green roofs, and green walls to provide natural shading and cooling, enhancing the building's microclimate
- use materials like concrete or brick with high thermal mass to absorb excess heat during the day and release it at night, stabilising indoor temperatures
- design with adequate ventilation and natural cooling strategies to prevent overheating, especially in summer
- implement passive cooling techniques, such as night-time ventilation and microclimate enhancements such as landscape evaporative cooling to enhance thermal comfort

4.34. By focusing on the building fabric, healthcare facilities can achieve significant energy savings, improve indoor comfort, and reduce operational costs, contributing to a more sustainable and resilient Healthcare Built Environment (HBE).

4.35. As a minimum building fabric should reach the following optimised values for both new build and refurbishment projects and wherever particular elements are in scope.

Table 4.1 - Fabric Performance (watts per meter squared Kelvin (W/m^2K))

Parameter	Health Centre	Hospital
Walls	0.12	0.12
Roof	0.10	0.10
Floors	0.09	0.09
Doors	0.80	1.20
Glazing	**Glazing**: • U-value 0.80 • G-value 0.3-0.6 **Rooflight**: • U-value 1.1 • G-value 0.3-0.6	**Glazing**: • U-value 0.80 • G-value 0.3-0.6
Air Permeability	1 $m^3/hr/m^2$@50pa	1 $m^3/hr/m^2$@50pa

4.36. As a minimum, up-front embodied carbon quantities should reach the maximum optimised quantities in the following table:

Table 4.2 - A1-A5 Upfront Embodied Carbon (kilograms of carbon dioxide equivalent per square meter ($kgCO_2e/m^2$))

Product Stage Embodied Carbon	Primary Care	Acute Care
Total Upfront Embodied Carbon ($kgCO_2e/m^2$)	**550**	**620**
Substructure	90	90
Superstructure	200	200
Facade	80	80
Internal Finishes	45	45
Building services	135	170

4.37. The figures given here are for new build construction and in the event that all other options for space optimisation and adaptive reuse have been exhausted. It is expected that deep retrofit options will reduce optimised targets by around 80 $kgCO_2/m^2$ and full refurbishments where facades are retained and upgraded will, dependant on extent of works, have an overall target reduction of around 200 $kgCO_2/m^2$.

4.38. For maintenance only or lifecycle replacement projects there are no specific optimised values for Upfront Embodied Carbon as it will be scope specific.

4.39. All projects will be required to review the total carbon impacts utilising WLCA as part of the decision making to ensure total emissions are as close to zero as possible from cradle to grave, further information in paragraph 6.9.

Energy efficiency

4.40. To achieve an efficient design, it is vital to reduce carbon emissions from both building operations and healthcare services. This requires that all systems operate at peak energy efficiency, supported by robust controls and continuous monitoring to sustain optimal performance.

Specify energy-efficient systems

4.41. Reducing carbon emissions from building operations and healthcare services is crucial. This involves specifying energy-efficient systems such as advanced heating systems and heat pumps and ensuring that these systems are properly maintained to perform at optimal efficiency throughout their lifecycle.

4.42. Energy efficiency for an asset is principally determined by the systems and equipment in place, the more energy efficient these are, the more energy efficient the asset can be overall. This, alongside advancing technologies and good maintenance are key requirements within the HBE.

Requirements

4.43. To meet these requirements, NHS boards should prioritise the selection of the most energy-efficient systems and the latest technologies, where aspects fall within scope, by incorporating the following elements.

High-efficiency systems

4.44. For high-efficiency systems:

- choose systems which are highly energy efficient
- implement programmable thermostats, zone control and occupancy detection to control heating and cooling based on need to be as efficient as practicable
- install light-emitting diode (LED) lighting and energy-efficient appliances to reduce electricity consumption

Heat pumps

4.45. For heat pumps:

- evaluate the suitability of different types of heat pumps based on the site's characteristics
- install heat pumps to provide efficient heating and cooling by transferring heat from the air, ground, or water

- consider the global warming potential of refrigerant gasses

Regular maintenance

4.46. For regular maintenance:

- ensure proper maintenance and operation to maximise efficiency and longevity
- ensure that systems are safe, efficient, and sustainable throughout their lifecycle as detailed in Chartered Institute of Building Services (CIBSE) Guide M (see ref 8)

Centralised control

4.47. For centralised control:

- install Building Management System (BMS) to centralise control of HVAC, lighting, and other building systems
- use BMS to monitor and adjust system settings for optimal performance

Energy monitoring

4.48. For energy monitoring:

- use BMS to track energy consumption and identify areas for improvement
- implement energy-saving measures based on monitoring data
- use data analytics to optimise energy consumption

System integration

4.49. For system integration:

- integrate HVAC, lighting, security, and other systems for coordinated operation
- use BMS to ensure systems work together efficiently and effectively

Smart sensors

4.50. For smart sensors:

- use occupancy sensors to control lighting and HVAC systems based on real-time usage
- implement daylight sensors to adjust artificial lighting based on natural light availability

Automated controls

4.51. For automated controls:

- integrate automated controls to optimise energy use and reduce waste
- use BMS to coordinate and control building systems

Commissioning

4.52. Commissioning of systems is crucial for ensuring that building systems operate as intended, optimising performance, and achieving energy efficiency. It involves thorough testing, adjusting, and verifying all systems to meet design specifications, which helps identify and rectify issues early, reduce operational costs, and enhance occupant comfort and safety.

Requirements

4.53. To meet these requirements, NHS boards should undertake proper commissioning, this should be led by a dedicated commissioning manager and be in line with the requirements of CIBSE Guide M, to ensure that systems function efficiently from the start, supporting long-term sustainability and reliability where aspects fall within scope, incorporating the following elements.

Commissioning plan

4.54. For commissioning plans:

- develop a plan that outlines the commissioning process for all building systems, including implementation and management of seasonal commissioning as well as the transition period from commissioning to handover and operation (see ref 8)
- include pre-functional checklists, functional performance tests, and system verification

Performance testing

4.55. For performance testing:

- conduct tests to verify that systems are installed and operating correctly
- identify and address any deficiencies to ensure optimal performance and energy consumption, ensure that where design performance is not met this is factored into finalised design tool assessments, for example WLCA, Technical Memorandum (TM54)

Retrofit existing systems

4.56. Retrofitting of existing systems is vital for improving energy efficiency and performance in older buildings. It involves upgrading old or inefficient systems with modern, energy-efficient technologies, which can significantly reduce energy consumption, lower operational costs, and enhance occupant comfort.

Requirements

4.57. To fulfil these requirements, NHS boards should ensure that when retrofitting existing systems, the most energy-efficient options are chosen, where aspects fall within scope incorporating the following elements.

Energy efficiency upgrades

4.58. For energy efficiency upgrades:

- replace outdated HVAC systems, lighting, and appliances with energy-efficient alternatives
- install high-performance insulation and windows to improve thermal performance

System optimisation

4.59. For system optimisation:

- conduct energy audits to identify opportunities for system optimisation
- implement measures to enhance the efficiency of existing systems

Compliance with regulations

4.60. To comply with regulations NHS boards should ensure that the design meets all applicable NHSScotland Technical Guidance and NHSScotland Policy where aspects fall within scope, incorporating the following elements.

4.61. For compliance with regulations ensure retrofitted systems comply with current building standards and NHSScotland Technical Guidance.

4.62. By focusing on specifying energy-efficient systems, integrating smart technologies, ensuring proper commissioning, retrofitting existing systems, and implementing BMS, healthcare facilities can significantly reduce carbon emissions, lower operational costs, and contribute to a more sustainable and resilient built environment.

4.63. As a minimum Operational Energy should fall within the following optimised values.

Table 4.3 - Operational Energy Use (kilowatt-hour per square meter of floor area per year ($kWh/m^2/yr$))

Site	Primary Care	Acute Care
Operational energy use ($kWh/m^2/yr$)	100	140
Heating	15	15
Cooling	6	6
Auxiliary	10	50
Interior lighting	12	12
Hot water	10	10
Small power	20	30

Site	Primary Care	Acute Care
Communications equipment	20	25
Lifts	2	2
External lighting	5	10

4.64. Alternatively, projects can utilise the NHS England tool, specifically the NHS Net Zero Building Standard - Operational Energy and Carbon Compliance Reporting Tool, to determine a bespoke Operational Energy Use Intensity (EUI) target for their building. See Additional Considerations (Section 5) for further guidance.

4.65. As part of designing to achieve the identified operational energy values, NHS boards should establish at an early stage how this can be delivered and continue to monitor delivery and any opportunities for improvement. This approach should be caried out throughout the project's life cycle including into operational stages.

4.66. At operational stage it should initially be established as part of any Post Occupancy Evaluation (POE) if actual performance is in line with design performance followed by continued review for improvement. This approach is included within the toolkit for Royal Institute British Architects (RIBA) Stages 6 and 7.

