NHS National Services Scotland

NHSScotland Sustainable Design and Construction (SDaC) Guide

Scottish Health Technical Note 02-01

SHTN 02-01

Draft 1.1 - March 2025

NHSScotland Assure

Quality in the healthcare environment

Contents

Preface

Technical guidance is vital in ensuring the safe and efficient operation of healthcare facilities and Scottish Health Technical Notes (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 and reducing the effects of the global climate emergency. It provides a framework for developing an environmentally and socially sustainable health service that is resilient to the impacts of climate change.

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.

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 Directorate 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 across Scotland.

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

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) and has defined reporting stages to align with project development. It should be used both as a self-assessment tool and for formal governance reporting purposes including for capital Investment projects where third party assessment is provided by NHSScotland Assure.

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 NHS board staff and contractors and reflects best practice for NHSScotland. It includes references to Scottish regulations and other relevant requirements drawn from associated UK-wide guidance.

Since NHS boards must adopt and adhere to this guidance it is vital that completion of the SDaC Evaluation Toolkit, along with the required evidence, are incorporated into procurement, governance, and project delivery 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

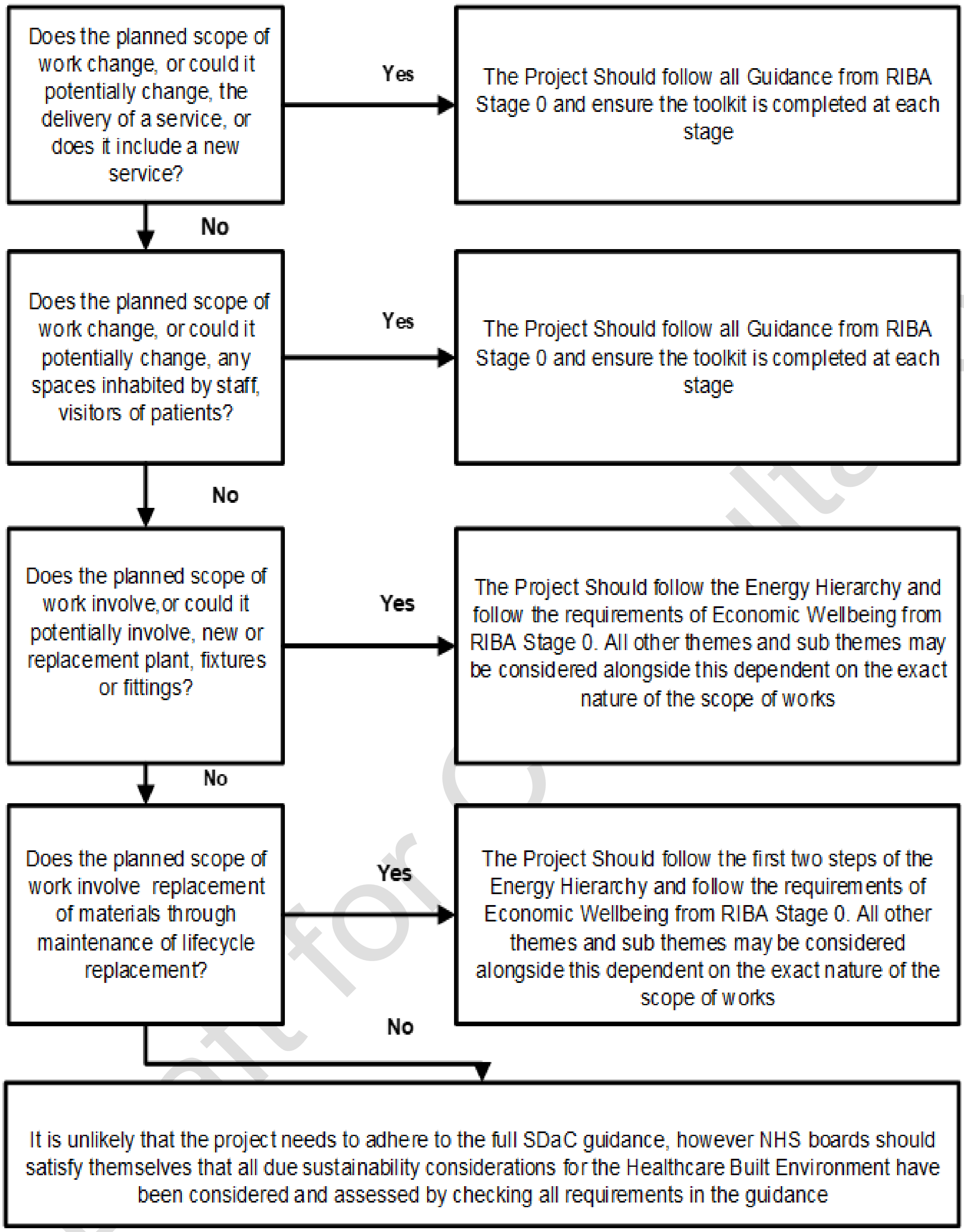
As such NHS boards should take cognisance of the following:

- **procurement routes**– NHS boards could 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 could engage sustainability consultants or in-house specialists to conduct Whole Life Carbon Assessments (WLCA) or Life Cycle Analysis
- **use of external bodies** - NHS boards could 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 full scope of work required as part of the SDaC framework.

Figure 0.1 - SDaC Application Process



Each NHS board is required to nominate an independent client-side champion(s), such as the NHS board Sustainability Champion, to 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 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 champion 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 facilities and estates, of any scale, must ensure that their NHS board meets its sustainability responsibilities and complies with national policy.

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 framework.

Example of use

NHS boards undertaking a new build or major refurbishment project should follow the guidance in its entirety. For other projects a limited application of the SDaC will be appropriate in accordance with Figure 0.1.

An example of this limited application is given below:

Scenario

Hospital A has identified that their original 1980s 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.

SDaC assessment

Following the SDaC 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 improvement's consequential benefits of reducing energy use and improving building efficiency.

The project team also consider key aspects of physical and mental wellbeing and ensured 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 reduce the spread of infections and meet service needs. This should be developed as part of an Indoor Environmental Quality Plan, which is covered in further detail in paragraph 3.46
- 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

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

- a u-value of 0.8 Watts per meter squared 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

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.

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.

The team discuss the need to review Ventilation Flow modelling to understand how the current vent 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 leakage 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.

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 55 years. The period of 55 years was chosen as this is the maximum expected remaining lifecycle of any single life limiting 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.

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

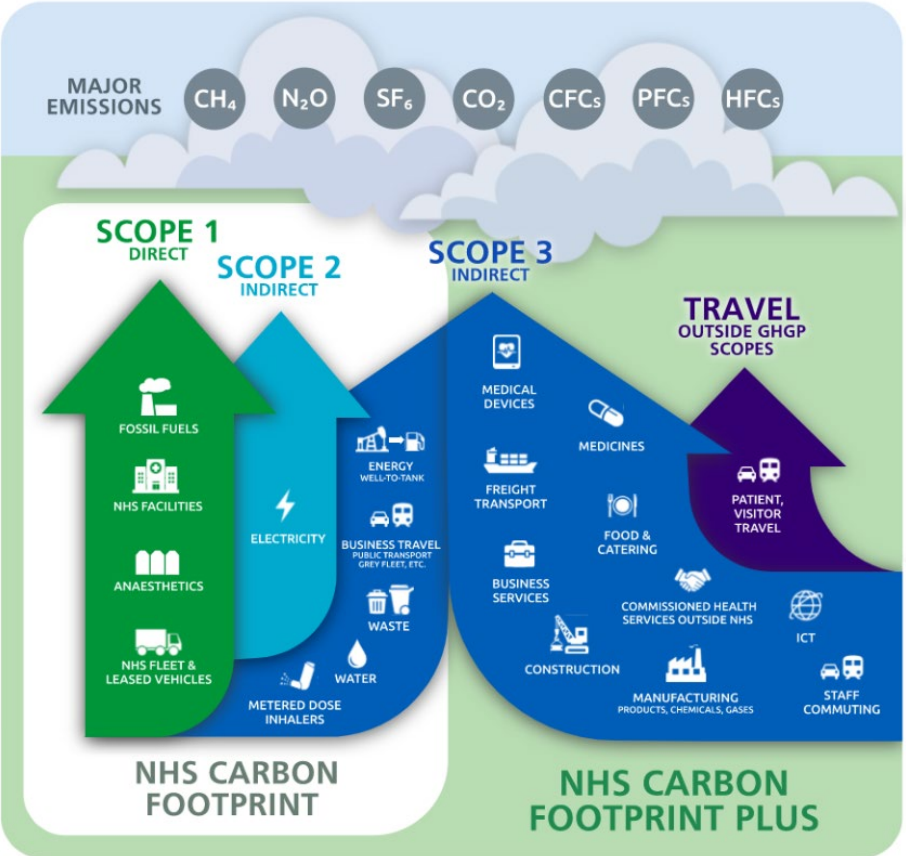
The project has successfully mitigated all current overheating issues which can be demonstrated through the remaining building lifecycle; it has reduced energy demand considerably; improved thermal comfort levels and eliminated draughts from occupied spaces as well as regaining the functionality that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

1. Introduction

1.1. NHSScotland is committed to the delivery of a high quality, resilient, and person-centred healthcare service. In addition to adopting a quality focused approach that enables this vision to become a reality, NHSScotland recognise that a response to the climate emergency is needed to mitigate the resulting health impacts and to achieve sustainable solutions in the present and future delivery of healthcare services across Scotland.

1.2. The following diagram highlights the existing scopes across the NHS carbon footprint that the guidance is seeking to address and is 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 Member States adopted the 2030 Agenda for Sustainable Development; a shared blueprint that has at its heart seventeen Sustainable Development Goals (SDGs). The Scottish Government has embedded these SDGs throughout the current National Performance Framework (NPF).

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 Governments direction regarding Greenhouse Gas (GHG) emissions
- meet Scottish Governments direction regarding the NPF outcomes

The above actions are addressed in the content of this guidance document, 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 needs will require 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 include interdependent sub-themes and influencing factors that must be considered holistically and are supported by guidance on how and when NHS boards should respond and evidence them.