Renewable, sustainable energy sources

4.67. It is essential to integrate sustainable energy systems into healthcare buildings. NHS boards should assess opportunities to integrate renewable energy systems, design for future integration, ensure proper commissioning, retrofit buildings where feasible, and upgrade existing systems. This reduces reliance on fossil fuels and lowers carbon emissions.

4.68. To meet policy and building standards, energy must be sourced from renewables with zero direct emissions. As of this writing, the only energy sources that align with policy requirements and offer a credible implementation pathway are the national electricity grid and onsite zero-emissions generation. Emerging technologies such as green hydrogen have yet to demonstrate their viability in meeting current policy criteria and timelines.

Integrate sustainable energy systems

4.69. Given the limited energy sources, and current available grid capacity, transitioning to all electric systems is not without challenge. It is therefore expected that NHS boards aim to limit that offsite energy requirement by insetting renewable technologies within their estate and including technologies such as Battery Energy Storage Systems (BESS) to increase resilience.

Requirements

4.70. Depending on the scale and ambition of a project NHS boards should consider the possibility of utility exports from sites, contributing further to economic and social wellbeing. This however should not be achieved at the expense of other valuable outdoor spaces that also helps contribute to wellbeing, where aspects fall within scope, incorporating the following elements.

PV solar panels

4.71. For PV solar panels:

- conduct a solar feasibility study to determine the optimal placement and size of PV solar panels
- install PV solar panels on rooftops or other suitable areas to maximise solar energy capture
- integrate energy storage systems to store excess energy for later use

Wind turbines

4.72. For wind turbines:

- assess the site's wind resources to determine the feasibility of wind turbines
- install small-scale wind turbines in areas with sufficient wind speeds

Heat Networks

4.73. For heat networks:

- assess potential for low-carbon heat networks on the site
- conduct heat mapping and energy master planning to identify areas with high heat demand density suitable for district heating
- evaluate technical and financial feasibility, including pipe routing and customer connection strategies

Design for future integration

4.74. Given the fast paced and complex developments in energy transition, it is essential that current projects are designed to remain flexible for future advancements. The net-zero targets achievable today may be surpassed by the lower emission levels that future technologies will make possible.

Requirements

4.75. NHS boards should ensure that projects are designed with sufficient flexibility to remain viable throughout their lifecycle. The requirements outlined below will help ensure that the HBE can continuously reduce its impact on climate change as targets and technologies evolve, where aspects fall within scope, incorporating the following elements.

Flexible infrastructure

4.76. For flexible infrastructure:

- design electrical and mechanical systems to allow for future integration of renewable energy technologies
- use conduit and piping systems that can accommodate additional wiring and plumbing for future upgrades and or expansion

Modular systems

4.77. For modular systems:

- consider modular HVAC and energy systems that can be easily expanded or upgraded
- use prefabricated components that can be added or replaced as needed

Space allocation

4.78. For space allocation:

- allocate rooftop or ground space for future PV solar panels or wind turbines
- consider areas for future renewable support infrastructure such as heat pumps, for example geothermal
- space for energy storage such as BESS

4.79. By focusing on integrating renewable energy systems and designing for their future integration, healthcare facilities can significantly reduce carbon emissions, lower operational costs, and contribute to a more sustainable and resilient built environment.

4.80. The three stages of the Energy Hierarchy described above are the most relevant to SDaC within NHSScotland however further stages look at using low carbon technologies and conventional energy sources.

4.81. Whilst it is unlikely these stages will allow adherence with current policy some projects may wish to consider these, having exhausted the initial three stages or with a view to providing backup resilience. Should direct emission energy sources be needed for resilience purposes, assets would not be Net-Zero ready.

Insetting - compensate for remaining emissions

4.82. Although NHSScotland Policy does not support offsetting, and implementing transparent, certifiable offset measures can be challenging, NHS boards should explore opportunities for insetting within their project boundaries.

Requirements

4.83. NHS boards should ensure that projects are designed with consideration to implementing measures to reduce and sequester carbon emissions within the building and its site where aspects fall within scope, incorporating the following elements.

Carbon insetting

4.84. For carbon insetting:

- develop a comprehensive plan to integrate carbon insetting measures during the design and construction phases
- use biochar in building materials like concrete to sequester carbon and enhance material performance
- install green roofs and living walls to absorb carbon dioxide (CO_2), improve insulation, and enhance biodiversity
- implement landscaping practices that enhance soil carbon storage (sequestration), such as planting deep-rooted vegetation
- install renewable energy systems like PV solar panels and wind turbines to reduce reliance on fossil fuels and lower carbon emissions

During construction

4.85. During construction:

- incorporate carbon insetting strategies throughout the construction process to reduce emissions from the start
- implement efficient construction practices and techniques that minimise waste and reduce energy consumption, such as modular construction and prefabrication
- incorporate materials that store carbon, such as wood and bio-based insulation

Continuous monitoring

4.86. For continuous monitoring:

- regularly track emissions and ongoing carbon sequestration within the building and site
- conduct regular assessments to verify the effectiveness of carbon insetting measures and make necessary adjustments
- ensure that carbon sequestration measures, such as biochar and green roofs, are maintained and monitored for long-term effectiveness

4.87. By focusing on carbon insetting within the building and its site, healthcare facilities can significantly reduce their residual carbon footprint, enhance sustainability, and contribute to a more resilient built environment.

Energy Hierarchy - influencing factors

4.88. While the Energy Hierarchy is the design approach that SDaC expects NHS boards to follow, there are several wider key considerations that should be considered.

Building component lifecycle

4.89. Project lifecycle, including renewal rates for individual elements, should be established at an early stage in the project and form part of the ongoing benchmarking process.

4.90. From a sustainability perspective the lifecycle of the project, for which WLCA and other modelling should be conducted is the maximum lifecycle of any physical component used. This is likely to differ from any commercial lifecycle review, with guidance independent of the requirements of WLCA. See paragraph 6.9 for further information.

4.91. For new build construction, as an example, it is likely that the substructure will be the longest lasting element and designed to a lifespan of 100 years whereas for existing buildings this might be much less depending on when they were constructed. In reality, some elements of the building would be replaced, sometimes multiple times, over 100 years and the embodied carbon figure would increase. The full WLCA would need to take this into account.

Conversion factors for predictions of EUI to carbon

4.92. As per Section 4 the current credible route for energy supply focuses on the national plan to decarbonise the UK's electricity supply by 2035. The UK government's figures indicate that decarbonisation of the grid may take until 2050 and even at that point there will still be residual carbon.

4.93. It is important that the conversion factor used for WLCA to calculate the impacts of future operational energy use is consistent. When NHS boards calculate this through the WLCA for the projected lifecycle of the project the conversion factors should be those provided by the UK Government Green Book (Electricity emissions factors to 2100, $kgCO_2e/kWh$) that projects electrical energy use in kWh to $kgCO_2$ equivalent per kilowatt hour based on the estimated carbon production of the electricity grid. This average factor accounts for the gradual decarbonisation of the grid.

Operational energy - water

4.94. Designing and specifying water-efficient features can significantly reduce operational water consumption, helping to lower Greenhouse Gas (GHG) emissions, minimise pollution impacts, and reduce both water usage and leakage-related costs.

4.95. The design should incorporate systems that prevent water quality deterioration, such as avoiding unnecessary cooling or extended storage that can lead to waste.

4.96. NHS boards should ensure that water efficiency is considered as part of their water safety plan to support an overall reduction in the operational carbon of the development while demonstrating a risk management approach to water hygiene. This will form part of the requirements noted under Energy Efficiency component of The Energy Hierarchy theme.

4.97. Flow control devices can regulate the water supply to each WC area or sanitary facility according to demand, to minimise undetected wastage and leaks from sanitary fittings and supply. These should be considered only where there is no perceived conflict with Scottish Health Technical Memorandum (SHTM) guidance in respect of infection prevention and control.

Metering strategy

4.98. NHS boards should develop a metering strategy with details of any sub metering arrangements and that allows for the monitoring of energy and water consumption as a minimum.

4.99. The sub-metering strategy, including the provision, location and accessibility of all sub-meters, should be discussed with the NHS board estate management team. All sub-meters should be pulsed output and compatible with and linked to the BMS/ Integrated Management System (IMS) prior to handover.

4.100. Separate sub-meters should be specified on the supply to the following areas where present and deemed beneficial:

- staff and public areas
- clinical areas and wards, for example:
    - renal
    - endoscopy
    - labs
    - theatres
- letting areas - energy supply to each tenant unit
- laundries
- main production kitchen
- specialist plant areas

Sustainable transport

4.101. Transport is a significant contributor to emissions both globally and nationally and Scottish Government aims to transform Scotland's transport system from one based on fossil fuels to one based on renewable energy and active travel.