2. Priority themes

Overview

2.1. The 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 in all relevant projects.

Wellbeing

2.3. Promoting environments that support the health, 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, and biophilic design 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 accessible pathways, 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-efficient, 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 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, 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
- **insetting** - 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, looking for ways to compensate for remaining residual emissions after following the first three steps of the hierarchy, which is covered in more detail in paragraph 4.2.

Balancing sustainable needs

2.8. The Sustainable Design and Construction (SDaC) guide as a framework covers the main themes and requirements relating to sustainability through design and construction. The guidance provides information on the tools 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 however 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 energy conservation strategy.

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, this guidance acknowledges the need to balance other competing priorities within the healthcare built environment, requirements from other policies and NHSScotland technical guidance. While these may seem to conflict with efforts to reduce 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 decision-making stages. This should be achieved through early and continuous engagement with key stakeholders, using decision-making 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.

3. Wellbeing

Overview

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

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

3.2. 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 places, using a place-making led approach.

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

Total wellbeing

3.4. 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.*" It is vitally important therefore that the design and operation of healthcare facilities support and enhance the total wellbeing of all users.

3.5. 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 healthcare built environment including reduced pressure on services from decreased demand, and less need for NHS estate expansion, leading to associated financial benefits.

3.6. 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 with these of particular importance to NHSScotland.

3.7. 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

3.8. 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.

3.9. To address the above requirements NHS boards must 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

3.10. For communal areas this includes:

- 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

3.11. For privacy this includes:

- 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

3.12. For inclusivity include:

- 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

3.13. For community wealth building include:

- 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

Mental wellbeing

3.14. 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.

3.15. 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.

3.16. To address the above requirements NHS boards must ensure that the design and quality of the built environment enhances mental wellbeing by creating environments that reduce stress and promote a positive mindset where aspects fall within scope, by incorporating the following elements.

Requirements

Visual comfort

3.17. For visual comfort include:

- 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, 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 and artwork to create a soothing atmosphere
- ensure wayfinding is intuitive to reduce stress and confusion

Landscape/ biodiversity

3.18. For landscape/ biodiversity include:

- provide significant areas of high-quality landscape that is rich in biodiversity
- incorporate 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, multi-sensory landscapes that reflect natural ecosystems
- incorporate walking paths, meditation spots, and observation areas that encourage people to engage directly with the 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 must achieve a green space factor (GSF) of 0.4 or greater.

Quiet spaces

3.19. For quiet space include:

- 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 elements such as indoor plants, 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

3.20. Physical wellbeing can be described as a state of ensuring the physical health of individuals through the design of spaces that promote movement, comfort, and safety.

3.21. 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.

3.22. 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.

3.23. To address the above requirements NHS boards must 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

3.24. For accessibility include:

- design environments with clear circulation routes, that are accessible and easily navigable for all, safe, secure and have appropriate lighting, with opportunities for respite to cater to individuals of all physical and cognitive 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 accordingly. 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 proper 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

3.25. For ergonomics include:

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

Safety

3.26. For safety include:

- 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 reduce the spread of infections and meet service needs. This should be developed as part of an Indoor Environmental Quality Plan, which is covered in further detail in paragraph 3.46
- 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 4.25
- 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 and, 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 materials:

- Total Volatile Organic Compounds (VOCs) <0.5 milligrams per cubic meter (mg/m^3)
- Formaldehyde <0.1mg/m^3

3.27. 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.

3.28. 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

3.29. 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.

3.30. Research shows that happier workforces that are 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.

3.31. To address the above requirements NHS boards must 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

3.32. For workspace include:

- 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 all spaces do not need a clinical aesthetic

Support facilities

3.33. For support facilities include:

- provide flexible spaces that can accommodate workforce and individual team changes, reduction or expansion
- provide space that accommodate 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

3.34. For professional development include:

- 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

3.35. 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.

3.36. Healthcare developments can be viewed as the ‘anchor institution’ or linchpin of a local economy and project teams should identify where collaborative opportunities exist between professions, public sector organisations, businesses, and communities to maximise prospective wellbeing benefits and further integrate healthcare services. This should include exploring the potential for Community Wealth Building as an approach to delivering inclusive economic growth.

3.37. The Place Standard tool provides a simple framework to structure conversations about place and encourages 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 paragraph 5.16.

3.38. 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 an effort to eliminate spending on any individual requirement.

3.39. To address the above requirements NHS boards must 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 incorporating the following elements.

Requirements

Efficiency

3.40. For efficiency withing include:

- use design strategies that maximise the efficient use of space, reducing operational costs
- emphasise passive design principles and a fabric first approach over high-maintenance system solutions (refer to the fabric first paragraph 4.25 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
- select materials that extend the building lifecycle and minimise future repair and replacement expenses
- maximise daylighting and natural airflow to reduce reliance on artificial lighting and mechanical ventilation
- introduce smart building management systems 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

3.41. For sustainability include:

- 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
- 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, rainwater harvesting systems, and greywater recycling to reduce water consumption and associated 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.

Affordability

3.42. For affordability include:

- 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, 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.