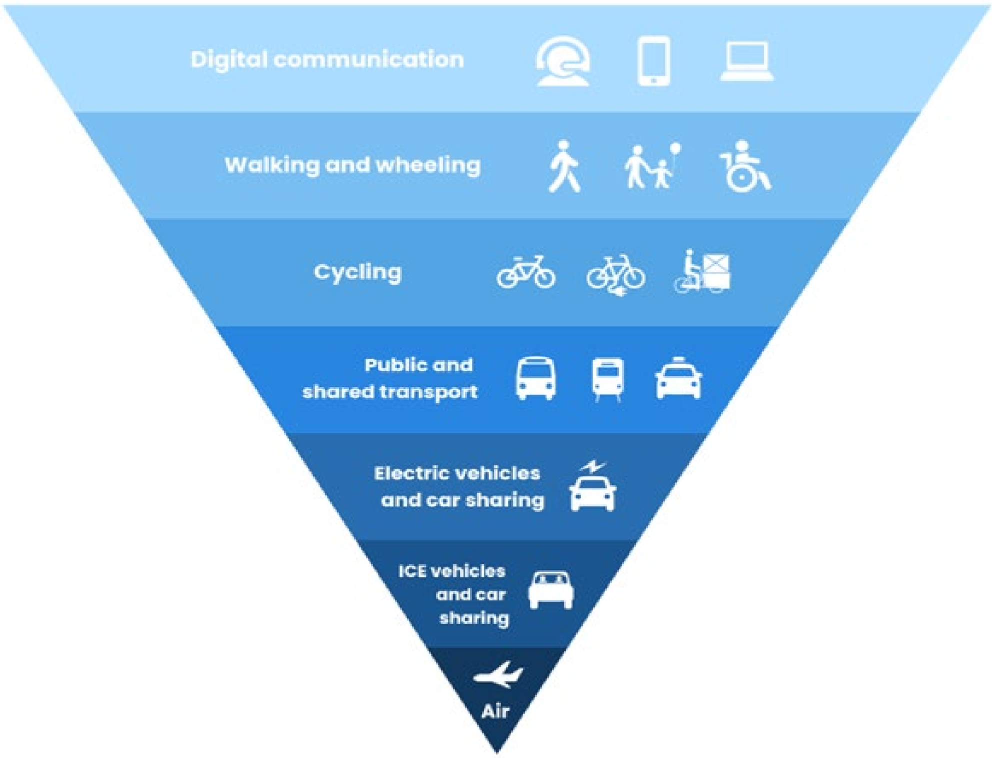
4.102. Furthermore, many journeys are short distance. 17% of journeys in Scotland in 2019 were under 1km, and more than half (54%) were under 5km. Lots of short distance trips offer real opportunities for increased active travel or use of public transport.

4.103. The transport system has a significant impact on local air quality, with road traffic contributing to recorded levels of Particulate matter (PM10) and nitrogen oxides (NOx).

4.104. Exposure to poor air quality can significantly harm health, increasing the risk of asthma, respiratory illnesses, and heart disease. Within SDaC's wellbeing theme, transport is closely linked to these health concerns, particularly due to air pollution from tailpipe emissions, particulate matter from tyre and brake wear, and noise, congestion, and traffic collisions.

4.105. Designs for sustainable transport should ensure site strategies and infrastructure have an element of resilience and can support the longer-term transition towards net zero.

Figure 4.2 - Sustainable travel hierarchy



4.106. Travel planning supports the implementation of sustainable transport interventions such as active travel, public transport, and trip sharing. As well as positive environmental impacts, these modes of travel also have both physical and mental health benefits.

Circular economy

4.107. A circular economy is considered an essential part of the solution to the global climate emergency and is one where products, services and systems are designed to maximise value and minimise waste.

4.108. Moving towards a more circular economy can have a positive impact on communities, the environment and businesses. Adopting circular design and construction practices increases supply chain resilience and certainty and reduces the amount of money lost on wasted construction materials.

4.109. A circular economy seeks to conserve and value all resource use and is guided by the following key principles:

- circular design and construction practices:
    - design out waste and pollution
    - adopting waste-efficient procurement and construction practices
    - designing for material optimisation and resilience
    - planning for deconstruction
    - responsibly managing site waste
    - design for maintenance action without disruption
- keeping products and materials in use:
    - recover and restore products, components, and materials through reuse and repair strategies, remanufacture or recycling
- regenerating natural systems:
    - avoid the use of non-renewable resources and preserve or enhance renewable ones, for example by returning valuable nutrients to the soil through food waste composting, or using renewable energy as opposed to consuming fossil fuels
- circular procurement:
    - engagement with the supply chain is essential to determine viability and to further explore available options

4.110. NHS boards should demonstrate a commitment to circular economy principles by requiring all projects to adopt circular design and construction practices, aim for zero waste outcomes, and support the regeneration of natural systems.

5. Additional considerations

Overview

5.1. Alongside the main themes of Wellbeing and Energy Hierarchy, and recognising the influencing factors noted for each of these, there are still a number of additional considerations that NHS boards should consider as they design and deliver a project.

5.2. By incorporating these additional considerations, NHS boards can not only minimise environmental impact but also enhance the health and wellbeing of building occupants, boost resilience and adaptation and address environmental, economic, social, and climate readiness objectives simultaneously, resulting in a built environment that offers sustainable benefits throughout its lifecycle.

Site selection

5.3. The following sets out some of the strategic decisions that should be considered by NHS boards when they are undertaking a site selection process. Site selection has the potential to save thousands of tonnes of carbon both through upfront energy use, operational use and waste as well as, for example, the consequential impacts on transport and travel. It is therefore vital that even at early stages of a project sustainability is a key element of decision making.

5.4. It is worth reiterating that for all developments, refurbishment of the existing estate should be prioritised over elements of new build. Where new build or deep retrofit is proven to be the only viable option, then; options for deep retrofit, including buildings/ locations which may not currently be within NHS ownership, should be exhausted prior to considering brownfield site selection; which in turn should be fully exhausted before considering greenfield development. Each step would need to fully evidence as unviable before proceeding to the next.

5.5. This is in accordance with Scottish Government Infrastructure Investment Plan 2021-2022 to 2025-2026 priorities as follows (see ref 9):

- determine future need
- maximise use of existing assets
- repurpose and co-locate
- replace or new build

5.6. As noted above, this site selection should extend to the refurbishing or repurposing of existing buildings, either already owned or not currently within NHS board ownership, the co-location with partner organisations and other options that improve the efficiency of existing assets. In addition, a Community Impact Tool is available and could assist in identifying local priority sites by gauging community perception of these.

5.7. Using the Sustainable Design and Construction (SDaC), its priority themes and sub themes to inform early stage strategic and site option appraisals can help to explore the various issues, principles and ambitions associated at an early development stage. For example, early engagement and involvement of a landscape architect can support the options/ site selection process and offer valuable insight and contributions in relation to planning and sustainability, which are more cost effective to consider at the earliest possible stage.

5.8. For new projects the importance of early appraisal and early-stage decision making greatly contributes to ensuring the most sustainable outcome is identified, and should consider environmental impact, transport and active travel, health and place.

5.9. Early consideration should be given to the opportunities and challenges that the site may present in relation to the following, for example:

- proximity and connectivity with local population
- proximity and connectivity with local road networks, services infrastructure, public transport and active travel infrastructure
- site context, surrounding building types and land uses
- site levels, conditions and associated ease of development
- ability to deliver efficient form factor, massing and orientation
- impact on, connectivity with, and opportunities to conserve and enhance existing landscape and biodiversity
- areas which are projected to be highly exposed to extreme weather events such as flooding, storms and high winds

Environmental security

5.10. Environmental security in terms of buildings refers to the measures taken to protect the physical assets of a building, including its infrastructure, equipment, and occupants, from environmental threats and hazards. It includes, for example, critical aspects such as Adaptation, Mitigation, Conservation, Pollution Control and Resource Management.

5.11. Climate change is driving more frequent, intense, and unpredictable extreme weather events, posing significant risks to healthcare infrastructure and services. It is therefore essential that assets are designed and built to be resilient to these evolving challenges.

5.12. These measures aim to ensure the safety, security, and resilience of buildings against various risks, such as heat events, flooding and so on and can be significantly improved through a considered approach to landscape design and the creation of multi-functional green infrastructure by making places safer, more sociable, and sustainable.

5.13. The building and the wider site have an opportunity to support the wider ambitions and strategy included within NHS board Climate Change Risk Assessments (CCRAs).

Stakeholder engagement

5.14. Stakeholder engagement plays an important part in understanding and positively influencing end user behaviour with the design demonstrating a clear connection between the space and its users.