3.43. 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

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

3.45. 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

3.46. Indoor environmental quality (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 should be addressed as part of a project specific Environmental Quality Plan:

- **air quality and ventilation** - ensuring high air quality through effective ventilation systems, air filtration, and reduced indoor pollutants to 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 to prevent discomfort and support patient healing, adaptive climate control, and energy-efficient heating and cooling systems
- **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.

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

Active travel

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

3.49. An active, accessible and sustainable transport strategy will also contribute to the Wellbeing priority theme by supporting the transition to a healthier and more inclusive society. Encouraging active travel, such as walking, cycling, and the use of sustainable transport options supports physical health, environmental sustainability, and economic wellbeing.

3.50. Early transport appraisals are essential to understanding local infrastructure and pinpointing opportunities for active, sustainable improvements. Additionally, 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.

3.51. 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.

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

Greenspace/ biodiversity

3.53. 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.

3.54. 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.

3.55. 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.

3.56. 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 activity 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

3.57. 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 indoor plants, water features, and natural materials to create calming, restorative indoor 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

3.58. Outdoor space must 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 space, along with other sustainable circularity and climate change co-benefits should be prioritised.

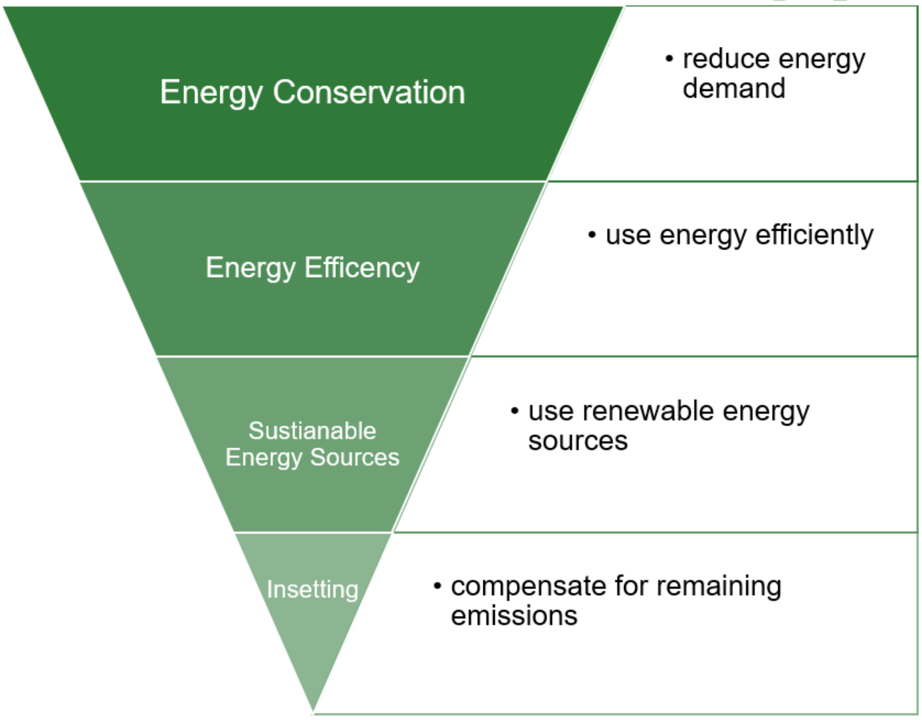
4. The energy hierarchy

4.1. In order 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 processes to achieve greater efficiency.

4.3. Below are the key principles of the Energy Hierarchy, along with the corresponding actions to implement throughout the design, construction, refurbishment, and maintenance phases of a building.

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



4.4. NHS boards should implement the energy hierarchy 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 is essential to reducing overall energy demand.

Space optimisation

4.6. 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.

4.7. NHS boards should consider the adaptive reuse, flows, occupation types and adjacencies (refer to paragraph 4.18) 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

4.8. To address the above requirements NHS boards must prioritise space optimisation from the outset of a project, especially when the need is driven by service change and must 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

4.9. For space utilisation analysis include:

- 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

4.10. For occupancy management include:

- 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

4.11. For departmental flow/ pathway analysis include:

- review department patient flows to understand movement between spaces, including movement for both patients and staff
- review key adjacencies for provision as required, and for opportunities to amend and improve within existing footprint
- adjust departmental layout based on optimal arrangement to maximise efficiency of movement and flows within existing footprint

Digital healthcare solutions

4.12. For digital healthcare solutions include:

- implement digital healthcare solutions, including remote monitoring, community working and remote work solutions that supports patients at home to 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

4.13. For flexible layouts include:

- 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

4.14. For efficient storage solutions include:

- implement vertical storage systems to maximise space
- use compact and mobile storage units to enhance accessibility and efficiency
- organise storage areas to ensure easy access and minimise clutter
- design storage spaces to ensure they are appropriate for department needs and not oversized
- 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

4.16. 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.

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

Adaptive reuse

4.18. 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 must be fully exhausted prior to consideration of any new build or replacement assets.

Requirements

4.19. To address the above requirements NHS boards must ensure that where the decision has been made to reuse an existing asset, either as part of service change, or through refurbishment or maintenance they consider the elements noted below. However, for like for like maintenance replacements it may only be necessary to consider these requirements if they fall within the scope of the works:

Functional adaptation

4.20. For functional adaptation include:

- 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 those with disabilities

Structural assessment

4.21. For structural assessment include:

- 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

Preservation of historical elements

4.22. For preservation of historical element include:

- 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

Energy efficiency upgrades

4.23. For energy efficiency upgrades include:

- 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 solar panels or geothermal systems
- use energy-efficient equipment and appliances to reduce operational costs

Compliance with guidance

4.24. For compliance with guidance include:

- work with design professionals suitable 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

4.25. 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

4.26. To address this, designs must 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 from the outset where aspects fall within scope, by incorporating the following elements.

Thermal bridging

4.27. For thermal bridging include:

- 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 metre Kelvin (W/mK)

U-values

4.28. For u-values include:

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

Low carbon materials

4.29. For low carbon materials include:

- 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

Airtightness

4.30. For airtightness include:

- 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 there are mechanisms for monitoring construction stage particularly focused on achieving airtightness

Form factor

4.31. For form factor include:

- 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 must achieve a form factor of less than 3

Orientation

4.32. For orientation include:

- 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 dynamic simulation modelling to determine the optimal orientation for energy efficiency
- incorporate features like atriums and light wells to enhance natural light penetration

Glazing ratios/ quantity

4.33. For glazing ratios/ quantity include:

- 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

Shading, overheating, and thermal mass

4.34. For shading, overheating, and thermal mass include:

- 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 evaporative cooling, to enhance thermal comfort

4.35. 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.

4.36. As a minimum building fabric should reach the following optimised values.

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

Parameter	Health Centre	Hospital
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

4.37. 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 ($kgCO_2e/m^2$)

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

4.38. 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 $kgCO_2/m^2$.

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

4.40. 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.

Energy efficiency

4.41. 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

4.42. 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.

4.43. 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 healthcare built environment.

Requirements

4.44. To meet these requirements, NHS boards must 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

4.45. For high-efficiency systems include:

- 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 LED lighting and energy-efficient appliances to reduce electricity consumption

Heat pumps

4.46. For heat pumps include:

- 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 gas, used within pumps, in decision making

Regular maintenance

4.47. For regular maintenance include:

- ensure proper maintenance and operation to maximise efficiency and longevity

Integrated building management systems

4.48. Building Management Systems (BMS), also referred to as Building Energy Management Systems, can significantly improve energy efficiency in healthcare facilities. Where opportunities allow, these technologies should be integrated not only to boost efficiency but also to improve the project's overall economic wellbeing.

4.49. Technologies range from full integrated management systems that comprise building services, life safety/ critical systems and other general systems including access controls, Automated Guided Vehicles (AGVs) or security systems down to integrated sensors.

Requirements

4.50. To meet these requirements, NHS boards must consider integrating technologies such as building management systems to improve energy efficiency and support economic wellbeing where aspects fall within scope, incorporating the following elements.

Centralised control

4.51. For centralised control include:

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

Energy monitoring

4.52. For energy monitoring include:

- 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

4.53. For system integration include:

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

Smart sensors

4.54. For smart sensors include:

- 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

4.55. For automated controls include:

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

Ensure proper commissioning

4.56. 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

4.57. To meet these requirements, NHS boards must undertake proper commissioning 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

4.58. For commissioning plans include:

- 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
- include pre-functional checklists, functional performance tests, and system verification

Performance testing

4.59. For performance testing include:

- conduct tests to verify that systems are installed and operating correctly
- identify and address any deficiencies to ensure optimal performance and energy consumption

Retrofit existing systems

4.60. 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

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

Energy efficiency upgrades

4.62. For energy efficiency upgrades include:

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

System optimisation

4.63. For system optimisation include:

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

Compliance with regulations

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

4.65. For compliance with regulations include:

- ensure retrofitted systems comply with current building standards and NHSScotland Technical Guidance

4.66. 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.

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

Table 4.3 - Operational Energy Use (kilowatt-hour per square metre 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	55
Interior lighting	12	12
Hot water	10	10
Small power	20	30
Communications equipment	20	20

Site	Primary Care	Acute Care
Lifts	2	2
External lighting	5	10

4.68. Alternatively, projects can utilise the NHS England tool to determine a bespoke EUI target for their building. See Additional Considerations Chapter 5 for further guidance.

Renewable, sustainable energy sources

4.69. It is essential to integrate sustainable energy systems into healthcare buildings. NHS boards must 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.

4.70. To comply with policy, and building standards, energy should be from a renewable source with zero direct emissions. At time of writing the only compliant energy source which has a credible route map, as required by policy, is the national electricity grid or onsite zero emissions generation. Technologies like green hydrogen have not yet proven their practicality in fulfilling current policy requirements and timelines.

Integrate sustainable energy systems

4.71. 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.

Requirements

4.72. Depending on the scale and ambition of a project NHS boards must 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.