5.15. As part of any wider stakeholder engagement exercises consideration should be given to sustainable design and construction requirements, for example when engaging with the following stakeholders:

- clinicians
- Infection prevention and control
- facilities managers
- patient representatives
- relevant transport providers and national transport steering groups
- estates teams
- compliance teams
- key supply chain partners
- third sector
- community groups
- equality groups
- staff groups (neurodiversity, disability)

5.16. Ongoing stakeholder engagement with communities is vital, offering opportunities for end-user groups to:

- express their views and influence the design process
- stay informed and connected, contributing insights that support more sustainable outcomes

To support this, a robust feedback and communication mechanism should be established throughout the project, aligned with a place-based approach.

5.17. Available for use and to support community engagement are the Scottish National Standards for Community Engagement: a set of good-practice principles designed to improve and guide the process of community engagement in Scotland. The seven standards are: Inclusion, Support, Planning, Working together, Methods, Communication, and Impact. The standards aim to build and sustain relationships between public services and community groups, helping them understand and address the needs and issues that communities experience.

5.18. A community-led health approach supports communities experiencing disadvantage and poor health outcomes to identify and define what is important to them about their health; identify the factors that impact on wellbeing; take the lead in identifying and implementing solutions. Community-led health can have a huge impact by targeting the provision of support to people and communities experiencing inequalities, disadvantage and marginalisation to take collective action, at both individual and community levels.

5.19. The Place Standard Tool supports the design and delivery of successful places, whether established, changing, or still being planned. It should be used during the early design stages and re-visited during development and improvement stages. The tool can help to identify project needs and align priorities and investment as well as empowering communities by allowing their views to be articulated and their voices to influence the design.

5.20. For larger projects, it is expected that the Place Standard Tool should be used from the earliest stage (Royal Institute British Architects (RIBA) Stage 0) to help influence decision-making. The tool should be reapplied at various stages to improve and assess the impact of the proposed development:

- early stages: identifying needs and assets, aligning priorities and investment, and engaging and involving communities
- during design and development stages: action planning, informing, or reviewing proposals
- for continuous improvement: monitoring changes or investments, community after-care or stewardship, and shared learning

Net Zero Public Buildings Standard

5.21. The Net Zero Public Sector Building Standard is a voluntary standard, owned by the Scottish Government and is applicable to public sector new build and major refurbishment projects. The Standard aims to elevate energy, emissions and environmental objectives to core project objectives and requires that checks are made at key stages and non-compliance rectified to ensure projects can proceed to subsequent stages without compromising the ability to meet all its core objectives.

5.22. The Standard follows the same project stage reviews as the SDaC guide and prioritises the same project outcomes including the requirement for NHS boards to meet Scottish Government targets for Net Zero, carry out detailed Dynamic Simulation Modelling (DSM) and set building specific targets for Energy Use Intensity (EUI) and Whole Life Carbon (WLC).

NHS England net zero building standard

5.23. The NHS Net Zero Building Standard provides technical guidance to support the development of sustainable, resilient, and energy efficient buildings that meet the needs of patients now and in the future. The Standard applies to all investments in new buildings and upgrades to existing facilities that are subject to HM Treasury business case approval process and are at pre-strategic outline business case approval stage.

5.24. As per paragraph 4.63, NHS boards may determine that a bespoke operational energy use target obtained using the NHS England Tool, specifically the NHS Net Zero Building Standard- Operational Energy and Carbon Compliance Reporting Tool, is preferable to the optimised targets noted in Table 4.3 The decision for this should be recorded and evidenced as part of the SDaC process.

Soft landings

5.25. Government Soft Landings (SL) is a key element of the design and construction process maintaining the 'golden thread' of the building purpose through to delivery and operation, with early engagement of end users and inclusion of a SL champion on the project team and commitment to aftercare post construction (see ref 10).

5.26. There are many benefits to a SL approach, mainly that the process helps to ensure that any asset created by an NHS board meets the end users' needs and required operational outcomes, plus through Post Occupancy Evaluation (POE), monitors the project outcomes post completion against performance and cost criteria, with lessons learnt captured for future projects.

National Planning Framework 4

5.27. The National Planning Framework 4 (NPF4) is Scottish Governments national spatial strategy for Scotland setting out the spatial principles, regional priorities, national developments and national planning policy (see ref 11).

5.28. As noted by Scottish Government, NPF4, is required by law to set out the Scottish Ministers' policies and proposals for the development and use of land. It plays a key role in supporting the delivery of Scotland's national outcomes and the United Nations Sustainable Development Goals, as referenced in Section 2.

5.29. NPF4 contains national strategy and development maps as well as regional spatial priorities. This information will therefore inform and be informed by the development of healthcare projects.

5.30. NPF4 also contains National Planning Policy setting intent, outcomes and the impact sought under 3 key areas of:

- Sustainable Places
- Liveable Places
- Productive Spaces

5.31. Content also details how these are to be used to inform Local Development Plans which NHS boards will align with as part of any developments of healthcare services, facilities or estates.

6. Design tools

Dynamic simulation modelling

6.1. Dynamic Simulation Modelling (DSM) is a key iterative design tool in the sustainable design and construction of healthcare buildings. It should be used with cognisance of the main priority themes, sub themes, influencing factors and additional considerations noted within this guidance to inform and guide decision making.

6.2. It is vitally important that the design of buildings is accurately modelled to ensure they deliver comfortable and stable internal environments for all occupants, during all seasons and for both present and predicted future climatic events.

6.3. The Scottish Futures Trust Net Zero Public Sector DSM Guide is part of the broader Net Zero Public Sector Buildings Standard (see ref 12) and provides guidance across the full lifecycle of public sector building projects in Scotland across key project stages.

6.4. A passive design approach and detailed Dynamic Simulation Modelling (dDSM) play an important role in the transition to net zero and should be delivered at an early stage of the project and used as an iterative design tool from early option/ site selection throughout the entire design process.

6.5. There are requirements for different types and levels of information at each stage in the modelling process to assess and identify suitable mitigation and adaptation measures. This for example will assist in minimising risk of overheating, whilst ensuring that the building can still benefit from good levels of daylight.

6.6. To address any performance gap issues, it is important that the information collated and used to predict theoretical performance during design development stage accurately represents the presence and use of systems, services and actual operational patterns, as far as reasonably possible and should be a collaborative process. Chartered Institute of Building Services Engineers (CIBSE) Technical Memorandum (TM54) and CIBSE TM61, provide guidance on data input requirements.

6.7. This principle should also apply when modelling in-use building performance, ensuring scenarios reflect how the building will actually operate. The model should be updated as more detailed information becomes available. This approach supports outcome-based learning and allows potential issues to be addressed, ideally through passive measures, rather than relying on late-stage technical interventions.

6.8. The following types of modelling should be used when an aspect of project scope is likely to impact performance in these areas:

1. **CIBSE TM54** (operational energy use):
   i. evaluates and predicts operational energy use at the design stage. Covers all energy uses (regulated and unregulated) and includes methodologies for dynamic simulation and detailed heating, ventilation, and air conditioning (HVAC) system modelling. For Healthcare, quasi-steady state tools should not be used in isolation as they do not provide adequate data points, detailed DSM should be used
2. **CIBSE TM52/ TM59** (overheating risk):
   i. provides a methodology to predict the risk of overheating in buildings, including sleeping accommodation (TM59). Use three criteria to assess thermal comfort and overheating: the number of hours the temperature exceeds a threshold, the severity of overheating, and the adaptive comfort model
   ii. within NHSScotland all three criteria should 'pass' for these assessments
3. **Climate-Based Daylight Modelling** (CBDM):
   i. assesses daylight availability and quality in buildings. Uses dynamic simulation to evaluate daylight metrics such as daylight autonomy, useful daylight illuminance, and annual sunlight exposure. For NHSScotland requirements of CIBSE Lighting Guide (LG02) Lighting for healthcare premises should be met alongside the wider suite of CIBSE Society of Light and Lighting (SLL) LG guides where appropriate (see ref 13)
4. **Ventilation Flows/ Computational Fluid Dynamics** (CFD):
   i. models natural and mechanical ventilation strategies. Includes analysis of airflow patterns, ventilation rates, and the impact on indoor air quality and thermal comfort
5. **Thermal Comfort Modelling**:
   i. evaluates indoor thermal comfort conditions. Uses dynamic simulation to assess factors such as temperature, humidity, air velocity, and radiant temperature
6. **Weather Files:**
   i. Using the correct weather files requires careful selection and application to ensure accurate building performance simulations. To ensure accuracy, refer to The Scottish Futures Trust Net Zero Public Sector Modelling Guide (see ref 14) which provides detailed guidance on the use of weather files and modelling practices to ensure accurate and robust predictions of building performance

Whole life carbon assessment

6.9. A Whole Life Carbon Assessment (WLCA) is a comprehensive evaluation of the carbon emissions associated with a building or infrastructure project throughout its entire lifecycle. This includes emissions from the extraction of raw materials, construction, operation, maintenance, and eventual demolition and disposal.