Solar panels

4.73. For solar panels include:

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

Wind turbines

4.74. For wind turbines include:

- assess the site's wind resources to determine the feasibility of wind turbines
- install small-scale wind turbines in areas with sufficient wind speeds
- ensure compliance with local regulations and obtain necessary permits

Geothermal systems

4.75. For geothermal systems include:

- conduct a geothermal feasibility study to evaluate the site's potential for geothermal energy
- install geothermal heat pumps to provide efficient heating and cooling
- integrate geothermal systems with existing HVAC systems for optimal performance

Design for future integration

4.76. 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 enable.

Requirements

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

Flexible infrastructure

4.78. For flexible infrastructure include:

- 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

Modular systems

4.79. For modular systems include:

- 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

4.80. For space allocation include:

- allocate rooftop or ground space for future solar panels or wind turbines
- designate areas for future geothermal use

4.81. 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.

4.82. 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. Whilst it is unlikely these steps 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

4.83. 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

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

Carbon Insetting Measures

4.85. For carbon insetting measures include:

- 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 CO_2, improve insulation, and enhance biodiversity
- implement landscaping practices that enhance soil carbon storage (sequestration), such as planting deep-rooted vegetation and using organic mulches
- install renewable energy systems like solar panels and wind turbines to reduce reliance on fossil fuels and lower carbon emissions.

Implement during construction

4.86. For implement during construction include:

- 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

4.87. For continuous monitoring include:

- 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

4.88. 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 - key influencing factors

4.89. While the energy hierarchy is the design approach that SDaC expects NHS boards to follow, there are several wider key considerations that must be taken into account.

Building component lifecycle

4.90. 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.

4.91. From a sustainability perspective the lifecycle of the project, for which WLCA and other modelling should be conducted, is the maximum lifecycle of any 'life limiting' physical component used. This is a component that would limit the life of the overall facility, typically substructure or superstructure. This is likely to differ from any commercial lifecycle review, with guidance independent of the requirements of WLCA.

4.92. 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. 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 be cognisant of that reality.

Conversion factors for predictions of Energy Use Intensity (EUI) to carbon

4.93. As per paragraph 4.69 the current credible route for energy supply focuses on the national plans 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 in the grid.

4.94. It is important that the conversion factor, used for WLCA to calculate the impacts of future operational energy use is consistent. When 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 based on the estimated carbon production of the electricity grid. This average factor accounts for the gradual decarbonisation of the grid.

Operational energy - water

4.95. The design and specification of water efficient features can help to significantly reduce water consumption levels in use, contributing to overall reductions in greenhouse gas (GHG) emissions, pollution impacts and associated costs, as well as reducing costs related to water consumption and water leaks.

4.96. NHS boards should develop a water efficiency strategy that supports 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, in order 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 where deemed beneficial (as a result of stakeholder engagement feedback), for example this may include:

- staff and public areas
- clinical areas and wards
- letting areas - energy supply to each tenant unit
- laundries
- main production kitchen

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.

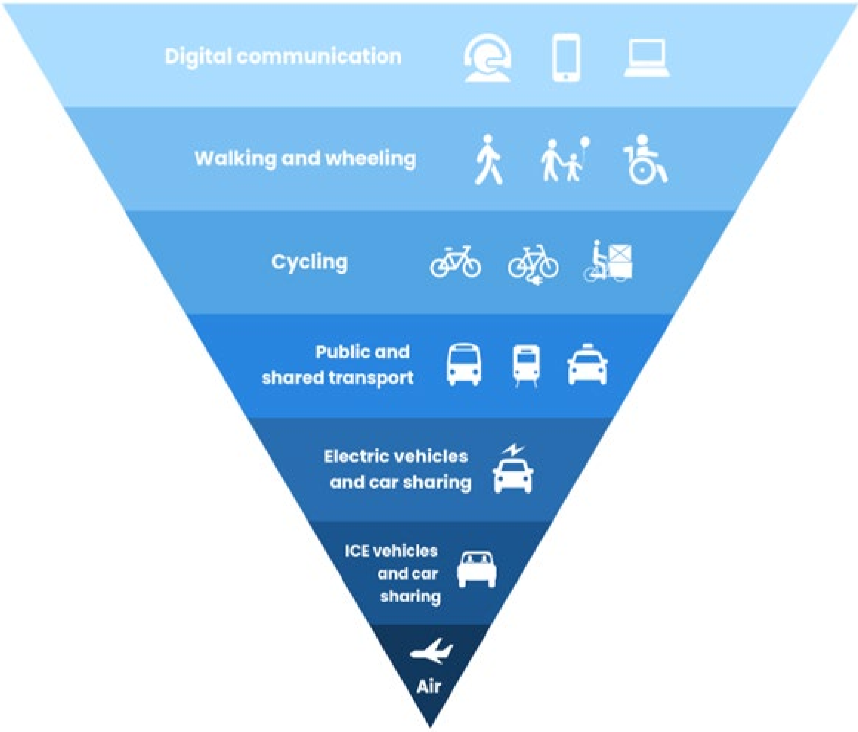
4.102. Furthermore, many journeys are short distance. 17% of journeys in Scotland in 2019 were under 1 km, and more than half (54%) were under 5 km. Lots of short distance trips offer real opportunities for increased active travel or use of public transport.