6.10. To reflect the varying life cycle stages and associated emissions and to ensure a project is on track to meet its policy targets and deliverables, an IMPACT compliant WLCA (see ref 15) should be carried out at various recognised stages through the project.

6.11. Data used as part of the WLCA should be credible and it is therefore essential that sources such as Environmental Product Declarations (EPDs) are used. EPDs are independently verified and registered documents that communicate information about the life cycle environmental impact of a product in a transparent and comparable way. It is noted that while EPDs may not be available in all instances, IMPACT compliant tools have in built methodologies to assist with this requirement.

6.12. Supply chain engagement is an important step in allowing project teams to understand the level of existing opportunity for embodied carbon reduction.

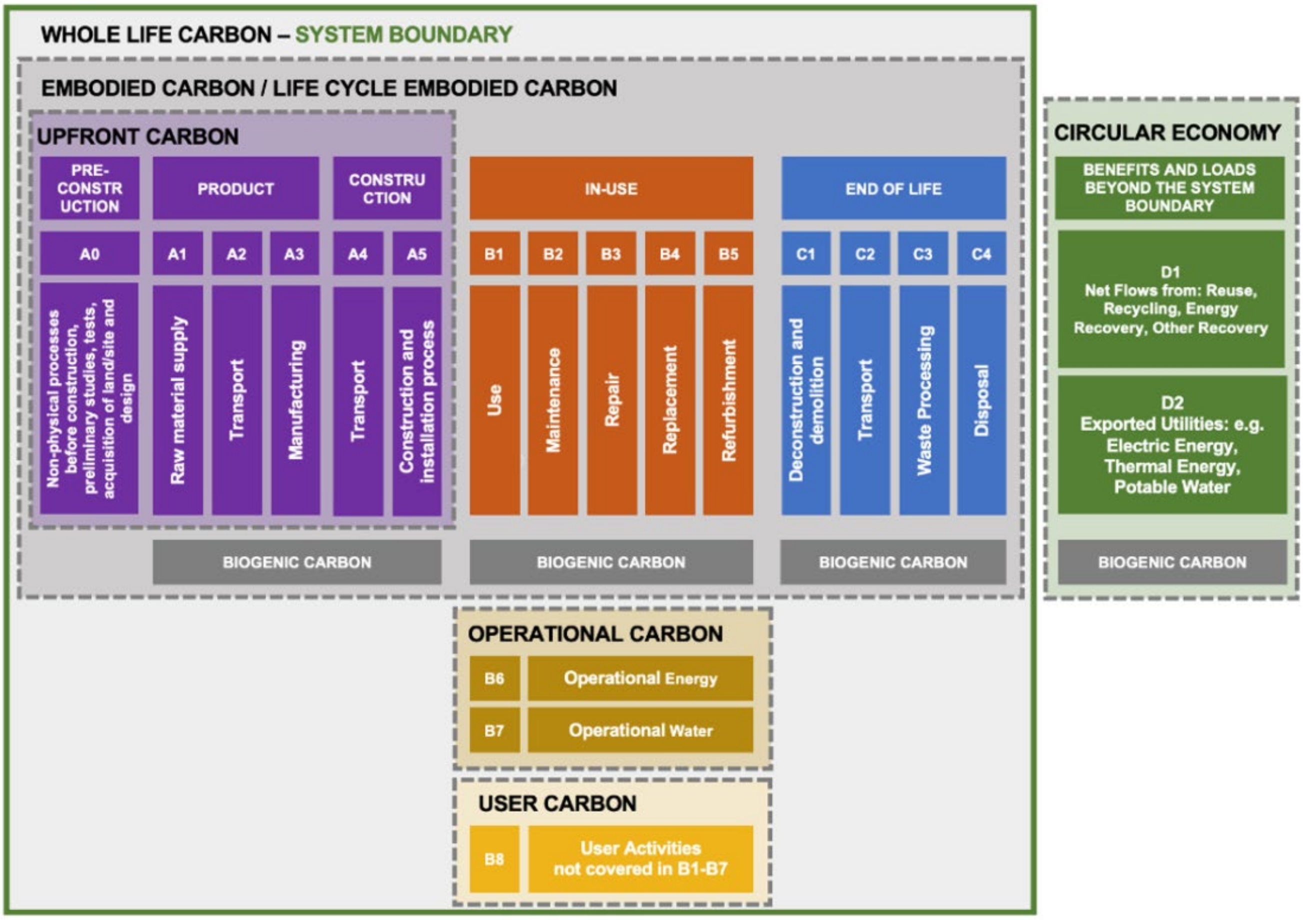
6.13. The assessment should be iterative however formal reporting should be carried out based on Royal Institute British Architects (RIBA) stages as follows:

- **pre-construction** (RIBA Stages 0-2) Strategic Definition, Preparation and Brief, Concept Design:
    - this is an outline assessment based on overall anticipated design solutions being considered at this stage, and the WLCA should be used to inform the stage 2 design optioneering
- **construction** (RIBA Stages 3-4) Spatial Coordination, Technical Design:
    - this is a more detailed review of the emerging technical design solution and should be conducted using a mature detailed analysis of the technical solution
- **operation** (RIBA Stages 5-6), Manufacturing and Construction, Handover, Use:
    - this is the final WLCA for the project prior to use and will be based on the as- built information to determine exactly how much upfront carbon has been used, and what carbon impacts the end of life for the asset will have and be based on extremely accurate final design modelling to understand the operational carbon use

Aspects considered in WLCA

6.14. Carbon emissions related to the various life cycle stages are described below and are aligned with the recognised British Standards (BS) European Norm (EN) 15978 (see ref 16) of modules A-D. The following chart sets out the modular structure for WLCAs which is broken down into several stages in the built asset's life cycle.

Figure 6.1 - Building life cycle stages and information modules (adapted from EN 15978)



6.15. For all areas of the WLCA, NHS boards should demonstrate that they have achieved the lowest possible carbon position for the scope for the project whist adhering, as a minimum to the optimised targets listed in Table 4.1, 4.2 and 4.3. as well as any NHSScotland and Scottish Government strategic policy goals.

Some of the above modules are broken down further into sub-modules as follows:

- embodied carbon - refers to the Greenhouse Gas (GHG) emissions associated with the production, transportation, installation, maintenance, and disposal of building materials throughout the entire lifecycle of a building. This includes:
    - upfront carbon - emissions released before the building is operational, including extraction, manufacturing, and transportation of materials:
        - A0: pre-construction carbon

- A1: raw material supply
- A2: transport
- A3: manufacturing
- A4: transport to site
- A5: construction and installation processes

- in-use carbon - emissions associated with the maintenance, repair, and refurbishment of the building during its operational life:
  - B1: use
  - B2: maintenance
  - B3: repair
  - B4: replacement
  - B5: refurbishment
- end-of-life carbon - emissions from the demolition, waste processing, and disposal of building materials at the end of the building's life:
  - C1: deconstruction and demolition
  - C2: transport
  - C3: waste processing
  - C4: disposal
- operational carbon - emissions from energy use during the building's operational phase:
  - B6: operational energy use
  - B7: operational water use
- circular economy - potential for materials to be reused or recycled at the end of the building's life, reducing waste and emissions:
  - D1: reuse, recycling, energy recovery
  - D2: exported utilities
- user carbon - emissions associated with the activities of building occupants, such as travel and resource use. Although part of the principles of WLCA considerations Sustainable Design and Construction (SDaC) does not currently require this to be captured as part of a WLCA

6.16. A WLCA should be completed and assessed, as a minimum, at each of the lifecycle stages noted above where the scope of a project includes the provision of materials, plant or equipment.

6.17. It is essential that the WLCA is considered holistically to ensure that carbon footprint emissions are balanced throughout the design to be as close to zero as possible, some examples of this are noted below:

- a wall build up with limited materials and a reduced upfront carbon cost:
    - while this may have a significant impact on reducing up front carbon costs it will also result in an increased need for heating and cooling resulting in higher operational carbon costs
- a material which has higher raw material and preconstruction carbon costs:
    - this may have a smaller upfront carbon cost overall than a similar item if it can be produced and sourced locally rather than from further afield
- a higher quality material with a higher initial carbon cost:
    - could offer whole life carbon advantages over another material which may have to be replaced more often during its operational lifecycle

6.18. As above, WLCA should be used to allow NHS boards to demonstrate that they have achieved the lowest possible carbon position for the scope for the project whilst adhering to any NHSScotland and Scottish Government strategic policy goals. With a focus on carbon this differs from any commercial life cycle review.

6.19. Emphasised within this guidance document is the balance required to achieve optimal sustainable outcomes across the NHSScotland estate. This balance extends to other parts of project delivery including applicable guidance and the clinical environments in which it will be applied, considering models of care, clinical pathways, service delivery, infection control as well as commercial considerations.

6.20. Considerations and decisions made as part of application of this guidance document are holistic and are as a response to overarching policy and should therefore be used to inform commercial reviews.