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 health conditions such as 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, as well as noise, congestion, and traffic collisions.

4.105. Designing beyond current minimum levels of compliance will ensure site strategies and infrastructure has 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 recognised 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 processes 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
- 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 commit to promoting circular economy principles and circular business models by requiring all projects to adopt circular design and construction processes, work towards achieving zero waste solutions and regenerating 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 must 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 occupant health and wellbeing, boost resilience and adaptation and address environmental, economic, social, and resilience 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 must be considered by NHS boards if they are undertaking a site selection process.

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:

- 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) guide, 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 with each 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, 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

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.

5.11. These measures aim to ensure the safety, security, and resilience of buildings against various risks 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.

5.12. 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

5.13. 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.

5.14. As part of any wider stakeholder engagement exercise, consideration should be given to involvement and engagement with the following individuals and organisations, for example:

- clinicians
- facilities managers
- patient representatives

- relevant transport providers and national transport steering groups
- estates teams
- compliance teams
- key supply chain partners

5.15. The importance of continued stakeholder engagement is essential and opportunities for end user groups to remain informed and connected to the design can help by offering insights and influence sustainable outcomes. As such it is essential that an appropriate feedback and communication mechanism is established throughout the project.

Place based approach

5.16. The Place Standard should be applied during the early design stages to help drive more positive outcomes. The Place Standard tool can help to identify the needs of a project, align priorities and investment and empower communities by allowing their views to be articulated.

5.17. There is an expectation for larger projects that the place standard should be used from stage 0 to help influence decision making and should be re-applied during the design development stages to help improve and finally assess the impact of the proposed development.

SFT net zero public buildings

5.18. Scottish Futures Trust (SFT) Net Zero public buildings 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 are able to proceed to subsequent stages without compromising the ability to meet all its core objectives.

5.19. The Standard follows the same project stage reviews as the Sustainable Design and Construction (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

5.20. 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.

5.21. As per paragraph 4.67, NHS boards may determine that a bespoke EUI target obtained using the NHS England Tool, if preferable, to the optimised targets noted in Table 4.2. The decision for this should be recorded and evidenced as part of the SDaC process.

Soft landings

5.22. 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.

5.23. 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, monitors the project outcomes post completion against performance and cost criteria, with lessons learnt captured for future projects.

6. Design tools

Dynamic Simulation Modelling

6.1. 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.

6.2. 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.

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

6.4. 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. Technical Memoranda (TM), Chartered Institute of Building Services Engineers (CIBSE) TM54 and CIBSE TM61, provide guidance on data input requirements.

6.5. This should also be the case when predicting in-use building performance scenarios that reflect how the building will be operated when in-use with the model to be updated as further detail evolves. This approach ensures learning from outcomes and that any issues identified can ideally be mitigated through passive measures, rather than a late-stage technical solution.

6.6. The following types of modelling must 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, quasi-steady state tools, and detailed heating, ventilation, and air conditioning (HVAC) system modelling

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. Within NHSScotland all three criteria must 'pass' for these assessments

3. **CIBSE TM49** (weather data):

   i. provides guidance on selecting appropriate weather data for building performance simulation. Includes datasets for different locations and future climate scenarios to ensure accurate modelling of building performance under various conditions. Using TM49, TM52, and TM59 together allows for a comprehensive evaluation of a building's performance under realistic weather conditions, ensuring both thermal comfort and energy efficiency whilst recognising the growing future risks of climate change and the need for adaptation and mitigation

4. **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

5. **Ventilation Flows/ Computational Fluid Dynamics**:

   i. models natural and mechanical ventilation strategies. Includes analysis of airflow patterns, ventilation rates, and the impact on indoor air quality and thermal comfort

6. **Thermal Comfort Modelling**:

   i. evaluates indoor thermal comfort conditions. Uses dynamic simulation to assess factors such as temperature, humidity, air velocity, and radiant temperature

Whole Life Carbon Assessment

6.7. 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.

6.8. 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, must be carried out at various recognised stages through the project.