7. Example of use

7.1. The following examples are included to help demonstrate how Sustainable Design and Construction (SDaC) is to be applied for smaller scale projects where it is accepted full application will not be possible as identified in Figure 0.1. NHS boards undertaking a new build or major refurbishment project should follow the guidance in its entirety with the toolkit completed from Royal Institute British Architects (RIBA) stage 0.

7.2. Examples are focussed on how SDaC is applied, this does not however mean SDaC is being applied in isolation, rather that sustainability is embedded as part of all decision making. It is confirmed that application of SDaC as part of these examples has considered applicable guidance, clinical environments, service delivery, infection control and so on.

7.3. It is also advised that the examples below refer to weightings used as part of a procurement exercise, these weightings from part of the example and are not prescriptive. Weightings are included to emphasise that sustainability and consideration of Whole Life Carbon Assessment (WLCA) form a key part of the decision-making process. It is expected that NHS boards will include sustainability as part of any procurement exercise and weightings will be decided by the board based on the project scenario and procurement route.

Scenario 1 - window replacement

7.4. Hospital A has identified that their original 1980's windows are well beyond their serviceable lifespan and are contributing to unsustainable maintenance costs as well as failing to deal with the growing impacts of climate change. There are areas affected by overheating, draughts and the general poor condition has led to limited functionality in some habitable areas.

7.5. Recognising the need to assess the extent of scope required as part of SDaC, the NHS board follow the process identified in Figure 0.1 and agree this scope of work aligns with the question *'Does the planned scope of work involve, or could it potentially involve, new or replacement plant, fixtures or fittings?'* As the window replacement aligns to the 'replacement of fixtures*'*, the extent to which SDaC should be followed is therefore clarified from the outset.

SDaC assessment

7.6. Following the SDaC guide the project team ensure that Energy Hierarchy and economic wellbeing are at the forefront of the briefing and procurement process, taking a fabric first approach and considering the window improvements' consequential benefits of reducing energy use and improving building efficiency.

7.7. The project team also consider key aspects of physical and mental wellbeing and ensure they include the SDaC Evaluation Tool requirements within their design journey, in this instance the team specifically focused on:

- optimise window placement and daylight to create a connection with the outdoors to help reduce stress and enhance mood
- incorporate views of nature or art and where possible access to outdoor areas that inspire tranquillity, helping to maintain a positive mental state and reduce visual fatigue
- enhance indoor air quality, incorporate natural lighting, and use non-toxic materials to create spaces that support overall physical health
- ensure appropriate ventilation and air quality to help reduce the likelihood of spread of infections and meet service needs. This should be developed as part of an Indoor Environmental Quality (IEQ) Plan, which is covered in further detail in paragraph 3.47
- provide stable thermal comfort levels for the activities being undertaken by ensuring spaces are appropriately designed with a fabric first approach and suitable energy efficient systems, further details in paragraph 4.25
- ensure spaces are designed using an environmental security approach to protect against the impacts of climate change such as overheating and flooding

7.8. Following initial design considerations an early performance specification for new windows is produced based on:

- a u-value of 0.8 Watts per square meter per Kelvin (W/m^2K)
- a like for like replication of original vent opening size
- the need to ensure an airtight, insulated jamb installation to limit thermal bridging

7.9. This specification is then tested through Climate-Based Daylight Modelling (CBDM)/ Technical Memorandum TM52/ TM59/ TM49 modelling to determine suitability and ensure avoidance of any overheating issues. This process helps identify the need for stronger g-values to glazing in several south facing wards as well as the need to restrict the actual glazing size, though not the vent opening size, in three bedrooms on an elevated southwest corner. These changes are added to the outline performance specification.

7.10. The team also determine that TM54 modelling is required as it is likely the change in windows will affect operational energy use. Modelling demonstrates that, despite some loss of thermal gain that previously contributed to reduced heating loads, the overall result will be lower cooling and heating demands.

7.11. The team discuss the need to review Ventilation Flow modelling (such as Computational Fluid Dynamics (CFD)) to understand how the current provision contributes to their ventilation strategy. Through discussions, they conclude that this falls beyond the project's scope, since no specific risks or issues with ventilation have been identified, and a like-for-like replacement, including the opening type, will not significantly affect ventilation, no further action is required. It was noted that air movement and therefore wind pressure would likely reduce around the window jambs however following further discussion the risk was assessed, and it was determined that a modelling review won't be undertaken as part of this process. This decision making was documented and discussed with the ventilation safety group.

7.12. With the outline specification now in place, the team put the contract out to tender with all the necessary drawings, scheduling and information. As part of their tendering, they require not only the return of full specification, programme and cost for works but also an IMPACT compliant WLCA for the next 50 years. The period of 50 years was chosen as this is the maximum expected remaining lifecycle of any single building component, in this instance the reinforced concrete foundations and frame. The WLCA was based upon the Life Cycle Embodied Carbon (see Figure 6.1) only as the operational energy was deemed to be consistent due to specification.

7.13. Tenders are returned and assessed based upon the key contract elements of programme, cost, quality, and sustainability. For this project the review was weighted as 30% time, 15% cost, 25% quality and 30% sustainability. Given that this was a full hospital replacement, sequence and programme is key to the delivery and the WLCA element within sustainability is known to recognise the replacement lifecycle over the whole life of the project so indirectly covers key elements of economic wellbeing not included within the prime costs returned. It is recommended that sustainability forms a substantial part of all decision making.

Programme outcomes

7.14. The project has successfully mitigated all current overheating issues which can be demonstrated through the remaining building lifecycle; it has reduced energy demand considerably; improved thermal comfort levels and eliminated draughts from occupied spaces as well as regaining the functionality that was originally intended. It has also improved the security of some of the more remote spaces within the hospital.

Scenario 2 - flooring replacement

7.15. Hospital B has identified that flooring within circulation and general in-patient ward spaces has reached end of life, and its poor condition is now contributing to both staff health and safety and clinical service risks. The existing flooring condition is causing issues with staff, patient and visitor circulation as well as movement of beds, trolleys and equipment. Flooring condition is also causing difficulties with cleaning and maintaining cleanliness standards generally, in particular for clinical functions.

7.16. Recognising the need to assess the extent of scope required as part of SDaC, the NHS board follow the process identified in Figure 0.1 and agree this scope of work aligns with the question 'Does the planned scope of work involve replacement of materials through maintenance or lifecycle replacement?'. The extent of which SDaC that should be followed is therefore clarified from the outset.

SDaC assessment

7.17. Following the SDaC the project team ensure that Energy Hierarchy, and economic wellbeing are at the forefront of the briefing, decision making and procurement process. This approach includes applying the principles of the fabric first approach to material selection and undertaking a WLCA. The project team also consider key aspects of economic wellbeing and ensure they include the SDaC Evaluation Tool requirements within their design journey, in this instance the team specifically focused on:

- select materials and determine design decisions based on the overall carbon impact, prioritise WLCA of material impacts over the full lifecycle
- circular economy incorporating circular design and construction practices; keeping products and materials in use and circular procurement
- use high quality, low maintenance, and durable materials that require less maintenance, extend the building lifecycle and reduce replacement costs
- encourage eco-friendly construction techniques and materials that minimise environmental impact while ensuring long-term performance

7.18. Following initial discussions about how best to assess material specific options related to overall carbon impact in advance of any tender process, it was agreed to review the Environmental Product Declarations (EPDs) for those materials identified as suitable for installation in circulation spaces and in-patient ward environments. This review also included consideration of adhesive and non-adhesive installation as it was identified that this will have an impact on IEQ as well as WLC.

7.19. Due to the different areas of the hospital requiring flooring replacement, the material choices identified as suitable for non-clinical circulation spaces and the clinical ward environments differed. It was agreed that adhesive free options would be suitable for circulation spaces whereas adhesive fixed would be required within the ward environment.

7.20. The EPDs of suitable products were then reviewed to allow an initial comparison of a product's material content including, renewable, recycled and non-renewable content, manufacturing and production processes including waste, and transport and delivery. This review process enabled a reduction in the number of suitable products allowing the project team to then further review and assess the other elements of WLCA including ongoing maintenance and cleaning requirements, durability and replacement cycles.

7.21. Consideration was given as to whether the tendering process would be based on a number of suitable products requesting WLCAs by the flooring contractor, or if the project team could carry out comparative WLCAs in advance to determine the specification. It was agreed that completing the WLCA by the NHS boards project team was the preference due to the required skillset being available within the board whereas this may not be readily available or part of the services provided by any flooring contractor.

7.22. Completing WLCAs based on the remaining options was then undertaken which ensured project team and NHS board ownership and understanding of the decision-making process as well as informing the preferred specification to be taken forward to the tender process. With this approach and the project team's overarching application of SDaC from the outset it was agreed tender reviews could be based on a lower percentage allocation for sustainability. For this project the review was weighted as 30% time, 35% cost, 25% quality and 10% sustainability with the sustainability allowance enabling those tendering the opportunity to offer further innovation though their delivery approaches.

Programme outcomes

7.23. The project has successfully replaced flooring as required, with the early-stage decisions related to floor fixing methods greatly reducing on site construction activities. Innovations offered by the contractor were also applied where it was agreed areas of flooring could be from existing supplier stock of the same specification of flooring. Consideration was given to where this may be best applied, agreeing this would be suitable for areas of less activity and areas identified where future change is likely and therefore the reduced product lifecycle would not have an impact.

Scenario 3 - ward refurbishment

7.24. Hospital C has agreed an in-patient ward area requires refurbishment due to numerous issues including, the age, quality and condition of internal finishes generally, fabric condition causing issues with overheating and draughts and associated issues with a lack of user and system control within the ward space. It is also recognised that room functions within the ward have changed use, been taken over by another function, or become shared spaces with other functions creating issues with clinical service delivery, patient safety and occupational wellbeing.

7.25. Recognising the need to assess the extent of scope required as part of SDaC, the NHS board follow the process identified in Figure 0.1 and agree this scope of work aligns with the question 'Does the planned scope of work change or could it potentially change, any spaces inhabited by staff visitors or patients?'. As the ward refurbishment works will seek to improve and therefore change the spaces inhabited by staff, patients or visitors, the extent to which SDaC should be followed is therefore clarified from the outset.

SDaC assessment

7.26. Following the SDaC guide the project team recognise that the project should follow all guidance from RIBA stage 0. It is also recognised that there will be limitations on the ability to follow all the guidance due to the ward forming part of a much larger site, it being on an upper level, the ward utilising and relying on numerous centralised services for staff, visitors and patients as well as being served by existing site infrastructure. Through review of the guidance, it was agreed that whilst application of all guidance should be sought and this approach would form part of the briefing development process, it was agreed that where guidance could not be followed, reasoning for not including would be provided at the appropriate stage as part of the toolkit self-assessment.

7.27. Early-stage reviews then took place related to each priority theme focussing on application of all guidance but identifying areas where this may not be possible. Following review of Wellbeing, it was acknowledged that while much of the guidance could be applied there are exceptions to requirements related to the following areas:

- creation of outdoor spaces, natural landscapes/ biodiversity
- community wealth building
- adjacencies outwith the ward location
- wider site accessibility and connectivity to active travel links
- safety related to environmental security to protect against the impacts of climate change
- incorporation of renewable energy sources

7.28. Following review of The Energy Hierarchy (see Figure 4.1), it was acknowledged that much of the guidance could be applied with the exception of requirements related to the following areas:

- implementation of renewable energy sources
- achieving form factor of 3
- orientation and ward positioning
- window size and placement
- incorporation of external shading devices, green roofs, walls or landscaping
- centralised control for building services

7.29. With an overall approach to try to apply all the guidance it was agreed that whilst the identified requirements could not be met, opportunities remained that could provide related improvements. Such improvements related to the above include:

- **Wellbeing**
    - creation of outdoor spaces, natural landscapes/ biodiversity:
        - ensure proposals clearly communicate the availability of access to outdoor spaces and nature, and explain how staff, patients, and visitors can make use of these areas
    - community wealth building:
        - ensure those appointed as part of the projects design and delivery team such as consultants and contractors seek to utilise local suppliers and workforces and make use of apprentices
    - adjacencies out with the ward location:
        - ensure wayfinding and signage strategies provide for key service delivery relationships with the ward as well as clarity of accessing from public areas
    - wider site accessibility and connectivity to active travel links:
        - ensure proposals provide a form of promotion of active travel links and options available to staff, patients and visitors
    - safety related to environmental security to protect against the impacts of climate change:
        - as fabric condition and overheating are a known issue, ensure proposals provide an environment where overheating issues are understood and mitigated and the space better provides for and protects infrastructure, equipment and occupants
    - incorporation of renewable energy sources:
        - ensure a clear understanding of the site's net zero route map, and that proposals align with it, avoiding contradictions or complications that could hinder future implementation

- **Energy Hierarchy**
    - implementation of renewable energy sources:
        - ensure focus on energy efficiency of all systems and appliances such as those associated with lighting, heating and ventilation. Whilst not being supplied from a renewable energy source this will reduce the energy demand from the existing infrastructure
    - achieving form factor of 3:
        - recognised there will be minimal change to the floor and envelope area or overall volume and therefore agreed this does not need to be measured. It is noted that improvements related to the building fabric will be modelled as required
    - orientation and ward positioning:
        - ensure that layout proposals consider best positioning of room functions within the ward space. For this scenario in-patient bed spaces are not changing location but support room functions, their activities and occupancy can all be modelled and reviewed related to orientation and impact on energy efficiency, thermal comfort lighting and so on
    - window size and placement:
        - ensure proposals, based on existing window placement, consider room functions to ensure suitability of views, quality of natural light, ability to open and that modelling is based on U values and G Values within Table 4.1
    - incorporation of external shading devices, green roofs, walls or landscaping:
        - recognised that such additions cannot be provided externally but that detailed Dynamic Simulation Modelling (dDSM) can identify areas where shading would provide a benefit. This should then be used to help inform the ward layout, room functions, occupancy and layout to best accommodate any lack of shading externally
    - centralised control for building services:
        - given the need to integrate with existing infrastructure, emphasis should be placed on introducing localised controls for temperature and lighting, and/ or zoning within the refurbished ward space. These measures should be aligned with metering or monitoring systems to provide insights into the ward's improved performance compared to other wards of similar design

7.30. The above approaches were incorporated as part of the overall project brief as well as a need for the project delivery team and associated designers and contractors to apply all remaining parts of the SDaC, including the various wellbeing themes and values associated with fabric performance and upfront embodied carbon.

Programme outcomes

7.31. The refurbishment project has successfully mitigated and provided substantial improvements to the identified areas of concern that led to the need to refurbish. All internal finishes have been replaced and, through application of SDaC, material and choices of finishes were informed by WLCAs.

7.32. Building fabric improvements and consideration of room function, occupancy, and arrangements have helped mitigate the overheating issues as well as help improve clinical service. The window design has further helped mitigate overheating issues and together with more localised controls and control of the immediate healthcare-built environment has helped improved mental and occupational wellbeing.

7.33. The introduction of localised controls along with monitoring systems has evidenced a reduction in operational energy and provides an insight into how systems are being used, identifying further opportunities for continuous improvement both in this ward location and for application in others.

7.34. In addition, the social, mental and occupational wellbeing of staff has been improved due to provision of dedicated staff space within the ward. Further contributing were the incorporated design and management efficiencies related to storage, storage systems, frequency of deliveries and dedicated spaces for equipment.

Abbreviations

AGV: Automated Guided Vehicle

BESS: Battery Energy Storage Systems

BIM: Building Information Modelling

BMS: Building Management System

BRE: Building Research Establishment

BS: British Standard

CBDM: Climate Based Daylight Modelling

CCRA: Climate Change Risk Assessment

CFD: Computational Fluid Dynamics

CIBSE: Chartered Institute of Building Services Engineers

CO_2: carbon dioxide

dDSM: detailed Dynamic Simulation Modelling

DL: Director Letter

DSM: Dynamic Simulation Modelling

EN: European Norm

EPD: Environmental Product Declaration

EUI: Energy Use Intensity

GSF: Green Space Factor

GHG: Greenhouse Gas

HBE: Healthcare Built Environment

HBN: Health Building Note

HVAC: Heating, Ventilation and Air Conditioning

IEQ: Indoor Environmental Quality

IMS: Integrated Management System

kgCO2e/m2: Kilograms of carbon dioxide equivalent per square meter

kWh/m2/yr: kilowatt-hour per square meter of floor area per year

LED: light-emitting diode

LG: Lighting Guide

mg/m3: milligrams per cubic meter

NOx: Nitrogen Oxides

NPF: National Performance Framework

NPF4: National Planning Framework 4

NSS: National Services Scotland

PM: Particulate Matter

POE: Post Occupancy Evaluation

PV: Photovoltaic

RIBA: Royal Institute British Architects

RTP: Regional Transport Partnership

SDaC: Sustainable Design and Construction

SDG: Sustainable Development Goal

SFT: Scottish Futures Trust

SHFN: Scottish Health Facilities Note

SHPN: Scottish Health Planning Note

SHTM: Scottish Health Technical Memorandum

SHTN: Scottish Health Technical Note

SL: Soft Landings

SLL: Society of Light and Lighting

SME: Subject Matter Expert

TM: Technical Memorandum

UKGBC: UK Green Building Council

UN: United Nations

VOC: Volatile Organic Compound

W/mK: Watts per meter Kelvin

W/m2K: Watts per square meter per Kelvin

WHO: World Health Organization

WLC: Whole Life Carbon

WLCA: Whole Life Carbon Assessment

Glossary

Accessibility - the design of spaces that are navigable, safe, and inclusive for individuals of all physical abilities, incorporating features like rest areas, lighting, and intuitive circulation routes.