6.9. Data used as part of the WLCA must 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.

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

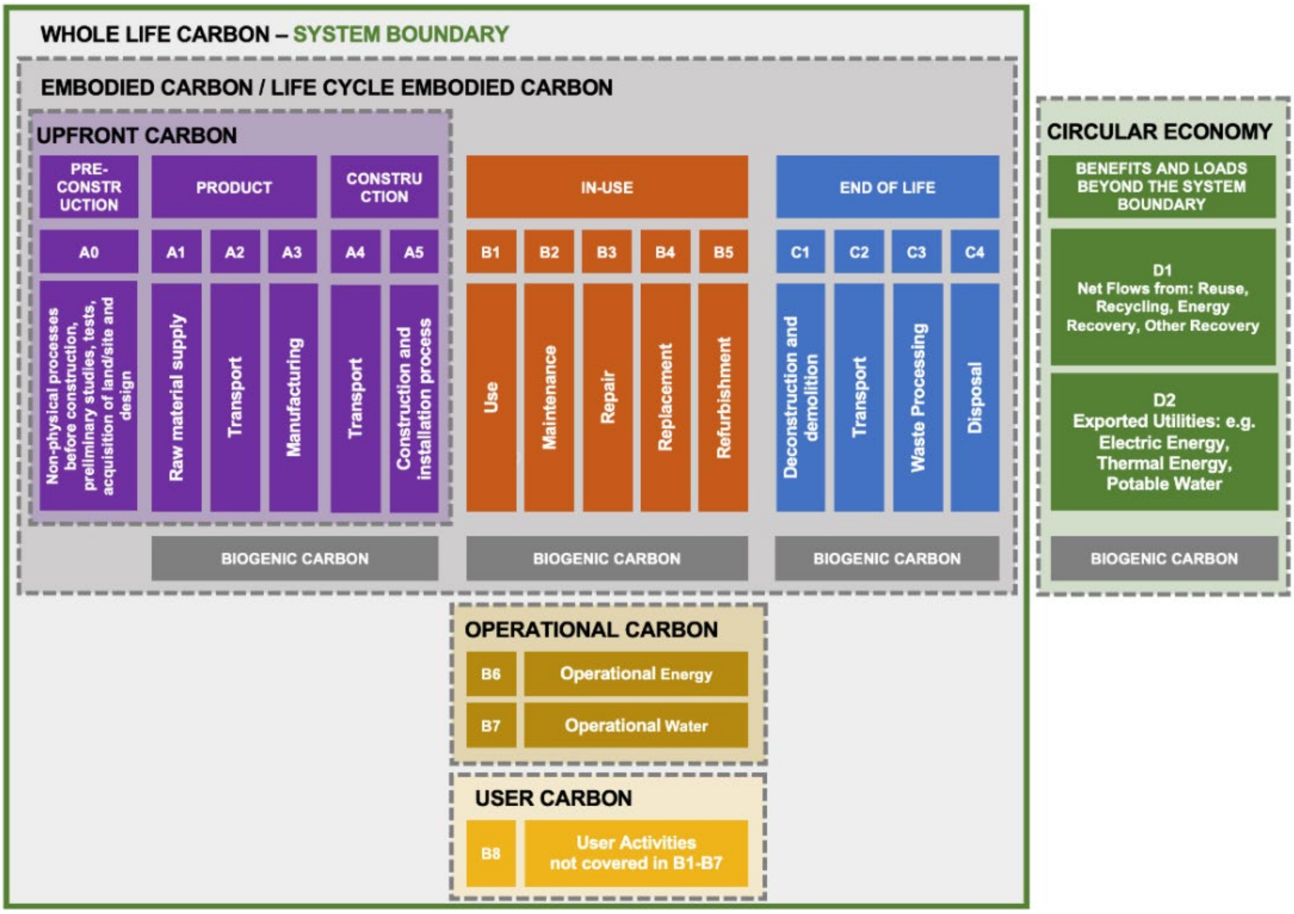
6.11. The assessment should be iterative however formal reporting should be carried out based on Royal Institute British Architects (RIBA) stages as follows:

- **pre-construction** (Royal Institute British Architects (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

6.12. 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 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)



6.13. 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 look for this to be captured as part of a WLCA.

6.14. For all areas of the WLCA, NHS boards must 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.

6.15. A WLCA must 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.

6.16. 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 may have a significant impact on reducing up front carbon costs but 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 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.

6.17. This along with the Dynamic Simulation Modelling (DSM) are key iterative design tools in the sustainable design and construction of healthcare building. They should be used with cognisance of the main priority themes, sub themes, influencing factors and additional considerations noted within this guidance.

Abbreviations

AGV: Automated Guided Vehicle

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

CIBSE: Chartered Institute of Building Services Engineers

dDSM: Detailed Dynamic Simulation Modelling

DL: Directorate Letter

DSM: Dynamic Simulation Modelling

EN: European Norm

EPD: Environmental Product Declaration

EUI: Energy Use Intensity

GSF: Green Space Factor

GHG: Greenhouse Gas

HVAC: Heating, Ventilation and Air Conditioning

IEQ: Indoor Environmental Quality

IMS: Integrated Management System

$kgCO_2e/m^2$: Kilograms of carbon dioxide equivalent per square meter

$kWh/m^2/yr$: kilowatt-hour per square metre of floor area per year

mg/m^3: milligrams per cubic meter

NOx: Nitrogen Oxides

NPF: National Performance Framework

NSS: National Services Scotland

PM: Particulate Matter

PV: Photovoltaic

RIBA: Royal Institute British Architects

SDaC: Sustainable Design and Construction

SDG: Sustainable Development Goal

SFT: Scottish Futures Trust

SHTM: Scottish Health Technical Memorandum

SHTN: Scottish Health Technical Note

SL: Soft Landings

SME: Subject Matter Expert

TM: Technical Memorandum

UKGBC: UK Green Building Council

VOC: Volatile Organic Compound

W/mK: Watts per meter Kelvin

W/m^2K: Watts per meter squared Kelvin

WHO: World Health Organization

WLC: Whole Life Carbon

WLCA: Whole Life Carbon Assessment

References

To be added in final version