Active Design - architectural and planning strategies that promote physical activity, such as visible staircases, walking paths, and exercise zones.

Active Travel - modes of transport that involve physical activity, such as walking and cycling, supported by infrastructure that connects to wider travel networks.

Airtightness - the degree to which a building prevents uncontrolled air leakage, achieved through sealing techniques and verified via blower door tests.

Anchor Institutions - large, locally rooted organisations like NHS facilities that can drive economic development and community wellbeing through procurement, employment, and partnerships.

Automated Controls - technology that automatically adjusts building systems based on real-time data to optimise energy use and reduce waste.

Bio-Based Insulation - natural insulation materials (such as wood fibre, hemp) that store carbon and offer sustainable thermal performance.

Biochar - a carbon-rich material added to building materials (such as concrete) to sequester carbon and improve performance.

Biodiversity Net Gain - a measurable improvement in biodiversity resulting from development, ensuring that natural habitats are enhanced rather than diminished.

Blower Door Test - a diagnostic test that measures a building’s airtightness by detecting air leaks under controlled pressure conditions.

Blue Infrastructure - water-based features such as ponds, streams, and rain gardens that enhance environmental quality and user experience.

Brownfield Site - previously developed land that may be repurposed for new construction, preferred over undeveloped (greenfield) sites for sustainability reasons.

Building Component Lifecycle - the expected lifespan of individual building elements (for example substructure, finishes), used to model sustainability impacts over time.

Building Information Modelling (BIM) - a digital process that enables accurate planning, design, and management of construction projects, improving budget control and collaboration.

Carbon Footprint - the total amount of greenhouse gas emissions caused directly and indirectly by a building or project, measured in carbon dioxide equivalents (CO_2e).

Climate Change Risk Assessments (CCRAs) - strategic evaluations conducted by NHS boards to identify and address climate-related risks to healthcare assets and services.

Climate Resilience - the ability of healthcare infrastructure to withstand and adapt to climate-related risks like flooding, heatwaves, and storms.

Climate-Based Daylight Modelling (CBDM) - a simulation method that evaluates daylight performance using metrics like daylight autonomy and annual sunlight exposure, aligned with Chartered Institute of Building Services Engineers (CIBSE) Lighting Guide (LG)02 for healthcare.

Community Impact Tool - a resource that helps NHS boards assess community perceptions and priorities when selecting sites, supporting inclusive decision-making.

Computational Fluid Dynamics (CFD) - a modelling technique used to simulate airflow and ventilation patterns, supporting analysis of indoor air quality and thermal comfort.

Cradle to Grave - a lifecycle approach that considers all stages of a product or building's existence, from raw material extraction to disposal.

Deep Retrofit - major upgrades to existing buildings that significantly improve energy performance and sustainability, often involving structural and systems overhauls.

Detailed Dynamic Simulation Modelling (dDSM) - a refined form of DSM applied early and throughout the design process to guide passive design strategies and optimise building performance.

Dynamic Simulation Modelling (DSM) - an iterative design tool used to simulate and evaluate building performance across seasons and climate scenarios, ensuring comfort, efficiency, and resilience.

Energy Audit - a systematic evaluation of energy use within a building to identify inefficiencies and recommend improvements for cost and carbon savings.

Energy Use Intensity (EUI) - a metric that quantifies a building's energy consumption per square meter per year, used to set performance targets.

Form Factor - the ratio of a building's external surface area to its internal volume. Lower form factors (target <3) reduce heat loss and improve energy efficiency.

Geo-Environmental Risk - potential environmental hazards related to soil, water, and pollution that must be assessed during site planning.

GHG Emissions - greenhouse gas emissions, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), which contribute to climate change and are targeted for reduction under national policy.

Glazing Ratio - the proportion of window area to wall area, which affects daylighting, heat gain, and thermal performance.

Global Warming Potential (GWP) - a measure of how much heat a greenhouse gas traps in the atmosphere compared to carbon dioxide; used to assess refrigerants in heat pumps.

Green Infrastructure - multi-functional natural systems (such as green roofs, rain gardens, tree planting) that enhance resilience, biodiversity, and social wellbeing.

Green Space Factor (GSF) - a metric used to assess the proportion and quality of green space in a development; a GSF of 0.4 or greater is recommended for new builds or deep retrofits.

Greenfield Development - construction on undeveloped land, typically avoided unless all other options are exhausted due to its higher environmental impact.

G-Value - a measure of solar heat gain through glazing. Lower g-values reduce overheating; dynamic glazing can adjust g-values in real time.

Heat Networks - systems that distribute heat from a central source to multiple buildings, often using low-carbon or renewable energy sources.

IMPACT Compliant WLCA - a Whole Life Carbon Assessment aligned with the IMPACT methodology, used to evaluate embodied carbon over a defined lifecycle (for example 50 years).

Integrated Management System (IMS) - a broader system that combines multiple management functions (for example energy, water, security) into a unified platform for operational oversight.

Lifecycle Stages - phases of a building's existence including design, construction, operation, maintenance, and end-of-life, each contributing to its total carbon footprint.

Low Carbon Materials - building materials selected for their minimal carbon footprint, evaluated through Whole Life Carbon Assessments (WLCA).

Massing - the overall shape, size, and form of a building, which influences energy performance, daylight access, and spatial planning.

Modern Methods of Construction (MMC) - innovative building techniques that improve efficiency, reduce costs, and shorten construction timelines, such as modular or prefabricated systems.

Modular Construction - a method involving prefabricated components assembled onsite, reducing waste, energy use, and construction time.

Modular Systems - prefabricated or scalable components such as HVAC or energy systems that can be easily added, replaced, or upgraded.

Nitrogen Oxides (NOx) - pollutants produced by combustion engines, contributing to smog and respiratory issues, and a key target for emission reduction.

Operational Energy - the energy consumed during the day-to-day operation of a building, including heating, cooling, lighting, and equipment use.

Particulate Matter (PM10) - airborne particles with a diameter of 10 micrometres or less, primarily emitted from vehicle exhaust, tyre wear, and brake dust, harmful to respiratory health.

Place-Making Led Approach - a design philosophy that prioritises creating meaningful, inclusive, and engaging spaces for people, enhancing wellbeing and community connection.

Psi Value (Ψ-value) - a measure of heat loss at junctions in building fabric, expressed in watts per meter Kelvin (W/mK).

Pulsed Output Meters - meters that emit electronic pulses corresponding to usage levels, allowing integration with Building Management Systems (BMS) or IMS.

Residual Carbon - the remaining carbon emissions after all feasible reductions have been made, often due to limitations in technology or grid decarbonisation.

Seasonal Commissioning - the process of testing and adjusting systems across different seasons to ensure year-round performance and comfort.

Soil Carbon Sequestration - landscaping practices that enhance the soil's ability to store carbon, often through deep-rooted plants and regenerative techniques.

Space Allocation - strategic planning of physical space (rooftops, grounds, interiors) to allow for future installation of renewable energy systems and support infrastructure.

Tailpipe Emissions - pollutants released directly from vehicle exhaust systems, including CO_2, NOx, and PM10, which degrade air quality and contribute to climate change.

Thermal Bridging - occurs when heat transfers through building elements (e.g., junctions, connections) more rapidly than surrounding materials, leading to energy loss. Mitigated through continuous insulation and thermal breaks.

Thermal Imaging - a diagnostic tool used to detect heat loss and thermal bridges in existing structures, guiding retrofit decisions.

Thermal Mass - the ability of materials (for example concrete, brick) to absorb and store heat, helping regulate indoor temperatures.

Upfront Embodied Carbon - the carbon emissions associated with the extraction, manufacture, transport, and installation of building materials before the building is operational.

Upfront Energy Use - energy consumed during the early stages of a project, including construction and material production, which contributes to embodied carbon.

U-Value - a measure of how well a building element (for example wall, window) conducts heat. Lower U-values indicate better insulation and energy efficiency.

Volatile Organic Compounds (VOCs) - harmful chemicals emitted from certain construction materials.

Waste-Efficient Procurement - purchasing practices that prioritise low-waste materials, reusable components, and suppliers committed to sustainability.

Whole System Approach - a strategy that considers the interdependencies between different sectors and systems to achieve holistic and sustainable outcomes, particularly in healthcare and environmental planning.

Whole-Life Costing - a financial assessment method that considers all costs associated with an asset over its entire lifespan.

Zero-Emissions Generation - energy production methods that do not emit greenhouse gases during operation, including solar PV and wind power.

Zone Control - a system that divides a building into separate areas with independent climate control, enhancing efficiency and occupant comfort.

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